Generative AI And Its Interactions With The World Of FOSS

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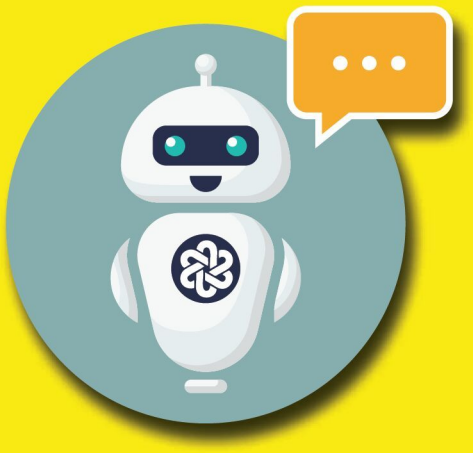

"Non-Free Programs Are A Threat To Everyone's Freedom"

—**Richard Matthew Stallman** (RMS), American Programmer And Free Software Advocate

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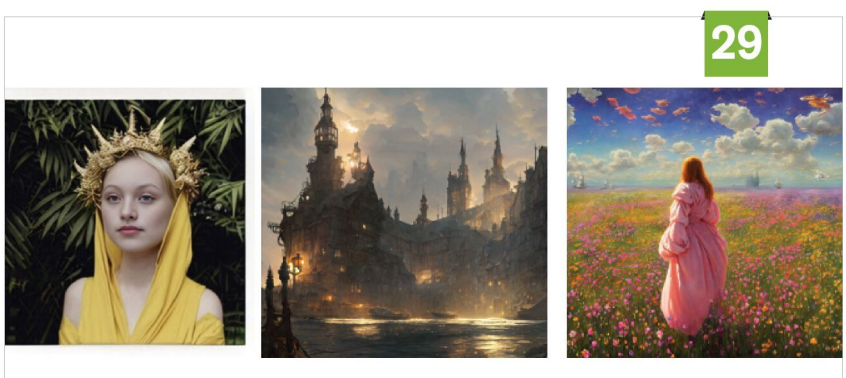

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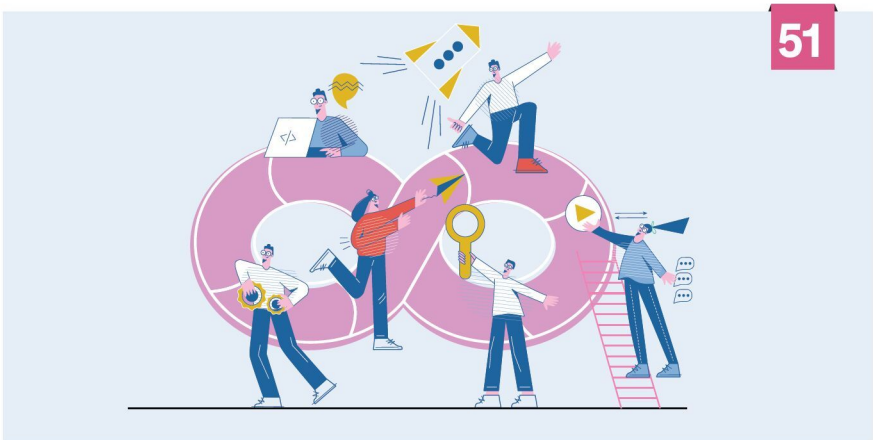

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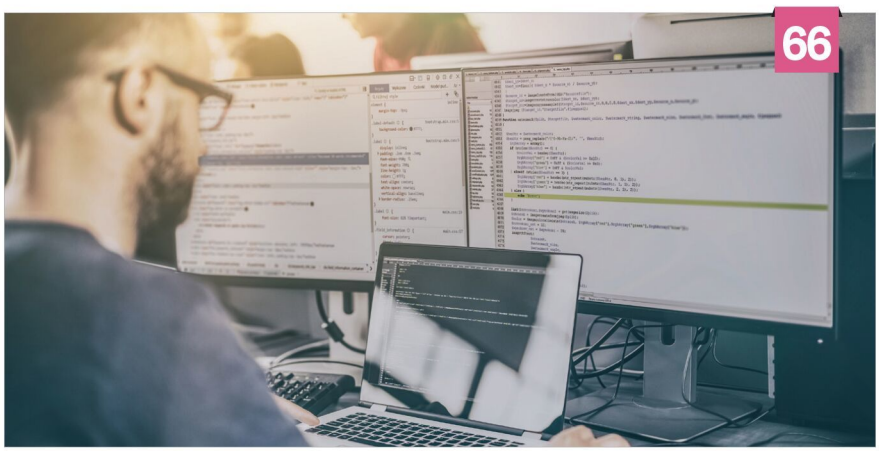
10 Useful Tools for DevOps Engineers



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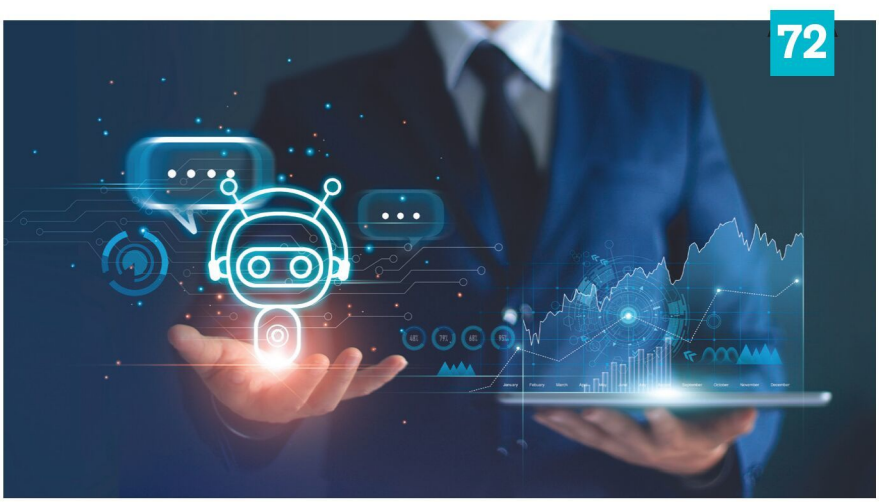

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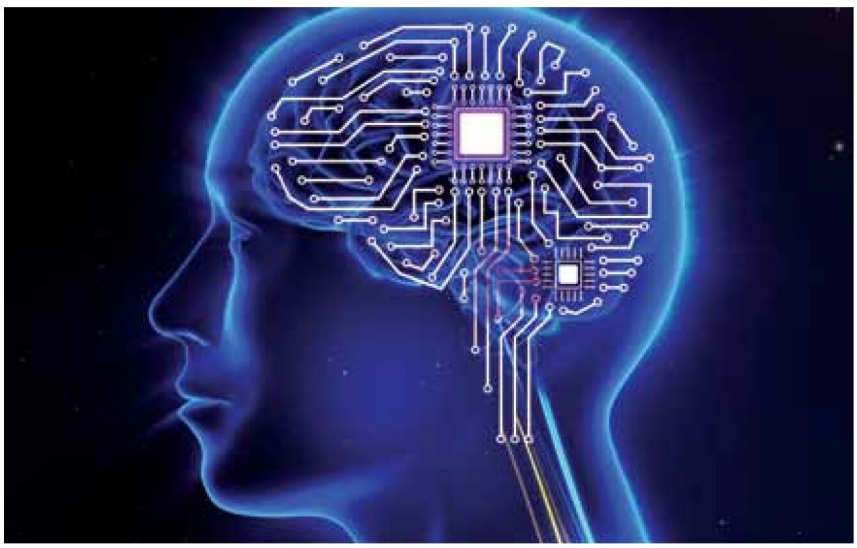
How Helpful is ChatGPT for Developers?

Open source software is helping the development of AI



Over the past few years, the importance of open source software in the realm of AI has increased significantly. Open source software has several advantages, one of which is the possibility for programmers to work together and exchange information. AI developers can build on the work of others and share their own contributions by adopting open source software, which promotes speedy innovation and growth in the field of AI.

The availability of numerous tools and resources for academicians and developers is another advantage of open source AI software. Many AI applications call for specialised tools and resources that may not be accessible to or be expensive for individuals or small businesses. These tools can be accessed and used without restriction when using open source software, which can help level the playing field and enable smaller businesses to compete with bigger ones.

Fortuna, a toolbox for assessing uncertainty in an ML model, is now available

Fortuna, an open source toolbox for machine learning (ML) model uncertainty assessment, has been made available, according to an announcement from AWS. Any trained neural network can generate calibrated uncertainty estimates using the calibration techniques provided by Fortuna, such as conformal prediction.

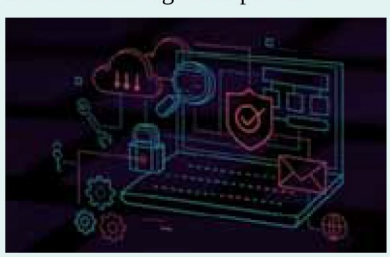
There are several published ways for calculating or calibrating the uncertainty of predictions, but the present tools and libraries for doing so have a narrow scope and do not offer a wide variety of methods. Fortuna fills this gap by combining well-known strategies and making them accessible to users through a standardised and user-friendly interface.

Fortuna has three usage modes, the first one being 'starting from uncertainty estimates'. This mode is the quickest level of interaction with the library and has the fewest compatibility requirements. This usage mode provides conformal prediction techniques for both regression and classification.

PaLM + RLHF, a ChatGPT alternative that is not quite ready yet

The first open source ChatGPT equivalent is out. It is an application of RLHF (Reinforcement Learning with Human Feedback) built on top of Google's PaLM architecture, which includes 540 billion parameters. It functions like ChatGPT but is still a work-in-progress. It combines PaLM, a sizable language model from Google, with RLHF to build a system that can practically execute every function that ChatGPT can, including email authoring and code recommendations.

PaLM + RLHF is not pre-trained. In order for the system to actually work, it must have acquired the crucial training utilising sample data from the web. After downloading PaLM + RLHF, a ChatGPT-like experience won't happen suddenly; that would require producing gigabytes of text from which the model can learn and finding hardware able to handle the training demand. PaLM + RLHF won't be able to take the place of ChatGPT unless a well-funded initiative (or individual) goes to the trouble of educating and making it available to the general public.



Both ChatGPT and PaLM + RLHF share a secret sauce called Reinforcement Learning with Human Feedback, which aims to better match language models with what users want them to do. In RLHF, a language model is fine-tuned using a data set that includes prompts that correspond to what volunteers' expectations for the model are, such as "Machine learning is a form of AI…" The language model used in PaLM + RLHF is PaLM.

The new FHSmart100 board is supported by HarmonyOS

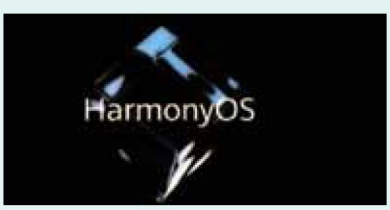
China's Fuzhou Huisibo Information Technology has launched the FHSmart100 development board, which is supported by the popular HarmonyOS operating system.

A printed circuit board with a microprocessor and the bare minimum of supporting logic is called a microprocessor development board. It can be used by electronics engineers or anyone else who wants to get to know the microprocessor on the board and learn how to program it.

The FHSmart100 development board is a smart device based on Zhanrui SL8541E, UIS8581E, and UIS7862S, according to information provided on the company's official website. The FlyHongOS, a smart software distribution created by Huisibo and based on the OpenHarmony open source HarmonyOS system, is also included with the FHSmart100.

The TMC THM3652 SE security chip, which may provide financial data protection, is another option available to the development board. Thermographic printing, key and sensitive data protection, SAM cards, IC cards, non-contact IC cards, and other business processing functions can also be used with it.

The motherboard has scalable financial-level security capabilities and a pluggable design. As a result, FHSmart100 is appropriate for many different businesses including those in finance, government, industry, mining, electric power, education, road transportation, and automotive electronics.



'Starting from model outputs' is the second usage mode. It assumes a model has already been trained in some framework. In this mode of operation, users can compute metrics, derive conformal sets, assess uncertainty, and calibrate model outputs.

The third usage mode is 'starting from Flax models'. It has higher compatibility requirements than the two earlier modes as it needs deep learning models written in Flax. However, it enables you to replace standard model training with scalable Bayesian inference procedures, which may significantly improve the quantification of predictive uncertainty.

Facebook whistleblower suggests Twitter should open source its algorithm

Frances Haugen, a Facebook whistleblower, has advised making Twitter's algorithm open source if Elon Musk wants it to be a public forum. According to her, making Twitter a virtual town square "where matters vital to the future of humanity are debated" was something Musk had previously suggested.

Musk has been vocal about handing "power to the people," one of the reasons he purchased Twitter. He added that he acquired it to foster conversation, which he feared had been lost, in a memo written soon after the

US$ 44 billion deal was finalised. Twitter should be the "most accurate source of information about the world," according to Musk. But he cut back on the staff whose primary responsibility it was to handle content moderation in the weeks after the acquisition.

Previously serving as a product manager for Facebook's civic integrity team, Haugen had in 2021 released a vast amount of internal records shedding light on judgements that, according to her testimony before the US Congress, had resulted in "more division, more harm, more lies, more threats, and more combat."

Myddleware for Moodle facilitates data integration

You may easily move data between your Moodle platform and other programs, like your e-commerce, CRM, messaging tools, and more, using the open source platform Myddleware, which was released on November 30, 2022.

Myddleware is simple to use, and you don't need to write any code thanks to its integration tool. You don't need to be an expert to use it, and it helps to ease the complex problem of data integration. Complete data models can be easily transferred and synced between applications. The platform not only allows you to share your data separately but also the connections between your data units.

All of the modules, objects, and fields that house your data may be transformed, moved, and synced from one app to another with the help of Myddleware. It helps you have unrestricted access to all data units in your applications.

You can also transfer and access older data using Myddleware by using the reference date, which is the time the information was first entered into the database. In addition, you can modify previous data items using new integration rules. As with more recent data, you can transfer and sync historical data between your applications.

Carles Aguiló-Collado, technology partner manager at Moodle, stated, "No single learning tool fulfills all educational needs, so we all need to be better connected with each other. By providing a no-code platform to automate data sharing, Myddleware democratises the ability to establish these connections between tools and makes it available to the non tech-savvy. In addition, it is an open source tool, which aligns with how we see the future of ed tech. This makes Myddleware the perfect partner for Moodle to provide data automation."

LineageOS 20 released

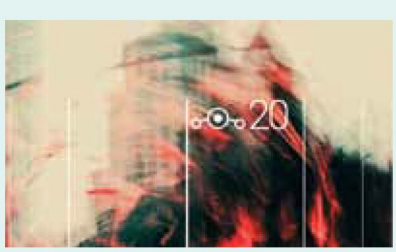
LineageOS 20 has now been released by its developers, and includes a number of noteworthy enhancements. This brand new camera app is based on Android 13.

People who want to install LineageOS' Android TV version can get an app launcher that is free of advertisements, among other things (like the one that Google uses by default). The Recorder app enables high-quality stereo audio recordings; the image gallery and web browser have both seen upgrades and bug fixes, and the volume panel has been updated.

The LineageOS team has also implemented Google's most recent security fixes (security updates are also available for older versions of the operating system going back as far as LineageOS 17.1).

The new camera app, Aperture, will be among the most obvious changes, though. With the release of LineageOS 19, the camera app that LineageOS had previously been using—a clone of Qualcomm's camera app called Snap—was ditched in favour of Google's default Android Open Source Project camera app, which isn't very good.

In order to add support for advanced features, the team used Google's CameraX software to create the new camera app. The new features of this app include full control over optical and electronic image stabilisation, video frame rate controls, a leveller that checks the device's orientation angle, and support for auxiliary cameras (although the latter feature may only be available on some devices because it's up to the person responsible for maintaining LineageOS support for each device to enable it).



Google Cloud focuses on curated open source software

According to Google Cloud VP of Infrastructure Eric Brewer, open source technologies will be used by four out of five developers by 2025. The goal of curated open source is to increase supply chain security while adding a higher standard of accountability. This is necessary "to operate the applications that will power our future," Brewer stated in a blog post. He mentioned laws from the US government, such as the Federal Risk and Authorization Management Program (FedRAMP) and President Biden's Cybersecurity Executive Order.

Curated open source depends on an individual or group of curators who examine open source software packages to find flaws and fix them. For instance, curators implement automated testing that streamlines open source security, track new dependencies, and update existing ones.

Today, open source curation is only available on a small scale through packages linked to supported Linux versions or premium open source platforms like Apache Spark. Brewer noted that currently "most of the packages we depend on are not curated." This will need to alter given the broad risk.

According to Brewer, the carefully selected open source packages offered by Google Cloud "allow enterprises to gain from the same end-to-end security capabilities and practices that we apply to our own OSS portfolio at Google Cloud."

OSS is popular but needs automation for better cybersecurity

According to estimates, open source software (OSS) now makes up between 80 and 90 per cent of all software. Even though it has been a fantastic accelerator for software development, it produces a big surface area that needs to be controlled because there are millions of packages published anonymously that developers use to build software. Most open source programmers behave honourably; they care about making other programmers' lives simpler. Because there is no financial reward for publishing an OSS package and a lot of negative feedback in comment threads, it is a thankless profession. "The most frequently encountered bad behaviour is rudeness (45% witnessed, 16% experienced), followed by name calling (20% witnessed, 5% experienced) and stereotyping (11% witnessed, 3% experienced)," according to GitHub's Open Source Survey.

Sadly, not all OSS packages can be relied upon. Since it is difficult to trace who made changes to open source code, it is nearly impossible to pin down bad actors that intend to jeopardise the integrity of the code. Harmful open source software packages have occasionally been injected to highlight the fact that major corporations use them but do not support their development, as well as just for malicious purposes.

Knowing the size of your application's surface area is the first step in determining the type of hazard you face. To acquire visibility into the OSS packages and version numbers being used in your software, it is important to include automation into your cybersecurity procedures. You can fit this technique into your developers' workflow by starting as early as the integrated development environment (IDE), preventing any delays.

Supply-chain levels for software artifacts (SLSA) is the industry standard; it is a set of guidelines and safeguards intended to prevent tampering, enhance integrity, and secure packages and infrastructure in your projects.

Tech Mahindra sets up a Google Cloud delivery centre In Mexico

Tech Mahindra, a supplier of business re-engineering, consulting, and digital transformation services and solutions, has announced the opening of its Google Cloud delivery centre in Guadalajara, Mexico. The centre will focus on Google Cloud-centric solutions that help clients manage workloads, update infrastructure, and use cloud native and open source technologies.

In the fields of data and analytics, artificial intelligence (AI), machine learning (ML), and more, the alliance will make use of the experience of both firms. By using hundreds of Google Cloud Certified engineers, the centre will enable clients throughout the Americas to expedite cloud adoption. It will concentrate on creating an effective landscape of solutions in significant verticals like retail and comprehensive digital transformation.

Through solutions for workload transfer to Google Cloud for enhanced velocity and scale, Tech Mahindra and Google Cloud will concentrate on assisting customers in advancing their digital transformation. The delivery centre will also develop a portfolio of 5G/Edge solutions with Google Cloud Global Distributed Edge Computing, as well as network AI and automation, in conjunction with network modernisation.

Duelyst source code released on GitHub

Counterplay Games, the developer of the free-to-play collectible card game Duelyst, has released the source code of the game on GitHub, nearly three years after its server was shut down in February 2020. The game was released in 2016.

ITMO introduces an open source mentorship programme

An open source mentorship programme has been developed by Russian ITMO University's Research Center 'Strong AI in Industry' that will enable students to work at the university, and assist research groups in creating open source frameworks and libraries.

At ITMO, mathematicians, physicists, biologists, chemists, and other researchers use open source libraries in their work. However, they frequently require the help of qualified software engineers for these tasks. The university also trains IT students who will undoubtedly benefit from hands-on experience while they are at ITMO; for example, they can do this by participating in projects created by the institution's labs.

The School of Translational Information Technologies and Research Center 'Strong AI in Industry' at ITMO made the decision to meet the needs of both students and researchers while developing this programme.

Mentors will be paid a salary of between 20,000 and 30,000 Russian rubles per month as official university employees. Students in their third and fourth years of undergraduate study, as well as those pursuing master's degrees and doctoral degrees, are eligible to participate, provided they have the necessary training and expertise in Python software development. Prospective mentors must be skilled in software engineering, including the ability to create documentation and auto tests, and a working knowledge of Gitflow.

The programme has already begun and will last until June 2023, making it possible for developers and academics working on multiple open source projects to collaborate effectively.

CISA and DHS are initiating greater cybersecurity in the US

The Cybersecurity and Infrastructure Security Agency (CISA) in the US plans to step up efforts to increase transparency and visibility in the software and technology supply chains, with a variety of initiatives building towards what the agency's executive director refers to as "cyber safety."

For example, CISA and the Science and Technology Directorate of the US Department of Homeland Security (DHS) are planning studies to examine the usage of open source software in key infrastructure sectors. At a GitHub-sponsored event in January this year at the Center for Strategic and International Studies, senior advisor and strategist Allan Friedman, CISA, made a statement. While the majority of open source operations take place outside of agency boundaries, according to Friedman, the government can step in when "huge resources aren't accessible today," such as when it comes to essential infrastructure.

One aspect of the Biden administration's focus on cybersecurity is open source software. In a panel discussion at this year's Consumer Electronics Show in Las Vegas, Nevada, CISA director Jen Easterly raised a concern about "decades of insecure technological design." The Software Bill of Materials concept is being promoted by Friedman and his colleagues at CISA, and the White House plans to introduce a national cybersecurity labelling programme for some Internet-connected products this spring.

By making the project open source, it will be possible for some of its components to continue to exist, even if only as a tool for other developers to understand how it was created.

Since the game is distributed under a Creative Commons Zero license, both private and commercial use of all the components is permitted. You might use the Duelyst sprite art into your own game or create something altogether new on top of the current codebase.

Duelyst II, the successor of Duelyst, is now available on Steam. It has been released by Dream Sloth Games, after taking permission from Counterplay Games to create it.

Tech leaders call for safeguarding consumer privacy in the blockchain industry

In an open letter released recently, digital rights advocacy group Fight for the Future has asked the US Congress to "take a bold position" to safeguard consumer privacy while regulating the blockchain industry. The letter has been signed by dozens of companies and organisations, including industry players such as the Blockchain Association, DeFi Education Fund, Ledger, Nillion Network, Protocol Labs and Proton.

The letter also criticised attempts by members of Congress to deanonymize blockchain transactions, such as legislation put forth late last year by Senators Elizabeth Warren and Roger Marshall, which would require blockchain intermediaries to register as financial institutions and follow the rules set forth by the Bank Secrecy Act for gathering information about customers. It urged Congress to adopt laws that will support privacy-preserving technologies.

These safeguards must include encrypted chat apps, which the group claims are vulnerable to assault. Privacy groups continue to be concerned about the protracted disputes over encryption between American law enforcement agencies domestically and abroad. The FBI deemed Apple's decision to completely encrypt its cloud services "very troubling" in December.

Rapid Silicon receives US$ 30 million in funding

Rapid Silicon, a maker of open source-based FPGAs with a focus on the intelligent edge and AI, has announced the completion of a US$ 30 million series A round of funding. The business has closed US$ 15 million in capital from Cambium Capital and other sources, including all the original seed round investors. The second closing is scheduled for Q1 2023.

The funding will be used to expand Rapid Silicon's product line; support the release of Gemini, its flagship low-end FPGA device; and continue the company's trend of promoting the use of open source software in commercial applications.

Gemini is a power-optimised programmable logic device (PLD) designed for embedded and edge applications' high sensor processing demands, constrained thermal environments, and constricting physical dimensions. The company says its

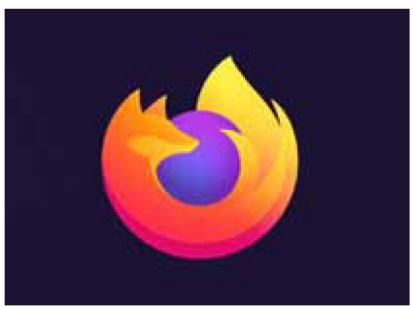
Raptor Design Suite software is the first commercial FPGA EDA suite in the world to be built entirely on open source code.

"Customers are looking for innovative ways to program FPGAs, reduce support load by leveraging the open source ecosystem of active expertise and development engineers, and shorten time-to-market," said Dr Naveed Sherwani, chairman and CEO of Rapid Silicon. "With open source software, Rapid Silicon is removing the barriers and providing its customers with a robust end-to-end FPGA design workflow. The open source software enables users to design complex applications quickly and efficiently on our FPGA devices."

"Driven by its purpose and world-class talent, we believe Rapid Silicon is ready to revolutionize design-to-silicon turnaround time and provide solutions that meet and exceed the robust performance, power, area, and time-to-market requirements for next generation applications," said Landon Downs, managing partner at Cambium Capital. "We see immense potential in the company's AI-enhanced EDA tools, and we believe this team has the experience needed to bring these solutions to the global market."

Firefox 109.0 released

Firefox 109.0 is the first release of the popular Firefox browser this year. First offered to release channel users on January 17, 2023, it comes with various bug fixes and new policies.



The biggest new feature is the *Unified Extensions* button in the toolbar. It also comes with Manifest Version 3 (MV3) extension support, which is enabled by default (MV2 remains enabled/supported). This major update also ushers an exciting user interface change in the form of the new extensions button. The Arbitrary Code Guard exploit protection has been enabled in the media playback utility processes, improving security for Windows users.

Effective on January 16, Colorways will no longer be in Firefox. Users will still be able to access saved and active Colorways from the *Add-ons* and *Themes* menu options.

Vulnerability discovered in JsonWebToken's verify function

JsonWebToken, which is supported by the Auth0 team and has more than 9 million weekly downloads, is used in many apps for authentication and authorisation. It was created to assist with the verification and signing of JSON web token (JWT) requests.A vulnerability, identified as CVE-2022-23529 (CVSS 7.6), was discovered in the package's verify function and can be exploited using a specially constructed JSON JWT request.

The user-supplied credentials are submitted to the authentication endpoint during the authentication process, which verifies the data and generates a JWT signed with a secret key. The application then sends a request with a JWT in the authorization header that is verified using the secret key whenever a user asks access to resources.

According to Unit 42 researchers, the vulnerability is caused by the lack of a check to ensure that one of the parameters the method gets is a string or a buffer. When no approved algorithms are specified, the package assigns the values in a file supplied by the vulnerable parameter automatically and utilises one of its techniques in blind mode.

The issue's severity score has been reduced since the attacker must successfully exploit a defect in the secret management procedure in order to exploit the vulnerability. The vulnerability affects JsonWebToken versions 8.5.1 and earlier, and has been fixed in version 9.0.0. Users are encouraged to upgrade as soon as possible to the patched version.

Several enhancements have been made to Red Hat Insights

Red Hat, Inc., announced several enhancements to Red Hat Insights in mid-December 2022 along with its predictive analytics offering. This includes integrations for ServiceNow and Slack, as well as expanded monitoring capabilities to identify known threats in Red Hat OpenShift and Red Hat Enterprise Linux.

"When it comes to managing wide-ranging hybrid cloud environments, flexibility, speed and visibility are keys to success. Customers leveraging a more integrated experience to access Red Hat Insights in existing IT processes, from deployment to use in day-2 operations, enables them to reduce process complexity and take faster action. Whether it's greater visibility for alerts in third party applications or greater visibility into known threats for IT infrastructure, integrating Red Hat Insights with existing tools enables awareness and the confidence necessary to effectively mitigate security and operational risks, wherever your organization is running across the open hybrid cloud," said Brent Midwood, director, Global Product Management, Red Hat.

The ServiceNow integration is available in the ServiceNow Store; the Slack integration is available within Red Hat Insights. The vulnerability detection capabilities for Red Hat OpenShift and malware detection for Red Hat Enterprise Linux are both included in Red Hat subscriptions.

On macOS, *Ctrl* or *Cmd* + trackpad or mouse wheel now scrolls the page instead of zooming. This avoids accidental zooming and matches the behaviour of other web browsers on macOS.

The *Recently Closed* section of Firefox View now equips users with the ability to manually close/remove URL links from the list.

Other changes include:

- Support for scrollend events
- Browser import support from Vivaldi, Opera GX
- PIP now supports subtitles on HBO Max
- Spanish (es-ES, es-AR) builds have built-in dictionary for spellchecker

Complete details are available in the release note available on the website.

New versions of 'stable' and 'longterm' kernels released

Linux kernel developers have released new versions of the 'stable' and 'longterm' kernels. These kernels contain a number of bug fixes.

The new Linux kernels are version 6.1.5 of the 'stable' kernel and version 5.15.87 of the 'longterm' kernel. As the names suggest, stable is intended as a kernel for everyday use, while the longterm variant is designed for applications that require a lot of uptime, such as in servers.

These kernels tend to rely less on flashy new features and more on fixing hardware support and security bugs. The 6.1.5 kernel fixes an issue with the kernel hanging when a system wakes up with certain Wi-Fi adapters, according to the kernel's changelog.

Linux users will want to upgrade to newer versions in the future, as kernels are the heart of the OS and intimately tied to the underlying hardware. Security updates also come through the kernel. Very few users install the kernel directly, but they will need to run their package manager periodically to ensure that the kernel is up to date.

Nexus, version 20.0 of Kodi, is out

The popular XBMC media player and media centre interface, which has been renamed to Kodi, has released its version 20, nicknamed 'Nexus'. It's a free and open source media player application developed by the Kodi Foundation, a non-profit technology consortium. Kodi is available for multiple operating systems and hardware platforms.

With over 4,600 commits since v19 'Matrix' was released on February 19th, 2021, this seems to be a huge effort with bug fixes and new features.

Several Kodi platforms now allow hardware decoding of AV1 media. The Inputstream API has been updated to support AV1, and this allows add-ons using *inputstream.adaptive* to play AV1 streams. New features include multiple instances of binary add-ons, subtitles rework, Windows HDR support and NFSv4 support.

The official announcement said that Nexus is being pushed to the usual channels right now, both our own download pages and various app stores/repositories. "It's worth noting that, for the first time in a while, we've cleared all known blockers, so all supported platforms will be updated just as soon as the various app stores process things," it added.

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"Non-free programs are a threat to everyone's freedom"

Richard Matthew Stallman (*aka* RMS) can be best described as a genius or a maverick. He graduated from Harvard in physics while working at the Artificial Intelligence Lab in Massachusetts Institute of Technology. In 1984, he started developing the GNU operating system; then in 1985 he founded the Free Software Foundation and invented the concept of copyleft—a legal mechanism to protect the modification and redistribution rights of free software. How have things progressed? How happy is he with the current state of affairs? Given the increased awareness and use of free software, we had (wrongly) assumed that he would be happy with the progress. He not only reiterated the weakness in defence of freedom but also outlined the threat humanity faces when "progress" (in the purely practical sense) is promoted at the neglect of freedom. Let's see what he has to say.

Richard Matthew Stallman (RMS)
American programmer and
free-software advocate

Q. For the benefit of our readers, who are new to the concept, what exactly is 'free' software?

A. It's best described by the phrase, "Free as in Freedom, and not Free as in Free Beer." So, when I talk about free software (aka *Swatantra* software), I am not referring to the cost of the software but to the level of freedom it provides to the user.

Q. How satisfied are you with the progress in the free software world?

A. We are moving towards horrible tyranny. People are being pressurised to use devices having non-free software for their day-to-day activities. And non-free software is malware. We have listed over 500 examples on *gnu.org/malware*. If a company has control over the software you are using, then it is almost sure to use that control to mistreat you. However, it is possible to refuse, as I do that myself.

I refuse to have a portable phone as every portable phone is a tracking device, which can be modified into a listening device. These so-called smartphones—I call them 'snoop' phones—invite you to talk to various online services or 'disservices.' But in the process, they snoop on you terribly; they can manipulate and pressurise you. It's not an acceptable kind of technology.

Q. How do you define malware?

A. Malware is software designed to mistreat, harm, or annoy the user. Users might be expected to stop this abuse if they could control what the software does.

Q. Do you consider marketing messages as malware?

A. Yes, because most users tend to turn those off in the settings. Software taking user permissions during installation is a racket. Users often don't understand what a program will actually do. But also in many cases, the choice is, either give permission for the program to do all these things, or it doesn't work at all.

Q. How is then the choice of users determined?

A. Suppose there are no taxis anymore. And the only kind of vehicle you can get is a Uber car. So then, when the Uber app says that it will track your location, to what extent is this a choice? In a theoretical and some literal sense, it's a choice. And I prove that because I absolutely refuse it; I boycott Uber. But most people don't believe they have another choice.

Practically speaking, in society as it is now, it's not optional. If your boss or your school asks you to use certain software, say, if they tell you to use Zoom, which has malicious functionalities (like the company Zoom can cut off your discussion, can also snoop on you), what will you do? There may be another side we don't know about. We haven't looked through the source code.

So, malware of non-free software is a real injustice which, in practice, people can't easily escape. This is an outgrowth of the free software issue, because when the program's not free, the developer will make it malware. S/he has an interest in making the program malware.

Q. What could be the alternative to such services in the free software world?

A. There are some services which ask for your location in order to provide you with the service. Though the service and the app are different, they're tightly associated and go together. The way things are you can't use the service without the app. But they're still conceptually distinct. And both carry out their own bunch of injustices.

I object to being required to identify myself to get a ride. With a taxi, I don't have to. Because I'm going to pay cash. Uber won't accept cash. I say any business that won't let you pay cash, unless it's for something very expensive like buying a house or a car, it's an injustice.

In general, a house owner or a car owner has to be registered. But a person taking a ride downtown today does not have to be registered, and in a free society must not be registered. The practice of tracking where people go is the kind of surveillance that puts all human rights in danger.

The most dangerous things to surveil are where you go, what you do there, and whom you're talking with. If those things are surveilled, human rights are gone. So that's my ultimate objection to any company that acts this way.

Now, in principle, digital payments can be anonymous. In fact, we've developed free software to make anonymous digital payments; it's called the GNU Taler. Switzerland seems to be very interested in using it as it has a tendency, to some extent, to oppose tracking people.

So, if there was something like Uber where I could request a ride without having a mobile phone and without running any non-free software (like calling someone), and if I could pay using free software like GNU Taler where I'd be paying digitally through the internet but not identifying myself, that would be okay for me. I would be willing to use that.

Q. Are you saying that digital cash, like the RBI introducing digital currency, is not a problem as long as it can be done without identifying users?

A. Digital cash is an ambiguous term because it means many different things. Taler is not digital cash, it's digital payment. You get other tokens that are denominated in some currency. The point is that you have a way of paying.

Totally anonymous payments have a problem as they lead to hiding

lots of money from taxation, helping the rich steal from everyone else. We don't want to cause that problem. I think digital payments are okay if the payer is anonymous. Here's a crucial point. With GNU Taler, the payee is always identified and hence, it does not promote tax dodging.

We identify the payee. So, if you paid for a service, it'd get something that it can submit to a bank or a similar entity, and get exchanged for money. This way, the transaction would get recorded with the bank.

Q. How does GNU Taler differ from cryptocurrencies?

A. GNU Taler has several advantages compared with cryptocurrencies. First, it doesn't fluctuate relative to the currency. And you'll avoid the speculation of cryptocurrencies. I've never used crypto; I don't like speculating.

Another difference is that it's more anonymous for the payer. With Bitcoin at least, every transaction is public because there are ways of figuring out who owns or uses a particular wallet. And the other thing is that it's always identified for the payee. And it's also much more efficient.

Q. How does it prevent the payer's information from being stored?

A. It uses blind signatures. Using an algorithm similar to RSA, you can arrange for someone else to sign a number for you and not know what number is signed. Essentially, you take a number and multiply it by a large prime and submit the product to be signed. Since you know that it's signed in a certain way, such that you know what the two factors were, you can deduce the signed version of the original number by dividing out that other prime. So, you now have a token that can be validated by the bank. But no one can tell that it came through you.

Q. When I buy a car, it now comes with non-free software and spyware. What's the respite then?

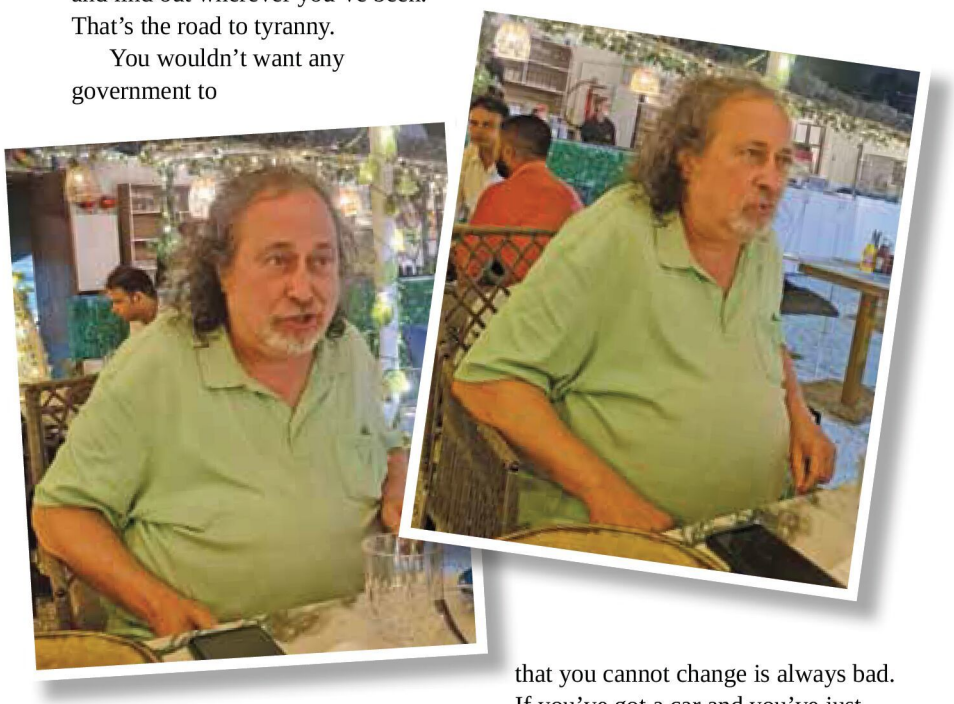
A. Nowadays, there are connected cars which have cellular data communication. And if that's operating, it can determine its location if anyone tells it to. But not if you disconnect it. Also, the GPS system, which shows you where you are, probably remembers all your locations as well. If you get the car serviced, someone can look in that and find out wherever you've been. That's the road to tyranny.

You wouldn't want any government to have that kind of power. But if you disconnect the GPS antenna, then it won't know where you are and obviously won't remember your locations. For each antenna, you have to either disconnect it or cover it with some sort of metal foil—a conductive foil that doesn't let radio waves through.

Those are the only things I believe you need to do. Though this is theoretical, it would be very interesting for people to try and verify that the system stopped working. One nice thing about these methods is that you can easily revert things back to how they were.

Q. There is an increasing trend where car companies are providing cars as a service. Toyota, for example, had proposed to charge $80 a year just for the facility of remotely locking and unlocking your car. BMW is offering heated seats in their cars as an optional service.

A. This is malicious; it's nasty behaviour. Selling you something that you cannot change is always bad. If you've got a car and you've just connected the data link antenna, then those services would work anyway. But if you disconnect, the related services won't function. That's what you have to expect.



Q. What are your thoughts on the emerging concept of the Internet of Things?

A. Well, we should respond to that with disgust. At the outset, I call it the Internet of Mal-things, or the Internet of Stings. Because although

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it's not inevitable that they must be malicious, they are.

In particular, if anything is designed so that you use a snoop phone to give commands to a device, and the commands pass through the manufacturer's server, that means everything between you and the device is being snooped.

Q. What is the way out of this scheme of things?

A. The freedom-respecting way to design such a product is that your computer should be communicating in some local way and not over the internet. Any device in your house that talks though the internet is a Mal-thing almost certainly, because it enables snooping on you without any special effort. The devices that you accept into your house should not have any way to talk to the internet, but only to your computer. That way, you have total control over what commands you send to those devices.

Any device that has software which can be changed by someone else but the user is already so unjust. It locks you out and turns the device against you. We must fight against this scheme of things where someone else can send commands to that software and you don't know. They're very likely to put in a universal backdoor just so that they can change the software. Why would they respect any of your freedoms? I don't accept such things in my house.

Q. Where do the values diverge between open source and free software?

A. At the outset, I'd like to clarify that free software doesn't mean *muft* software, but *swatantra*. We talk about the essential freedom for all users. The idea of open source was invented in 1998, which is 14-15 years after I started the free software movement. It describes the same practices that were already there in the free software community.

They have the same activities, but different values. With the free software movement, the values are freedom and community. We cooperate so we can all do things and have freedom. Open source doesn't talk about freedom at all.

Q. What does the concept of open source talk about, then?

A. They talk about openness. But openness is narrower and shallower than freedom. Openness just means you can see what the software is doing. Now, when you look at their criteria, it's almost equivalent to the free software criteria. But that's not part of the word 'openness.' They don't make that a matter of principle.

Around the year 2000, they talked about the possibility of making practically better software by allowing everyone to participate in studying it, looking for flaws, fixing them, and so on. They didn't declare a good, convenient but non-free program as an injustice for your freedom's sake. They didn't refuse to use and develop that. They didn't fight it. That's what we did.

We said that if the program's not free, it is an injustice to its user. The users are entitled to have control over the software that does their computing.

Q. Please elaborate on these kinds of licenses.

A. Copyleft is a technique of licensing that I invented because I wanted to make sure that the modified version of my programs will also be free. I use the copyright law as a basis for a license that says: You are given the permission to release and modify the versions of these programs as long as they're under the same license.

There are other free licenses also, that respect the core essential freedoms, but they do not have that requirement. I generally call those lax, permissive, and weak licenses. So, they are not copyleft licenses. But the programs released under them are still free software and are also open source. But modified versions of them can be non-free.

This is why you need to be very careful when somebody says something is based on free software. It could mean they could have taken a program that is not copyleft-ed and modified, and released it as non-free software.

It could also be possible that they took good GNU plus Linux distributions, some of which are free. Suppose they take one that's free and then add some non-free programs. Now, it's not false to say that it's based on free software. But that doesn't mean it respects your freedom.

Q. How to identify if something is truly free software or not?

A. We have a list of thousands of free programs in the directory at *fsf.org*. And we're always looking for more people to help update the software directory for the highest-possible accuracy and new additions. Because there are still thousands of free programs that are useful but unlisted. Any volunteer can just go to the site and contribute to the directory. We also rate GNU/Linux distributions and other system distributions in the same sense. Some are 100% free, that is, *swatantra* software. You can look at *gnu.org/distros*.

Q. Your journey with FSF had some issues in the recent past. Is there anything that you want to share with your audience?

A. I resigned from the FSF presidency and Board in September 2019. And I rejoined the Board in 2021. And I'm still on the Board, but I'm not the President. The FSF is learning to get along without me as President, which it eventually has to do.

It's well known that people started spreading lots of accusations against me, which were mostly false or based on partial truth. I'm not perfect, but I didn't do anything really horrible. But some people pointed out little things

about what I say and do, and turned them into something horrible. And if you want to read about this, you can look at the Stallman support network which refutes lots of falsehoods.

Q. What do you think FSF India needs to learn from the US or the global counterpart in terms of implementation?

A. FSF India is not very active. It started as a separate organisation in the early 2000s, but it never really started functioning effectively. At this point, I think it'd be necessary to find a new set of activists who want to carry it forward. Some activists in it are still active in the free software community but FSF India as such is not doing anything.

Q. What are the goals that you would want FSF India to have?

A. Teach people about free software at the practical level and at the level of ethical philosophy. Convey why it's very important, not merely as a matter of convenience, but as to what is at stake here.

Q. And what is really at stake here?

A. Freedom is at stake here. Fundamentally, it starts with the freedom to control the software that does your computing. If you let your computing be done by somebody's online service, neither do you control what's running that service nor can you have a way to control it.

Q. How do we that computing into our own hands?

A. If you want to use Google Docs, there's software on the server that has to be there. And obviously, Google can't let you change that software. Because different people might want different changes, and that doesn't make sense.

But if each of us is free and each of us has the source code, the programmers among us who want the same changes as we want, can get together and make a change.

It's up to you which version you're going to install and use. This is why free software means you can get what you want. And it's under your control. Otherwise, the software is under the control of somebody else, who is probably looking for an opportunity to mistreat you with it.

Looking at *gnu.org/malware*, you'll see how many different ways they mistreat people with it. They design non-free programs to restrict people (digital restrictions management). They make people give personal data in order to keep using it. There are famous online disservices which swindle people and get them addicted. And partly that's the fault of the server code. But the client code is also involved. If the client code were free software, you could change it and overcome some of the addictive aspects.

So, software freedom, in the direct sense, is freedom in one area of your life. But the more software and computing become involved in other areas of your life, the more software freedom becomes essential to freedom in those areas. END

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The Metaverse is Here to Stay

The metaverse is no longer an unfamiliar term. The technology behind it is evolving each day and promises to engulf our lives in the years to come. We take a look at its history, evolution, applications and risks, as well as the top 12 metaverse platforms today.

When Facebook (now Meta) introduced the term 'metaverse' and the technology behind it, many companies began evolving strategies to implement it for their business solutions. Metaverse combines decentralised technology such as distributed ledger technology (DLT), non-fungible tokens (NFTs) and Web3 to enable secure, robust and resilient architecture. It also uses immersive, haptic and spatial technology to bring the user from the physical world into the virtual world.

Immersive technology is based on two principles — augmented reality (AR) and virtual reality (VR) — to merge the physical world with a virtual, digital or simulated reality.

Haptic technology is a 3D touch sense technology, also known as kinaesthetic communication. It is used to create the sense of touch through virtual application of force, vibration or motion.

Spatial technology or geospatial technology helps to map a location by studying its position, size and

area. This helps to localise the user experience.

Metaverse technology is the latest buzzword, and many organisations believe that it can disrupt their IT policies, customer experience and market reach. However, there is a concern that metaverse may be over-hyped and we may be overthinking about metaverse enabled solutions. While we cannot overlook this technology, understanding its industrial applications and popular use cases will help us comprehend its impact better.

Though metaverse is the talk of the town since the last two years, it is not a new concept. In 1992, Neal Stephenson's fictional work 'Snow Crash' talked of digital avatars in a parallel digital world, with whom humans could interact. This was perhaps the first time that something like the metaverse was envisioned.

In June 2021, the famed venture capitalist Matthew Ball released a nine-part series of essays titled 'The Metaverse Primer'. He defines metaverse as a "massively scaled and interoperable network of real-time rendered digital world."

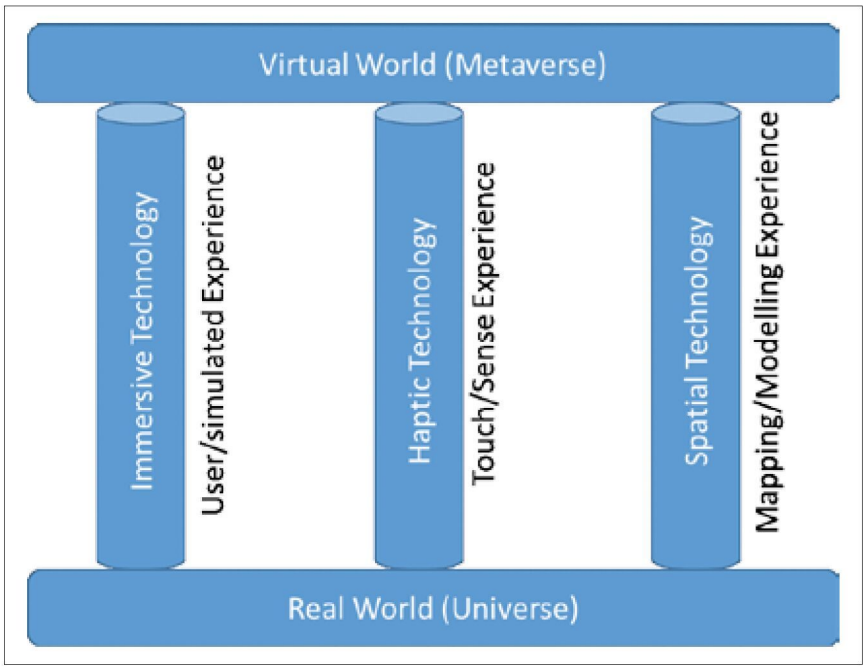

Figure 1: Pillars of metaverse

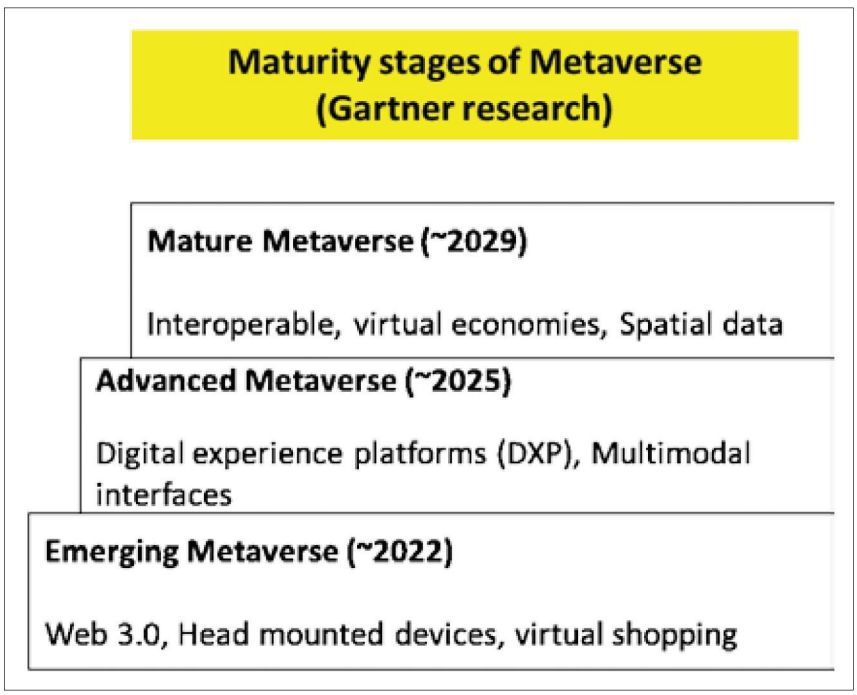

Figure 2: Maturity stages of the metaverse

Examples of how metaverse tech is being used

Metaverse technology has led to a number of industrial solutions, one of which is a banking solution named MetaFi (metaverse for financial services). Here, a personalised avatar interacts with customers for services like core banking, wealth and asset management, and retail banking. Recently, Tintra announced that it is developing a new-age Web3 solution called Metaverse Bank that offers fully-functional private and investment solutions for end users with immersive services.

In Japan, virtual games played over the network were very popular for a long time. These 'Manga' games later transformed into massively multiplayer online (MMO) interactive 3D games. The popularity of Microsoft's HoloLens and Mesh prove that there is a huge market for gaming.

Axie Infinity (AXS) and Smooth Love Potion (SLP) have converted crypto-tokens (earned from virtual games) to ETH and then to USD. This is a new business model for earning through the digital world.

Tardiworld has hosted virtual marriage receptions, with friends and relatives attending from across the world. Gifts are being given as

cryptocurrencies through the Zionverse platform. And an art event was hosted on the NextMeet platform by Broward College, Florida, USA.

Second Life platform has introduced a metaverse social platform for making new friends and interacting with them. LokaLocal has introduced virtual touring through a metaverse world that has 3D real-world images of cities and places.

The metaverse has been conceptualised by various platforms for training, education and virtual collaboration, healthcare, banking, financial services and retail sectors for an improved customer experience and to spread the reach of businesses.

The different stages of maturity of metaverse platforms

Metaverse promises to be a disruptive technology over the next five years across many sectors. Its early adoption is envisaged in home office and collaborative platforms, and in virtual training and education services. As per Gartner, the different maturity stages of metaverse are:

- Technology using Web3, head-mounted devices, and use cases like virtual shopping — this is the 'emerging metaverse' which we are experiencing currently.
- Technology developed for digital experience platforms (DXP), multi-modal interfaces and immersive experience systems — this is the 'advanced metaverse', a stage we can expect to reach by 2025.
- Technology that is interoperable using digital currency, blockchain, security and compliance for the crypto economy (and uses spatial data) will be part of the 'mature metaverse', a stage that will be reached by 2029.

The future

The metaverse promises to evolve into something very similar to our real world, and may even replace some real-world activities.

A few metaverse non-fungible token (NFT) vendors have enabled their NFTs to be used on some metaverse games for clothing and footwear; others are planning to do so. An increasing number of NFT enthusiasts are also sensing opportunities to invest in virtual lands on such games, and sell or rent them for a price. The metaverse can be a huge contributing factor to the growth of the virtual economy, which depends on video games and virtual worlds.

If NFTs are incorporated as in-game assets, decentralisation of the virtual economy can become a reality. Today, we already have a nascent version of the metaverse with NFTs representing popular art and digital memorabilia being lapped up by investors and crypto fans alike.

With major players like Meta entering this space and confidently signalling a great future for it, it is only a matter of time before others follow suit. This could lead to an exponential expansion of the boundaries of the metaverse and unlock vast volumes of value hitherto unknown to consumers and investors alike.

The future of the metaverse also rides on the idea of it running openly, almost without any interruption from a single community or company, with brands from across the world opening their outlets on it, just like they have done on the internet today.

The Top 12 metaverse platforms

In our opinion, the following are the top 12 metaverse platforms today.

Altspace VR: Acquired in 2017 by Microsoft, this virtual platform enables the creation of virtual events and is part of the tech giant's mixed reality division. Users can host a meetup, a show or a class.

BlueJeans: BlueJeans from Verizon is a video platform designed to optimise flexible work in enterprises and mid-sized businesses. In 2021, the company partnered with MootUp to reimagine "virtual events in the era of the metaverse with 3D, VR and AR immersive environments, avatars and AI chatbots."

Cryptovoxels: Cryptovoxels is a virtual world gaming platform powered by crypto and the Ethereum blockchain. It includes real-life infrastructure such as roads and buildings.

Gather: Gather is focused on video chat that builds a virtual layer over the physical world. It is an enterprise-specific offering that mimics an office construct and deeply integrates with video conferencing.

Metahero: Metahero, from Web 3 company Pixel Vault, is a universe where anyone can be a hero. The platform offers six different kits with avatars that can be customised and personalised.

Meta Horizon Worlds and Horizon Workrooms: Meta (formerly Facebook) bills its fledgling metaverse Horizon platform as an "ever-expanding social universe" to hang out with friends and create your own worlds. Workrooms is the company's mixed reality app for employee collaboration.

Nvidia Omniverse: The chipmaker's virtual platform focuses on 3D design work on computer graphics, simulations and the creation of new worlds.

Roblox: Roblox's vision is to give people a platform that empowers them to create their own experiences. "Our vision is to reimagine the way people come together to create, play, explore, learn and connect with one another."

Rooom: Rooom specialises in enterprise virtual showrooms, 3D product presentations and virtual events that can be used by marketing and sales groups in verticals such as education, retail, life sciences and manufacturing.

Sandbox: Sandbox is a community-driven gaming platform built on the

Ethereum blockchain. Creators can monetise voxel assets.

Second Life: Second Life's Metaverse City bills itself as "a welcoming role-play community" with immersive experiences that let players come in and out as they like. It's a relatively unsecured space.

Somnium Space: Open source platform Somnium Space is termed as more of a consumer gaming platform. Users can purchase digital land parcels and build homes and buildings, as well as start businesses, among other activities.

The risks

While the metaverse seems exciting and enjoyable, it has its own set of risks and drawbacks.

Harassment and cyberbullying: Young adults and teens are vulnerable to cyberbullying. Its impact, which can range from a feeling of low self-worth to suicidal impulses, particularly among teens, has been well-documented. According to experts, because the human experience in the metaverse is as genuine as in the physical world, pain and suffering too are as real and severe.

Some hazards are more difficult to prevent in a virtual environment. Many free-to-play games, for example, rely on advertisements to fund their growth. Malicious people may hypothetically replace these advertisements with images that cause sickness, which may be sent to a virtual reality headset.

Theft of identity: Many experts are afraid that if rigorous security measures are not adopted, identity theft in the metaverse may become even easier. In the real world, identity theft is now a multibillion-dollar industry, with damages being estimated at US$ 24 billion.

Collection of unauthorised data by companies: Your personal information is today collected by legitimate businesses. Virtual reality, on the other hand, has the potential to push data collection to a new level. Virtual reality headsets, for example, may hypothetically allow third parties to collect sensitive personal data including voiceprint data, biometric data, and even facial geometry data.

Ransomware attacks: Ransomware is malicious software that encrypts your data and prevents you or anyone else from accessing it. It will then display a message demanding you to pay a particular amount of money to regain access to your data, thus the term 'ransomware'. Your metaverse profile will have a lot more information than a regular social media page; it will also include a lot of sensitive information. Hence, such attacks will have a much larger impact.

A change in real world perceptions: According to a study done at Stanford University, both virtual reality and augmented reality, two of the foundations of metaverse, can influence how individuals see the actual world. Participants in that study, for example, avoided sitting in a chair where a computer-generated avatar had sat in their AR environment.

Deepfake videos: In a world where information is king, experts are concerned about bogus information campaigns delivered via deep falsified audio and video snippets, endangering a country's security. Deepfakes are modified video or audio clips that appear and/or sound like someone else.

Attacks using social engineering: The activity of mentally influencing someone into giving sensitive information is known as social engineering. Because of the large quantity of personal data that will be kept in the metaverse, it might become a gold mine for hackers trying to sell personal data on the Dark Web. Education will be the foundation for metaverse security management.

Shared spaces come with their own set of dangers: The metaverse is built on the idea of bringing people together. While this might be beneficial in certain respects, it can also raise issues. In the metaverse, you will have to deal with people who have contrary viewpoints. People behave differently in a virtual environment than they do in the actual world, according to studies. This is particularly evident in the field of massively multiplayer online role-playing games (MMORPGs), where veteran players frequently criticise newcomers and even abuse girls.

New applications will need to be vetted: New apps, like today's internet, have the potential to disrupt our digital life, leading to digital risk. The enormous volume of sensitive data that will be retained in a metaverse scenario, however, can make the damage considerably worse. We'll need to come up with ways to ensure that all new apps are scanned for harmful code.

Key technologies integrated with the metaverse platform

Blockchain: Blockchain technology forms the bedrock of the metaverse, as most of the applications run on blockchains. It provides the decentralisation and transparency that is necessary for the functioning of the metaverse. Blockchain technology helps developers integrate several functions in the metaverse such as digital ownership verification, value transfer, governance, digital collectability, accessibility and interoperability.

Cryptocurrency: Cryptocurrency is one of the primary technologies used in the metaverse. The platforms on metaverse only accept cryptocurrencies. So, users have to change their real-world currencies to crypto before they can carry out any transaction in the metaverse. It can be used to purchase resources such as NFTs, digital real estate and to make in-game purchases. In the metaverse, cryptocurrencies have massive value. For example,

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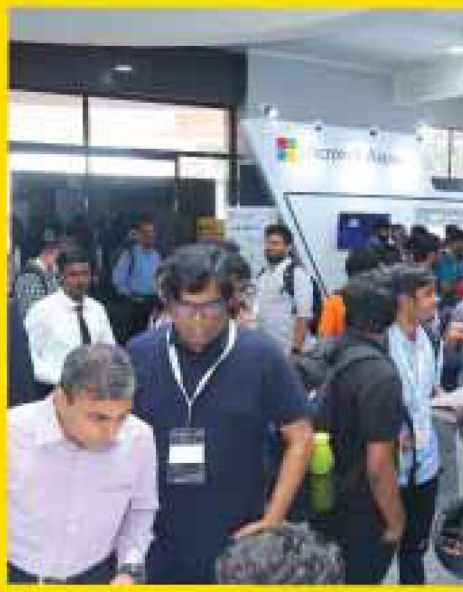

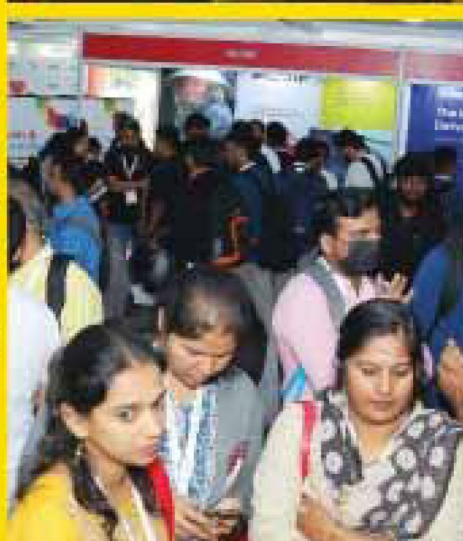

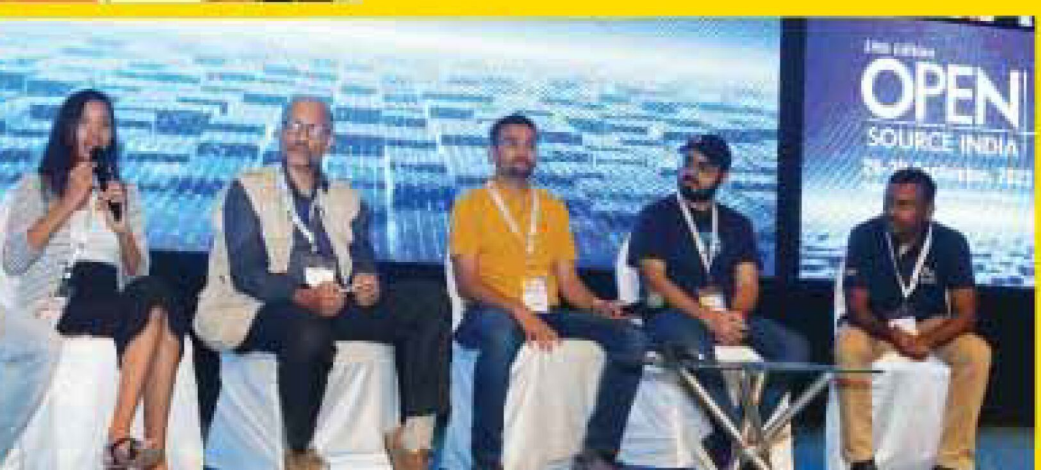

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if you want to buy a plot of land on Decentraland, you will have to convert your real-world currency to MANA, the native token of the game. It's the same story for all the games and platforms on the metaverse.

Augmented reality and virtual reality: Augmented reality (AR) and virtual reality (VR) engines play an important role in enabling the metaverse to be an enthralling virtual experience. They help create immersive and engaging 3D environments for the metaverse.

While VR and the metaverse might seem like the same thing, there are certain differences between the two:

- VR is only a part of the broader metaverse. The metaverse is made up of several other technologies that complement VR technology.
- While VR enables users to see 3D simulations, the problem is that VR technologies cannot provide physical stimulations, which is an important part of the metaverse.

This is where AR comes in. It helps expand the scope of the metaverse by enabling users to actually feel things by creating physical stimulations. As a result, users can hear, feel and interact with the virtual metaverse as if they are physically present in it. The combination of VR and AR technologies is likely to create a more realistic metaverse and bring in massive investments from various companies.

Artificial intelligence (AI): AI has become an inextricable part of our lives — from Alexa and Siri to the smart sensing air conditioner that helps us sleep. So, it is only expected that the metaverse will also use AI to improve its performance.

AI plays a major role in making every process that happens in the metaverse an immersive one. It can help process data at lightning speed with the aid of machine learning techniques. Within the metaverse, prior historical data can be used by AI algorithms to create unique outputs and insights. Another important use of AI in the metaverse is to create metaverse avatars. AI engines can analyse 2D and 3D images to generate more realistic looking and accurate avatars. AI can also add more character by helping create different facial expressions, hair styles, clothes, and features to enhance the appearance of the avatars.

Internet of Things (IoT): IoT enables applications to collect data and feed it to the metaverse to adjust more precisely to real-world conditions. For example, weather or temperature data collected via IoT can help the metaverse adjust its environment.

Another advantage of IoT is that it can seamlessly connect the 3D world to a large number of devices from the physical world, enabling real-time stimulations in the metaverse.

IoT can also use AI and machine learning algorithms to further improve on and optimise the metaverse environment by managing the data that it collects.

Edge computing and 5G communications: Edge computing basically facilitates faster data transfer with fewer delays and helps enable smoother experiences. It is one of the primary factors that has enabled the metaverse to be viable, as computers need to handle the intense stimulations with efficiency to reduce lag and ensure that users have an immersive and unhindered gaming experience.

Another important feature that is often combined with edge computing is the availability of 5G networks. Previously, users often faced issues with their network while engaging in the metaverse due to slow data transfer speed resulting from unavailability of fast internet speed. However, with 5G being rolled out and made available at affordable rates, users can experience the metaverse from their desktops and other devices without facing a lag due to network speed.

Together, edge computing and 5G enable users to engage in the metaverse and enjoy a truly immersive experience. END

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By: Dr Anand Nayyar and Dr Magesh Kasthuri

Dr Anand Nayyar is a PhD in wireless sensor networks and swarms intelligence. He works at Duy Tan University, Vietnam, and loves to explore open source technologies, IoT, cloud computing, deep learning and cyber security.

Dr Magesh Kasthuri is a senior distinguished member of the technical staff and principal consultant at Wipro Ltd. This article expresses his views and not that of Wipro.

Generative AI and its Interactions with the World of FOSS

Here's a primer on generative AI, thoughts on how you can empower yourself with this tech, and an insight into how Stable Diffusion has achieved success as an open source effort.

Figure 1: Three mysterious images

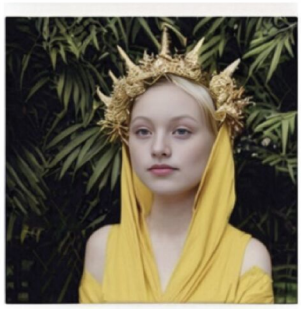
Take a look at Figure 1. Can you guess what these three images have in common? From a quick look, you may think that it's just the fantastical art style. What if I told you that none of them were drawn by a human artist but were generated on-the-fly within seconds by an AI model?

This is the power of generative AI — models capable of generating novel content based on a broad and abstract understanding of the world, driven by training over immense data sets. The 'artist' of the above images is a model named 'Stable Diffusion' released as open source software by the organisation Stability AI. All you have to give it is a text prompt describing the image you want in detail, and it will do the rest for you. If you're curious, I've dropped example prompts that can generate the images in Figure 2.

Stable Diffusion is not the first of its kind. OpenAI's 'DALL-E' beat it to the chase as it was released a few months prior. However, looking at the state of the art, it is the first generative AI model capable of image synthesis and manipulation that was released to the public as FOSS software while also being practical to adopt.

These models are not limited to images. The first generation (and possibly the most popular use case) of these models targets text generation, and sometimes more specifically code generation. Recent advances even include speech and music creation. Zooming out into a timeline with some of the major generative AI milestones (Figure 3), we see that this technology has been out for a while, but only gained monumental traction recently.

It all started with the paper titled 'Improving Language Understanding by Generative Pre-Training' released by OpenAI. The paper alluded to GPT (generative pretrained transformer), and laid the seed for 'large language models'. However, generative AI started coming into the limelight with the public release of GPT-3 and DALL-E. The former is a next-generation version of the already performant GPT-2 model and the latter is an image generative model like Stable Diffusion. Their public demos and API access set ablaze the imagination of technologists across the planet. However, these



a beautiful enchantress, blonde hair, wearing a yellow dress, glowing aura, wearing a crown

old harbour, tone mapped, shiny, intricate, cinematic lighting, highly detailed, digital painting, artstation, concept art, smooth, sharp focus, illustration, art by terry moore and greg rutkowski and alphonse mucha

(painting of girl from behind looking a fleet of imperial ships in the sky, in a meadow of flowers.) by donato giancola and Eddie Mendoza, elegant, dynamic lighting, beautiful, poster, trending on artstation, poster, anato finnstark, wallpaper, 4 k, award winning, digital art, imperial colors

Figure 2: Prompts that produced those images

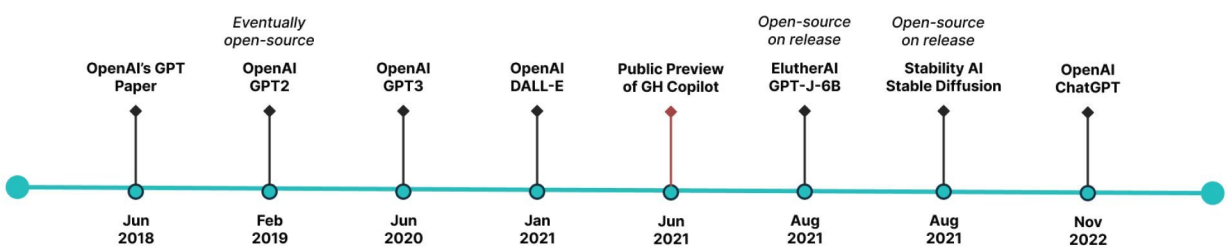


Figure 3: A timeline of events surrounding generative AI

implementations remain closed-source and proprietary.

Programmers were enthused and drawn towards generative AI when GitHub opened up a private preview of GitHub Copilot. Copilot utilised OpenAI Codex — an extension of GPT-3 that is trained on thousands of GitHub repositories. This specialisation allowed it to generate code on-the-fly, infer functionality of code and, more recently, automatically write test cases.

Around this time, EleutherAI created an open source model similar to GPT-3 as well with some impressive demos. It was named 'GPT-J-6B', the J alluding to the Google JAX framework used to develop the model.

However, nothing expanded the open source generative AI scene more than the open source release of Stability AI's Stable Diffusion. Within hours of its release, technology forums were flooded with inspired individuals expanding the art of the possible. Several developers had built feature-complete, easy-to-use user interfaces and deployment strategies within days of its release. Some even released, modified, and optimised the model to suit specific use cases.

The release of Stable Diffusion was still not the biggest splash that generative AI had created in the world. That's credited to the recent public demo release of ChatGPT, a purpose-built GPT-3 based model capable of holding context-aware conversations and providing an easy-to-use and familiar interface. It reached over one million users in the short span of a week, a figure that took earlier social networks months and years to achieve.

The keen-eyed among you must have noticed that Stable Diffusion isn't the first open source generative AI model that was launched publicly, yet it somehow broke out of the mould with millions of users. A large chunk of these users self-hosted this model, integrating it deeply into their products and open source projects. So, what did they do differently?

The accessibility and wide adoption can be chalked down to two key factors.

Availability of pretrained weights

Generative AI models are often 'deep neural networks' with millions/billions of parameters, trained over

data sets with hundreds and thousands of items, whether text or images. To look at some metrics, the cost of training GPT-3 is over 4.6 million dollars using a Tesla V100 cloud instance with training times of up to nine days. Similarly, Stable Diffusion was trained using 256 Nvidia A100 GPUs on Amazon Web Services for a total of 150,000 GPU hours, at a cost of US$ 600,000. These costs are prohibitive for individuals and even small businesses. Putting these trained models to use is more inexpensive by orders of magnitude.

Fortunately, it is possible to share the outcome of this training in the form of 'weights', which can be loaded by anyone who wants to use the model. This is the approach taken by GPT-J 6B and Stable Diffusion, who had weights available for download from day one. This allows individuals that have access to sufficiently powerful hardware to load up the model and put it to use.

Highly efficient architecture with lower hardware requirements for deployment

Even after obtaining a set of weights to pretrain your model, many of them require expensive GPUs like the Nvidia A100. The primary resource essential here is large reserves of VRAM, in the range of 10s of gigabytes. The VRAM is required to keep model weights in memory for reasonably fast execution. A requirement like this automatically filters out individuals with consumer-grade, yet fairly powerful GPUs.

For instance, running the full-fat version of GPT-J-6B requires upwards of 20-25GB of VRAM. Additionally, in many practical use cases, you would want to "fine-tune" the model, which involves making the model more specialised to a given use case. This is done by retraining the already trained model over a specific, curated data set. This is yet another process that requires powerful GPUs.

Stable Diffusion gets past this by utilising a novel architecture known as 'latent diffusion', which maps the image generation process to a smaller logical space. This allows it to run with reasonable performance on GPUs with even 8GB of VRAM, a figure easily attainable in consumer GPUs. This meant that, on release, anyone with a laptop with reasonable specifications could run the model entirely locally, resulting in no hard limits imposed on the model in terms of output filtering or the rate at which one could iterate.

You don't need to be in the space of AI/ML to be excited by these advances. Generative AI is penetrating our lives and making us more efficient. As a developer and open source maintainer myself, I find myself using generative AI in my day-to-day tasks.

I have a significant backlog of articles that I've always wanted to read and gain insights from. I now find myself using ChatGPT to summarise and ask introspective questions about those articles. In the same vein, I also use it to refine and refactor code documentation, READMEs, and other artefacts in a pinch. I've also extensively used GitHub Copilot for writing boilerplate code and exploring unfamiliar codebases.

From a more creative perspective, I've begun to extensively use Stable Diffusion to provide abstract imagery for my presentations and to edit images to make minor modifications. As an experiment, I've been using a fine-tuned GPT-3 model and Stable Diffusion to aid my poetry writing.

In my use of generative AI, I've found that it's currently far away from entirely replacing any sort of human-generated work. However, it is an invaluable asset in anyone's toolbox that enables us to do more with less. It enables non-native speakers to write effectively, technologists to rapidly consume and summarise knowledge, and brings iterative artistry to creatives and even creatively challenged individuals. In a way, it's open sourcing creativity!

It's important to remember that just like other disruptive technologies, generative AI has its downsides. One of the most contentious issues is around the legality and ethical morality of using public content as training data. It's been argued that AI shouldn't be allowed to create derived works from the content, especially since current-generation models are incapable of appropriate attribution. From a FOSS standpoint, there has been a heavy backlash around GitHub's use of code in open repositories to train Copilot, a paid product.

Additionally, as we employ generative AI, we must be cognizant that the models only possess an abstract understanding inferred from the training data. This means that we can't know for sure if they are giving us the right answers. This becomes incredibly obvious when you try pushing text-based models to generate content around items that aren't present in their training set. Most models confidently generate sentences that seem correct from a high level but are entirely inaccurate. This has led to the ban of AI-generated responses from popular Q&A sites like Stack Overflow.

In conclusion, it's an exciting time for this field! And I for one cannot wait to see where we go in the future.

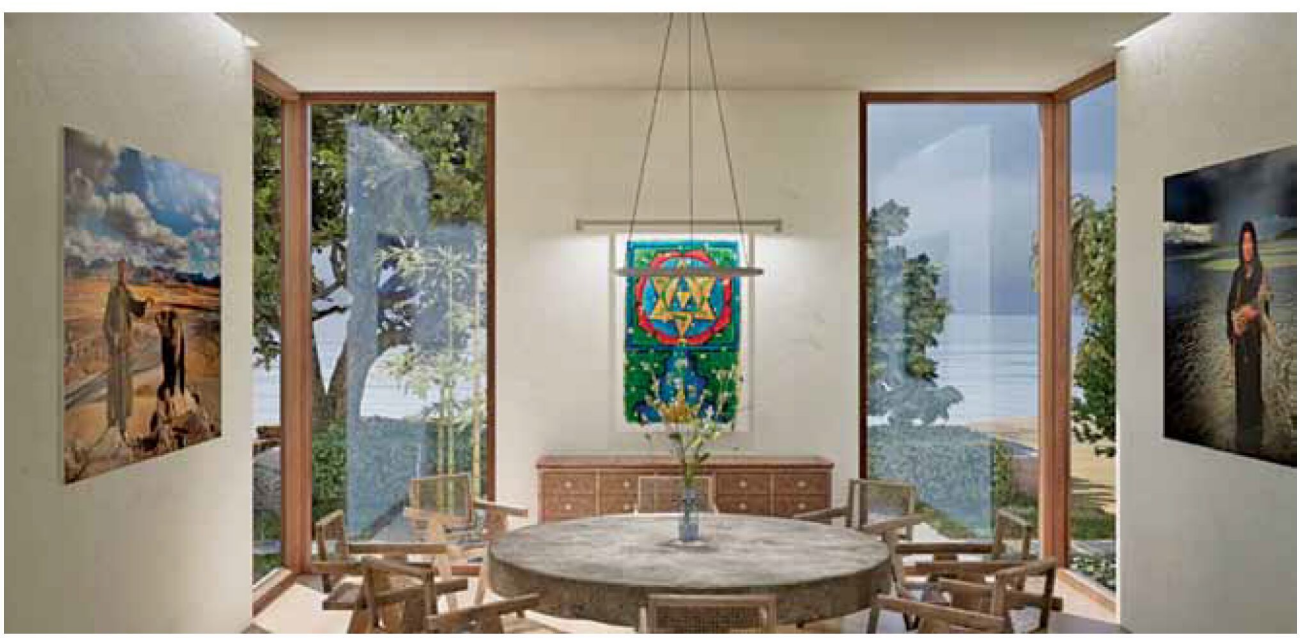
P.S.: Staying true to the spirit of 'practice what you preach', this article has been co-edited by ChatGPT! END

By: Amith K.K.

The author is a senior developer specialising in emerging technologies. He started his journey with open source at the age of 12 and has never looked back since!

Is Metaverse just a Poorly built Video Game or a Great Marketing Tool?

What do INTERPOL, Flipkart, Union Bank of India, and Virat Kohli have in common? They all entered the metaverse in the past quarter.



A room in The House of Enlightenment, Deepak Chopra's personal home in the metaverse (Courtesy: Seva.Love)

Virtual reality (VR) gear is still too expensive for most people. Technically, you can enter the metaverse without it using a normal web browser. But, sadly, it feels like a badly designed video game without the proper gear!

Facebook, which betted big on the metaverse and even changed the name of the company to Meta to reflect its commitment to the concept, is not doing so well. And industry-watchers are suggesting the company should start focusing on other things, and even change the name again. What's more, Apple CEO Tim Cook thinks the metaverse is too bizarre a concept for common folks to understand and meaningfully incorporate into their daily lives.

Yet, none of this seems to discourage people—especially companies—from setting foot in the metaverse. Some early movers feel there will be tangible gains in the near future, while some are simply curious, and adventurous enough to explore and test the new waters. Others are driven mainly by the fear of missing out.

Whatever be the motive, there is undoubtedly a lot happening in this emerging new world called the metaverse. Therefore, we continue to bring you our quarterly update.

E-tailers wooing customers in the metaverse

All major e-commerce brands have been experimenting with the metaverse in the past few months. As part of its Great Indian Festival, Amazon brought its Metaworld experience to a few Indian cities, including Bengaluru, Hyderabad, Kanpur, and Nagpur. This was an expo kind of setup, replete with actual physical events like concerts and games.

The highlight, however, was the kiosks that visitors could use to experience the virtual Metaworld. Here their *avatars* could browse through their favourite Amazon categories, as well as play against each other to win offers and deals.

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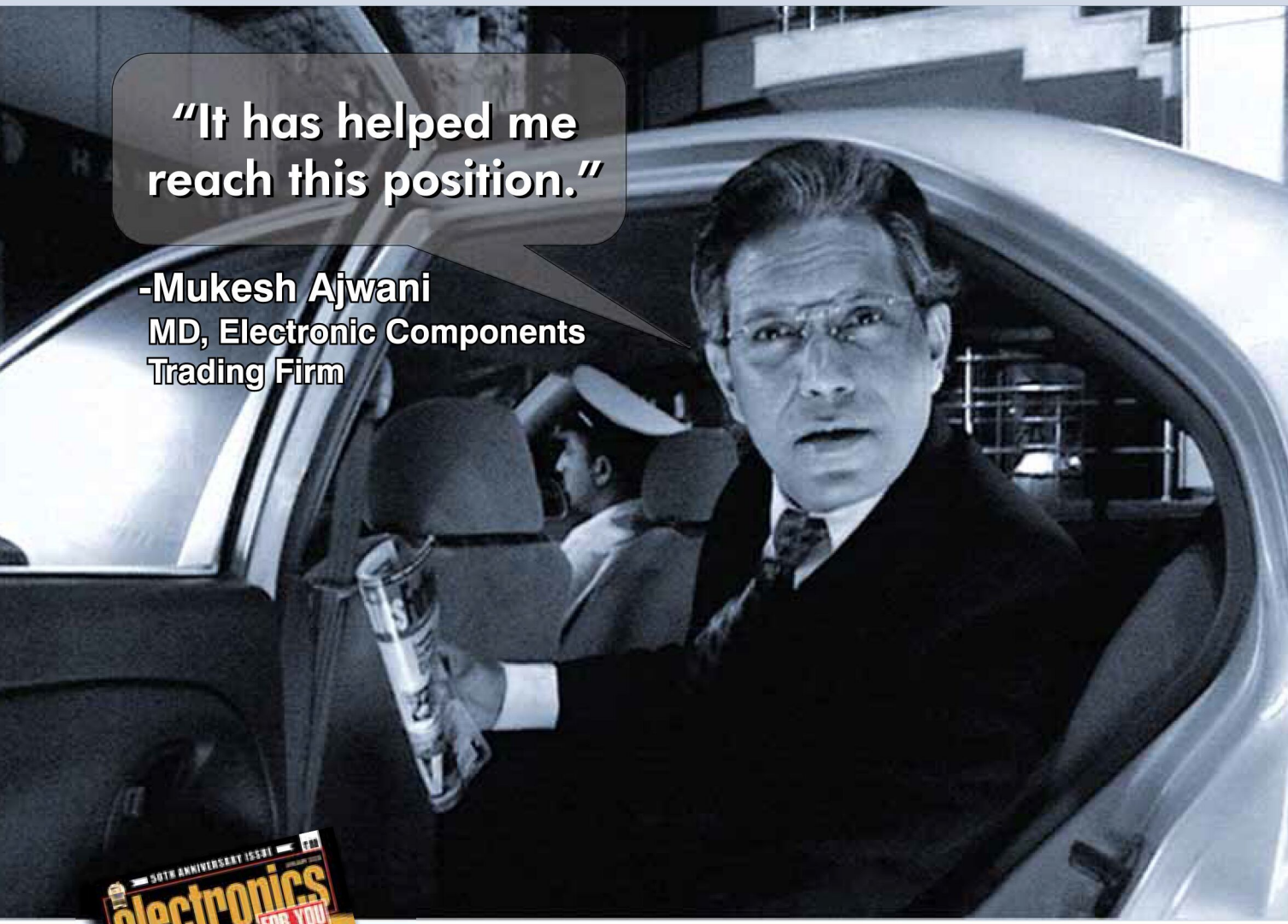

Mr Ajwani is not the only one who owes his success to *Electronics For You*. The technology magazine that started off in 1969 is today, South Asia's most popular one. Covering the latest on emerging technologies, changing industry trends, evolving trade practices...

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In October, Flipkart also trialled its Flipverse on the Polygon platform. Several well-known brands, including Puma and Noise, participated in the week-long pilot run. Touted to be the company's entry into Web3, and as the beginning of E-commerce 2.0, Flipverse gives users an AAA gaming environment (a high-profile, high-budget, high-performance gaming experience, informally expanded as a lot of money, a lot of resources, and a lot of time) where their digital avatars can discover products, unlock special offers, and purchase unique collectibles.

The company aims to enter the next level of consumer engagement and retention through Flipverse by creating a bi-directional bond between users and their favourite brands. Flipverse apparently features a very photorealistic visual space, and also lets users build photorealistic digital avatars from selfies.

According to a Polygon blog, "The crown jewel in the Flipverse is eDAO's The Strand, a free collectible that opens access to intellectual properties (IPs), brands, and culture. The Strand gives users a tangible connection to their beloved icons, artists, and brands. It is a promise that you will always be a citizen of the culture multiverse. Over 75,000 have been activated to date."

In September, Walmart launched Walmart Land and Walmart's Universe of Play on the popular metaverse platform Roblox. Basically, digital avatars can move through the space and collect coins strewn around, or play games to earn them and spend them at a virtual store to buy virtual merchandise—termed as 'verch'—for their digital avatars. Well, sounds like just another virtual reality game (creating the fear of missing out).

Speaking at the Yahoo Finance All Markets Summit in October this year, Suresh Kumar, the global CTO of Walmart, remarked that the way customers are getting inspired and are discovering products is changing. Hence, in the future, live broadcasting on the metaverse and marketing through social media platforms would be effective ways to reach a large segment of consumers.

He also predicted that Bitcoin might play a significant role in that environment's payment system, adding that both physical and virtual goods would be purchased using crypto. Some of Walmart's patent applications indicate that the company is working on creating digital currency, tokens, and non-fungible tokens (NFTs) for the metaverse.

Automakers and others too

Not just e-tailers, but even offline brands are dipping their feet in the metaverse. We caught up with the long list of automakers launching models on the metaverse in September's metaverse round-up. This included names like Mahindra, Maruti Suzuki, MG Motor, and Hyundai.

More of them joined this quarter. TVS Motor Company, a leading two-wheeler manufacturer headquartered in Chennai, launched the TVS Raider with SmartXonnect technology on their metaverse platform, TVS Motoverse. According to the company, this is the first motorcycle to be launched on the metaverse.

In October, 1Verse and Tyremarket.com launched the world's first fully-integrated metaverse based dealership to sell two- and three-wheel electric vehicles (EVs) throughout India. They have adopted a fusion model, which allows users to shop through local metaverse kiosks (basically local dealers equipped with VR gear), or through their own computers or mobile phones. Through a newly-formed subsidiary, Tyremarket.com provides sales expertise, local EV distribution, technology enhancements, and access to tens of millions of existing customers in India.

"1Verse features the capability to create metaverse EV storefronts, where brick and mortar sales infrastructure is limited. Instead of traveling 50 miles or more to an EV dealership, people will be able to access a physical location right near them, where they can look at, customise and even test drive the EV that they want to purchase," says Prashanth Joshua, co-founder and CEO of 1Verse.

Potential buyer exploring EVs on metaverse dealership (Courtesy: 1Verse)

Democratising the metaverse

Recently, Reliance Industries Limited (RIL) posted the proceedings of its second quarter earnings on the metaverse. This was done using GMetri, a platform on which you can create your metaverse within minutes without any coding at all. The metaverse content included over an hour of results summary and commentary by the top management, as well as several slides, graphics, transcripts, and quotes that analysts could view and download. It could be accessed using any device, even smartphones and laptops, without the need for any VR or augmented reality (AR) gear.

GMetriXR is a no-code toolkit to create, manage, and track your own metaverse. It is replete with a large number of ready-to-go media assets and gamified features, which you can put together to create an immersive environment. The company is aiming to democratise the metaverse, so anyone can create their own space without any prior experience or coding skills.

Democratisation seems to be a prominent theme today. Shriram

Group's Novac Technologies was speaking on similar lines when they showcased their tools at the Gulf Information Technology Exhibition (Gitex) in Dubai this October. Novac believes that Indian companies are more comfortable having their own metaverse domain rather than having to buy land in decentralised ones like Decentraland or The Sandbox, and they help them with this requirement. They have over 50 clients in the manufacturing space. For most, they have helped create digital twins replicating the physical models in their factories for training across departments, including operations, human resources, and administration. They have also developed several immersive soft skills training courses in association with a European company called Bodyswaps.

Inside Walmart Land (Courtesy: Roblox)

In a media report, Pradeep B., associate vice president, Novac, remarked that financial services companies are also now interested in tapping into the potential of the metaverse for branding and product development. "For instance, banks are likely to have digital avatars of real bank executives alongside existing AI-powered chatbots to help customers during and after office hours," he said.

On the same lines of democratisation, digital entertainment and technology company JetSynthesys announced in September that it has acquired a major stake in Metaphy Labs to offer metaverse-as-a-service (MAAS) to brands desirous of building their own metaverses, with immersive user experiences and meta-commerce as well. JetSynthesys is backed by famous investors like Kris Gopalakrishnan, Adar Poonawalla, and Sachin Tendulkar.

NVIDIA has also fashioned a neat MAAS offering, especially suited for manufacturing industries. NVIDIA CEO Jensen Huang explained in a recent media report that, "When you say 'metaverse,' they imagine putting on VR headsets, but it's obviously not just that. You can do that, but you can also enjoy it in 2D. One of my favourite ways of enjoying the metaverse is a whole bunch of robots in the metaverse doing work and communicating with robots that are outside in the physical world. The physical world and the metaverse can be connected in a lot of different ways. It doesn't just have to be humans. It can be machine to machine."

As part of Omniverse Cloud—a suite of cloud services for metaverse applications—NVIDIA is rolling out simulations for developing, testing, and managing artificial intelligence based robots and autonomous vehicles. Omniverse's 3D collaborative tools run on NVIDIA's well-known chips and hardware, including NVIDIA OVX—a computing system specifically designed to power large-scale digital twin simulations, which replicate real-world spaces in a metaverse environment.

Banks too have started banking on meta

After the pandemic, which proved that online services are indispensable, banks and other financial institutions are looking at the metaverse as one more way to stay in touch with customers. The first bank to enter the metaverse was perhaps JP Morgan, which opened a lounge called Onyx on Decentraland in February this year to engage with next-gen users. Subsequently, HSBC also opened a similar lounge on The Sandbox.

In July this year, Union Bank of India launched its metaverse virtual lounge, the Uni-verse, in association with Tech Mahindra. Users can roam around the lounge and get information about bank deposits, loans, government welfare schemes, and so on. The bank plans to use the lounge to publicise its products, but does not intend to enable transactions on it in the near future.

Recently, Kiya.ai, a Mumbai based fintech company, launched Kiyaverse—supposedly India's first banking metaverse. Banks as well as non-banking finance companies (NBFCs) can use the platform to create their own in-branch experiences on the metaverse. Users can access the platform through multiple interfaces, including digital banking units, mobiles, laptops, VR headsets, and mixed reality (MR) environments. Through their virtual avatars, users can interact with a virtual relationship manager, and avail basic and value-added services like portfolio analysis, wealth management, co-lending, and corporate banking.

Kiya.ai will also offer various analytics based services to its partner banks and NBFCs. Future phases are likely to support central bank digital currencies (CBDCs) for transactions and interoperability with other metaverses. Open application programming interface (API) connectors with aggregators and gateways will eventually enable a banking super-app and marketplace.

They hope to give users a near real-world interaction experience with haptics-enabled headsets and using the 'Internet of Senses.' The Internet of

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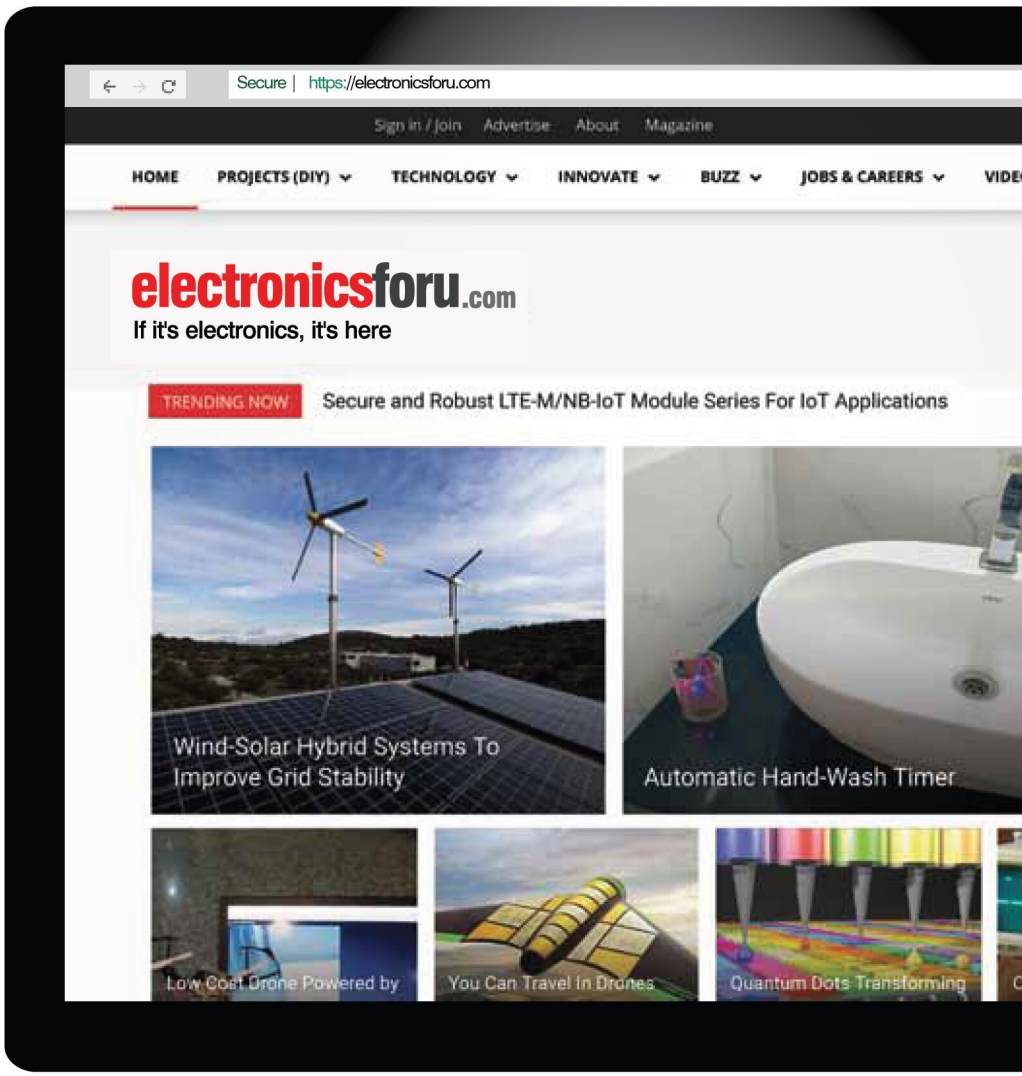

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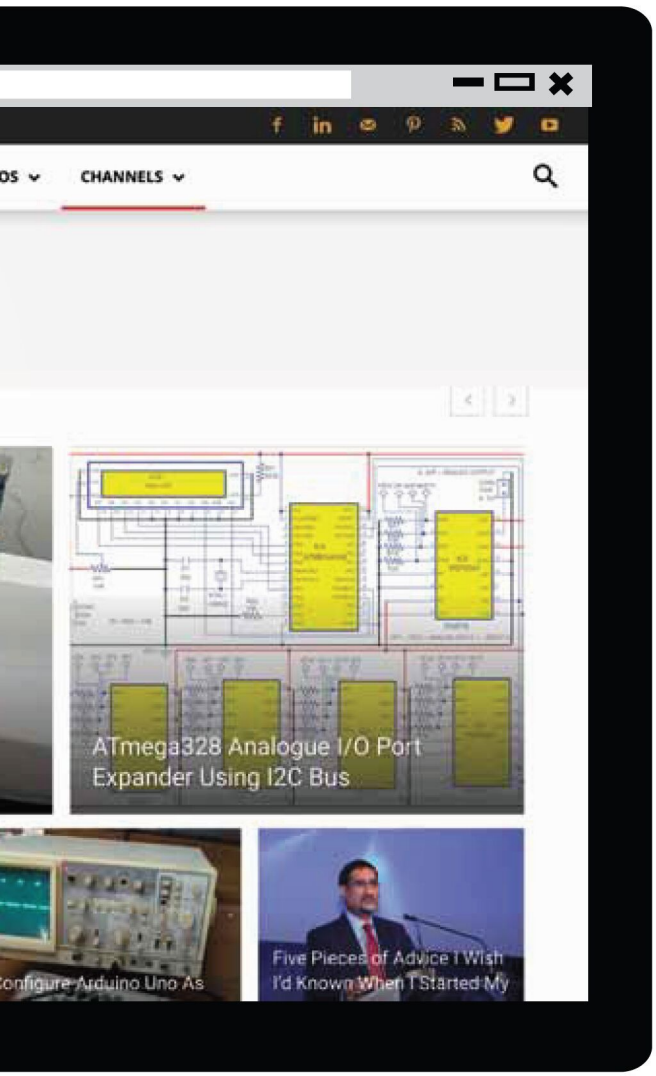

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Senses is a concept floated last year by Ericsson as part of its vision for 2030. It proposes the idea of a full sensory immersion in cyberspace, made possible by the low latency and high bandwidth of 5G.

Users can tour a virtual facsimile of the INTERPOL General Secretariat headquarters in Lyon, France without any geographical or physical boundaries (Courtesy: INTERPOL)

The new-age collectibles

Movies and cricket are two undying passions in India. Digital collectibles, that is NFTs, are likely to do well in both these fields.

A couple of months back, Singapore based Vistas Media Capital partnered with *Rocketry - The Nambi Effect* to introduce NFTs themed around the movie plot and scientific research on their metaverse space called the VistaVerse. It was a runaway success, with more than 10,000 NFTs being claimed.

Zee Entertainment Enterprises, the well-known media house, opened its Tech & Innovation centre in Bengaluru a couple of months ago. Among other things, the centre will focus on Zee's metaverse, the Zeeverse, which will offer numerous interesting NFTs from the movies, music, and shows that the company holds the license to. According to the company, viewers will also be able to meet their favourite stars through the Zeeverse.

Earlier this year, T-Series announced a partnership with Hefty Entertainment, a division of Hungama Digital Media, to drop NFTs that leverage its mega content library.

In October, cricketer Virat Kohli tweeted that he was super pumped to enter the metaverse exclusively with FanCraze. This means, his fans can now buy digital collectibles, such as the digital version of a signed bat or poster, or a valuable cricketing moment, directly licensed from Kohli, and display them on their social media handles, trade them, and use them in various games.

Kohli joins a long list of Indian cricketers, including Rohit Sharma, Hardik Pandya, Suryakumar Yadav, Ravindra Jadeja, Shikhar Dhawan, Ravichandran Ashwin, Yuzvendra Chahal, and Shreyas Iyer, who have also partnered with FanCraze to drop digital collectibles and build a direct connect with their fans. "We view marquee athletes as artists who create their art on the field of play," said FanCraze CEO Anshum Bhambri, in a media report.

It does not stop with buying NFTs but leads to more ways of engagement. For example, fans may be able to get on a Zoom call with a player whose collectibles they own, go to a nets session with them, interview them, or have access to signed merchandise.

A new crime scene for INTERPOL

At the 90th INTERPOL General Assembly held in New Delhi in October, the global police organisation unveiled its new metaverse, designed specifically for law enforcement. Registered users can tour a virtual replica of INTERPOL's headquarters, interact with other officers via their avatars, and even take immersive training courses. During the demo, experts delivered a training on travel document verification and passenger screening using INTERPOL capabilities in a metaverse classroom. Students were then teleported to an airport where they were able to practically try out these skills at a virtual border point.

Law enforcers from around the world will benefit greatly from this metaverse in terms of remote work, networking, collaboration, collecting, and preserving evidence from crime scenes, and training in specific skills like forensic investigation. However, skilling up is not the only motive behind launching the metaverse. INTERPOL also wants law enforcers to better understand metaverse dynamics so they can prevent or address crimes therein.

The INTERPOL also announced the creation of an expert group on the metaverse, "to represent the concerns of law enforcement on the global stage—ensuring this new virtual world is secure by design."

According to a Gartner report, by 2026, one in every four people will spend at least an hour a day in the metaverse to work, study, shop, and socialise. On the other hand, the newly released INTERPOL Global Crime Trend report shows that crime has increasingly moved online. The World Economic Forum has also warned of social engineering scams, violent extremism, and misinformation on the metaverse.

As the metaverse grows, we are likely to see crimes against children, data theft, money laundering, financial fraud, counterfeiting, ransomware, phishing, and sexual assault and harassment. These will present significant challenges for law enforcement. Hence, this pre-emptive

step by INTERPOL to experience and understand the metaverse is extremely noteworthy.

"By identifying these risks from the outset, we can work with stakeholders to shape the necessary governance frameworks and cut off future criminal markets before they are fully formed," says Madan Oberoi, INTERPOL's executive director of Technology and Innovation. "Only by having these conversations now can we build an effective response."

Teams can meet and collaborate in NVIDIA Omniverse's real-time, photorealistic virtual environment (Courtesy: NVIDIA)

Diwali pujas and wellness *gyaan*

This Diwali, Totality Corp organised Lakshmi Puja on the Zionverse, its metaverse that is based on Indian culture and mythology! Zionverse offered users a choice of private or public rooms to experience the puja. Users could invite their family and friends to their private room through a QR code. In the public room, users celebrated with the rest of the community.

Speaking of spirituality and well-being, personal transformation coach Deepak Chopra announced the launch of the ChopraVerse, a collaboration between Seva.Love—a metaverse for wellbeing initiative, and Utopia—an emerging Web3 ecosystem. Deepak Chopra's home in the metaverse, The House of Enlightenment, has been designed by Vera Iconica Architecture.

As part of the initial launch, users can experience the house on the metaverse and purchase downloadable blueprints as NFTs. This is something interesting, because the design, which incorporates elements of eastern wisdom and design principles for wellness, can be replicated in the physical world using these blueprints. ChopraVerse will also feature gamified content for kids, to play and learn the secrets of wellness early in life. Checkout *https://www.chopraverse.io.*

Speaking to CoinDesk TV's *First Mover* in October, Deepak Chopra remarked that tech giants need better motivation for moving into the metaverse than just making money, if they want to make a true impact and avoid the fate of the dinosaurs!

AR, meta, mobiles, who will win the race?

Despite so many people trying to set foot in the metaverse, many global thought leaders and industry majors have radically different views about it. At the WSJ Live Conference in October, Evan Spiegel, founder of Snap Inc. argued that the future of computing is not the metaverse, and that most people would prefer augmented reality, which lets people harness computing power without forcing them to rely on a single screen. "The metaverse is 'living inside of a computer.' The last thing I want to do when I get home from work during a long day is live inside of a computer," Spiegel says.

More nuggets of meta news

- Adobe has added a new set of tools to its Substance 3D suite of creator tools, for users to create metaverse-ready immersive experiences. The company has signed a partnership with Meta to make Substance 3D available to users of the Quest VR platform, so they can build their own 3D content. According to Adobe, Substance 3D is already used by companies like Microsoft, Ubisoft, Epic Games, and NVIDIA to prototype and deploy early metaverse experiences.
- Ghaziabad based AnyTech Ventures has developed AnyTech Meta, a tech expo that is available 24×7, 365 days in the metaverse. According to the company, participants can look around virtual stores showcasing computer hardware, software, and other products from global manufacturers. They can get their questions answered through real-time, two-way audio conversations with company representatives and other users. This gives companies an opportunity to directly engage with the user community from across the world. AnyTech gives the exhibitors a number of options for integrating call-to-action (CTA) and point-of-sale (POS) systems into their metaverse spaces, allowing for extensive personalisation.
- Meta and Microsoft recently announced a partnership to enable the use of Mesh for Microsoft Teams, Windows 365, and Microsoft 365 apps like Excel, Outlook, and PowerPoint on Meta Quest virtual reality devices. This will make remote collaboration an exciting experience.
- The world is facing a real energy crisis. There is a shortage, and hence a rise in the price of oil, gas, and electricity. Miners have been taking flak from energy campaigners, since traditional proof-of-work (PoW) blockchains are very energy intensive. Moreover, increase in energy prices also raises the costs for miners, which could eventually force them to sell their Bitcoins, thereby pushing down prices. Experts feel this is the right time for miners to move to sustainable platforms like Ethereum 2.0, which relies on a far more energy-efficient proof-of-stake (PoS) mechanism.

At the same event, Greg Joswiak, senior vice president of Worldwide Marketing at Apple Inc., is said to have commented that the metaverse is a word he would never use! And Phil Spencer, head of Xbox at Microsoft, called the metaverse a "poorly built video game."

In a recent interview with Bright, a Dutch media house, CEO Tim Cook explained why Apple is still hesitant to join the metaverse hype. He said, "I always think it's important that people understand what something is. And I'm really not sure the average person can tell you what the metaverse is."

He instead bets on AR becoming the next big trend in computing. From teaching to medicine, there are many fields that it will revolutionise, and it is likely to be to the next generation what the internet is to us. "I think AR is a profound technology that will affect everything. Imagine suddenly being able to teach with AR and demonstrate things that way. Or medically, and so on. Like I said, we are really going to look back and think about how we once lived without AR," he remarked.

Nokia, on the other hand, seems to have a positive prediction for the metaverse. As reported by *The Spokesman-Review*, Nokia's chief strategy and technology officer Nishant Batra shared their belief that the mobile phone will be overtaken by a metaverse experience in the second half of the decade. "Widespread adoption of the technology from both corporations and consumers will be critical for it to really take off, and this will also depend on the availability of affordable, ergonomic wirelessly connected VR and AR devices," he added.

In the meanwhile, Meta, the name that comes to mind as soon as you think about the metaverse, is in dire straits. The company's market value has plummeted pathetically this year. With the steady drop in share prices, Mark Zuckerberg has already lost around 61% of his wealth since the start of 2022,

Microsoft 365 in VR (Courtesy: Microsoft)

according to the Bloomberg Billionaires Index. This has pulled him down from being the third richest person in the world to twenty-third.

In *Time to Get Fit—an Open Letter from Altimeter to Mark Zuckerberg* (and the Meta Board of Directors), Brad Gerstner, CEO of Altimeter Capital and Meta shareholder, wrote, "Meta has drifted into the land of excess—too many people, too many ideas, too little urgency. This lack of focus and fitness is obscured when growth is easy but deadly when growth slows and technology changes." To get its mojo back, Gerstner says Meta needs to get fit and focused. He recommends that they reduce headcount expense by at least 20%; reduce annual capex by at least $5 billion; and limit investment in metaverse/Reality Labs to no more than $5 billion per year.

Yet, Zuckerberg is not ready to give up. After posting a dismal third-quarter earnings statement, he is said to have defended the company saying, "I get that a lot of people might disagree with this investment but from what I can tell, I think this is going to be a very important thing... It's some of the most historic work we're doing that people will look back at over decades. Those who are patient and invest with us will end up being rewarded."

A McKinsey report predicts that the metaverse will add $5 trillion to the value of the global economy by 2030. Thought leader Bernard Marr states in a Forbes report that, "There's everything to play for, and 2023 is likely to be a key year for defining the direction it will take."

The metaverse is likely to emerge as an effective marketing channel. Industries will warm up to the idea of using 'digital twins' to bring in operational efficiencies. VR and AR technologies are likely to improve. And all of these might give the metaverse a much-needed fillip. We will see you with more metaverse news and trends next year! END

By: Janani G. Vikram

The author is a freelance writer based in Chennai, who loves to write on emerging technologies and Indian culture. She believes in relishing every moment of life, as happy memories are the best savings for the future.

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The Quantum Ecosystem of the Future

It will still take about a decade for quantum computing technology to be a part of our daily lives. Nevertheless, one of the most active areas of research and development nowadays is quantum computing. That's because the adoption of quantum processing units (QPUs) for both application-specific and general-purpose computing is likely as they develop from being just simple scientific testbeds to reliable devices.

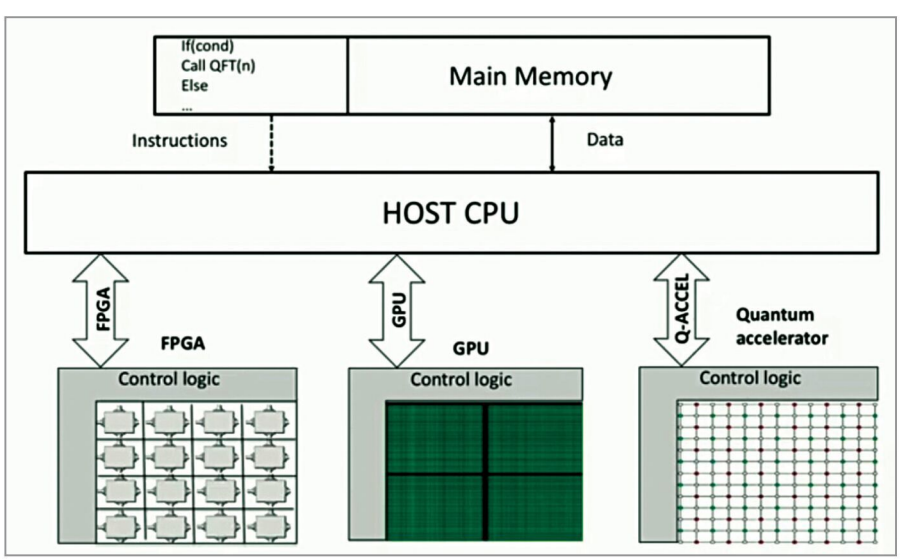
The term 'quantum chip,' or 'quantum processing unit,' or 'QPU' refers to a physical (fabricated) chip that has several interconnected qubits, or quantum bits. A QPU serves as the basic building block of a complete quantum computer, which also consists of the control electronics, the QPU's housing environment, and several other parts. A QPU enables a form of computation that's built on quantum physics—nature's operating system.

How a QPU differs from a CPU

A quantum computer (with QPU) operates in a fundamentally different way from a classical computer. A 'bit' in traditional computing (using a CPU) is a very small unit of binary data, which can be either a one or a zero. A processed bit is implemented by one of two levels of low DC voltage in traditional computer systems. The most recent variation of this concept is the 'qubit,' or quantum bit. Qubits use the phenomenon of superposition, which enables them to be in numerous states simultaneously, in contrast to binary bits, which can only be in either/or situations.

The capabilities of quantum computers surpass those of traditional computers, especially in terms of speed. A quantum computer can complete a task in two or three stages, whereas a classical computer needs thousands of steps to handle the same problem. Therefore, most quantum chips or QPUs are used as accelerators in heterogeneous multi-core computing devices. These can be connected with a classical processor (CPU) to provide a performance boost that cannot be achieved classically.

The classical control circuitry and the quantum processing unit (QPU) are two of the most important components of hardware in quantum computing. Some of the subsystems of the QPU include registers and gates (sometimes called QRAM), a quantum control unit for driving the system states, and circuitry to interface between the classical host CPU and the QPU. However, there are various types of QPUs with variations in the subsystems as well as the underlying principles.



An example of a heterogeneous multi-core system with a quantum co-processor that provides a substantial increase in computational power (Credit: QuTech Academy)

Types of QPU hardware

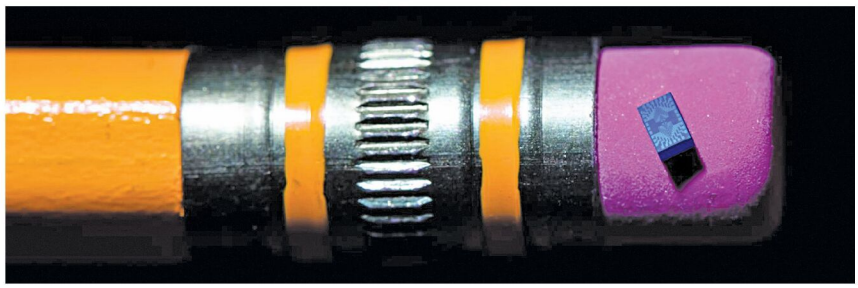
Spin based: The spin qubit quantum computer works by manipulating the spin of electrons and electron holes, which are the charge carriers in semiconductor devices. Here, individual charges and their associated spins are trapped in semiconductor quantum dots (QDs), which are subsequently utilised as qubits. Leti, Intel, Imec and others are working on this technology.

When asked why Intel focuses on silicon qubits in an IEEE Spectrum interview, Jim Clarke, director of Quantum Hardware at Intel said, "Silicon spin qubits look exactly like a transistor... The infrastructure is there from a tool-fabrication perspective. We know how to make these transistors. So, if you can take a technology like quantum computing and map it to such a ubiquitous technology, then the prospect for developing a quantum computer is much clearer."

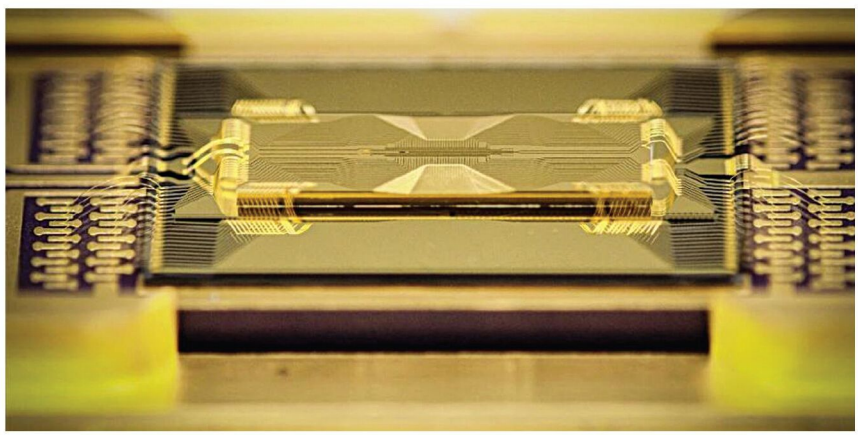
Trapped ion based: In this system, the qubits are ions trapped by electric fields and controlled by lasers, as the name suggests. The qubits are long-lived because trapped ions have relatively long coherence periods. They can also communicate with each other without difficulty.

Trapped-ion qubits are the technology of choice for research teams at numerous universities across the world as well as at firms doing similar work, like Honeywell and IonQ. In fact, IonQ has released what they claim to be the industry's first programmable multicore quantum architecture (RMQA), which is based on trapped-ion qubits.

Infineon Technologies and Oxford Ionics announced a partnership in July 2022 to develop highly effective, fully integrated QPUs. The innovative electronic qubit control (EQC) technology from Oxford Ionics provides a way to incorporate trapped ion qubits into Infineon's established semiconductor manufacturing processes.



Intel's silicon spin qubit chip balanced on a pencil eraser (Credit: Intel)



IonQ's EGT series ion trap chip (Credit: IonQ)

Superconductor based: One of the most promising methods for creating quantum computers is using superconducting qubits. Superconductivity, being a quantum phenomenon, permits us to employ superconducting circuits as controllable quantum systems. The Eagle quantum processor, based on the transmon superconducting qubit architecture, was introduced by IBM Quantum in November last year. It has 127 qubits. By 2023, the company plans to release a processor with 1121 qubits.

Some interesting developments in the quantum world

- In June 2022, Rigetti Computing, a pioneer in full-stack quantum-classical computing, announced the launch of its 32-qubit Aspen-series quantum computer in the UK.
- Nvidia, in July 2022, announced its new Quantum Optimized Device Architecture (QODA) framework, which will help accelerate developers' efforts around hybrid classical-quantum projects.
- For 2022 and 2023, IBM is developing processors with 433 and 1121 qubits, respectively.
- Google plans to develop a 1-million qubit processor by 2029.
- In April 2022, researchers at Intel and QuTech created the first silicon qubits at scale at Intel's D1 manufacturing factory in Hillsboro, Oregon.
- Recently, a QPU developed by Canada based company Xanadu has outrageously outperformed a classical system in a computing task, bringing down 9000 years of compute to 36 microseconds!

How to select a suitable QPU for your application

Every firm has a different set of insights that it needs in order to make the best choices. Based on your organisation, your current applications, and your computational needs, you need to take a decision on whether to use QPUs or not. First, you need to check if you have truly potential applications of quantum computing, and whether you have the funds to facilitate them.

As seen previously in this article, every quantum computer is built using a somewhat distinct hardware design and a multitude of qubit kinds. Each can also have a different architecture. Because

Some common use cases of QPUs

- ***Medical and pharmaceutical:*** By reducing the reliance on trial-and-error and increasing efficiency, the target identification, drug design, and toxicity testing might all be far faster, more targeted, and more precise thanks to quantum processors.
- ***Automotive:*** Quantum computing has applications for the automobile sector in research and development, product design, supply-chain management, production, mobility, and traffic control.
- ***Artificial intelligence:*** With regard to applications in artificial intelligence, quantum computers' capacity to analyse enormous data sets, simulate intricate models, and swiftly resolve optimisation issues has attracted interest.
- ***Logistics:*** Optimisation comes easily to quantum computers. Theoretically, a quantum computer might solve a challenging optimisation issue in a matter of minutes that would take a supercomputer years to complete. Hence, it can help tackle difficult logistics challenges.
- ***National security:*** Global governments, including the government of India, are making significant investments in quantum computing research projects, mainly to boost national security.
- ***Defence:*** Quantum computers could be used for a variety of defence-related tasks, including cracking spy codes, simulating battles, and creating better materials for military equipment.

A customised QPU for your application

QuantWare, a Netherlands based company, has declared that it can now provide researchers and other companies in the field with a custom 25-qubit QPU. This new QPU can be delivered, according to QuantWare, in just 30 days! Buyers can select the components they want for the new QPU from a library, and they can also decide how the qubits are connected based on their individual requirements.

of this diversity, certain systems will be more effective at resolving various types of issues than others. Therefore, you must be prepared to consider a variety of factors while selecting a QPU for any application. Here are some pointers that will make that decision easier.

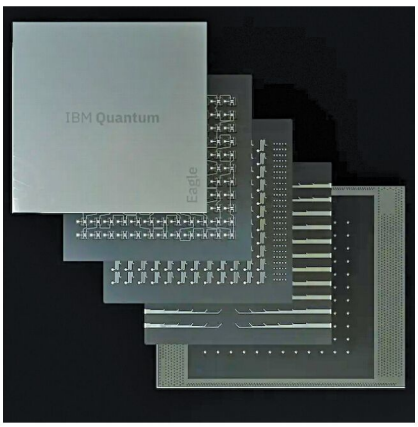
Identifying and analysing the problem: First, you need to identify the problem in your company or organisation that has the potential to be solved by quantum computing. The ideal strategy is to first identify the parameters that most likely indicate quantum opportunities. These parameters include complexity, problem size, potential for more precise outcomes, and potential for quicker turnaround times for results.

You should then analyse the problem in terms of its processing and mathematical computing requirements, then relate those requirements to the capabilities of a variety of QPUs. Refer the box item above to have a look at some common use cases of QPUs.

Testing the QPU: Before investing, you need to test the system to make sure it meets your requirements and benchmarks. The typical method would be to perform a number of tests for a few qubit operations and compare the findings with those from a conventional (classical) computer model imitating the quantum tech.

Be aware that the output of quantum computers differs from that of classical systems. A quantum computer, for instance, produces a variety of outcomes for optimisation problems that all satisfy the optimisation requirements. Classical systems only produce the best outcome.

Testing the software: To operate a quantum computer, new code and algorithms must be written. In order to test them, you can either test a single algorithm on a quantum computer or use ready-to-run software.



The Eagle Chip (Credit: IBM Quantum)

Important performance metrics of a QPU

In their paper, High-Performance Computing with Quantum Processing Units, researchers Keith A. Britt and Travis S. Humble identify various performance metrics of QPUs, which capture the interplay between system architecture and the quantum parallelism that underlies computational performance. Here, FTQEC stands for fault-tolerant quantum error correction, an error correction technique commonly used in QPUs.

"The comparison of these metrics with each other offers a quantitative means of assessing the value of QPU-enabled systems, but only when they can be related to existing system metrics, e.g., FLOPS, etc," wrote the authors.

India and the quantum race

With strategic partnerships, budding startups, early investments and adoption, India has joined the quantum race and aims to be the quantum hub of the future. "Indian philosophy and scriptures have been talking about quantum, and it is the basis of the Indian Vedanta system," says Sunil Gupta, co-founder & CEO of QNu Labs.

QNu Labs is a great example of an Indian quantum startup. In fact, it is India's only quantum-tech cybersecurity company as of now. It is trying to reimagine cybersecurity in a futuristic way, build it here in India, and then take it to the whole world.

Another example would be BosonQ, a Bhilai based startup founded in 2021. The company creates cutting-edge software for quantum computing, such as multidisciplinary optimisation, computational aeroacoustics, computational fluid dynamics, computational structure dynamics, and computational heat transfer.

On the research front, a collaborative declaration to create a virtual network centre for quantum computing was signed by the governments of India and Finland on April 18, 2022. Even IBM is planning to create a national quantum plan in India. Institutions like TCS, DRDO, TIFR and many educational institutions are also working towards the same broad goal—developing a quantum ecosystem in India.

Metric	Significance
Number of Qubits	Problem size capabilities
FTQEC Qubit Overhead	Number of additional qubits required to implement FTQEC
FTQEC Gate Overhead	Number of additional gates required to implement FTQEC
Clock Cycles Per Gate	Basis for determining quantum computation time
FTQEC Latency	Additional computation time needed to incorporate FTQEC
Number of Gates	Number of gates used to complete circuit
Sample Rate	The life-cycle frequency to obtain a result and reset a circuit to obtain an additional result
Entanglement Latency	Time needed to initially entangle a set of qubits
Entanglement Rate	Time needed to refresh or reestablish entanglement between a set qubits
Intra-QPU Connectivity	The number of qubits a single qubit can entangle with directly
Inter-QPU Connectivity	The number of qubits a single qubit can entangle with indirectly or at a remote site
Teleportation Rate	The rate at which quantum data can be exchanged
ISA Complexity	The diversity of gates that can being executed

Metrics of a QPU (Credit: Keith A. Britt and Travis S. Humble, ACM Journal on Emerging Technologies in Computing Systems, Vol. 1, No. 1, Article 1)

In a relatively short period of time, India certainly seems to be advancing its capabilities in quantum technology. And there's a lot more to come. END

By: Aaryaa Padhyegurjar

The author is an Industry 4.0 enthusiast at EFY with a keen interest in innovation and research.

The article was originally published in the November 2022 issue of Electronics For You.

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FOCUS

Trending tools

Platforms and Toolkits for Blockchain Development: A Quick Look

The blockchain is today being used in a range of applications and fields, including e-governance, logistics and financial transactions. There are quite a few platforms and toolkits that are available today that can be used for developing a blockchain.. *Read more on page.....48*

Open Source Tools for the Modern Workplace

Organisations need a wide range of software tools in order to run efficiently, especially with a large section of their workforce working from home, fully or partially. Thankfully, there are quite a few open source tools they can rely on.
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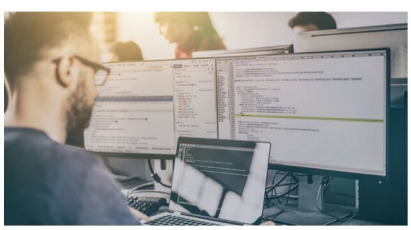
Popular IDEs for Developers and How to Choose One



Get acquainted with the popular open source IDEs, and find out how to make an informed decision while selecting one.
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Ten New Age Technologies Built on Open Source

Let's take a quick look at ten new age technologies that are fuelled by or almost fully based on open source.
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10 Useful Tools for DevOps Engineers

Here's an overview of ten tools that can be used by DevOps practitioners.
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Open Source: Emerging Tech in 2023!

Here's a brief overview of the emerging technologies and trends in the field of IT. What's interesting is that these are backed by some highly innovative open source software.
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Ten New Age Technologies Built on Open Source

Let's take a quick look at ten new age technologies that are fuelled by or almost fully based on open source.

Today's technologies seamlessly combine machine-like accuracy and agility with human-like learning and evolution. Open source has played a vital role in the development of these technologies that promise to rule the world in the years to come. Ten new age technologies that are based on open source, which we will rely a lot on, are briefly listed here.

1

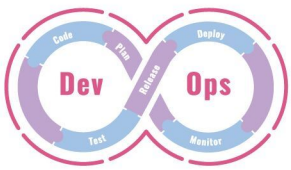
AI or artificial intelligence

In simple words, AI refers to the intellectual intelligence of smart machines in areas like problem-solving, taking decisions, human-like comprehension and perception. As opposed to their conventional counterparts that just follow instructions and execute as programmed, AI-powered machines can not only take instance-based decisions but also gain more efficiency and capabilities over a period of time.

AI includes reactive AI, and machines with limited memory, mind theory and self-awareness. Though work on the concept began in the 1960s, it was in 2006 that the term gained popularity. Today AI is used in one way or the other across different sectors like banking and finance, retail, government and healthcare, among others.

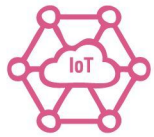
2

DevOps or development and operations



DevOps refers to different tools and practices that combine software development and operations – hence, the name DevOps. It works in the areas of software development and IT operations by automating production and deployment processes between them to significantly speed up tasks, eliminate execution discrepancies and delays, and thus enhance the organisation's IT productivity. DevOps works throughout the entire SDLC (software development life cycle). As compared to the conventional infrastructure management process and development methods, DevOps can help improve products at a quick speed due to its robust architecture.

3



IoT or Internet of Things

IoT or Internet of Things refers to a system equipped with sophisticated software, sensors and various high-end technologies. IoT seamlessly connects with a massive number of computing devices, machines and digital devices over communication/internet connections across the globe. It enables seamless data exchange between those devices. Open source is the vital enabler of IoT platforms and processes. In simple terms, IoT creates a communication system between different devices to boost their performance and applications.

4

Cyber security methods

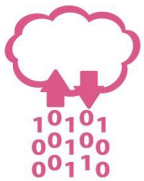
Cyber security has become a huge challenge in the modern data-enabled era. With the help of powerful open source based cyber security methods, the probability, frequency and magnitude of cyber attacks can be remarkably reduced. These methods focus on providing failsafe protection against unauthorised system/network exploitation by threat actors or bots.

5

AR/VR or augmented reality/virtual reality

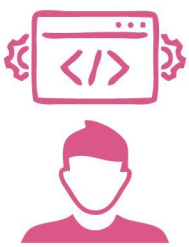
AR or augmented reality refers to the interactive experience brought about by the strategic use of digital audio/video elements. VR or virtual reality refers to simulating real-life scenes so sophisticatedly that a user feels fully immersed in the surroundings. It is achieved through advanced computer modelling, 3D visuals and a finely simulated environment. There are three broad types of VR — non-immersive, semi-immersive and fully-immersive. While AR works in a real-world setting and can be experienced on a mobile device, VR is fully virtual in nature and you will require a headset to experience it. While VR works on an entirely virtual model, AR enhances both spheres — real and virtual.

6 Cloud computing



Cloud computing enables storage of massive volumes of data across multiple, globally-accessible remote servers rather than a centralised storage device like a hard drive. This data is accessible through the net, and can be monitored, managed, accessed, shared across different stakeholders in real-time. It utilises middleware to establish flawless, real-time connectivity between devices and computers. Though it has become popular only recently, its history goes back to 1960 when it was first invented by Joseph Carl Robnett. Cloud computing can further be divided into other types like IaaS, PaaS and SaaS.

7 Full stack development



Full stack development refers to the backend (server-side) and frontend (client side) areas of web applications. A full stack developer can be compared to an all-rounder when it comes to front- and back-end development, as well as debugging and database management of any web application. The training for such a developer is hard but comes with high rewards due to wider career opportunities, better remuneration and good career prospects. Developers in this field need good professional knowledge of UI/UX management, graphics design and other skills.

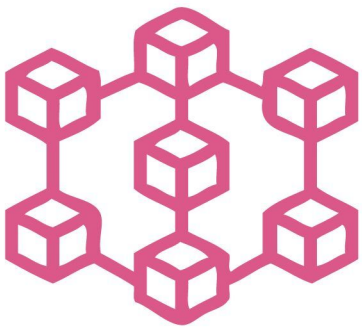
8 Big Data and analytics

To gain the maximum value out of data, you need to extract, structure, categorise and analyse it. Big Data and analytics make it easier to analyse massive amounts of diverse sets of data from multiple sources. They track different platforms for diverse types of data — structured, semi-structured, and unstructured. Big Data and analytics also assist organisations with purpose-built tools/mechanisms for data extraction, storage, and analysis to get logical insights. Businesses use it to understand correlations, current market trends and different types of patterns.

9 Robotics

Robotics is a multi-disciplinary field of engineering and computer science that includes all the tasks related to it like conception, design and manufacturing, and operations. It also involves strategic implementation of robots for meeting specific objectives. It enhances IoT services by collecting data, as well as understanding and manipulating movements. Robotics proactively assists human beings perform highly complicated, risky and humongous tasks with the help of robots.

10 Blockchain technology



Blockchain is a fully decentralised digital ledger, which is publicly distributed with a massive amount of encrypted blocks for recording various transactions in a trackable format. It uses sophisticated mechanisms to ensure maximum transparency and security to fully eliminate centralised control of information. These include cryptography, time stamps and chronically organised transaction data. Blockchain developers should be familiar with data structures, networking and cryptography. It facilitates P2P transactions for exchanging funds, information and other vital data.

The ten new age technologies briefly described above help institutions and individuals to extend their operational skills, knowledge, productivity and working speed, and are already transforming many fields. They have all been built on open source and signify the power of sharing.

By: Jitendra Bhojwani
The author is an open source enthusiast and a technical blogger.

Platforms and Toolkits for Blockchain Development: A Quick Look

The blockchain is today being used in a range of applications and fields, including e-governance, logistics and financial transactions. There are quite a few platforms and toolkits that are available today that can be used for developing a blockchain.

As per a report from *GrandViewResearch.com*, there is a huge scope for blockchain based implementations. Between 2022 and 2030, the market for blockchain technology is projected to increase at a compound annual growth rate (CAGR) of 85.9 per cent, from a market size of US$ 5.92 billion in 2021. Increased venture capital investment for blockchain technology startups is one of the reasons for this market expansion. For instance, blockchain technology supplier Circle Internet Financial Ltd revealed in May 2021 that it had secured US$ 440 million in investment from institutional and strategic investors. Legalisation of cryptocurrencies in nations like El Salvador and Ukraine is expected to open up new avenues for blockchain expansion.

The key applications and use cases of blockchain are:

- Cryptocurrencies and financial transactions
- Supply chain management
- Non-fungible tokens (NFTs)
- Digital health records
- Smart contracts
- E-governance
- Secured personal information
- Gaming
- Digital voting
- Internet of Things (IoT)

The blockchain market is divided into digital identity, exchanges, remittances, smart contracts, logistics management, and others based on applications. Blockchain technology increases the effectiveness of payment systems, lowers operational costs, and makes transactions transparent. Due to the advantages that it offers, its application in payment solutions is

growing. Blockchain eliminates the need for a facilitator in the processing of payments, which is another important reason for its growth.

According to data from *Statista.com*, the market size of blockchain technology has been growing quite quickly over the past several years, and is expected to reach close to US$ 40 billion by 2025.

The acceptance of cryptocurrencies in some countries is encouraging companies and investors to increase their investments in blockchain technology. Decentralised finance (DeFi) is a new blockchain-based financial system that lessens the power banks have over financial services and payments. Market growth of blockchain technology is anticipated to be driven by strategic efforts in the decentralised finance domain.

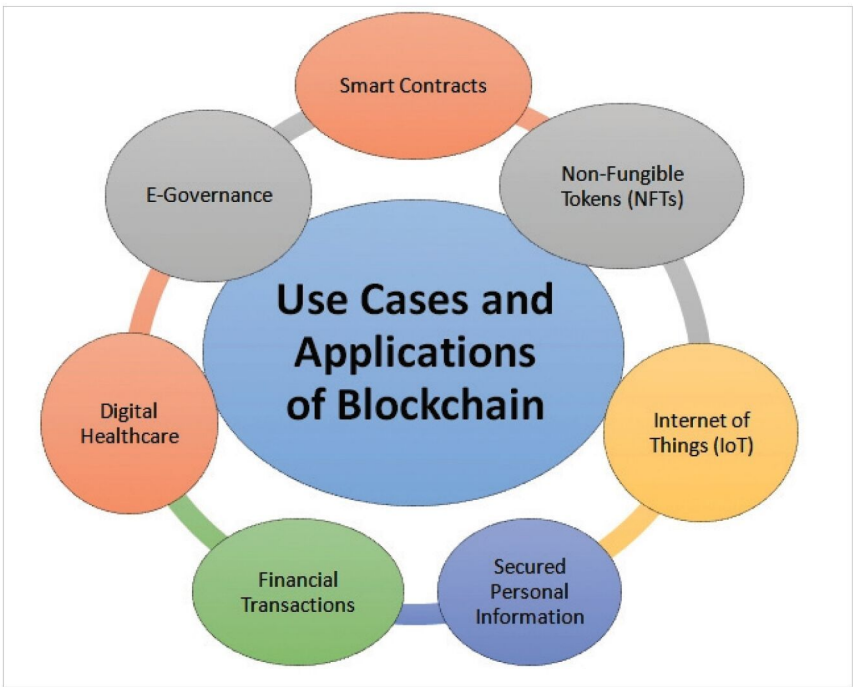


Figure 1: Use cases and applications of blockchain

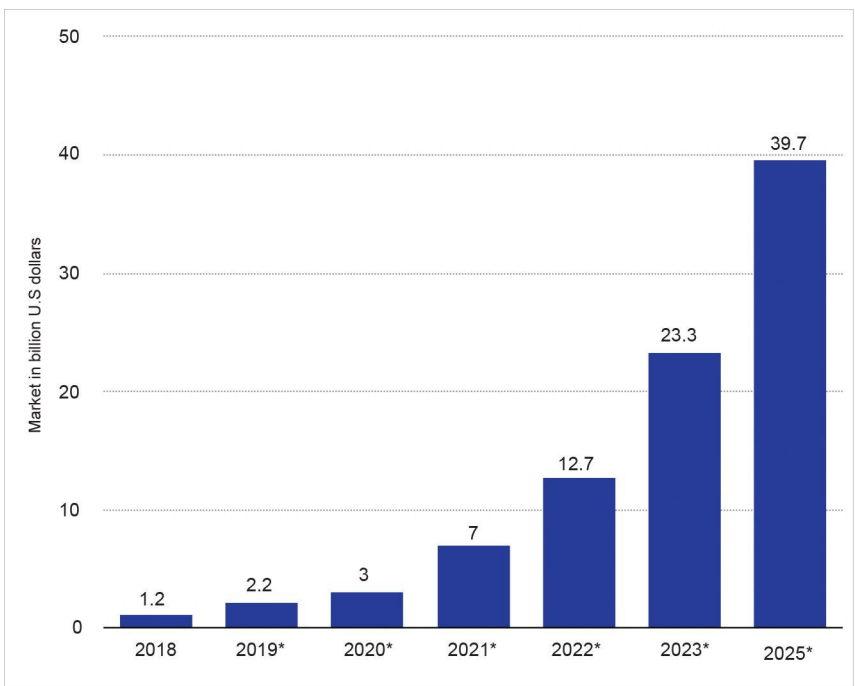


Figure 2: Market size of blockchain technology (*Source:* Statista)

Blockchain vs traditional applications

Blockchain improves the traceability, security, trustworthiness, and transparency of data shared across a corporate network while saving costs. The traditional web based applications are centralised, which can be exploited or hacked by malicious traffic.

Blockchain for businesses employs an open, unchangeable digital ledger that only authorised blockchain members can view. The nodes of the network control what data each organisation or member may view, and what actions they may take. Because business partners don't have to trust one another, blockchain is frequently referred to as a 'trustless' network.

This trust is based on the increased security, transparency, and immediate traceability of blockchain technology. Beyond issues of trust, blockchain offers commercial advantages such as cost savings due to accelerated speed, efficiency, and automation of transactions.

Blockchain technology has the potential to fundamentally alter how sensitive and important data is seen. It reduces fraud and illegal behaviour by generating a record that cannot be changed and is encrypted end-to-end. By employing permissions to restrict access and anonymizing personal data, privacy concerns are addressed. In order to prevent hackers from accessing data, information is kept across a network of computers rather than on a single server.

Without blockchain, every company needs to maintain a different database. Blockchain employs a distributed ledger, which ensures that transactions and data are recorded consistently across all locations. Full transparency is offered since any network user with permissions may see the same data at once. All transactions are time- and date-stamped records with immutability. Members may access the whole transaction history thanks to this, which almost eliminates the possibility of fraud.

Blockchain establishes an audit trail that records an asset's origins at each stage of its travel. This helps industries plagued by fraud and counterfeiting. Blockchain makes it feasible to directly communicate provenance information to customers. Traceability data can reveal weak points in any supply chain, such as items stored on a loading dock while being transported.

Traditional paper-intensive processes take a long time, are subject to human mistakes, and frequently need third-party mediation. Transactions may be finished more quickly and effectively by automating these operations with blockchain. The blockchain can hold both documentation and transaction information, doing away with the necessity for paper exchange. Clearing and settlement happens more quickly because there is no need to reconcile several ledgers.

With smart contracts, transactions can be automated, enhancing productivity and accelerating processes even further. The subsequent stage in a transaction or workflow is automatically initiated after pre-specified requirements are met. Smart contracts lessen the need for human involvement and rely less on outside parties to confirm that a contract's provisions have been adhered to. For instance, when a consumer files a claim for insurance, it can be immediately settled and paid once he or she has submitted all the required evidence.

Table 1: Frameworks, platforms and toolkits for blockchain development

Platform and software toolkit	How it can be used in blockchain development
Truffle Suite URL: *https://trufflesuite.com/*	Useful for smart contracts development and blockchain emulation
Solidity URL: *https://soliditylang.org/*	Multi-featured programming language for smart contracts
Vyper URL: *https://vyper.readthedocs.io/*	Secured and contract oriented programming language
Rust URL: *https://www.rust-lang.org/*	Efficient and reliable software for blockchain development
Hardhat URL: *https://hardhat.org/*	Extensible, fast and flexible environment for blockchain development
Embark URL: *https://framework.embarklabs.io/*	Powerful framework for decentralised apps development
ThirdWeb URL: *https://thirdweb.com/*	Framework for Web3 development in the blockchain environment
Geth URL: *https://geth.ethereum.org/*	Implementation patterns and modules for Ethereum

Platforms and toolkits for blockchain development

A number of frameworks and programming platforms are available to develop and deploy blockchain based applications. Table 1 lists some of the important ones.

Blockchain technology has a vast array of development frameworks and platforms for use in many applications. Many of these platforms are open source and free, and can be used to design and develop algorithms in a variety of fields, such as security, authentication, privacy, and cryptocurrency. END

References

- Blockchain Technology Market Size, Share & Trends Analysis Report By Type (Private Cloud, Public Cloud), By Application (Digital Identity, Payments), By Enterprise Size, By Component, By End Use, And Segment Forecasts, 2022 - 2030, Report ID: GVR-1-68038-329-4, *https://www.grandviewresearch.com/industry-analysis/blockchain-technology-market*
- Statista Research Portal, *https://www.statista.com/statistics/647231/worldwide-blockchain-technology-market-size/*

By: Dr Gaurav Kumar

The author is associated with various academic and research institutes for delivering expert lectures and conducting technical workshops on the latest technologies and tools.

10 Useful Tools for DevOps Engineers

Here's an overview of ten tools that can be used by DevOps practitioners.

DevOps is a culture and its implementation helps us to manage the application life cycle effectively by using automation. DevOps has three pillars:

- People
- Processes
- Tools

Tools play a critical part in DevOps or culture transformation initiatives. However, people and processes help to maintain uniformity and sustainability across business units or projects in an organisation. DevOps enables faster time to market with high quality products.

I have used a few tools and believe they will be very important in the implementation of DevOps and DevSecOps practices in 2023 and beyond. Let's take a brief look at what they offer.

1. GitLab

GitLab is the DevOps platform that provides features for different phases of software development, from planning to production. It helps to plan, develop, secure, and operate software in a single application. Its features include cache and artifact management.

GitLab is one of the most futuristic and forward-looking tools for the implementation of DevOps practices.

Initial release	2014
Stable release	15.7.1
Written in	Ruby, Go and JavaScript
Licence	Community Edition - MIT License
Website	about.gitlab.com
GitHub repository	*https://gitlab.com/gitlab-org/gitlab* *https://gitlab.com/gitlab-org/gitlab-foss/*
Features	• Highly scalable • Supports collaboration • Supports on-premise and cloud installation
How is it useful in DevOps practices implementation?	DevOps platform • Version control • CI/CD • Package management • Resource management • Security • Distributed architecture • Cloud support
Can we integrate it with Pipeline as Code?	Yes; Gitlab-ci.yaml
Is a commercial flavour available?	Yes
Pricing	DevSecOps platform: *https://about.gitlab.com/pricing/* *Free, Premium, Ultimate*
Community	Number of wider community contributors: 778
Use cases	• Digital transformation • Security and governance • Value stream management • Agile development • Source code management • Continuous integration (CI/CD) • Out-of-the-box pipelines • Security (DevSecOps) • GitOps • The DevOps platform

Important Git commands

Description	Command
Set a user name	*git config --global user. the name "Mitesh"*
Set email address	*git config --global user. email "xxxxxxxxx@xxxxx. com"*
Initialise a Git repository	*git init*
Clone a repository	*git clone https://github. com/xxxxxxxx/Angu- lar9786-DevOps*
Verify the status of files in the reposi- tory	*git status*
Add files in the cur- rent directory for commit operation	*git add*
Commit files	*git commit -m "First commit in the reposi- tory"*
List your branches	*git branch*
Switch branch	*git checkout*
Create a new branch	*git branch new-branch- name*
Merge current branch with the target branch	*git merge target-branch*
Show all commits	*git log*
Save modified and staged changes	*git stash*
Fetch and merge any commits from the remote branch	*git pull*

2. Jenkins

Jenkins is an open source tool that provides integration with the existing tools used in application life cycle management to automate all activities -- build, test, and deploy. It is almost a synonym for DevOps, and is one of the easiest to learn. It has a huge community for support. We can easily install Jenkins in the Kubernetes cluster and utilise multiple cloud services to make it highly available.

Jenkins provides a simple way to create a pipeline that includes continuous integration and continuous delivery. It can be used creatively for managing entire life cycle management activities easily. Plugin based architecture helps us to use the existing tools in the pipeline and hence too many changes in culture can be avoided in one go.

Initial release	2011
Stable release	2.375.1 LTS. More information at *https://www.jenkins.io/changelog-stable/*
Written in	Java
Licence	MIT
Website	*www.jenkins.io*
GitHub repository	*https://github.com/jenkinsci/jenkins*
Features	• Jenkins installation is supported for Docker, FreeBSD, Gentoo, MacOS X, OpenBSD, OpenSUSE, Red Hat/ Fedora/CentOS, Ubuntu/Debian, Windows, and Generic Java pack- age (*.war*) • Multiple views are supported along with folders to manage jobs in an easier manner • New UI for Jenkins dashboard with ease of use • New user interface to create Pipe- line as a Code in an easier way • Pipeline as a Code/multi-branch pipeline to manage pipelines easily in repositories • Distributed architecture to manage Jenkins effectively • Authorisation: Role-based access to users based on build jobs/fold- ers/pipelines/configurations/actions • Authentication: Integration with active directory, LDAP and with internal database
How is it useful in DevOps practices implementation?	Automation server that helps to auto- mate activities involved in application life cycle management
Can we integrate it with Pipeline as Code?	Pipeline as Code using Jenkinsfile • Declarative pipeline • Scripted pipeline • Pipeline as YAML • Blue Ocean
Is a commercial flavour available?	CloudBees Jenkins
Awards	• DevOps Dozen 2017: Best DevOps Open Source Project • DevOps Dozen 2016: Best DevOps Open Source Project • Bossie Awards 2014: The best open source application development tools • Geek Choice Award 2014 • SDTimes 100, 2014: DevOps & SCM • SDTimes 100, 2013: Development Tools & CI • SDTimes 100, 2012: Development Tools & CI • InfoWorld Bossies Award, 2011 • O'Reilly Open-Source Award, 2011 • SDTimes 100, 2011: ALM&SCM • SDTimes 100, 2010: ALM Plat- forms • GlassFish Community Innovation Award 2008 • Duke's Choice Award

Third party integrations	• More than 1500 plugins to integrate Jenkins with many open source and commercial tools *(https://plugins.jenkins.io/)* • Platforms (iOS development, .NET, Android development, Ruby development) • User interface (List view column plugins) • Administration (Agent controllers, Page decorators, Users and security, Cluster management, CLI extensions) • Source code management (SCM connections, SCM related) • Build management (Build triggers, Build wrappers, Build notifiers, Deployment plugins, Build parameters, Clean-up actions, Build tools, Build reports, Artifact uploaders)

3. SonarQube

SonarQube helps to clear bugs, vulnerabilities and code smell in the code. SonarQube 9.8 brings new rules across JavaScript, Kotlin, C++, and Python. It supports more than 20 programming languages for static code analysis (SCA).

It is much easier to integrate SCA using SonarQube in Pipeline as Code. It helps to transform the culture of an organisation from manual to automated code reviews with quality gates and quality profiles.

Initial release	2006-07
Stable release	9.8, *https://www.sonarsource.com/products/sonarqube/whats-new/sonarqube-9-8/*
Written in	Java
Licence	Lesser GNU General Public License
Website	*https://www.sonarqube.org/*
GitHub repository	*https://github.com/SonarSource/sonarqube*
Features	• Support for the programming languages Java (including Android), C#, C, C++, JavaScript, TypeScript, Python, Go, Swift, COBOL, Apex, PHP, Kotlin, Ruby, Scala, HTML, CSS, ABAP, Flex, Objective-C, PL/I, PL/SQL, RPG, T-SQL, VB.NET, VB6, and XML • Quality gates • Quality profiles
How is it useful in DevOps practices implementation?	Static code analysis
Can we integrate it with Pipeline as Code?	Yes
Is a commercial flavour available?	Yes

4. Docker

A Docker container image is a standalone package that contains all the dependencies required for running an application. This open source lightweight tool helps to create, deploy, and manage containers on a different host operating system using resource isolation features, such as cgroups and Linux kernels. Docker Desktop is a very helpful application for beginners and advanced users of MacOS, Linux, and Windows machines for building and sharing containerised applications and microservices. It can be used for free as part of a Docker Personal subscription.

A container can package application code, libraries, and configurations. The container engine is installed on the host OS.

Docker and Kubernetes have changed the game as Infrastructure as Code and Pipeline as Code have become a norm in recent times.

Initial release	2013
Stable release	20.10.22
Written in	Go
Licence	Apache License 2.0 Docker Community Edition
Website	*https://hub.docker.com/* *https://www.docker.com/*
GitHub repository	*https://github.com/docker*
Features	Easy management of applications Docker Hub – Public Registry Uniform packaging Integrates well with Kubernetes
How is it useful in DevOps practices implementation?	OS-level virtualisation, Containers
Can we integrate it with Pipeline as Code?	Yes
Is a commercial flavour available?	Docker Enterprise Edition

Docker commands	

Description	Command
Log in to the registry	*docker login*
To build an image from the Docker file	*docker build -t sample-app :1.0*
List all the images	*docker images*
Delete an image	*docker rmi imagename*
Create a container	*docker run --name containerName dockerImage*
Pull an image from the registry	*docker pull imageName*
Push an image	*docker push image-name: tag*
Clean and unused image	*docker image prune*
Switch branch	*git checkout*
Create a new branch	*git branch new-branch-name*
Merge current branch with the target branch	*git merge target-branch*
Show all commits	*git log*
Save modified and staged changes	*git stash*
Fetch and merge any commits from the remote branch	*git pull*

5. Trivy

Trivy is an open source yet simple and comprehensive vulnerability/misconfiguration scanner for containers and other artifacts. It can scan targets such as container image, file system, Git repository (remote), virtual machine image, Kubernetes, and AWS.

In my experience, it is easy to integrate Trivy scanning in Pipeline as Code and make sure that images are secure.

Stable release	V0.36.0
Written in	Go
Licence	Apache-2.0 License
Website	*https://aquasecurity.github.io/trivy/v0.36/*
GitHub repository	*https://github.com/aquasecurity/trivy*

Features	• Simple, fast and easy to install • Vulnerabilities detection for Docker images, Red Hat Enterprise Linux, CentOS, Oracle Linux, Debian, Ubuntu, Amazon Linux and other OS packages • Vulnerabilities detection for language-specific packages such as npm and maven • Secret and misconfiguration detection
How is it useful in DevOps practices implementation?	To find vulnerabilities of Docker images; DevSecOps
Can we integrate it with Pipeline as Code?	Yes. The pipeline stage can be used to analyse Docker images and publish the report
Example	*trivy image python:3.4-alpine*
Docker image	*docker pull aquasec/trivy*
Installation	• *apt-get install trivy* • *yum install trivy* • *brew install aquasecurity/trivy/trivy* • *docker run aquasec/trivy*

6. Terraform

Terraform is an open source 'Infrastructure as Code' tool, created by HashiCorp, which helps us to create immutable infrastructure to avoid the problem of configuration drift. This platform-agnostic declarative coding tool helps developers use a high-level configuration language to manage infrastructure.

Terraform supports different cloud providers and different services provided by cloud providers, as listed below:

AWS	Azure	Google Cloud Platform	Oracle Cloud Infrastructure
Alibaba Cloud	VMware vSphere	GitHub	Kubernetes
Apigee	GitLab	Artifactory	Octopus Deploy

Terraform Cloud is HashiCorp's managed service offering that helps you with infrastructure automation.

In my experience, this is yet another tool that has changed the game.

<table>
<tr><td>Initial release</td><td>2014</td></tr>
<tr><td>Stable release</td><td>1.3.6</td></tr>
<tr><td>Written in</td><td>Go</td></tr>
<tr><td>Licence</td><td>Mozilla Public License v2.0</td></tr>
<tr><td>Website</td><td>https://www.terraform.io/</td></tr>
<tr><td>GitHub repository</td><td>https://github.com/hashicorp/terraform</td></tr>
<tr><td>How is it useful in DevOps practices implementation?</td><td>Infrastructure as Code</td></tr>
<tr><td>Can we integrate it with Pipeline as Code?</td><td>Yes.
It can be part of Pipeline as Code and different strategies can be used to create resources and deploy applications in different cloud platforms.</td></tr>
<tr><td>Important Terraform commands</td><td>
<table>
<tr><th>Description</th><th>Command</th></tr>
<tr><td>Verify Terraform version</td><td>terraform --version</td></tr>
<tr><td>Install Terraform modules</td><td>terraform init</td></tr>
<tr><td>Check configuration and create a plan</td><td>terraform init -input=false</td></tr>
<tr><td>Execute the plan</td><td>terraform plan</td></tr>
<tr><td>Delete all resources</td><td>terraform apply</td></tr>
<tr><td>Validate/check the syntax of the Terraform files</td><td>terraform apply -auto-approve</td></tr>
<tr><td>Reformat Terraform configuration in the standard style</td><td>terraform destroy</td></tr>
<tr><td>Update the state to match remote systems</td><td>terraform plan –destroy</td></tr>
<tr><td>Show the current state or a saved plan</td><td>terraform validate</td></tr>
<tr><td>Show the current Terraform version</td><td>terraform fmt</td></tr>
<tr><td>Workspace management</td><td>terraform refresh</td></tr>
<tr><td>Show all commits</td><td>terraform show</td></tr>
<tr><td>Save modified and staged changes</td><td>terraform version</td></tr>
<tr><td>Fetch and merge any commits from the remote branch</td><td>terraform workspace</td></tr>
</table>
</td></tr>
<tr><td>Tutorials</td><td>https://learn.hashicorp.com/terraform</td></tr>
</table>

7. Kubernetes

Kubernetes or k8s is an open source, extensible, and portable container orchestration platform founded by Google. It provides declarative configuration and automation for deployment automation. It has become one of the most popular tools in DevOps practices implementation with its features related to deployment, management, and scaling applications in Kubernetes clusters. It works as a booster in managing resources effectively.

We can create a Kubernetes cluster in an on-premise environment as well as different cloud deployment models such as private and public clouds. Public cloud provides managed services for Kubernetes. Google Cloud Platform has Google Kubernetes Engine, AWS has Amazon Elastic Kubernetes Services (EKS), while Azure has Azure Kubernetes Service (AKS) for managing Kubernetes cluster in a cloud environment.

Some major removals, deprecations and changes in version 1.26 are:

- Based on inclusive naming initiative, the *--prune-whitelist* flag has been replaced with *--prune-allowlist*
- Dynamic kubelet configuration has been removed from the API server
- Deprecations for *kube-apiserver* command line argument *--master-service-namespace*
- Deprecations for *kubectl run* command line arguments such as *--cascade, --filename, --force, --grace-period,* and so on
- The v1beta1 flow control API group and the v2beta2 HorizontalPodAutoscaler API have been removed

Initial release	2014
Stable release	1.26
Written in	Go
Licence	Apache License 2.0
Website	*https://kubernetes.io/*
GitHub repository	*https://github.com/kubernetes/Kubernetes*
Features	• Distributed architecture • Easy integration with Docker • Supports hybrid, on-premise, or cloud environments
How is it useful in DevOps practices implementation?	Container orchestration and management. Combined with Infrastructure as Code practice, automation can be achieved in an end-to-end manner for resource provisioning based on the support provided by IaC tool.
Can we integrate it with Pipeline as Code?	Yes
Is a commercial flavour available?	Cloud flavours are available such as EKS, AKS, and GKE

Important Kubernetes commands

Description	Command
Get Kubectl Version	*kubectl version*
Get details on Kubernetes cluster	*kubectl cluster-info*
Get details about a node	*kubectl describe nodeName*
Get details about a pod	*kubectl describe podName*
List of all pods	*kubectl get pods*
List of all services	*kubectl get services*
List of all deployments	*kubectl get deployments*
List one or more nodes	*kubectl get node*
List all resources in the cluster	*kubectl get all –all-namespaces*

8. Lens

Lens Desktop is an exciting platform for working with Kubernetes. It is a distribution of the OpenLens repository with specific customisations, and is free of charge. For more details, you can visit *https://k8slens.dev/pricing.html*.

Lens is extremely useful for all those who are managing infrastructure, as it gives a 360 degree view of all the resources available in a cluster along with description and logs. You can also view YAML files for deployments, services, pods, secrets, and so on.

Initial release	2019 *(https://github.com/lensapp/lens/tags?after=v3.2.0-rc.1)*
Stable release	6.3.0
Written in	TypeScript, JavaScript, Makefile
Licence	MIT License
Website	*https://k8slens.dev/*
GitHub repository	*https://github.com/lensapp/lens*
How is it useful in DevOps practices implementation?	• Simplicity and increased productivity – no need to learn kubectl commands • Visibility in existing Kubernetes resources • Built on open source • Observability — live statistics, events, and log streams in real-time • Errors and warnings are directly available on the Lens dashboard • Supports EKS, AKS, GKE, Minikube, Rancher, k0s, k3s, OpenShift • Huge community support — 450,000 users and 17,000 stars on GitHub
Can we integrate it with Pipeline as Code?	N/A. Helps to view all the resources available in the Kubernetes Cluster.
Is a commercial flavour available?	Lens Pro is a complete solution for cloud native professionals. Monthly and annual billing included in Lens Pro: • Lens Desktop • Lens Teamwork • Lens Security • Lens Desktop Kubernetes • Community Forums and Slack • 24 x 5 commercial support

9. OWASP ZAP

In software security testing, we assess and verify a system against security risks and vulnerabilities. System security testing can be categorised as per the Open Web Application Security Project (OWASP) in the following way:

- Vulnerability assessment, where scanning and analysing of security risks are performed
- Penetration testing, where simulated malicious attackers attack the system and analyse it
- Runtime testing, where end users perform security testing
- Code review, where review and analysis of the system takes place to find vulnerabilities.

OWASP's Zed Attack Proxy (ZAP) is a flexible, extensible and open source penetration testing tool, also known as a 'man-in-the-middle proxy'. ZAP can intercept and inspect messages sent between browser and web applications, and perform other operations as well.

Automated pen testing is an important part of the CI/CD pipeline. Pen tests have stages such as explore, attack and report. OWASP ZAP fills the important gap of verifying applications and protecting them from multiple security threats.

Initial release	2014
Stable release	2.12.0
Written in	Java
Licence	Apache License 2.0
Website	*https://owasp.org/www-project-zap/*
GitHub repository	*https://github.com/zaproxy/zaproxy*
Features	• Intercepting proxy • Active and passive scanners • Traditional and Ajax spiders • Brute force scanner • Port scanner • Web sockets

Risk categories	• High • Medium • Low • Informational • False positive
How is it useful in DevOps practices implementation?	Penetration testing
Can we integrate it with Pipeline as Code?	Yes
Is a commercial flavour available?	N/A
ZAP Docker image scan	Docker stable image can be obtained using docker pull *owasp/zap2docker-stable:* 1. ZAP - baseline scan: It executes the ZAP spider against the specified target for 1 minute and then completes the passive scanning. **zap-baseline.py -t <target> [options]** 2. ZAP - full scan: It executes ZAP spider against the specified target, an optional Ajax spider scan and then a full active scan. **zap-full-scan.py -t <target> [options]** 3. ZAP - API scan: This is suitable to perform scans against APIs defined by OpenAPI, SOAP, or GraphQL **zap-api-scan.py -t <target> -f <format> [options]**

10. Grafana

Grafana is available as a fully managed tool with Grafana Cloud, or you can run the enterprise version on your infrastructure with self-managed options. You can visit publicly available dashboards from *https://grafana.com/grafana/dashboards/* and import them in your Grafana instance to visualise data quickly.

In my experience, Grafana is one of the most useful tools while using Kubernetes on-premise or cloud providers such as AWS, Microsoft Azure or GCP. It supports Windows, Linux, and MacOS. It is easy to install, configure, and manage Grafana and monitoring metrics keeping Prometheus as a data source.

Initial release	2014
Stable release	9.3.1
Written in	Go, TypeScript
Licence	GNU Affero General Public License, version 3.0

Website	*https://grafana.com/*
GitHub repository	*https://github.com/grafana/grafana*
Supported data sources	• Alertmanager • AWS CloudWatch • Azure Monitor • ElasticSearch • Google cloud monitoring • Graphite • InfluxDB • Jaeger • Loki • Microsoft SQL Server (MSSQL) • MySQL • OpenTSDB • PostgreSQL • Prometheus • Tempo • Testdata • Zipkin
Features	• Panels - heatmaps to histograms • Plugins - *https://grafana.com/grafana/plugins/* • Alerts • Annotations
How is it useful in DevOps practices implementation?	Visualisation of monitoring metrics. Another important thing to note is that you can convert the logs of third party tools into normal logging such as *Google Cloud Logging -> Create Log Router Sink* to route logs to supported Google services.
Is a commercial flavour available?	*https://grafana.com/pricing/*

Loki is built on an open source, horizontally scalable, highly available, multi-tenant log aggregation system started at Grafana Labs in 2018 and released under the AGPLv3 license. It is designed to store and query logs from applications and infrastructure. Loki follows minimal indexing. It creates an index only for metadata and not for the entire log text. END

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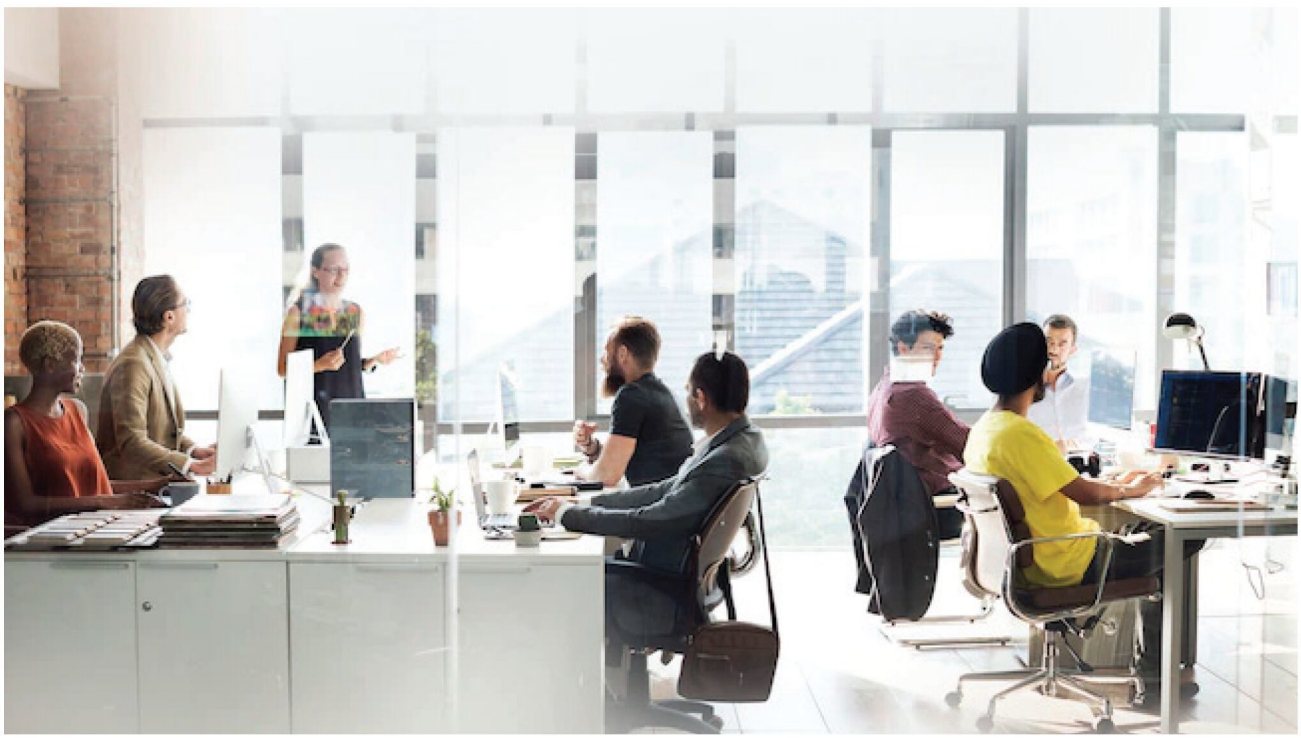
- ZAP - *API Scan, https://www.zaproxy.org/docs/docker/api-scan/*

By: Mitesh Soni

The author has written the books 'Hands-on Azure DevOps, Agile, DevOps and Cloud Computing with Microsoft Azure', 'Hands-on Pipeline as Code with Jenkins', and 'Hands-on Pipeline as YAML with Jenkins'.

Open Source Tools for the Modern Workplace

Organisations need a wide range of software tools in order to run efficiently, especially with a large section of their workforce working from home, fully or partially. Thankfully, there are quite a few open source tools they can rely on.



Workplaces have undergone tremendous changes in recent years, from using desktops and laptops, to virtual desktops, the cloud, mobile devices, containers, and so on. A number of commercial tools and platforms have enabled this transformation. Many open source alternative tools have also evolved over time, which reduce cost, avoid vendor monopoly and improve interoperability.

VPNs and remote working

During Covid-19, almost everyone was forced to work from home. To quickly facilitate remote access to IT systems, many IT departments started using VPNs for all. Post Covid, hybrid working has become the new normal. Bring your own device (BYOD) adoption and rise of the gig economy has accelerated remote working even further. Remote teams need to access enterprise applications and data in a secure manner. A virtual private network (VPN) gives online privacy and anonymity. It creates a private network from a public internet connection, and establishes a secure and encrypted connection for greater privacy.

A remote access VPN connection allows a user to connect to an enterprise private network from a remote location using a laptop or desktop computer connected to the internet. The user can access the secure resources on that network as if they were directly plugged into the network's servers. Pulse Secure, Cisco's AnyConnect, etc, are some commercial VPN solutions used by enterprises. There are a number of enterprise-level, open source VPN solutions that meet the needs of any corporation, large or small. Popular open source VPNs are:

- ***OpenVPN:*** OpenVPN is a full-fledged, open source VPN solution for enterprises as well as individuals. Using OpenVPN's technology, we can deploy the certification, encryption, and authentication features of the OpenSSL library for protection. The VPN provides support for dynamic IP addresses and DHCP. OpenVPN is available for Android, macOS, Linux, Windows, and iOS.
- ***Libreswan VPN:*** Libreswan offers free and open source VPN software based on the popular IPsec and IKE standards of VPN protocols. Libreswan has been active for over 15 years.
- ***SoftEther VPN:*** SoftEther stands for 'Software Ethernet', and it is a free, open source VPN supporting multiple protocols. SoftEther VPN uses an ultra-optimised SSL-VPN protocol that delivers firewall resistance, low latency, and fast throughput. It can easily penetrate a network firewall with built-in NAT traversal. It supports SSL-VPN, L2TP, IPsec, EtherIP, OpenVPN, and L2TPv3 protocols.
- ***Openswan VPN:*** Openswan VPN is one of the most popular VPNs and is specially designed to cater to the network security demands of Linux users. It is an IPsec implementation for Linux and comes pre-installed in several Linux versions from Fedora, Ubuntu, Debian, Gentoo, and Red Hat.
- ***Freelan VPN:*** Freelan is a free, open source, multi-platform VPN software that abstracts a LAN over the internet. It works on Windows, Linux and Mac OS X.

Desktop virtualisation

Desktop virtualisation is a method of simulating a user workstation so that it can be accessed from a remotely connected device. By abstracting the user desktop in this way, organisations can allow users to work from virtually anywhere with a network connection, using any desktop, laptop, tablet, or smartphone to access enterprise resources irrespective of the device or operating system employed by the remote user.

Remote desktop virtualisation is also a key component of digital workspaces. Virtual desktop workloads run on desktop virtualisation servers, which typically execute on virtual machines (VMs) either at on-premise data centers or in the public cloud. Since the user device is basically a display, keyboard, and mouse, a lost or stolen device presents a reduced risk to the organisation. All user data and programs exist in the desktop virtualisation server, and not on client devices. Some open source platforms/tools that enable desktop virtualisation are listed below.

Hypervisor: Hypervisor acts as a governing mechanism. It is a software layer that allows you to create and work on many virtual machines on a single hardware unit. There are several open source hypervisors available. Given below are a few popular ones.

- *Xen:* Xen is among the market leaders in the open source hypervisor arena. It supports the virtualisation of x86 IA64, and ARM, among other architectures. Xen has been used in the virtualisation of a wide array of guest OSs. A few operating systems supported by Xen are Windows, Solaris, and other versions of the BSD OS.
- *Linux KVM:* A kernel-based virtual machine (KVM) is a project based on GNU/Linux that has been developed for x86 computers. KVM is a full virtualisation solution for Linux on hardware containing virtualisation extensions. It provides the hardware virtualisation for a wide variety of guest operating systems, including Linux, Windows, macOS, ReactOS, and Haiku. Using KVM, you can run multiple VMs on unmodified Linux or Windows images. Each VM has private virtualised hardware -- a network card, disk, graphics adapter, etc.

HCI: Hyper converged infrastructure (HCI) is fully software-defined IT infrastructure that virtualises all the elements of conventional 'hardware-defined' systems. It is essential for deploying modern virtual desktop infrastructure (VDI). A hyper converged environment is one where compute, storage, and network resources are all on the same servers, managed by a single interface.

We can run a full-featured virtualised infrastructure with optimal use of servers by using open source oVirt and Gluster to deploy a hyper converged solution. These two open source solutions work together to provide a hyper converged solution. Each server provides both hypervisor and storage capabilities, with the VM disk images stored on the Gluster volume. The Gluster volume allows storage from multiple servers to be presented as a single, unified name space to the client. It is configured from storage on the three servers as a replica-3 volume, which means every bit of data that's written is replicated to two other servers to provide redundancy and resiliency against server outages.

Red Hat Hyperconverged Infrastructure—based on leading OpenStack and virtualisation platforms—provides co-located, scalable, software-defined compute and storage, automated by the Red Hat Ansible Automation Platform on economical, industry-standard hardware.

RHV: Red Hat Virtualization (RHV) -- the virtualisation management solution to support server or desktop applications -- is an open, software-defined platform that virtualises Linux and

Microsoft Windows workloads. Red Hat Enterprise Virtualization infrastructures are based on KVM hypervisor (kernel-based virtual machine) and features management tools that virtualise resources, processes, and applications to ensure service performance and business continuity. RHV uses the SPICE protocol and VDSM (virtual desktop server manager) with an RHEL-based centralised management server. The OpenShift container platform is its successor.

Workplace deployment automation and administration

Enterprises need Infrastructure as Code (IaC) tools to automate workplace deployment and provisioning. There are open source tools available for this purpose too. These tools have evolved and matured to meet the diversified demands of enterprises.

- ***Terraform:*** IaC removes the human component of setting up servers, virtual machines, and provisioned cloud computing through an automated process. Terraform is a free and open source tool created by HashiCorp. It is also one of the most popular IaC tools. Terraform makes a pre-execution check to ensure the desired result has been achieved. It is sometimes used as a base tool in conjunction with Ansible. It is highly compatible with cloud services such as AWS, Google Cloud, and Microsoft Azure.
- ***OpenStack:*** OpenStack is a free, open standard cloud computing platform. It is mostly deployed as Infrastructure-as-a-Service (IaaS) in both public and private clouds, where virtual servers and other resources are made available to users. The software platform consists of interrelated components that control diverse, multi-vendor hardware pools of processing, storage, and networking resources throughout a data center. Users manage it either through a web-based dashboard, through command-line tools, or through RESTful web services. Beyond standard Infrastructure-as-a-Service functionality, additional components provide orchestration, fault management and service management amongst other services to ensure high availability of user applications.

Puppet and Chef are two other popular open source tools used for workplace deployment and provisioning.

Workplace support tools

Workplace support teams need many tools to support end users. Three open source tools that can be chosen as alternatives to commercial tools for this purpose are listed below.

Open source helpdesk is software that offers a ticket management system. Built on open source technology, it is a great solution for offering efficient customer support.

OSTicket is an open source helpdesk and ticketing system used by more than 5 million users worldwide, and by more than 15,000 businesses.

Rocket.chat is an open source versatile communication platform that enables you to engage in seamless interactions regardless of how end users connect.

DevOps workplaces

Most DevOps workplaces make use of containers as a primary resource. These workplaces require tools covering container builds, orchestration, microservices networking, configuration management, CI/CD automation, full-stack monitoring and more. Popular open source tools deployed in DevOps workplaces are:

Kubernetes: It is used to orchestrate containers. Instead of releasing microservices manually, Kubernetes can automate deployment, maintenance and scaling of groups of containers in production. It is hosted by the Cloud-Native Computing Foundation (CNCF).

Docker: This free and open source platform is used to build, ship and run an application as a lightweight container. Containers package up the binaries, libraries, configuration files and dependencies required for a program to run. It makes configuration management, issue control, and scaling much easier through the use of containers that can be moved from place to place.

Istio: Istio enables organisations to secure, connect, and monitor microservices, so that they can modernise their enterprise apps swiftly and securely. It manages traffic flows between services, enforces access policies, and aggregates telemetry data, all without requiring changes to application code.

Ansible, Puppet, Jenkins, and Git are a few other popular open source tools used in DevOps workplaces. END

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Disclaimer: The views expressed in this article are that of the author and Wipro does not subscribe to the substance, veracity or truthfulness of the said opinion.

Open Source: Emerging Tech in 2023!

Here's a brief overview of the emerging technologies and trends in the field of IT. What's interesting is that these are backed by some highly innovative open source software.

A lot has changed in these past three years, and technology is no different. The hybrid workforce is already a well-adopted model that has been embraced across the globe since the pandemic. The digital workplace that many tech-savvy IT leaders were pushing for has come into fruition during the last three years organically. This change has forced unified endpoint management using collaboration tools, taking advantage of the readily available cloud services.

A major shift happening across all types of organisations is clarity over the use of cloud services. There seems to be a unification of Software as a Service (SaaS) and the cloud at some levels, paving the path to cloud-agnostic architecture, design, and implementations. While cloud-agnostic platforms help move applications and data from one service provider to another, a lot of it has been achieved with open source technologies. It's largely been made possible because of continued innovation leading to new IT capabilities.

Let's look at the emerging technologies, trends, and their applications in the domain of open source.

Artificial Intelligence (AI)

AI has been around for over 50+ years, helping us navigate with GPS and perform repetitive tasks with machines. Autonomous AI has the ability to adapt and change in order to address complex problems. In recent months, much of the buzz has been about the launch of ChatGPT and Quillbot

types of open source solutions that are taking the world by storm. It proves the active open source community is continuing to innovate above and beyond large enterprise technology offerings consistently. Microsoft has committed to spending US$ 10 billion in investment into ChatGPT towards commercialisation. It will be an interesting year ahead as this emerging technology shapes the world we live in.

There are other AI technologies, too, that are in focus, mainly TensorFlow and PyTorch, which are driving the development of machine learning and deep learning applications.

Internet of Things (IoT)

IoT has come a long way in interconnecting devices and appliances through the internet to collect, share, and act on the data that is generated. IoT technologies such as Eclipse IoT and The Things Network are helping to drive the development of connected

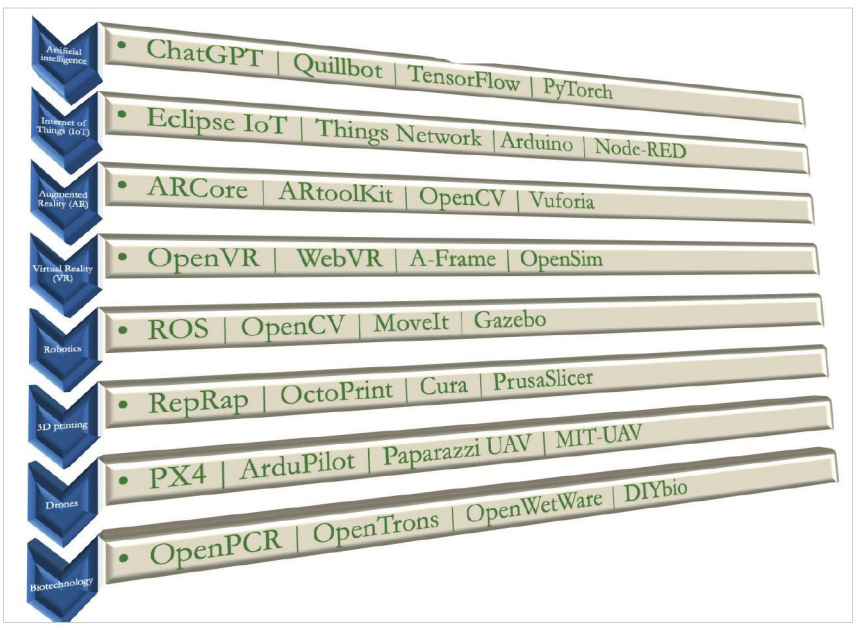

Figure 1: Emerging open source technologies in 2023

devices and systems. Arduino is a firmware platform catering to the needs of DIY projects. Node-RED is a visual programming tool that is useful for creating workflows for IoT applications.

Augmented reality (AR)

AR focuses on overlaying digital information of the real world on the user's view. It found its way into game development initially, and has today spread across various industries and use cases. ARToolKit and ARCore are libraries for building AR applications on Windows, Linux, and iOS. Its ability to track and overlay digital content on real-world objects has been emerging into many everyday use cases in airports, shopping malls, and other venues. OpenCV and Vuforia are platforms that provide a wide range of image processing and object recognition abilities.

Virtual reality (VR)

VR supports the creation of a computer-generated, multi-dimensional interactive environment with the help of special equipment like a VR headset. Many commercial attempts have failed to capitalise on this technology -- from Google to Apple to recent Meta platforms. However, the open source community is thriving and developing new innovative ways in which it can be used. OpenVR and WebBR are at the forefront of driving the development of VR applications. A-Frame has become the popular framework for building AR-integrated VR experiences using HTML, CSS, and JavaScript; it's built on WebGL. OpenSim is a multi-platform for 3D simulation and visualisation allowing users to create their own virtual worlds; it supports Oculus and Vive.

Robotics

Robotics aims to create intelligent machines that can assist us in various ways. With Intrinsic acquiring ROS (Robot Operating System), a popular open source platform that drives the development of autonomous robots and systems, one can hope for the best year ahead with new innovative solutions coming to support the open source community. OpenCV is another similar platform for robotics development with a rich vision library that can be used to detect and track objects, faces and more. Gazebo is simulation software that allows the simulation and testing of robot software in a realistic environment. MoveIt is popular in motion planning capabilities for various robotic arms and mobile bases.

3D printing

3D printing has advanced beyond the manufacturing industry. RepRap and OctoPrint lead the development of 3D printing applications. Cura and PrusaSlicer are slicing software developed with rich features for handling 3D printers.

Drones

Drones are flying robots that can be remotely controlled or fly autonomously using software-controlled flight plans with onboard sensors and GPS. PX4 and ArduPilot are popular platforms for the development of autonomous drones. Paparazzi UAV is an autopilot system for fixed-wing and multi-copter drones used for DIY and model development purposes. MIT-UAV is research-grade technology used in complex autonomous aircraft use cases.

Biotechnology

Biotechnology addresses the medical, agricultural, industrial, food, and marine industries in one broad stroke. Genetics engineering has been its focus area, and helped to develop the first drug for overcoming the Corona virus. OpenPCR and OpenTrons are popular development tools used for biological and medical applications. OpenWetWare is a platform that allows sharing of protocols, data, and information about research projects. DIYbio exposes citizens to biology projects, and is a promising and innovative open source platform.

As the year unfolds, one thing is certain: technology is going to play a major role in every facet of our lives and innovation is going to continue making everyday life easier. Talent shortage is one of the top concerns IT leaders are faced with when adopting emerging technologies. However, open source platforms thrive better than others, and help groom next-generation talent. END

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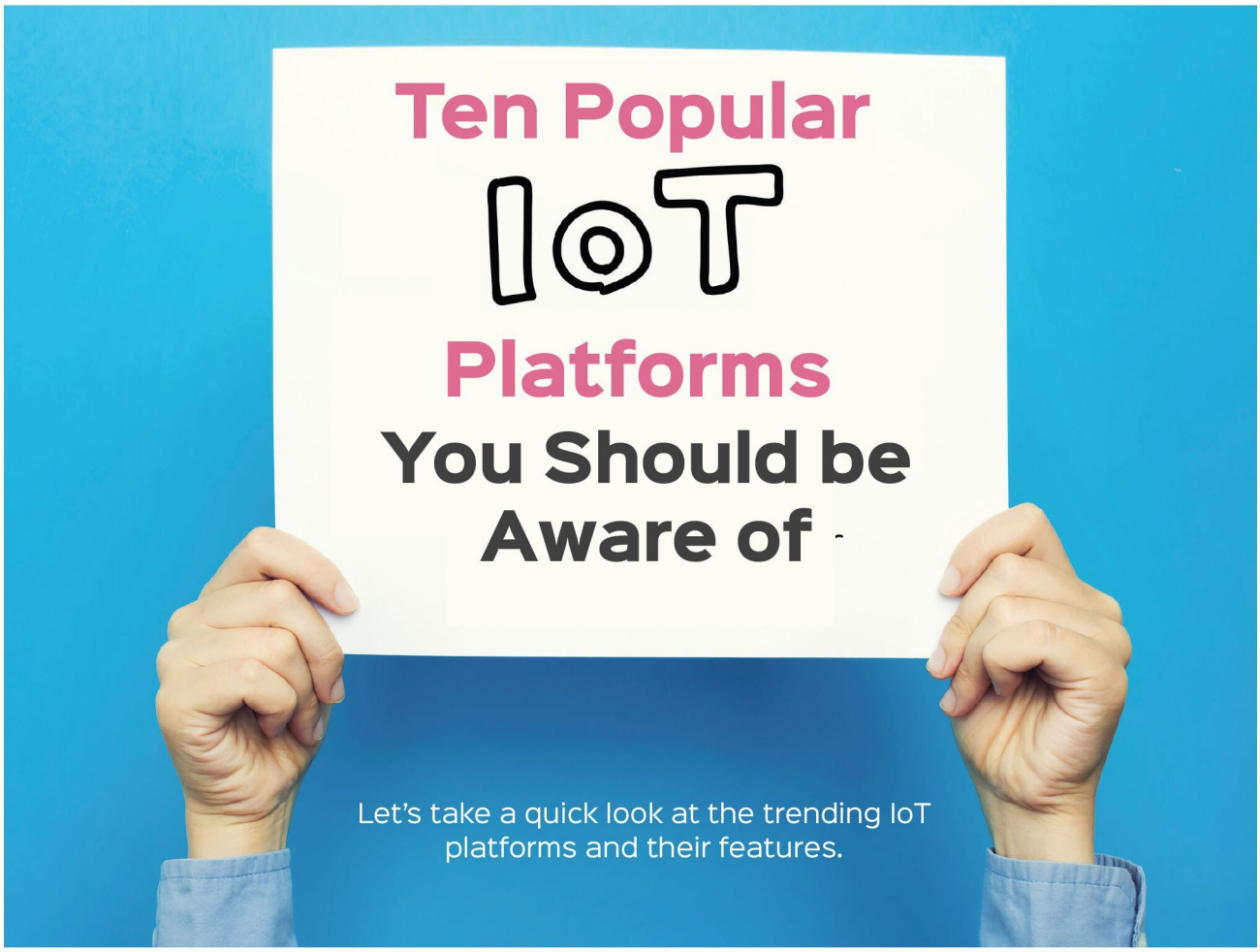
- 3D printing portal, *https://www.3dsourced.com/*

By: Bala Kalavala

The author is a technical architect, evangelist, thought leader, and sought-after keynote speaker. He currently works as a distinguished member of the technical staff and head of the enterprise architecture practice as chief architect in a global technology consulting firm.



Every Internet of Things (IoT) device expands connectivity beyond standard devices, namely, computers, laptops and smartphones. Its integration with low energy wireless technology enables communication over the internet. Today these devices have innumerable applications in the domains of agriculture, healthcare, automation, Industrial IoT, wearables and logistics.

There are many platforms that are being used extensively to build IoT solutions. We take a look at the ten open source IoT platforms that seem to be very popular today due to various reasons.

Arduino IoT Cloud

URL: https://cloud.arduino.cc/

One of the best-known open source platforms, Arduino encompasses both hardware and software. The software includes an integrated development environment (IDE) for writing code in the Arduino language. Connected devices around the world are increasing by billions every year. The Arduino IoT Cloud is a platform that allows anyone to develop IoT solutions. It has a user-friendly interface, and an all-in-one solution for configuration, writing code, uploading and visualisation. Its features include data monitoring, variable synchronisation, scheduler, over-the-air (OTA) uploads, WebHooks, Amazon Alexa support, and dashboard sharing.

Its subscription plans are Free, Entry, Maker and Maker Plus. Paid plans are offered on a monthly and yearly billing cycle, except for the Entry plan, which is only available on a yearly basis.

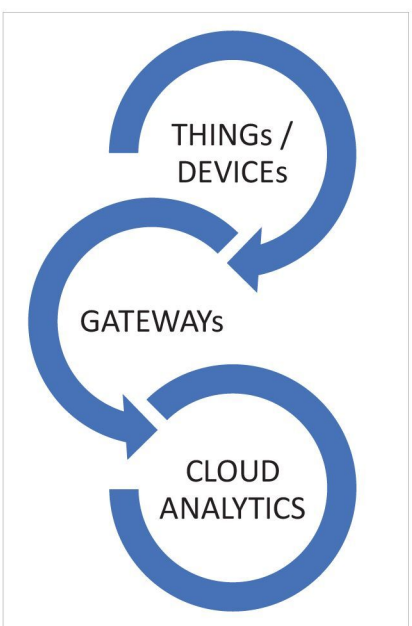


Figure 1: Major components of Internet of Things

OpenRemote

URL: https://openremote.io/

OpenRemote is an intuitive, user-friendly, 100 per cent open source IoT device management platform for original equipment manufacturers (OEMs), integrators and governments. Its functions and features include building applications for services, configuring dashboards; building logic with When-Then, Flows, Javascript or Groovy; and customised apps under the AGPLv3 license. The major domains it is used in include energy management and smart cities.

Mainflux

URL: https://mainflux.com/

Mainflux is a performant and secure open source IoT platform with full-scale capabilities for developing IoT solutions, IoT applications and smart connected products. Built as a set of microservices containerised by Docker and orchestrated with Kubernetes, the Mainflux IoT platform serves as a software infrastructure and middleware which provides device management, data aggregation and data management, connectivity and message routing, core analytics, and application enablement. Mainflux Labs (under an Apache 2.0 license) is the technology company that offers end-to-end, open source, edge computing gateway and consulting services for the software and hardware layers of IoT technology.

ThingsBoard

URL: https://thingsboard.io/

This platform offers the Community Edition, the Professional Edition and Cloud. The Community Edition is completely free. ThingsBoard is an open source IoT platform meant for device management, data collection, processing and visualisation to build the IoT solution. This enables you to connect devices, push data from devices, build real-time end-user dashboards, define thresholds, trigger alarms, and push notifications about new alarms over email, SMS or other systems.

Thinger.io

URL: https://thinger.io/

In Thinger.io you have an easy-to-navigate, ready-to-use cloud infrastructure that allows users to integrate, monitor, and control millions of IoT devices. It helps to connect an API, supports geofencing, and can create custom alerts using real-time data from devices. It permits you to collect and store data in the platform, and create dashboards with custom or built-in widgets. There is also a provision to share dashboards with customers and on the cloud.

Thinger.io offers the following three choices – Community, Private Cloud and On-Premise. The Community plan provides free access for evaluation and testing that is limited to two devices, simple analytics and a single tenant.

Kaa

URL: https://www.kaaiot.com/

Kaa provides a flexible, multi-purpose middleware platform for developing end-to-end IoT solutions, connected applications, and smart devices. Its products are diversified into Kaa IoT Platform, Kaa Cloud, Kaa IoT Gateway, Kaa IAM and Kaa Cloud Migration. It has applications in the domains of agriculture, healthcare, automation, Industrial IoT, wearables and logistics. It offers an end-to-end IoT development experience with its customisable microservice architecture and open protocols.

Table 1: Features of the various IoT platforms

IoT platform	Integration	Protocols	Security	Free and open source
Arduino IoT Cloud	REST APIs	MQTT	Basic authentication	Up to two devices
OpenRemote	WebSocket, HTTP, MQTT APIs	HTTP, MQTT, KNX	AES, 256-bit encryption	Yes
Mainflux	REST APIs	HTTP, MQTT, CoAP	TLS v1.3	Yes
ThingsBoard	WebUI, REST APIs	HTTP, MQTT, CoAP	Basic authentication	Yes
Thinger.io	REST APIs	HTTP, MQTT, CoAP	SSL/TLS	Up to two devices
Kaa	Portable SDKs	HTTP, MQTT, CoAP	TLS / DTLS	Up to five devices
Blynk	REST APIs	HTTP, MQTT	Basic authentication	Up to two devices
SiteWhere	REST APIs	MQTT, AMQP	SSL	Yes
ThingSpeak	REST APIs, MQTT APIs	MQTT	Basic authentication	Yes
Zetta	WebSocket, REST APIs	MQTT	Basic authentication	Yes

Table 2: Device management, visualisation and analytics of the IoT platforms

IoT platform	Device management	Data visualisation	Analytics	Multi-tenancy
Arduino IoT Cloud	Yes	Yes	Yes	-
OpenRemote	Yes	Yes	Yes	Yes
Mainflux	Yes	Grafana	Yes	Yes
ThingsBoard	Yes	Dashboard widgets	Yes	Yes
Thinger.io	Yes	Grafana	Yes	Yes
Kaa	Yes	Direct/IoT gateway	Yes	Yes
Blynk	Yes	Yes	Yes	Yes
SiteWhere	Yes	Grafana	Can detect outliers too	Yes
ThingSpeak	Yes (with MATLAB)	MATLAB visualisation app	Yes	-
Zetta	Yes	Yes	Yes	Yes

Plans include Kaa Cloud 5, Kaa Cloud 15, and Kaa Cloud 100, of which only Kaa Cloud 5 offers a 14-day free trial on up to five connected devices with multi-user access.

Blynk

URL: https://blynk.io/

Blynk helps to build and manage connected hardware. It offers device provisioning, sensor data visualisation, remote control with mobile and web applications, over-the-air firmware updates, secure cloud, data analytics, user and access management, alerts and automations. The Blynk IoT platform prototypes, deploys, and remotely manages connected electronic devices at any scale.

Blynk powers low-batch manufacturers of smart home products, complex HVAC systems, agricultural equipment, and everyone in between. It offers two plans -- Free and Business.

SiteWhere

URL: https://sitewhere.io/en/

SiteWhere provides a multi-tenant microservice-based infrastructure that includes the key features required to build and deploy IoT applications. SiteWhere infrastructure and microservices are deployed on Kubernetes, allowing for deployment on-premise or almost with any cloud provider. It runs on Apache Tomcat and offers MongoDB and HBase implementations. You can deploy SiteWhere to cloud platforms like AWS, Azure, GCP, or on-premise.

ThingSpeak

URL: https://thingspeak.com/

ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualise, and analyse live data streams in the cloud. You can send data to ThingSpeak from your devices, create instant visualisation of live data, and send alerts. Data collection in the cloud with advanced data analysis using MATLAB is possible.

Zetta

URL: https://www.zettajs.org/

Zetta is an open source platform built on Node.js for creating IoT servers that run across geo-distributed computers and the cloud. Zetta combines REST APIs, WebSockets and reactive programming perfect for assembling many devices into data-intensive, real-time applications. It is a server-oriented platform with a flow-based reactive programming development philosophy and connected by cloud services to develop IoT frameworks. These cloud services include visualisation tools and support for machine analytics tools like Splunk. It creates a zero-distributed network by connecting endpoints such as Linux and Arduino hacker boards with platforms such as Heroku. END

By: Dr Geetali Saha

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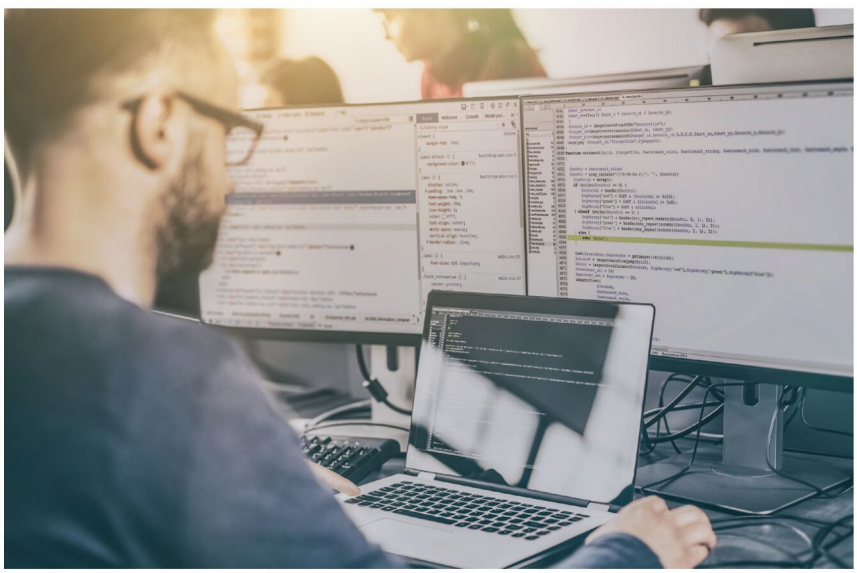
Popular IDEs for Developers and How to Choose One

Get acquainted with the popular open source IDEs, and find out how to make an informed decision while selecting one.



An IDE, or integrated development environment, is a software application that provides a comprehensive set of tools for software development. It typically includes a source code editor, a compiler or interpreter, a debugger, and a variety of other features such as a project manager, version control integration, and a graphical user interface. IDEs are designed to make it easier for developers to write, test, and deploy code by providing a single, unified interface for all the different tasks involved in software development. Some popular examples of IDEs include Visual Studio Code, Eclipse, IntelliJ IDEA, and PyCharm.

Why use an IDE?

Using an IDE can greatly benefit a developer in several ways.

Productivity: IDEs provide a wide range of tools and features that can help developers write, test, and debug code more efficiently. This can save a lot of time and effort, and allow developers to focus on the logic and functionality of their code rather than worrying about the details of the development process.

Consistency: Many IDEs come with built-in templates and conventions that can help developers write consistent and well-organised code. This can make it easier to maintain and update the codebase over time.

Error prevention: IDEs often include features such as syntax highlighting, code completion, and real-time error checking, which can help developers catch and fix errors before they become a problem.

Collaboration: Most IDEs have support for version control systems, which can make it easier for developers to collaborate and share code with other members of a team.

Learning: IDEs often provide comprehensive documentation and tutorials, which can be a great resource for developers who are new to a programming language or framework.

Customisation: Many IDEs allow developers to customise the environment to their liking, by adding or removing plugins, creating custom templates, and changing the layout and functionality of the interface.

IDEs can help developers work more efficiently and effectively, and can be an essential tool for any software developer to maintain productivity.

Things to consider before choosing the right IDE

When choosing the right IDE, there are several things to consider.

Programming languages: Make sure that the IDE supports the programming languages that you will be working with. Many IDEs are language-specific, while others support multiple languages.

Platform support: Consider the operating system that you will be using, and choose an IDE that is compatible with that platform.

Features and tools: Different IDEs offer different features and tools. Consider the specific features that you need for your project, such as debugging, version control integration, and code refactoring.

Customisability: Some IDEs are highly customisable, while others are

more rigid. Consider whether you need an IDE that can be easily tailored to your specific needs.

Community and support: Look for an IDE with a large and active community, as this will ensure that there are plenty of resources, tutorials, and support available.

Integration with other tools: If you are already using tools like testing frameworks, build systems, or other libraries, look for an IDE that can integrate with them seamlessly.

Cost: Consider the cost of the IDE and whether it fits your budget. Some IDEs are free and open source, while others are commercial.

Learning curve: If you are new to programming, you may want to consider an IDE with a steeper learning curve, as this will provide a more comprehensive set of tools and features.

Personal preference: Finally, consider your personal preference, as the IDE that works best for one developer may not work as well for another.

The best IDE for you will depend on your specific needs and preferences, as well as the programming languages and tools that you are working with. It's advisable to try several IDEs and choose the one that you feel most comfortable and productive with.

Popular IDEs are:

- Visual Studio Code
- Eclipse
- IntelliJ IDEA
- Code::Blocks
- PyCharm

Note that this list may change over time and different developers may have their own preferences based on their experience, programming languages they are working with, and the specific features they are looking for in an IDE.

Visual Studio Code (VS Code)

One of the most popular IDEs is Visual Studio Code (VS Code). It is developed by Microsoft and has a large and active community of developers. It is developed on the Electron Framework, for Windows, Linux and macOS. Its key features include:

- *Intuitive user interface*: VS Code has a clean and modern user interface that is easy to navigate and customise.
- *Built-in support for debugging:* It includes a built-in debugging tool that allows developers to step through their code, set breakpoints, and inspect the state of variables.
- *Code editing:* VS Code provides powerful code editing features such as syntax highlighting, code completion, and IntelliSense (a smart code completion feature) for multiple languages.
- *Built-in Git integration:* It has built-in integration with Git, which makes it easy for developers to collaborate and share code with other members of a team.
- *Extensibility and customisability:* VS Code is highly extensible and customisable; it has a large library of plugins and extensions that can be added to the IDE to provide additional functionality and support for various programming languages and frameworks.

It also has multi-platform support, a large and active community, and is free and open source.

VS Code is a powerful and versatile IDE that can help developers work more efficiently and effectively. It's known for its speed, flexibility and the ability to integrate with a wide range of tools and services.

Latest version: 1.74
URL: https://code.visualstudio.com/
Operating systems supported: Windows 7 or later, OS X 10.10 or later, Linux
You can use *vscode.dev* for quick edits online too.

Eclipse

Eclipse is widely used by developers for a variety of programming languages and platforms. It's a Java-based IDE that can be used for development in various languages. It's also highly extensible and customisable. Some of the benefits of using Eclipse include:

- *Cross-platform compatibility:* Eclipse runs on multiple platforms, including Windows, Linux, and macOS, which makes it accessible to a wide range of developers.
- *Extensibility and customisability:* Eclipse is highly extensible and customisable. It has a large library of plugins and extensions that can be added to the IDE to provide additional functionality and support for various programming languages and frameworks.
- *Built-in support for Java development:* It has built-in support for Java development, including features such as code completion, refactoring, and error checking, making it a popular choice for Java developers.
- *Support for multiple languages:* Eclipse supports development in multiple languages, including Java, C++, Python, and more, which makes it a versatile choice for developers working on a variety of projects.
- *Built-in version control integration:* It provides built-in support for version control systems, such as Git and SVN, which makes it easy for developers to collaborate and share code with other members of a team.

This free and open source IDE has a large and active community

Eclipse is a powerful and versatile IDE that can help developers work more efficiently and effectively, and can be a great choice for a wide range of development projects.

Latest version: 4.23
URL: https://www.eclipse.org/
Operating systems supported: macOS, Windows and Linux

IntelliJ IDEA

Developed by JetBrains, IntelliJ IDEA is primarily used for Java development, but also supports other languages such

as Python, Scala, and Kotlin. Some of the key features of IntelliJ IDEA include:

- *Advanced code analysis:* IntelliJ IDEA has a powerful code analysis engine that can detect and fix errors, bugs and performance issues in real-time.
- *Intuitive navigation:* The IDE provides a variety of tools for fast and easy navigation through the codebase, such as a class hierarchy, call hierarchy, and a structure view.
- *Refactoring:* IntelliJ IDEA provides a wide range of refactoring options, such as renaming, moving and changing signatures, which can help developers write more maintainable and readable code.
- *Debugging:* The IDE provides a powerful debugging tool that allows developers to step through the code, set breakpoints, and inspect the state of variables.
- *Built-in support for version control:* IntelliJ IDEA supports a variety of version control systems, including Git, SVN, and Mercurial, which makes it easy for developers to collaborate and share code with other members of a team.

This open source IDE has plugins and extensions support, a customisable interface, and a large and active community.

The IDE is a powerful and versatile tool that can help developers work more efficiently and effectively, and is a great choice for Java development and other languages.

Latest version: 2022.3.1 Community Edition
URL: https://www.jetbrains.com/
Operating systems supported: macOS, Windows and Linux

Code::Blocks

Code::Blocks is a cross-platform IDE for C, C++, and Fortran. Its key features include:

- *Multi-compiler support:* Code::Blocks supports multiple compilers, including GCC, MSVC, and Digital Mars.
- *Built-in debugging:* It includes a built-in debugger that allows developers to step through their code, set breakpoints, and inspect the state of variables.
- *Customisable interface:* The IDE can be customised to fit the developer's needs, with options to change colour schemes, key bindings, and layouts.
- *Syntax highlighting:* Code::Blocks provides syntax highlighting for multiple languages, which can make it easier to read and write code.
- *Code completion:* It provides code completion, which can help developers write code more efficiently and reduce the risk of errors.
- *Project management:* Code::Blocks provides a project management system that allows developers to organise and manage the files in their project.

This free and open source IDE has a large and active community.

Code::Blocks is a powerful and versatile IDE that can help developers work more efficiently and effectively, and can be a great choice for C, C++, and Fortran development projects.

Latest version: 20.03
URL: https://www.codeblocks.org/downloads/
Operating systems: Windows 7 or later, OS X 10.10 or later, Linux

PyCharm

PyCharm is a popular open source IDE developed by JetBrains, specifically designed for Python development. Some of its key features are:

- *Syntax highlighting and code completion:* PyCharm provides advanced code editing features such as syntax highlighting and code completion, which can help developers write code more efficiently and reduce the risk of errors.
- *Debugging and testing:* It includes a built-in debugging tool that allows developers to step through their code, set breakpoints, and inspect the state of variables. It also includes a built-in testing tool that allows developers to run and debug unit tests.
- *Integrated development tools:* PyCharm provides a wide range of integrated development tools, such as a source code editor, a compiler, a debugger, and a visual layout editor, which can save developers time and effort.
- *Built-in support for version control:* PyCharm supports a variety of version control systems, including Git, SVN, and Mercurial, which makes it easy for developers to collaborate and share code with other members of a team.
- *Customisable interface:* The IDE can be customised to fit the developer's needs, with options to change colour schemes, key bindings, and layouts.

This free and open source IDE also has cross-platform compatibility, and a large and active community.

Latest version: 2022.3.1
URL: https://www.jetbrains.com/pycharm/download/
Operating system: Windows 7 or later, OS X 10.10 or later, Linux

Other notable open source IDEs include Atom (retired), Sublime Text, NetBeans, Visual Studio and Android Studio.

Just remember that the choice of the best IDE depends on the users' specific needs, preferences, and the programming languages they are working with. END

By: Suvesh K.

The author is developer by profession with a keen interest in open source technologies

R Series: Data Sets

In this eighteenth article in the R series, we take a look at the various data sets available in R.

The data sets available in R cover a wide range of fields. We have data sets that give information on the performance of automobiles, the approval rating of the presidents of the United States, the magnitude of the earthquakes around Fiji, the number of international passengers travelling in aeroplanes over a certain period, and much more.

mtcars

We have been using the *mtcars* data set which contains information on automobiles, fuel consumption and performance from the 1974 *Motor Trend* US magazine. The data frame has 32 entries and has 11 numeric fields, as shown below:

```
> head(mtcars)
                   mpg cyl disp  hp drat    wt  qsec vs am gear carb
Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

The various fields are described below:

Field	Description
mpg	Miles/gallon
cyl	Number of cylinders
disp	Displacement
hp	Horse power
drat	Rear axle ratio
wt	Weight in 1000 lbs
qsec	1/4 mile time
vs	Engine (0=V-shaped, 1=straight)
am	Transmission (0=automatic, 1=manual)
gear	Number of gears
carb	Number of carburettors

airquality

The *airquality* data set provides air quality measurements in New York between May and September 1973. The data was obtained by the New York State Department of Conservation and the National Weather Service. The data frame has 153 observations and six variables, as follows:

```
> head(airquality)
  Ozone Solar.R Wind Temp Month Day
1    41     190  7.4   67     5   1
2    36     118  8.0   72     5   2
3    12     149 12.6   74     5   3
4    18     313 11.5   62     5   4
5    NA      NA 14.3   56     5   5
6    28      NA 14.9   66     5   6
```

The description of the numeric fields is as follows:

Field	Description
Ozone	Ozone in parts per billion
Solar.R	Solar radiation in Langleys
Wind	In mph
Temp	Temperature in degrees Fahrenheit
Month	Values: 1-12
Day	Values: 1-31

AirPassengers

An example of time series data is provided by the *AirPassengers* data set given by Box & Jenkins. It contains the monthly totals of international airline passengers (in thousands) between 1949 and 1960. The data set is illustrated below for reference:

```
> AirPassengers
     Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1949 112 118 132 129 121 135 148 148 136 119 104 118
1950 115 126 141 135 125 149 170 170 158 133 114 140
1951 145 150 178 163 172 178 199 199 184 162 146 166

...
```

presidents

Another example of time series data is the approval rating for the President of the United States for various quarters from 1945 till 1974 in the *presidents* data set. It has 120 values and has been provided by the Gallup Organisation.

```
> presidents
     Qtr1 Qtr2 Qtr3 Qtr4
1945   NA   87   82   75
1946   63   50   43   32
1947   35   60   54   55
1948   36   39   NA   NA
1949   69   57   57   51
1950   45   37   46   39
   ...
```

Titanic

A summary of the passengers who travelled on the Titanic ship is available in a four-dimensional array categorised by economic status, gender, age and survival in the *Titanic* data set. The complete information on the fate of the passengers is given below:

```
> Titanic
, , Age = Child, Survived = No

      Sex
Class  Male Female
  1st     0      0
  2nd     0      0
  3rd    35     17
  Crew    0      0

, , Age = Adult, Survived = No

      Sex
Class  Male Female
  1st   118      4
  2nd   154     13
  3rd   387     89
  Crew  670      3

, , Age = Child, Survived = Yes

      Sex
Class  Male Female
  1st     5      1
  2nd    11     13
  3rd    13     14
  Crew    0      0

, , Age = Adult, Survived = Yes

      Sex
Class  Male Female
  1st    57    140
  2nd    14     80
  3rd    75     76
  Crew  192     20
```

The variables and their values are described below:

Name	Values
Class	1st / 2nd / 3rd / Crew
Gender	Male / Female
Age	Child / Adult
Survived	Yes / No

quakes

The *quakes* data set provides the locations of 1000 seismic activities. It reports earthquake magnitude scales of MB > 4.0 near Fiji since 1964. A sample output from the data set is given below for reference:

```
> head(quakes)
     lat   long depth mag stations
1 -20.42 181.62   562 4.8       41
2 -20.62 181.03   650 4.2       15
3 -26.00 184.10    42 5.4       43
4 -17.97 181.66   626 4.1       19
5 -20.42 181.96   649 4.0       11
6 -19.68 184.31   195 4.0       12
```

The numeric variables and their descriptions are as follows:

Name	Description
lat	Latitude
lon	Longitude
depth	In km
mag	Richter magnitude
stations	Number of stations that reported activity

melanoma

The measurements on patients who had malignant melanoma between 1962 and 1977 are available in the *melanoma* data set. The tumours were completely removed from these patients by surgery, and measurements were taken. The patients were reviewed until 1977. A sample data set is as follows:

```
> library(boot)

> head(melanoma)
```

```
  time status sex age year thickness ulcer
1   10      3   1  76 1972      6.76     1
2   30      3   1  56 1968      0.65     0
3   35      2   1  41 1977      1.34     0
4   99      3   0  71 1968      2.90     0
5  185      1   1  52 1965     12.08     1
6  204      1   1  28 1971      4.84     1
```

The data frame consists of the following columns:

Name	Description
time	Survival time in days since being operated
status	1=Died from melanoma, 2=Alive, 3=Died from other causes
sex	1=Male, 0=Female
year	Year of operation
thickness	Tumour thickness (mm)
ulcer	1=present, 0=absent

nitrofen

The *nitrofen* data set has 50 rows and five columns. It is a herbicide that was used to control weeds in cereals and rice. Although nitrofen is non-toxic to humans, it is no longer used in the US. The data frame is given below:

```
> library(boot)

> head(nitrofen)
  conc brood1 brood2 brood3 total
1    0      3     14     10    27
2    0      5     12     15    32
3    0      6     11     17    34
4    0      6     12     15    33
5    0      6     15     15    36
6    0      5     14     15    34
```

The five fields are described below in detail:

Name	Description
conc	The nitrofen concentration (mug/litre)
brood1	Number of live offspring in the first brood
brood2	Number of live offspring in the second brood
brood3	Number of live offspring in the third brood
total	Total number of live offspring in the first three broods

nuclear

The *nuclear* data set has information on light water reactor (LWR) plants that were constructed in the US in the early 1970s. Thirty-two plants were constructed, and the data was used for future cost prediction of such plants. The first few entries from the data set are given below:

```
> library(boot)

> head(nuclear)
    cost  date t1 t2  cap pr ne ct bw cum.n pt
1 460.05 68.58 14 46  687  0  1  0  0    14  0
2 452.99 67.33 10 73 1065  0  0  1  0     1  0
3 443.22 67.33 10 85 1065  1  0  1  0     1  0
4 652.32 68.00 11 67 1065  0  1  1  0    12  0
5 642.23 68.00 11 78 1065  1  1  1  0    12  0
6 345.39 67.92 13 51  514  0  1  1  0     3  0
```

The description of the various numeric columns is as follows:

Name	Description
cost	Cost of construction (millions of dollars)
date	Date on which construction permit was issued
t1	Time between application and construction permits
t2	Time between issue of operating licence and construction permit
cap	Capacity of power plant (MWe)
pr	1=Prior existence of LWR plant on site, 0=None
ne	1=Plant in north-east US, 0=Otherwise
ct	1=Cooling tower in plant, 0=None
bw	1=Nuclear steam supply system by Babcock-Wilcox, 0=Otherwise
cum.n	Cumulative number of power plants constructed by architect-engineer
pt	1=Plant with partial turnkey guarantees, 0=Otherwise

You are encouraged to explore the various other R data sets available at *https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/00Index.html*. END

By: Shakthi Kannan

The author is a free software enthusiast.

How Helpful is ChatGPT for Developers?

If there is anything that has caught the attention of the tech world in the last few weeks, it is ChatGPT. The media is projecting it as the next big thing after Google Search Engine, and experts are competing with each other in predicting its impact on society. This article tries to peek into ChatGPT from the perspective of a software developer.

ChatGPT is a chatbot backed by artificial intelligence. Built by San Francisco-headquartered OpenAI, it was announced to the world in the month of November 2022.

In the words of ChatGPT, it is an AI assistant trained to help answer questions and provide information on a wide range of topics, including general knowledge, history, science, mathematics, language, and many others. Sounds familiar? Are search engines already not doing that job? There is a difference!

According to OpenAI, ChatGPT has been trained to interact in a conversational way. The dialogue format makes it possible for ChatGPT to answer follow-up questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests.

Using ChatGPT

Well, let's experience it! The first thing is to log in to ChatGPT. Visit the URL *https://chat.openai.com/auth/login* on any modern browser to open the login page. It appears as in Figure 1.

Since we haven't signed up yet, click on the 'Sign up' button. It opens the dialog, offering multiple ways to sign up.

In my case, I chose to continue with Google. After entering the Google credentials, it prompted for a name and phone number to initiate the verification process. Upon entering the received OTP, the ChatGPT opened up at the URL *https://chat.openai.com/chat*, as in Figure 2.

The ChatGPT clearly states that the current version is just a free research preview. Its goal is to get external feedback

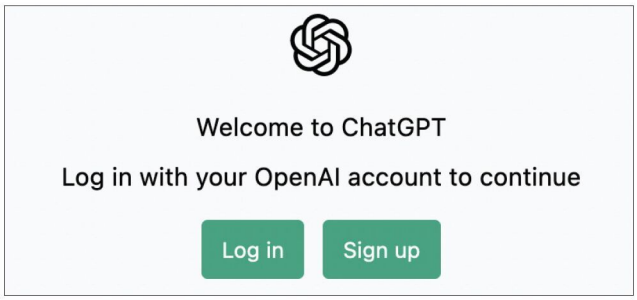


Figure 1: ChatGPT login page

in order to improve its systems and make them safer. It also cautions that the system may occasionally generate incorrect or misleading information and produce offensive or biased content, despite the safeguards that are in place.

Since ChatGPT conversations may be reviewed by AI trainers to improve the systems, we must not share any sensitive information in our conversations.

Let's play with ChatGPT

Programming is one of the areas in which ChatGPT proves to be a useful assistant. For instance, type the following question on the prompt and look at the response:

```
java command to compile a file
```

Apart from such simple questions, we can even ask ChatGPT to write code for us. How about getting some help in writing some Python code? I started a new conversation with the following prompt:

```
sort numbers using bubble sort in python
```

The assistant generated the following code:

```
def bubble_sort(numbers):
    n = len(numbers)
    for i in range(n):
        for j in range(0, n - i - 1):
            if numbers[j] > numbers[j + 1]:
                numbers[j], numbers[j + 1] = numbers[j + 1],
numbers[j]

# test the function
numbers = [3, 4, 1, 2, 5]
bubble_sort(numbers)
print(numbers)  # [1, 2, 3, 4, 5]
```

You can verify the code just by reviewing it in case you are a Python developer. Or copy the code into a source file, and try running it in a Python environment. It works!

But it doesn't just end there. We know that there is more than one way to write the code for bubble sort. ChatGPT agrees. I asked her to try again.

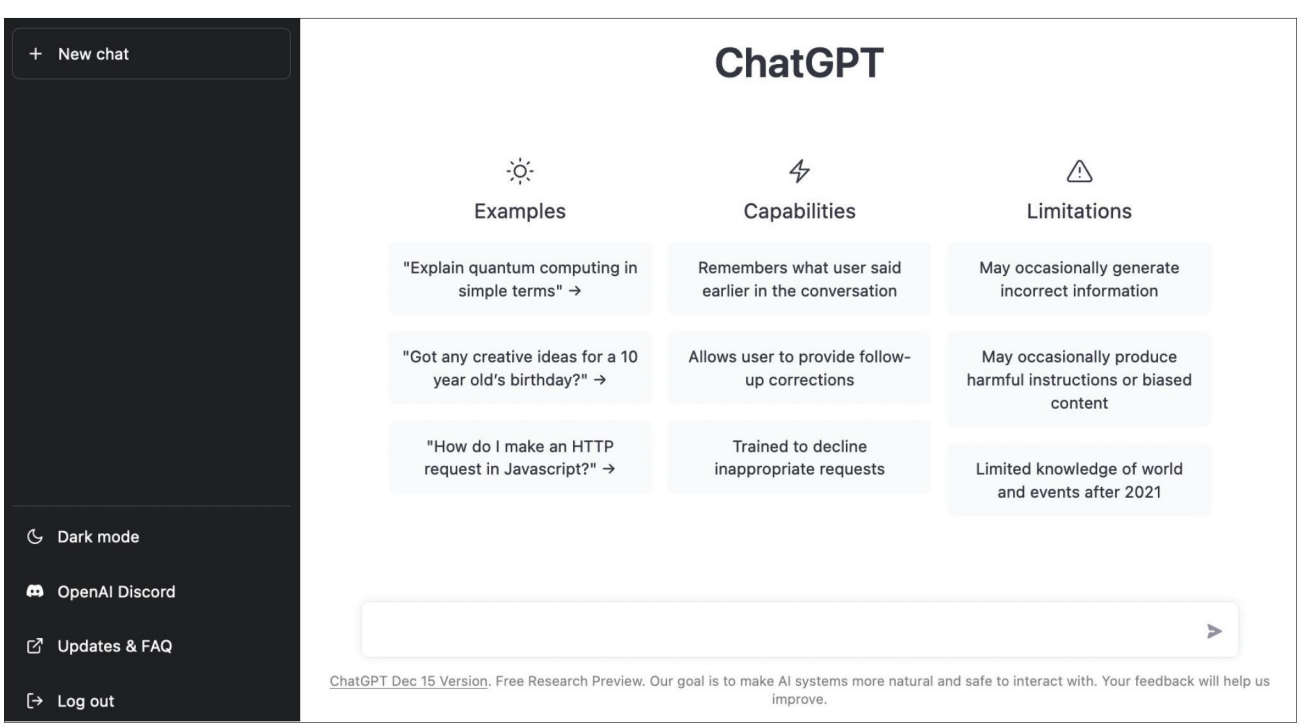


Figure 2: ChatGPT conversations

This time it generated the following code:

```
def bubble_sort(numbers):
    # Set the flag to True to start the sorting
    flag = True

    # Keep looping until the flag is False
    while flag:
        # Set the flag to False
        flag = False

        # Loop through the numbers
        for i in range(len(numbers) - 1):
            # Check if the current number is greater than the
next number
            if numbers[i] > numbers[i + 1]:
                # If it is, swap the numbers
                numbers[i], numbers[i + 1] = numbers[i + 1],
numbers[i]

                # Set the flag to True to indicate that a swap
has occurred
                flag = True

    # Return the sorted list
    return numbers

sorted_numbers = bubble_sort([3, 5, 2, 1, 4])
print(sorted_numbers)  # Output: [1, 2, 3, 4, 5]
```

You can keep asking it to try any number of times. In my case, the following was suggested in the third iteration:

```
def bubble_sort(numbers):
    # We set swapped to True so the loop looks runs at least once
    swapped = True
    while swapped:
        swapped = False
        for i in range(len(numbers) - 1):
            if numbers[i] > numbers[i + 1]:
                # Swap the elements
                numbers[i], numbers[i + 1] = numbers[i + 1],
numbers[i]
                # Set the flag to True so we'll loop again
                swapped = True

# Verify it works
numbers = [3, 7, 4, 9, 1, 6]
bubble_sort(numbers)
print(numbers)  # Should print [1, 3, 4, 6, 7, 9]
```

Tired of different versions of the code for the same problem? How about asking the assistant to optimize the code instead? I just typed the following on the prompt:

```
optimize
```

The following is the result.

```
There are several ways you can optimize the bubble sort
algorithm to make it run faster. Here are a few ideas:
 Use a flag to keep track of whether any swaps were made on the
last iteration of the loop. If no swaps were made, it means the
list is already sorted and we can exit the loop early.
Only iterate up to the last element that has already been
sorted. On each pass, the largest element will "bubble" up to
the end of the list, so there's no need to compare it to any
other elements on the next pass.
Use a different sorting algorithm altogether, such as quicksort
or merge sort, which have better average-case time complexity
than bubble sort.
I hope these suggestions are helpful! Let me know if you have
any questions.
```

I am sure you noticed that the assistant is remembering the whole conversation and answering the questions contextually.

Development with ChatGPT

The above conversation only illustrates how the assistant can help us in writing code for smaller problems. However, developing software is not just about writing code. Let's act as if we do not know much about developing Spring Boot applications and see how much the assistant helps us.

I started by asking the following question:

```
difference between log4j and slf4j
```

It gave a whole lot of information. Try this yourself and find out how useful it is.

Then, I asked the following question:

```
spring program with slf4j
```

It generated the following code:

```
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.
SpringBootApplication;

@SpringBootApplication
public class MySpringApp {
  private static final Logger logger = LoggerFactory.
```

```
getLogger(MySpringApp.class);

  public static void main(String[] args) {
    SpringApplication.run(MySpringApp.class, args);
    logger.info("Spring application started!");
  }
}
```

The assistant does not wash its hands off with just code. It gives a lot of notes as well. For instance, the following is the note generated along with the above code.

```
In this example, we use the LoggerFactory class from slf4j
to create a logger for the MySpringApp class. We can then
use the logger object to output log statements at different
levels (e.g., info, debug, error).
To use slf4j in a Spring application, you will need
to include the slf4j-api library as a dependency in
your project. You will also need to include a concrete
implementation of slf4j, such as log4j, logback, or java.
util.logging.
For example, to use log4j as the underlying logging
implementation, you will need to include the log4j library
as a dependency in your project. You can then configure log4j
to output log statements to the desired destination (e.g.,
console, file).
```

Since it is advising some dependencies, I acted as if I do not know how it can be done. So, I asked this follow-up question:

```
pom file for spring with slf4j
```

Here is the resulting suggestion:

```
<project>
  <!-- Other project configuration -->

  <dependencies>
    <!-- Other dependencies -->
    <dependency>
      <groupId>org.slf4j</groupId>
      <artifactId>slf4j-api</artifactId>
      <version>1.7.30</version>
    </dependency>
    <dependency>
      <groupId>org.slf4j</groupId>
      <artifactId>slf4j-log4j12</artifactId>
      <version>1.7.30</version>
    </dependency>
  </dependencies>
</project>
```

Again, the notes suggested a log4j dependency. I asked the assistant to add that too, and it generated the following refined configuration.

```
<project>
  <!-- Other project configuration -->

  <dependencies>
    <!-- Other dependencies -->
    <dependency>
      <groupId>org.slf4j</groupId>
      <artifactId>slf4j-api</artifactId>
      <version>1.7.30</version>
    </dependency>
    <dependency>
      <groupId>org.slf4j</groupId>
      <artifactId>slf4j-log4j12</artifactId>
      <version>1.7.30</version>
    </dependency>
    <dependency>
      <groupId>log4j</groupId>
      <artifactId>log4j</artifactId>
      <version>1.2.17</version>
    </dependency>
  </dependencies>
</project>
You will also need to include a log4j.properties file in your
project to configure log4j to output log statements to the
desired destination (e.g., console, file).
```

The story doesn't end here. I asked the assistant to help me with the *log4j.properties* file:

```
log4j.properties for spring with slf4j
```

It obliged.

```
# Root logger
log4j.rootLogger=INFO, stdout, file

# Console appender
log4j.appender.stdout=org.apache.log4j.ConsoleAppender
log4j.appender.stdout.layout=org.apache.log4j.PatternLayout
log4j.appender.stdout.layout.ConversionPattern=%d{yyyy-MM-dd
HH:mm:ss} %-5p %c{1}:%L - %m%n

# File appender
log4j.appender.file=org.apache.log4j.FileAppender
log4j.appender.file.File=app.log
log4j.appender.file.layout=org.apache.log4j.PatternLayout
log4j.appender.file.layout.ConversionPattern=%d{yyyy-MM-dd
HH:mm:ss} %-5p %c{1}:%L - %m%n
```

I was thrilled. Not that we cannot get this help from the web using a search engine. But the conversational experience with ChatGPT was just awesome.

Let us try ChatGPT for one last time by taking help in developing and deploying REST API. I started a new conversation with a simple question:

```
design rest api to add a customer
```

It responded with the following explanation:

```
To design a REST API to add a customer, you will need to
define the endpoints and the request/response payloads for the
API.
Here is an example of how you could design the API:
Endpoint:
POST /customers
Request payload:
{
  "name": "John Smith",
  "email": "john@example.com",
  "phone": "555-555-5555"
}
```

Quite useful! We normally use Swagger for documenting the REST API. There is a lot of boilerplate in it. ChatGPT is perfect in such cases. I asked the following in the same conversation:

```
swagger doc for adding a new customer
```

Here is Swagger documentation for the POST */customers* endpoint that I described above:

```
/customers:
  post:
    summary: Add a new customer
    requestBody:
      content:
        application/json:
          schema:
            type: object
            required:
              - name
              - email
              - address
            properties:
              name:
                type: string
              email:
                type: string
                format: email
              address:
                type: string
    responses:
      201:
        description: The customer was successfully created
        content:
          application/json:
            schema:
              type: object
              properties:
                id:
                  type: integer
                  format: int64
                name:
                  type: string
                email:
                  type: string
                  format: email
                address:
                  type: string
      400:
        description: The request body is invalid
      409:
        description: A customer with the same email already
exists
```

What else could I ask for? The final version of the documentation may not look this simple. Yet, it is a good starting point.

I was curious to see if ChatGPT could give me code for publishing the above REST API using Spring Boot. It did! The question was this:

```
spring controller for the above endpoint
```

And the response was:

```
@RestController
@RequestMapping("/customers")
public class CustomerController {

    @PostMapping
    public ResponseEntity<Customer> createCustomer(@Valid @
RequestBody Customer customer) {
        // save the customer and return it
        Customer savedCustomer = customerRepository.
save(customer);
        return ResponseEntity.status(HttpStatus.CREATED).
body(savedCustomer);
    }
}
```

This is imperative Spring. Nowadays, we prefer the reactive paradigm. I asked the same thing with this question:

```
i want it with spring reactive
```

ChatGPT gave the starter code.

```
@RestController
@RequestMapping("/customers")
public class CustomerController {

    @PostMapping
    public Mono<ResponseEntity<Customer>> createCustomer(@
Valid @RequestBody Mono<Customer> customer) {
        // save the customer and return it
        return customer.flatMap(customer ->
customerRepository.save(customer))
                       .map(savedCustomer -> ResponseEntity.
status(HttpStatus.CREATED).body(savedCustomer));
    }
}
```

No modern development is completed without creating a Docker image. I took help from ChatGPT to generate a Dockerfile for the above code with this question:

```
dockerfile for the above application
```

And I got the following response, which is sufficient to start with:

```
FROM openjdk:11-jdk-slim
ARG JAR_FILE=target/*.jar
COPY ${JAR_FILE} app.jar
EXPOSE 8080
ENTRYPOINT ["java", "-jar", "app.jar"]
```

Instead of asking for specific help, I just tried the following to spice up the conversation:

```
what is the next step?
```

It surprised me with this answer:

```
Once you have written the code for your application and
created a Dockerfile, the next step is to build a Docker image
and run a Docker container.
To build the Docker image, open a terminal and navigate
to the directory containing the Dockerfile. Then, run the
following command:
docker build -t my-app .
This will build a Docker image with the name "my-app" using
the instructions in the Dockerfile.
To run a Docker container, use the following command:
docker run -p 8080:8080 my-app
This will start a Docker container from the "my-app" image,
and map the container's 8080 port to the host's 8080 port.
Is there anything else I can help with?
```

See! ChatGPT maintains the conversational context. It answers in the given context, not just dry static results. And that is amazing. What else can I say? I said:

```
thanks
```

And the assistant was good enough to acknowledge.

```
You're welcome! I'm glad I could help. If you have any other
questions, feel free to ask. I'll do my best to assist you.
```

ChatGPT: Boon or Bane?

I remember people arguing about the good and bad of the computerisation of banks in the 90s and autonomous vehicles in the 2020s. Every disruptive technology raises this question. It's the same with ChatGPT as well.

The precise question that is relevant for the software development community is this: Will ChatGPT replace developers?

At this point, the answer is clearly 'no'. Technology always destroys some jobs and creates new ones. But replacing a developer takes a lot of effort. Software development is not just coding. Certainly, ChatGPT can help in writing code just like IDE helps in code completion, compilation, debugging, etc. But, like IDE, it cannot replace human involvement in end-to-end development. We, as developers, used text editors to write the code in the 80s, and used IDEs in the 90s. We have copied code from Google search results and used solutions from StackOverflow. All of this was done to improve productivity. And yet, none of them were really able to replace the developer. The same is going to happen with ChatGPT as well. It's a disruptive productive tool for programmers. But, it neither makes you a programmer nor takes away your programming job. At least for now! END

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AI: More About Neural Networks and an Introduction to PyTorch

The previous article in this series on AI and machine learning was critical in many respects. First, we started using scikit-learn, a very powerful Python library for developing AI and machine learning based applications. Second, we deployed our first trained model. But, most important, the article introduced ChatGPT, maybe for the first time by a print magazine in India. This eighth article in the AI series talks a little more about neural networks as well as unsupervised learning, and introduces PyTorch, a very powerful framework capable of learning from data.

As mentioned in the last article, ChatGPT is a chatbot launched by OpenAI in November 2022. Within just two months of its existence, ChatGPT has created two opposing factions. One faction is supporting AI based tools like ChatGPT and waiting for a Utopian world created by AI. The other faction is worried about AI and making doomsday predictions. They fear a dystopian future — a *Terminator*-like scenario in which machines control humans and not the other way round. Some of the people in this faction also believe that ChatGPT will be a job killer. The jobs potentially under jeopardy according to these people include business transcription, medical transcription, copywriting, teaching, legal work, etc. But do remember that half a century ago many people believed that computers were job killers and see how mistaken they were. Some people also predict that tools like ChatGPT might be the beginning of the end for conventional search engines like Google, Bing, Baidu, etc — a belief I don't share personally.

But what about the popularity of ChatGPT? FaceBook took 10 months to get one million subscribers in 2004. Twitter took about two years to obtain one million subscribers in 2006. Instagram was downloaded by more than one million users within 2.5 months of it being made public in 2010. All are amazing achievements. But do you know how much time ChatGPT took to obtain one million subscribers after it was made available to the public? Less than a week! Simply amazing, isn't it? I don't know the exact number of subscribers as of writing this article. But nowadays the services of ChatGPT are often unavailable due to the large number of users.

What about DALL-E 2, also provided by OpenAI, a tool capable of generating images from descriptions. Will normal people ever be able to distinguish between images generated by master painters and the ones generated by tools like DALL-E 2. For the sake of art, I hope at least expert curators will be able to distinguish between the two, just like a gemologist can easily distinguish between a real and a duplicate diamond, a task not easy for common people.

It is also time to think how such a ground-breaking tool like ChatGPT will affect AI related research funding. It could lead to an even bigger pile of funding in the field of AI, which might lead to further ground-breaking tools and inventions. However, such heightened expectations could also lead to disappointment and a negative reaction from the industrial giants who fund most of this research. Well, it is not safe to make predictions in times like this about the future of AI. Maybe we should ask ChatGPT to make a prediction. However, I urge you to read the Wikipedia article titled '*AI winter*' to know more about research funding in the field of AI when exaggerated expectations are not reciprocated in reality. Also, if you still haven't used ChatGPT or DALL-E 2, I once again implore you to try them out. You will be mesmerized. Now, let us return to our humble efforts of creating simple applications based on AI and machine learning.

Keras and neural networks

In the last article, we trained our first model using the MNIST database of handwritten digits. We have also tested our model using a few scanned images of handwritten digits. In the last article itself, we had a detailed line by line explanation of the code, except for lines 16, 19, and 20. These lines of code were the core of the model and we merely stated that fact in the last article. These three lines of code defined the properties of the neural network used in our model as well as the training parameters used. In this article, we will discuss these three lines of code in detail so that we have a clearer understanding about neural networks and their training. First, consider line 16 of the code shown below, used to develop our model. Notice that though the code spans multiple lines, syntactically it is a single statement of code.

```
model = keras.Sequential(
        [
keras.Input(shape=input_shape),
layers.Conv2D(32, kernel_size=(3, 3),
activation="relu"),
layers.MaxPooling2D(pool_size=(2, 2)),
layers.Conv2D(64, kernel_size=(3, 3),
activation="relu"),
layers.MaxPooling2D(pool_size=(2, 2)),
layers.Flatten(),
layers.Dropout(0.5),
layers.Dense(num_classes,
activation="softmax"),
        ]
    )
```

Let us briefly recall what lines 1 to 15 did to our model. First, we imported the necessary Python libraries like NumPy, Keras, etc. Then we fixed the number of classes, input shape, etc. Next, we loaded the MNIST data set and divided it into training data and testing data. Later, we checked whether a trained model exists in our system or not. We are doing this to avoid the time and resource consuming training process of a model, if a trained model already exists. If such a trained model does not exist, then the properties of a model for training are defined by the 16th line of code.

Now, let us go through that line of code shown above in detail. First, the type of neural network used is decided. Recall that a neural network has an input layer, a number of hidden layers and an output layer. Further, each layer has a number of nodes (neurons). We have defined a sequential model with the class *Sequential( )* provided by the *Sequential* API of Keras. A sequential model is a stack of layers, where each layer has exactly one input tensor and one output tensor. This model allows us to create the neural network layer by layer. The sequential model is a relatively simple neural network model. If you want to create a more complicated neural network then use the *Model( )* class provided by the *Functional* API of Keras. The *Functional* API can handle models with shared layers and multiple inputs or outputs, if required. However, I preferred the simpler sequential model.

Now, let us try to understand the input parameters given to our sequential model. The code '*keras.Input(shape=input_shape)*' defines the shape of the input given to the input layer. In this case, the shape is (28, 28, 1) because the MNIST data set we used for training consists of a collection of 28x28 pixel grayscale images of handwritten digits. The code '*layers.Conv2D(32, kernel_size=(3, 3), activation="relu")*' defines a 2D convolution layer.

By the way, what is a convolution layer? A convolution layer applies a filter to an input that results in an activation. The integer 32 in the code specifies the parameter *filters*, which defines the number of output filters in the convolution. The second parameter *kernel_size* specifies the height and width of the 2D convolution layer. Recall that we have already discussed activation functions in general and the activation function called '*relu*' (rectified linear unit) in particular, in the 6th article in this series. Notice that a lot of other parameters can also be specified for a 2D convolution layer. But our simple example only specifies the three parameters we have discussed already. The code '*layers.MaxPooling2D(pool_size=(2, 2))*' generates a maximum pooling layer for processing 2D spatial data. This performs a down sampling of the input along its spatial dimensions by taking the maximum value over an input window for each channel of the input. The size of the input window is specified by the parameter *pool_size*, which in this case is (2, 2). Now, let us go through a simple

```
1  import tensorflow as tf
2  data = tf.constant([[44.1, 44.2], [44.3, 44.4]])
3  data = tf.reshape(data, [1, 2, 2, 1])
4  max_pool = tf.keras.layers.MaxPooling2D(pool_size=(2, 2))
5  print(max_pool(data))
```

```
tf.Tensor([[[[44.4]]]], shape=(1, 1, 1, 1), dtype=float32)
```

Figure 1: The effect of a 2D Max Pooling layer

```
1  from tensorflow.keras import layers
2  model = tf.keras.Sequential()
3  model.add(layers.Conv2D(10, 1, input_shape=(4, 10, 10)))
4  print(model.output_shape)
5  model.add(tf.keras.layers.Flatten())
6  print(model.output_shape)
```

```
(None, 4, 10, 10)
(None, 400)
```

Figure 2: The effect of a Flatten layer

example to understand how maximum pooling works. Consider the code shown in Figure 1.

Line 1 imports TensorFlow. Line 2 defines a two-dimensional tensor named *data*. Line 3 reshapes the dimension of *data* to (1, 2, 2, 1). Line 4 uses the class *MaxPooling2D* to create the object *max_pool*. Notice that the parameter *pool_size* is (2, 2). Line 5 performs the maximum pooling operation on the tensor named *data* and prints the result. Since *data* is a two-dimensional tensor, only one element will be returned by *max_pool*. Figure 1 also shows the output of the script. It can be seen that the value returned is 44.4, the maximum value stored in the tensor named *data*.

Now, let us go back to the remaining parts of the 16th line of code in our model. The code *'layers.Conv2D(64, kernel_size=(3, 3), activation="relu")'* defines another 2D convolution layer of the neural network, but this time the parameter *filters* is specified as 64. Similarly, the code 'layers.*MaxPooling2D(pool_size=(2, 2))*' again generates a maximum pooling layer. The code *'layers.Flatten( )'* generates a layer that gets a multidimensional tensor as input and converts it into a single dimensional tensor. For better understanding of the working of this layer, consider the code shown in Figure 2.

Line 1 imports the *Layers* API of Keras. Line 2 defines a sequential model. Line 3 adds a 2D convolution layer to this model by using the *add( )* method. This line of code also demonstrates how a sequential model can be built layer by layer. Line 4 prints the output shape of this layer. Figure 2 shows that the output shape currently is (None, 4, 10, 10). Line 5 adds a *Flatten* layer. Line 6 prints the output shape of this *Flatten* layer. Figure 2 shows that the output shape of this layer is (None, 400). Notice that this layer does not affect the data values; it merely reshapes the data.

Now, let us consider the remaining code in the 16th line of code in our model. The code *'layers.Dropout(0.5)'* creates a *Dropout* layer. This layer randomly sets input units to 0 with a frequency of *rate* at each step during training. This helps prevent overfitting. In simple terms, overfitting is an issue faced by mathematical models when they learn too much from the training data. This results in the model not being able to make predictions based on new data. In a *Dropout* layer, input data not set to 0 is scaled up by a factor of 1/(1 - rate) so that the sum over all input data remains unchanged. In our model the parameter *rate* is specified as 0.5. The code *'layers.Dense(num_classes, activation="softmax")'* creates a densely connected neural network layer. The first parameter called *units* (provided by the variable *num_classes* in our example) defines the output dimension of this layer. Notice that in our model the variable *num_classes* has the value 10, because we were trying to classify the decimal digits from 0 to 9. Also, instead of *'relu'*, the activation function used is *'softmax'*, which is a slightly more complicated activation function. Please read the Wikipedia article titled *'Softmax function'* for better understanding of this activation function. Finally, the generated model returned by the class *Sequential* in the 16th line of code is stored in an object named *model*. So altogether, our model has seven layers. Lines 17 and 18 of our code define the batch size and the epoch size of the model.

Now, consider the 19th line of code, shown below, used in developing our model.

```
model.compile(loss="categorical_crossentropy", optimizer="adam", metrics=["accuracy"])
```

Let us try to understand the above line of code. We need to configure the training process using the method *compile( )* before we start training our model. Three parameters are given to the method *compile( )*. These are: loss, optimizer, and metric. Loss function is the objective that the model will try to minimise. Some of the loss functions include *mean_squared_error, mean_absolute_error, mean_absolute_percentage_error, mean_squared_logarithmic_error, hinge, binary_crossentropy, categorical_crossentropy, poisson, cosine_proximity,* etc. In our model, we have used the objective function called

categorical_crossentropy. It is used to optimize classification models. Some of the available choices for optimizer include SGD, RMSprop, Adagrad, Adadelta, Adam, Adamax, Nadam, etc. In our model, we have used an optimizer called 'adam' (Adam). Adam is a first-order gradient-based optimization algorithm for stochastic objective functions. A detailed discussion of Adam is beyond the scope of our tutorial. Finally, a metric is a function that is used to measure the performance of a model. In our model, we have given 'accuracy' as the metric. This metric calculates how often predictions equal labels. The inclusion of this metric is the reason why we were able to print the accuracy of our model while processing the test data. In addition to the accuracy metric, there are other metrics like probabilistic metric, regression metric, image segmentation metric, etc.

Now, consider the 20th line of code shown below, used in developing our model.

```
model.fit(x_train, y_train, batch_
size=batch_size, epochs=epochs,
validation_split=0.1)
```

Let us try to understand the above line of code. The following parameters are passed to the *fit( )* method. The variable *x_train* contains the training data. Training data could be either a NumPy array or a TensorFlow tensor. The variable *y_train* contains the target data. Target data could also be either a NumPy array or a TensorFlow tensor. Parameters to specify the batch size and the number of epochs are also passed to the *fit( )* method. The parameter *validation_split* fixes the fraction of the training data to be used as validation data. Thus, the parameter takes a floating point value between 0 and 1. In our model, the value specified for this parameter is 0.1. After training, this model is saved in our system so that unnecessary training can be avoided in the future. Later, the test data is used to test the accuracy of the model we have trained. Finally, our model can be used to make predictions about new images of handwritten digits. With this, the discussion about our first trained model is complete.

Unsupervised learning with scikit-learn

We know that the two important paradigms of machine learning are supervised learning and unsupervised learning. Though not as popular as these two models, there are other paradigms also, like semi-supervised learning and reinforcement learning. But our discussion so far in this series was exclusively based on supervised and unsupervised learning. Though we have discussed unsupervised learning, we have given a lot of importance to supervised learning algorithms like linear regression and classification so far.

Now, it is time to discuss more about unsupervised learning, which works with unlabelled data. Just like supervised learning, in unsupervised learning also there are different algorithms like clustering, dimensionality reduction, etc. In this article, we will be focusing on clustering. Clustering is grouping a set of objects in such a way that objects in the same group are more related to each other than objects in other groups. There are many different clustering algorithms — K-Means clustering, affinity propagation clustering, mean shift clustering, spectral clustering, hierarchical clustering, DBSCAN clustering, OPTICS clustering, etc. In this article, we will be implementing K-Means clustering using the library scikit-learn.

The K-Means clustering algorithm begins by choosing K random points as cluster centres. Objects to be grouped are assigned to one of these K randomly chosen clusters. Based on the number of objects assigned to each of the clusters, new cluster centres are repeatedly calculated until the grouping of objects becomes stable. Now, let us get familiar with the Python script, shown below, implementing K-Means clustering using scikit-learn. Since the program is relatively large, a part by part explanation is given here for better understanding. Line numbers are added to the program for ease of explanation.

```
1. import numpy as np
2. from matplotlib import pyplot as plt
3. from sklearn.datasets import make_
   blobs
4. from sklearn.cluster import KMeans
5. X, y = make_blobs(n_samples=200,
   centers=2, n_features=2, cluster_
   std=0.5, random_state=0)
6. plt.scatter(X[:,0], X[:,1])
7. plt.show( )
```

Let us try to understand the above lines of code. Lines 1 and 2 import NumPy and Matplotlib. Line 3 imports the method *make_blobs()*. Line 4 imports the class *KMeans()*. Line 5 calls the method *make_blobs( )* to generate isotropic Gaussian blobs for clustering. A collection of binary data stored as a single entity is called a blob (binary large object). But what do I mean by the previous two sentences? Well, in this example, we are not using actual data; instead, we are generating sample data to test the K-Means clustering algorithm. But unlike many other occasions in this series, we are not generating random data this time. The sample data generated depends on the parameters we pass to the method *make_blob( )*. In this example, we are taking 200 samples (parameter *n_samples*) with just two centres (parameter *centers*). The parameter *n_features* determines the number of columns or features the generated data set will have. In this case it is 2. Since we are plotting the generated data in a two-dimensional plane, *n_features* should be at least 2. The parameter *cluster_std* fixes the standard deviation of the clusters. In this case

it is 0.5. The parameter *random_state* determines the random number generation for creating the data set. The method *make_blob( )* returns the generated samples (stored in array *X*, in this case) and the integer labels for cluster membership of each sample (stored in *y*, in this case). Finally, lines 6 and 7 plot and display the sample data generated in a two-dimensional plane. Figure 3 shows this plot of the generated sample data.

Now that we have the necessary data, let us try to identify clusters from this data. The following lines of code do exactly that.

```
8.  kmeans = KMeans(n_clusters=2,
    init='k-means++', max_iter=1000,
    random_state=0)
9.  predict_y = kmeans.fit_predict(X)
10. plt.scatter(X[:,0], X[:,1])
11. plt.scatter(kmeans.cluster_centers_
    [:, 0], kmeans.cluster_centers_
    [:, 1], s=500, c='green')
12. plt.show( )
```

Now, let us try to understand the above lines of code. Line 8 calls the class *KMeans* to create an object of it called *kmeans*. Let us discuss the parameters passed to this class. The parameter *n_clusters* fixes the number of clusters to be formed as well as the number of cluster centres to be generated. In our case it is 2. The parameter *init* decides the method for initialisation. The two possible options for the parameter *init* are *'k-means++'* and *'random'*. This parameter decides how cluster centres are identified. We chose *'k-means++'* because it results in faster convergence while finding the cluster centres. The parameter *max_iter* decides the maximum number of iterations of the K-Means algorithm on a single execution. In this case, it is 1000. The parameter *random_state* determines the random number generated for initialising the cluster centres. In this case, it is 0. Line 9 uses the method *fit_predict( )* of the class *KMeans()* to compute the cluster centres and also predicts the cluster to which each sample in the sample data belongs. Line 10 again plots the sample data generated. Line 11 plots the cluster centres in green colour. Finally, Line 12 displays the images plotted. Figure 4 shows this plot of the sample data generated and the cluster centres identified. Thus we have implemented our first, though simple, unsupervised learning algorithm.

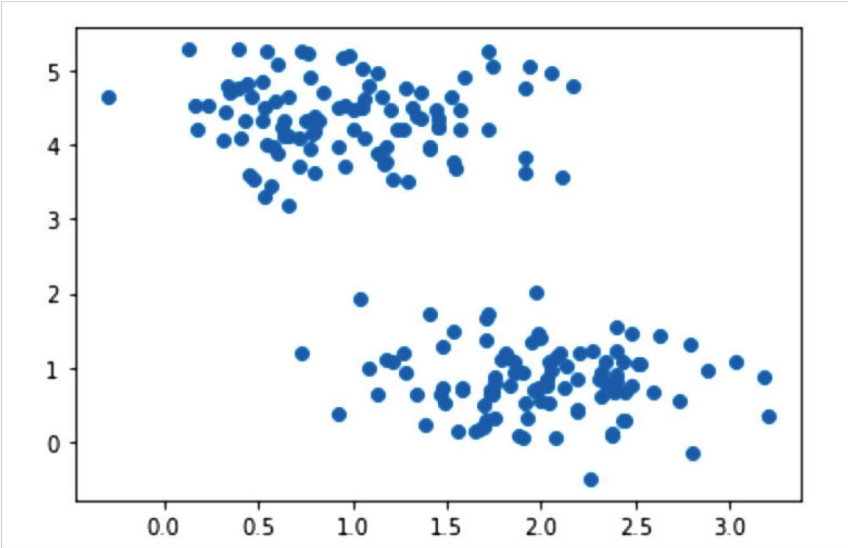

Figure 3: Sample data generated

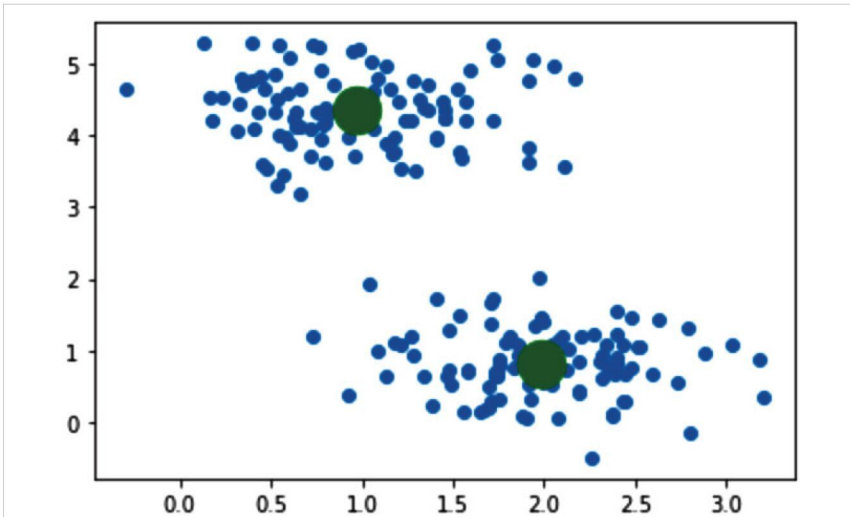

Figure 4: Cluster centres identified by K-Means clustering

An introduction to PyTorch

Now let us make ourselves familiar with PyTorch, a powerful machine learning framework based on the Torch library. Torch is an open source machine learning library and a scientific computing framework based on a programming language called Lua. PyTorch is free and open source software released under the modified BSD licence. PyTorch can work in both CPU mode and GPU mode. But in order to work with the GPU mode of PyTorch, we need to have an Nvidia graphics card and

CUDA platform installed in our system. As before, the installation of PyTorch will be handled by Anaconda Navigator. Let us begin by discussing a simple Python script using PyTorch. Consider the Python script shown in Figure 5.

We have already discussed tensors and how they can be created using TensorFlow. We can also create tensors using PyTorch. Now, let us try to understand the Python script shown in Figure 5, which creates a tensor using PyTorch. Line 1 imports the library PyTorch. Line 2 defines a two-dimensional list named *val*. Line 3 converts the list *val* to a tensor named *ten*. Line 4 prints the content of the tensor *ten*. Figure 5 also shows the output of the script. Notice that the values in the list *val* remain unchanged even after getting converted to tensor *ten*. Finally, Line 5 prints the type of the tensor *ten*, which is of type *torch.Tensor*.

Figure 6 shows a Python script generating a tensor with random values. Line 1 of the script uses the method *rand( )* to generate a 3x3 matrix and store it in a tensor named *random_tensor*. Line 2 prints the content of the tensor *random_tensor*. The output of the script is also shown in Figure 6. Notice that the content will change with each iteration because we are using the *rand( )* method to generate random tensors. Finally, Line 3 prints that the type of *random_tensor* is also *torch.Tensor*.

It is also possible to convert a NumPy array to a PyTorch tensor. Consider the Python script shown in Figure 7. Line 1 imports NumPy. Line 2 creates a two-dimensional NumPy array and stores it in a variable named *val*. Line 3 prints the type of the *val*. Figure 7 also shows the output of the script. It can be seen that *val* is of type *numpy.ndarray* (NumPy array). Line 4 uses the method *from_numpy( )* to convert the array *val* to a PyTorch tensor and stores it in a variable named *ten*. Line 5 prints the type of the variable *ten*. Notice that *ten* is of type *torch.Tensor*. Finally, Line 6 prints the content of the tensor *ten*. The values in the tensor *ten* are the same as the values in the array *val*. We will be revisiting PyTorch in the next article in this series when we discuss natural language processing.

```
1 import torch
2 val = [[11, 22, 33], [44, 55, 66], [77, 88, 99]]
3 ten = torch.tensor(val)
4 print(ten)
5 print(type(ten))
```

```
tensor([[11, 22, 33],
        [44, 55, 66],
        [77, 88, 99]])
<class 'torch.Tensor'>
```

Figure 5: A first introduction to PyTorch

```
1 random_ten = torch.rand(3, 3)
2 print(random_ten)
3 print(type(random_ten))
```

```
tensor([[0.3473, 0.6767, 0.1339],
        [0.3764, 0.5648, 0.4349],
        [0.4054, 0.2175, 0.2619]])
<class 'torch.Tensor'>
```

Figure 6: A random tensor

```
1 import numpy as np
2 val = np.array([[11, 22], [32, 44]])
3 print(type(val))
4 ten = torch.from_numpy(val)
5 print(type(ten))
6 print(ten)
```

```
<class 'numpy.ndarray'>
<class 'torch.Tensor'>
tensor([[11, 22],
        [32, 44]])
```

Figure 7: Array to tensor conversion

Now, it is time to wind-up this article. In this article, we have developed more intuition about neural networks. Further, we used scikit-learn to learn more about unsupervised learning. We also had our first interaction with PyTorch. In the next article in this series on AI and machine learning, we will continue exploring model training and neural networks. Natural language processing (NLP) is an important area in AI and machine learning. However, so far in this series we haven't discussed anything about AI based NLP. So in the next article, we will discuss NLP using PyTorch as well as familiarise ourselves with NLTK (natural language toolkit), a Python library used exclusively for NLP. END

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Building an App Using Android Jetpack Compose

Android Jetpack Compose is a new way of creating an Android layout; it eases the difficulties faced in traditional layout creation and maintenance. This article is a simple demonstration of how to use Jetpack Compose to build a sample app along with code based on Kotlin.

Jetpack Compose is a UI kit made for declarative programming in Android. With Jetpack Compose, you can avoid complicated xml layout files, but programmatically design the screens. The UI is built using composable functions in Jetpack Compose. In this tutorial, we will use it to make a simple application that will help users make a bio for themselves.

Figure 1 shows what our app looks like when it is opened. It should show an *Edit* button at the top. The profile picture should be displayed below the *Edit* button. Below this picture, the name, about, email, and the phone number are displayed. The app provides options to edit all the details by clicking the *Edit* button.

In editing mode (Figure 2), the app will display an *Edit* button on the profile picture; all other fields become editable, and a *Save* button is displayed.

On clicking the *Edit* button on the profile picture, the app will display an option to pick a profile picture from the list, as shown in Figure 3.

Creating the app

Open the Android Studio (Android Studio Dolphin or later). Go to it, then click *File -> New -> New Project -> Empty Compose Activity.* Give application name, package name, save location and minimum SDK. API 21 is given as the minimum SDK.

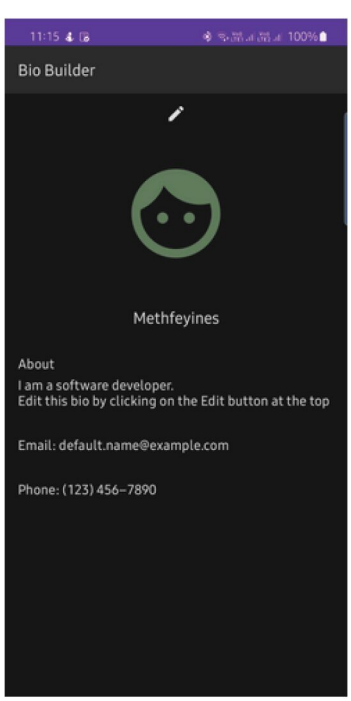

Figure 1: The Bio app

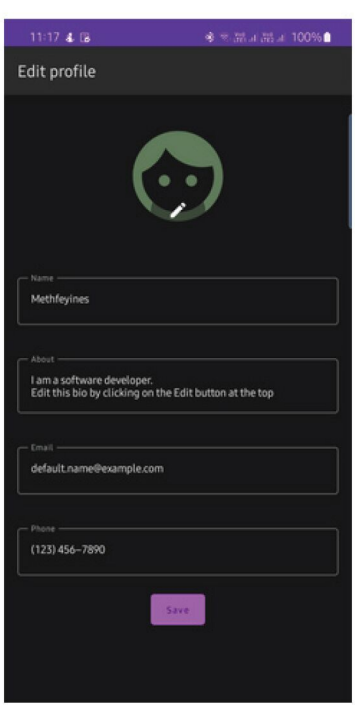

Figure 2: The app in editing mode

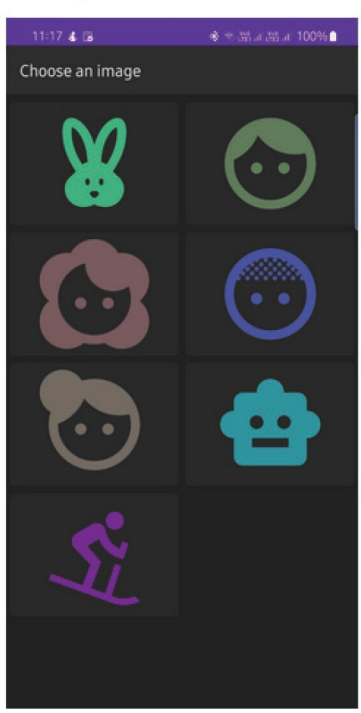

Figure 3: Selecting the profile picture

String resources

Create a *string.xml* file with all of the required strings in our code. As per the UI, we require the following

strings in our app:

```
   <string name="app_name">Bio Builder</string>
    <string name="profile_pic">Profile Picture</string>
    <string name="edit_profile">Edit profile</string>
    <string name="update_profile_picture">Update picture</
string>
    <string name="text_template">%1$s: %2$s</string>
    <string name="name_label">Name</string>
    <string name="about_label">About</string>
    <string name="phone_label">Phone</string>
    <string name="email_label">Email</string>
    <string name="dob_label">Date of Birth</string>
    <string name="save_label">Save</string>
    <string name="default_name">Default name</string>
    <string name="default_about">I am a software developer.\
nEdit this bio by clicking on the Edit button at the top</
string>
    <string name="default_phone">(123) 456-7890</string>
    <string name="default_email">default.name@example.com</
string>
    <string name="editable_app_title">Edit Bio</string>

    <string name="choose_image">Choose an image</string>
```

Bio-page: *EditButton*

Create a composable function called *EditButton*. Composable functions can be created by adding the *@Composable* prefix.

```
@Composable
fun EditButton(
    modifier: Modifier = Modifier,
    onEdit: () -> Unit
) {
    IconButton( modifier = modifier, onClick = onEdit) {
        Icon(
            imageVector = Icons.Default.Edit,
            contentDescription = stringResource(id =
R.string.edit_profile)
        )
    }
}
```

Inside the *EditButton* composable, we can add an *IconButton*. We use the *Modifier* object to apply parameters like padding, size, etc. onEdit lambda is called when the button is clicked. We call an Icon composable with *Icons.Default.Edit* as the imageVector inside the content lambda.

Now create a state variable for storing the value of *editable* inside the *setContent* composable:

```
var editable by rememberSaveable {
    mutableStateOf(false)
}
Create a lambda for enabling the editing:
val onClickEdit = {
    editable = true
}
```

Create another lambda for cancelling the editing:

```
val cancelEdit = {
    editable = false
}
```

Now, we can preview our *EditButton* using the *@Preview* annotation. Create another composable function named *PreviewEditButton*. Inside the *PreviewEditButton*, call *EditButton* composable. Pass an empty lambda as onEdit parameter. If we build the application now, you can see our *Edit* button.

```
@Preview
@Composable
fun PreviewEditButon() {
    EditButton {
   }
}
```

Profile picture

We can now create a composable for our profile picture. Create a composable function called *ProfileImage*. This function will show an *Edit* button in edit mode. On clicking the *Edit* button, it will show an option to pick a profile picture. This function will have three other parameters along with a modifier parameter -- a Boolean value to determine the mode, an ID of the profile picture, and a lambda for changing the image upon clicking the *Edit* button.

```
@Composable
fun ProfileImage(
    modifier: Modifier = Modifier,
    editable: Boolean,
    picId: Int,
    onChangePic: () -> Unit
) {
    Box(
        modifier = modifier,
        contentAlignment = Alignment.BottomCenter
    ) {
        Image(
            modifier = Modifier.size(128.dp),
            painter = painterResource(id = picId),
            contentDescription = stringResource(id =
R.string.profile_pic)
        )
        AnimatedVisibility(visible = editable) {
```

```
            ChangePicButton(onChangePic)
        }
    }
}
```

For the profile image, we are calling an Image composable inside a Box composable. We will create a composable named *ChangePicButton* for showing the *Edit* button on top of the profile pic. We call it inside the *AnimatedVisibility* composable function. *AnimatedVisibility* composable will animate and make the *ChangePicButton* visible when the value of the editable parameter is true.

Button to change the picture

Now, let's implement the *ChangePicButton* composable.

```
@Composable
private fun ChangePicButton(onChangePic: () -> Unit) {
    IconButton(
        onClick = onChangePic
    ) {
        Icon(
            modifier = Modifier
                .background(
                    color = MaterialTheme.colors.surface.
copy(alpha = 0.5f),
                    shape = CircleShape
                )
                .padding(horizontal = 20.dp, vertical = 8.dp),
            imageVector = Icons.Default.Edit,
            contentDescription = stringResource(id = R.string.
update_profile_picture),
            tint = MaterialTheme.colors.onSurface
        )
    }
}
```

Here we added the background and padding modifiers to the Icon composable. We applied the surface colour with 0.5 alpha as the background colour. We also applied the onSurface colour as the icon tint.

ViewModel class for the biodata

Before creating the next composables, create a *ViewModel* class called *BioModel* for temporarily storing the biodata. Create a *BioModel.kt* file with the following contents:

```
class ProfileModel: ViewModel() {

    private val _profilePicId: MutableLiveData<Int> =
MutableLiveData()
    val profilePicId: LiveData<Int> = _profilePicId

    private val _name: MutableLiveData<String> =
MutableLiveData()
    val name: LiveData<String> = _name

    private val _dob: MutableLiveData<Time> = MutableLiveData()
    val dob: LiveData<Time> = _dob

    private val _about: MutableLiveData<String> =
MutableLiveData()
    val about: LiveData<String> = _about

    private val _email: MutableLiveData<String> =
MutableLiveData()
    val email: LiveData<String> = _email

    private val _phone: MutableLiveData<String> =
MutableLiveData()
    val phone: LiveData<String> = _phone

    fun updateName(name: String) {
        _name.value = name
    }

    fun updateDob(time: Time) {
        _dob.value = time
    }

    fun updateAbout(about: String) {
        _about.value = about
    }

    fun updateEmail(email: String) {
        _email.value = email
    }

    fun updatePhone(phone: String) {
        _phone.value = phone
    }

    fun updatePicId(id: Int) {
        _profilePicId.value = id
    }

    fun updateProfile(name: String, about: String, email:
String, phone: String) {
        updateName(name)
        updateAbout(about)
        updateEmail(email)
        updatePhone(phone)
    }
}
```

Now declare an object of the *ProfileModel* inside the

setContent lambda.

```
val bioModel: ProfileModel = viewModel()
```

Name field

Next, let's create a composable for the *Name* field. It should display a text in the centre in normal mode. But it should display a *TextField* in the editing mode.

```
@Composable
fun EditableName(
    modifier: Modifier = Modifier,
    editable: Boolean,
    label: String,
    text: String,
    textStyle: TextStyle = MaterialTheme.typography.h5,
    onTextChanged: (String) -> Unit
) {
    AnimatedVisibility(visible = !editable) {
        Text(
            modifier = modifier,
            text =  text,
            style = textStyle,
            textAlign = TextAlign.Center
        )
    }
    AnimatedVisibility(visible = editable) {
        OutlinedTextField(
            modifier = modifier,
            value = text,
            onValueChange = onTextChanged,
            label = {
                Text(text = label)
            },
            keyboardOptions = KeyboardOptions(keyboardType =
KeyboardType.Text),
        )
    }
}
```

Here, too, we use *AnimatedVisibility* to animate the visibility changes. The text value will store a default value, and the *onTextChanged* lambda will be executed when the text in the *TextField* is changed in the editing mode.

Now create a state variable for storing the name and a lambda for updating the name.

```
var name by rememberSaveable() {
    mutableStateOf(bioModel.name.value)
}

val onNameChanged = {changedName: String ->
    name = changedName
}
```

About Field

Similarly, we can create composable, state variables and lambda for the *about* field:

```
@Composable
fun EditableAbout(
    modifier: Modifier = Modifier,
    editable: Boolean,
    label: String,
    text: String,
    onTextChanged: (String) -> Unit,
) {
    AnimatedVisibility(visible = !editable) {
        Column(modifier = modifier) {
            Text(
                text = label,
                style = MaterialTheme.typography.h6
            )
            Spacer(modifier = Modifier.height(4.dp))
            Text(
                text = text,
                style = MaterialTheme.typography.h6
            )
        }
    }
    AnimatedVisibility(visible = editable) {
        OutlinedTextField(
            modifier = modifier,
            value = text,
            onValueChange = onTextChanged,
            label = {
                Text(text = label)
            },
            keyboardOptions = KeyboardOptions(keyboardType =
KeyboardType.Text)
        )
    }
}

var about by rememberSaveable() {
    mutableStateOf(bioModel.about.value)
}

val onAboutChanged = { changedAbout: String ->
    about = changedAbout
}
```

Email and phone

We can create a common composable for displaying the email

and the phone number:

```
@Composable
fun EditableText(
    modifier: Modifier = Modifier,
    editable: Boolean,
    label: String,
    text: String,
    textStyle: TextStyle = MaterialTheme.typography.h6,
    onTextChanged: (String) -> Unit,
    keyboardType: KeyboardType = KeyboardType.Text
) {
    AnimatedVisibility(visible = !editable) {
        Text(
            modifier = modifier,
            text = stringResource(id = R.string.text_
template, label, text),
            style = textStyle
        )
    }
    AnimatedVisibility(visible = editable) {
        OutlinedTextField(
            modifier = modifier,
            value = text,
            onValueChange = onTextChanged,
            label = {
                Text(text = label)
            },
            keyboardOptions = KeyboardOptions(keyboardType =
keyboardType)
        )
    }
}
```

The *keyboardType* will be *KeyboardType.Email* and *KeyboardType.Phone* for the email and the phone composables, respectively.

Now create the state variables and lambdas for email and phone:

```
var email by rememberSaveable() {
    mutableStateOf(bioModel.email.value)
}
val onEmailChanged = { changedEmail: String ->
    email = changedEmail
}
var phone by rememberSaveable() {
    mutableStateOf(bioModel.phone.value)
}
val onPhoneChanged = { changedPhone: String ->
    phone = changedPhone

}
```

Save button

Next, create a composable function for the *Save* button, as shown below:

```
@Composable
fun SaveButton(modifier: Modifier = Modifier, onSave: () ->
Unit) {
    Button(onClick = onSave) {
        Text(text = stringResource(id = R.string.save_label))
    }
}
```

Create a lambda for calling on clicking the *Save* button:

```
val onSave = {
    // Saving the details to the viewModel
    bioModel.updateProfile(
        name?: "",
     about?: "",
     email?:"",
     phone?:""
    )
    editable = false

}
```

App title

Let's now create a title composable function for displaying the app title.

```
@Composable
fun Title(modifier: Modifier = Modifier, title: String) {
    Surface(
        modifier = modifier,
        elevation = 4.dp
    ) {
        Text(
            modifier = Modifier
                .fillMaxWidth(1f)
                .padding(horizontal = 16.dp, vertical =
16.dp),
            text = title,
            style = MaterialTheme.typography.h5
        )
    }
}
```

Bio-page title

Next, create a title composable for displaying the title of the bio page. It will have different titles in *Edit* mode and in normal mode.

```
@Composable
```

```
fun BioTitle(editable: Boolean) {
    if (editable) {
        Title( title = stringResource(id = R.string.edit_
profile))
    } else {
        Title(title = stringResource(id = R.string.app_name))
    }
}
```

Bio page

Create a composable function called *BioPage*, as shown below:

```
@Composable
fun BioPage(
    modifier: Modifier = Modifier,
    onEdit: () -> Unit,
    editable: Boolean,
    profilePicId: Int,
    onChangePic: () -> Unit,
    name: String,
    onNameChanged: (String) -> Unit,
    about: String,
    onAboutChanged: (String) -> Unit,
    email: String,
    onEmailChanged: (String) -> Unit,
    phone: String,
    onPhoneChanged: (String) -> Unit,
    onSave: () -> Unit,
    onEditCancel: () -> Unit
) {
    Column(
        modifier = modifier,
        horizontalAlignment = Alignment.CenterHorizontally
    ) {
        BioTitle(editable = editable)
        AnimatedVisibility(visible = !editable) {
            EditButton(
                modifier = Modifier
                    .fillMaxWidth()
                    .wrapContentWidth(align = Alignment.End)
                    .padding(horizontal = 8.dp, vertical =
8.dp),
                onEdit = onEdit
            )
        }
        ProfileImage(
            modifier = modifier
                .padding(32.dp)
                .clip(CircleShape),
            editable = editable,
            picId = profilePicId,
            onChangePic = onChangePic
        )
        val textModifier = Modifier
            .fillMaxWidth(1f)
            .padding(vertical = 16.dp, horizontal = 16.dp)

        EditableName(
            modifier = textModifier,
            editable = editable,
            label = stringResource(id = R.string.name_label),
            text = name,
            onTextChanged = onNameChanged
        )

        EditableAbout(
            modifier = textModifier,
            editable = editable,
            label = stringResource(id = R.string.about_
label),
            text = about,
            onTextChanged = onAboutChanged
        )

        EditableText(
            modifier = textModifier,
            editable = editable,
            label = stringResource(id = R.string.email_
label),
            text = email,
            onTextChanged = onEmailChanged,
            keyboardType = KeyboardType.Email
        )

        EditableText(
            modifier = textModifier,
            editable = editable,
            label = stringResource(id = R.string.phone_
label),
            text = phone,
            onTextChanged = onPhoneChanged,
            keyboardType = KeyboardType.Phone
        )
        AnimatedVisibility(visible = editable) {
            BackHandler {
                onEditCancel()
            }
            SaveButton(onSave = onSave)
        }
    }
}
```

Clicking the *Back* button while the app is in editing mode will cancel the editing mode handled by the *BackHandler* in the above code segment.

Preview the *BioPage*

You can now preview the *BioPage* by creating a preview function. You can pass empty lambdas for functions that require a lambda.

```
@Preview(showBackground = true)
@Composable
fun PreviewBioPage() {
    BioBuilderTheme {
        BioPage(
            onEdit = { /*TODO*/ },
            editable = false,
            profilePicId = R.drawable.head,
            name = "Jake Sully",
            onNameChanged ={} ,
            about = "I am a human-navi hybrid who lives among
the other navi people in pandora.",
            onAboutChanged = {},
            email = "jake.sully@pandora.com",
            onEmailChanged = {},
            phone = "111222333444",
            onPhoneChanged = {},
            onChangePic = {},
            onSave = {},
            onEditCancel = {}
        )
    }
}
```

At a time, you can view multiple previews in compose.

Choose picture screen

Create a state variable for storing the value of *ChangePicture* mode and a lambda for enabling this mode.

```
var changePicture by rememberSaveable() {
    mutableStateOf(false)
}

val onChangePicture = {
    changePicture = true
}
```

Create lambdas for updating the profile picture with new ID, and cancel the *Change Picture* mode.

```
val onPictureChanged = { pictureId: Int ->
    bioModel.updatePicId(pictureId)
    changePicture = false
}

val cancelChooseImage = {
    changePicture = false
}
```

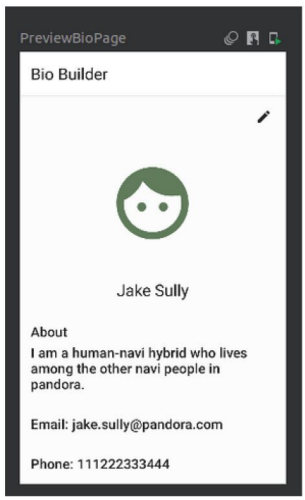

Figure 4: The final preview

Create a composable function named *ChoosePictureTitle* for the title of *ChoosePicture* screen.

```
@Composable
fun ChoosePicTitle() {
    Title(title =
stringResource(id = R.string.
choose_image))
}
```

Create a new Kotlin file named *Constants.kt* with the IDs of some drawable resources you have.

```
val PICTURE_LIST = listOf(
    R.drawable.rabbit,
    R.drawable.head,
    R.drawable.flower_head,
    R.drawable.baldhead,
    R.drawable.bumpy_head,
    R.drawable.boy,
    R.drawable.downhill
)
```

Create a composable function named *ChoosePicture* with the following contents:

```
/*A function for selecting an image from the list*/
@Composable
fun ChoosePicture(
    modifier: Modifier = Modifier,
    onChoose: (Int) -> Unit,
    onCancel: () -> Unit
) {
    BackHandler() {
        onCancel()
    }
    Surface(
        modifier = modifier,
        shape = RoundedCornerShape(4.dp),
        elevation = 1.dp
    ) {
        Column() {
            ChoosePicTitle()
            LazyVerticalGrid(
                columns = GridCells.Adaptive(180.dp),
   horizontalArrangement = Arrangement.spacedBy(8.dp),
contentPadding = PaddingValues(horizontal = 4.dp, vertical =
4.dp)
```

```
            ){
                items(PICTURE_LIST) {picture ->
                    Button(
                        modifier = Modifier.padding(vertical =
4.dp),
                        onClick = {
                            onChoose(picture)
                        },
                        colors = ButtonDefaults.buttonColors(
                            backgroundColor = MaterialTheme.
colors.background
                        )
                    ) {
                        Image(
                            modifier = Modifier.size(128.dp),
                            painter = painterResource(id =
picture),
                            contentDescription = null
                        )
                    }
                }
            }
        }
    }
}
```

The above function uses the *LazyVerticalGrid* composable to show the images in a grid. An Image composable placed inside a Button composable will show the images in our list in a button. On clicking the button, the particular image is updated as the profile picture. For each item in the list, a button with an image is generated as provided inside the *itemContent* lambda of the *items* function. The column count is changed based on the screen size by setting it using *GridCells.Adaptive* (180dp). Each column will have a width of 128dp. Each content has a space of 8dp in-between. Horizontal and vertical content padding is added to the *LazyVerticalGrid.*

Preview choose image screen

Create a *Preview* function for previewing the *ChoosePicture* screen, as follows:

```
@Preview
@Composable
fun PreviewChooseImage() {
    BioBuilderTheme() {
        ChoosePicture(onChoose = {}, onCancel = {})
    }
}
```

Putting it all together

Add the following code inside the *BioBuilderTheme* composable inside the *onCreate* function:

```
Surface(
    modifier = Modifier.fillMaxSize(),
    color = MaterialTheme.colors.background
) {
    AnimatedVisibility(visible = !changePicture) {
      BioPage(
      modifier = Modifier.fillMaxWidth(1f),
      onEdit = onClickEdit,
      editable = editable,
      profilePicId = profilePicId.value ?: R.drawable.head,
      onChangePic = onChangePicture,
 name = name ?: stringResource(id = R.string.default_name),
      onNameChanged = onNameChanged,
about = about ?: stringResource(id = R.string.default_about),
            onAboutChanged = onAboutChanged,
   email = email ?: stringResource(id = R.string.default_
email),
            onEmailChanged = onEmailChanged,
   phone = phone ?: stringResource(id = R.string.default_
phone),
            onPhoneChanged = onPhoneChanged,
            onSave = onSave,
            onEditCancel = cancelEdit
        )
    }
    AnimatedVisibility(visible = changePicture) {
        ChoosePicture(
            modifier = Modifier
                .fillMaxWidth(1f),
            onChoose = onPictureChanged,
            onCancel = cancelChooseImage
        )
    }
}
```

Now you can run the app and interact with it. You will be able to update the bio and change the profile picture. You can also try out different things using the concepts learned above.

Note: The complete code can be downloaded from *https://github.com/dicortech/bio_builder.*

END

By: Ashish Joseph

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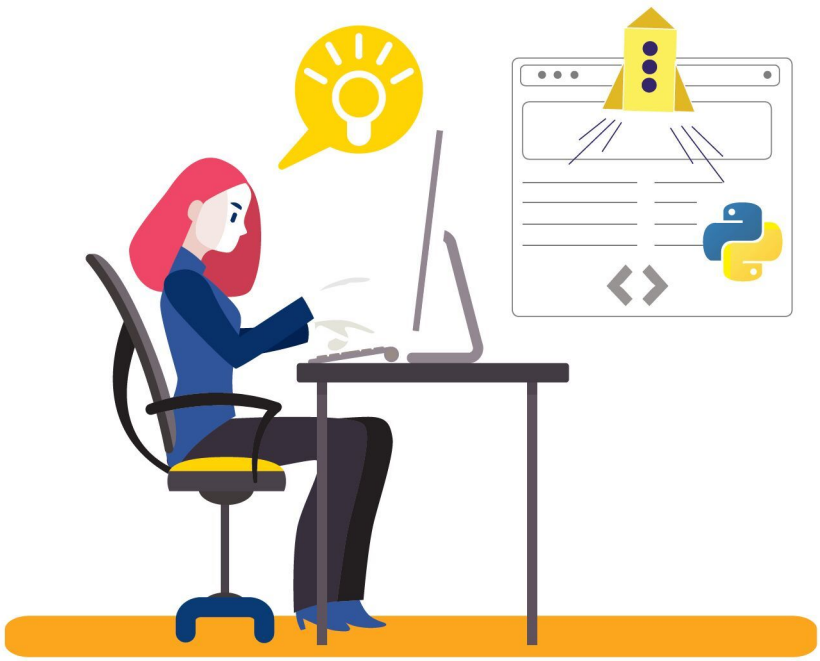
Deploying a Flask Application via the Apache Server

This tutorial will guide you on how to deploy a Python application using the Apache server. It also demonstrates how to use WSGI to allow Apache to interact with Python.



There are various applications that can work as a local server. Free and open source servers such as XAMPP, WAMP, LAMP and MAMP are a group of tools that run together to make a complete server environment. The 'P' in each stands for PHP and 'A' for Apache. However, such resources are limited for Python, so developers can take advantage of using Apache to connect to Python in different operating systems. Python's frameworks are inbuilt with their own server, but this server is just for testing and is not fit for a production environment. Once in production, we need a real server like Apache. This server takes care of the load balancing and scaling for the deployed application.

This tutorial focuses on deploying a Python application along with Apache in a Linux (Ubuntu) based environment. I would suggest you try this out on a development environment and not a production server.

Python

Python is a great, easy-to-learn, and all-powerful programming language, and with frameworks such as Django and Flask, we can use it to create full-fledged web applications. Once we create a web application using libraries and frameworks such as Flask, we need to host it on a server and expose it to the public.

Flask

Flask is a micro web framework for Python. It is provided with its own http server, and is not a native language. It has limited capacity. To prevent overloading, we must use Apache, which will use WSGI files to access Flask applications. This will let Apache interact with Python as if it is a native.

Apache

Apache is a high-performance, free and open source HTTP server software and is ranked to be the second most popular after Nginx. However, Apache doesn't understand Python script. This is where WSGI is needed.

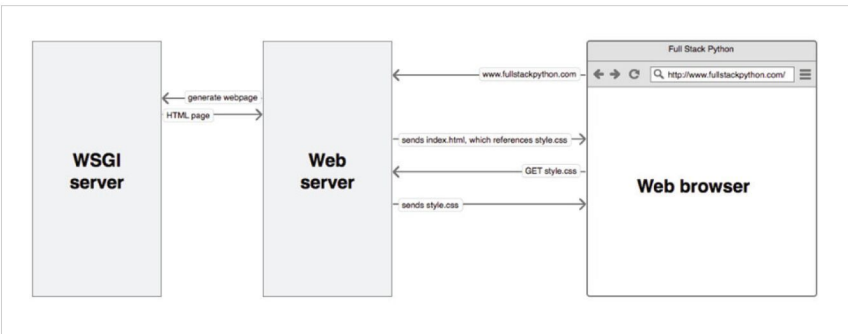


Figure 1: Request handling

WSGI

WSGI is the web server gateway interface between web servers and web apps for Python. It is a specification that describes how a web server communicates with web applications, and how web applications can be chained together to process one request.

WSGI forwards requests from users received by the web server to the Python script. The output of the Python script is forwarded to WSGI, then to the web server, and finally to the user acting as an interface between the front-end server (Apache) and the Flask application (refer Figure 1).

mod_wsgi

This Apache HTTP server module provides a WSGI-compliant interface for hosting Python based web applications under Apache. The mod_wsgi module embeds the Python application (the Flask app) within the server, and allows communication via the Python WSGI interface.

Figure 2: Apache status

Note: We will be using Python3.6 for development, so we should install *mod_wsgi (py3)*.

Setting up the environment

We will start by installing the Apache 2 server. Use the following command:

```
$sudo apt install apache2
```

We will use *systemctl*, a utility for controlling the *systemd* system and service manager; it is used to start, restart, stop services and beyond. The *systemctl status* sub-command, as the name states, is used to view the status of a service. You can use it for the above purpose by using the following command:

```
$sudo systemctl status apache2
```

The output of the command will confirm the status of Apache and its installation.

After letting the command run, all required packages are installed, and we can test this out by typing in our IP address in the web browser. If the Apache server is running properly, you will see the 'Apache2 Ubuntu Default Page'.

Installing and setting up Flask

To install Flask, you should be in your applications root directory. Flask, its dependencies, and most Flask extensions support Python 3.

The standard package manager for Python is *pip*. It allows you to install and manage packages that aren't part of the Python standard library.

Now we will install Python3 in the next step using the following command:

```
$sudo apt install python3
$sudo apt install python3-pip
```

Python3 mainly affects WSGI middleware interacting with the WSGI environ data. Werkzeug, a comprehensive WSGI web application

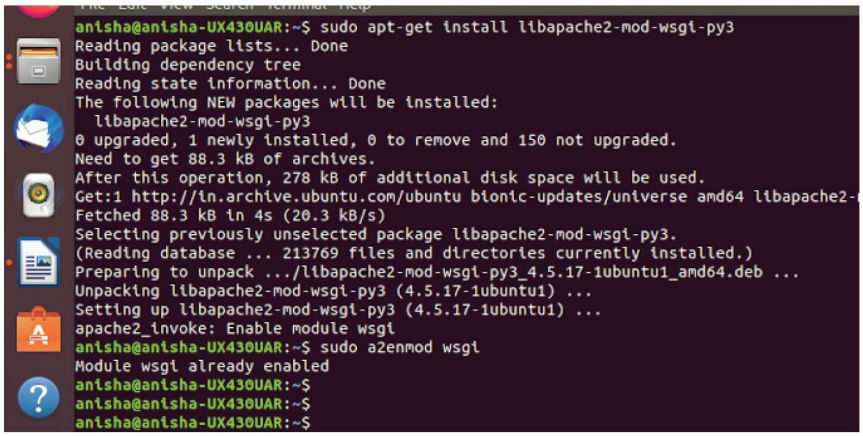


Figure 3: Installing *mod-wsgi*

library, wraps that information in high-level helpers, so encoding issues should not affect you. Werkzeug doesn't enforce any dependencies. It is up to us to choose a template engine, database adapter, and even how to handle requests.

Figure 3 shows how to install *mod_wsgi* and enable it.

Now you are good to go with setting up the Flask application! To do so we need to create a separate directory and create *__init.py* file. I will be using nano editor to make a simple 'Hello World' Flask app where we add a shebang line to specify which interpreter to use.

```
#!/bin/usr/python
from flask import Flask
app = Flask(__name__)
@app.route("/")
def hello():
     return "Hello world!"
if __name__ == "__main__":
     app.run()
```

Next, we need to create a configuration file. Make sure the name of the configuration file is the same as that of *nano/etc/apache2/sites-available/flask_Apache.conf* and write the configuration file as below. Provide your system IP address.

```
<VirtualHost *:80>
                ServerName yourdomain.com(yours system ipaddress)
                ServerAdmin youemail@email.com
                WSGIScriptAlias / /var/www/FlaskApp/flaskapp.wsgi
                <Directory /var/www/FlaskApp/FlaskApp/>
                        Order allow,deny
                        Allow from all
                </Directory>
                Alias /static /var/www/FlaskApp/FlaskApp/static
                <Directory /var/www/FlaskApp/FlaskApp/static/>
                        Order allow,deny
                        Allow from all
                </Directory>
                ErrorLog ${APACHE_LOG_DIR}/error.log
                LogLevel warn
                CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>
```

Next, we need to create a *flaskapp.wsgi.*

```
nano flaskapp.wsgi

#!/usr/bin/python
import sys
import logging
logging.basicConfig(stream=sys.stderr)
sys.path.insert(0,"/var/www/FlaskApp/")

from FlaskApp import app as application
application.secret_key =
'fhkjdskjgf(anything)'
```

a2ensite

a2ensite is a script that enables the specified site (which contains a <VirtualHost> block) within the Apache2 configuration. It does this by creating symlinks within */etc/apache2/sites-enabled.* Likewise, a2dissite disables a site by removing those symlinks. It is not an error to enable a site which is already enabled, or to disable one which is already disabled.

The very first virtual host is treated in a special way as every request not matching the actual directive is redirected to this. It is also known as the 000-default due to the same.

Then use a2ensite to enable the Apache server.

```
sudo a2ensite /etc/apache2/sites-available/flask_.conf
apache2 -f /etc/apache2/apache2.conf -k stop

apache2 -f /etc/apache2/apache2.conf -k start
```

Use the URL given below on your web browser to start your Flask application.

```
http://{your IP address}/test Flask/
```

You will see the 'Hello world!' message.

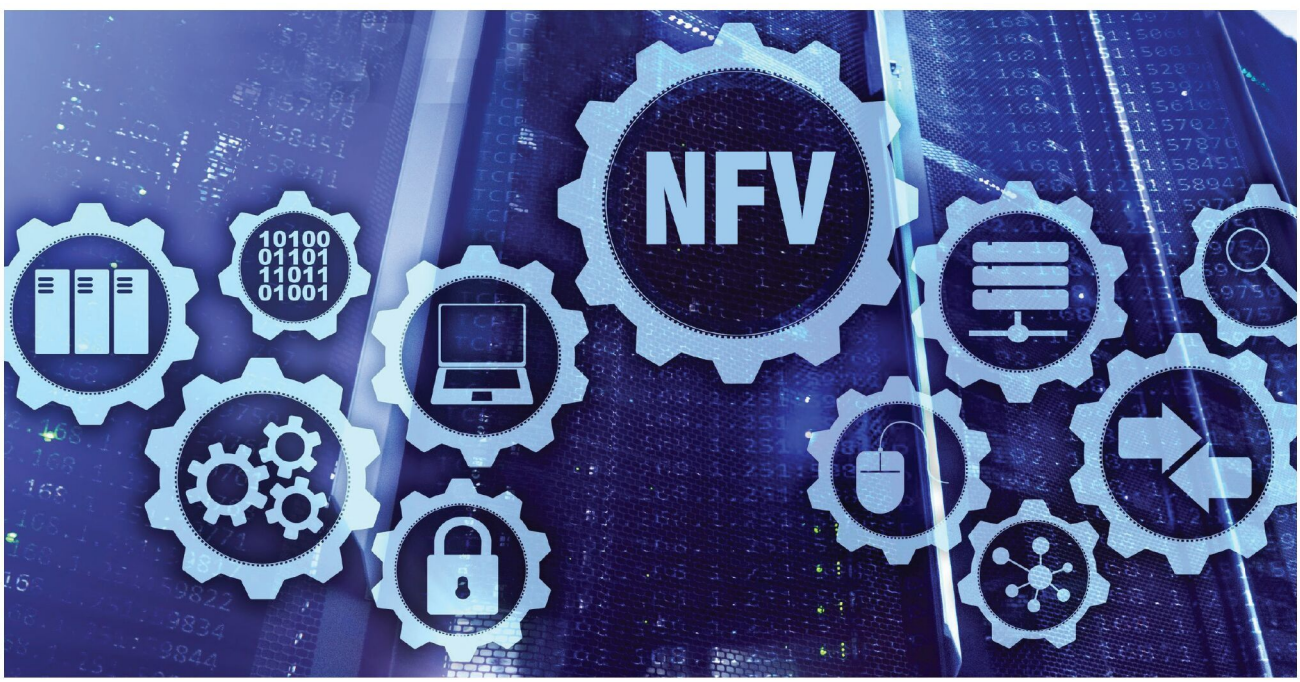
Congratulations, you have successfully deployed a Flask application! END

By: Anisha Ghosh

The author is an open source enthusiast, and a contributor to the open source communities and repositories. She likes to take interest in various development based projects.

Integrating Network Function Virtualization with the DevOps Pipeline: Containerization

This multi-part series of articles will take you through the various components of DevOps. It will introduce you to network function virtualization and its integration with the DevOps pipeline. This second article in the series focuses on containerization.



Virtualization is today the backbone of many data centers around the globe, providing resources for modern-day applications. Containerization is a sort of virtualization, where multiple user spaces can be created over the top of the existing kernel. We can define a container as a plug-and-play box, which contains all the dependencies required for the application or service inside of it to run.

Containers are well known for less overhead and are more performant compared to hypervisor-based virtualization. When VMs are compared with containers, Docker containers have outperformed KVMs (kernel-based virtual machines) in overhead for CPU, memory performance, and I/O-intensive workload. Containers are used to ship software, applications, or services. For example, if you want to set up your web application on a web server, you can do it via a portable tool like a container. You put all the required dependencies and the application artifact in the container of a web server and run it for your application to be available to make any request. Figure 1 depicts the hypervisor and container architecture.

Architecture

Advances in the Linux kernel made OS virtualization possible. Now the kernel provides mechanisms such as name spaces and control groups. With these advances, one can isolate processes on the host machine. This is supported via the Linux container (LXC) project.

Let us discuss in brief the internals of the container. A set of processes is called a group. For each group, we can set process attributes and a proportionate share of system resources like CPU, memory, disk space, and

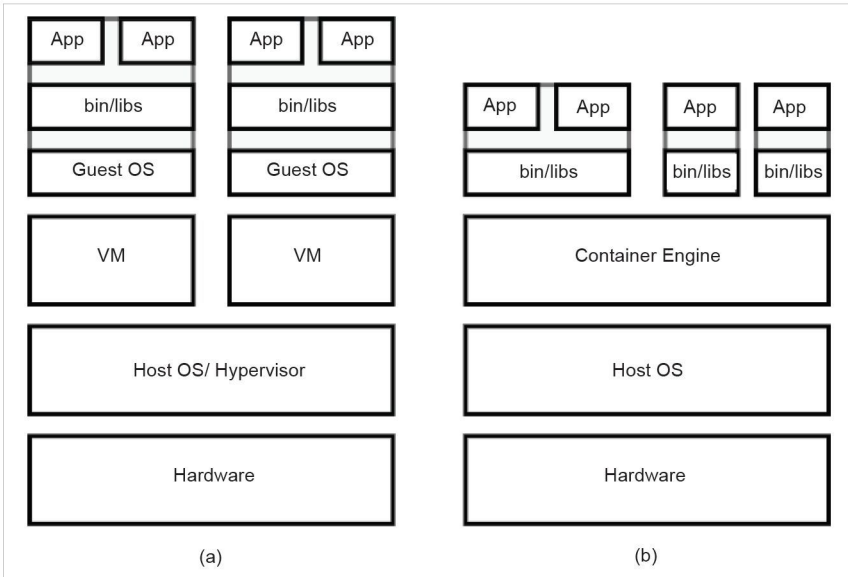


Figure 1: (a) Multiple VMs over the top of the hardware
(b) Multiple containers are mounted over the host OS without any additional guest OS or hypervisor

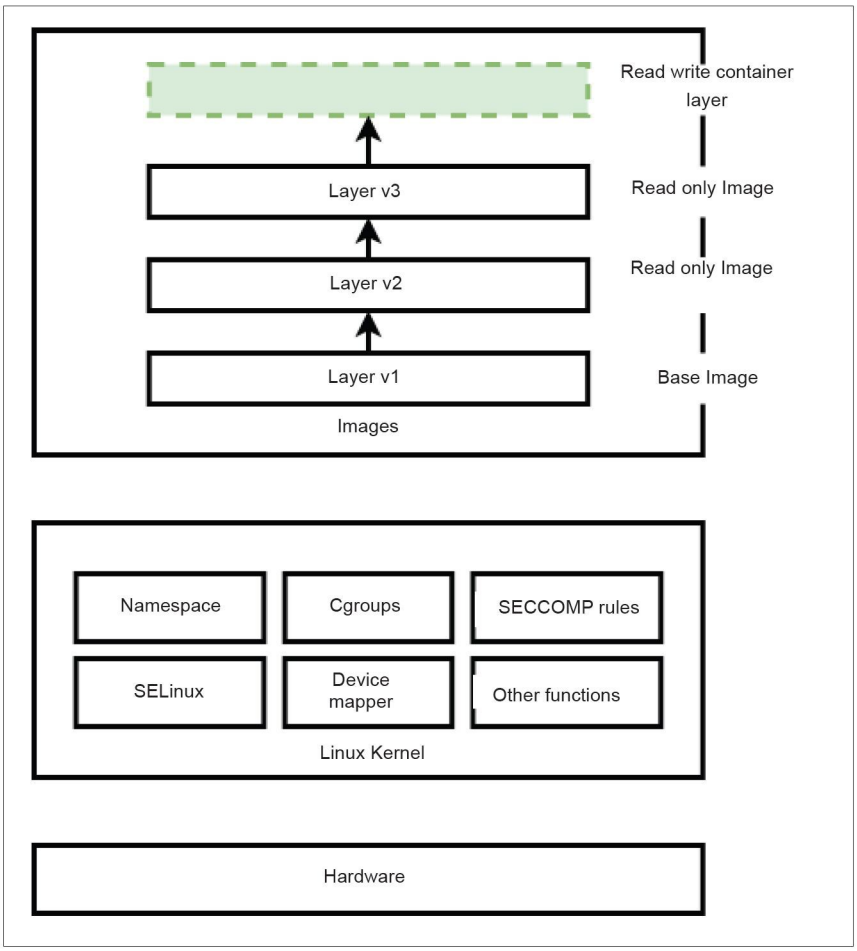


Figure 2: Various image layers over the top of container architecture

network interface. The cgroup feature takes care of the allocation and control of system resources for a group. The cgroup has a resource controller that monitors as well as accounts for resource usage. It is used by many of its subsystems such as debug, devices, freezer, perf-event, CPU, cpuset, cpuacct, memory, hugetlb, blkio, net-cls, and systemd. These subsystems can be viewed in the */sys/fs/cgroup* directory. The process ID inside the group is global; therefore, it is NOT isolated from the host. However, the requirement here is to isolate each group.

The name space feature helps the group to isolate its process IDs from the host system. The isolation features are implemented in the mounted file systems, UTS, IPC, PID, network, and user. This way, each group is created as an isolated environment for a user with the help of cgroup and name space.

The container runs as a user process inside the server and helps make every operation possible, as is done by a user process such as creation, deletion, monitoring, performance tuning, etc. At the same time, it is isolated from other system processes on the server. Therefore, each container works like a standalone system. The container can have its own process IDs, mounted file systems, system resources, network, and logs. A container can be executed without adding any overhead to the hypervisor, and launching a container is miraculously fast.

Figure 2 depicts how various layers are added to the top of the base image of the container, where the container is connected directly to the Linux kernel via the daemon process running over the host operating system. The top layer of the image can always be topped with another layer, where the user can add self-defined functionalities.

Container engine

There's one more aspect to the container — the container engine, which accepts users' requests related to the containers. These requests can vary from pulling a container image to running that image. When the container is started, the container engine unfolds all the required files and metadata, and hands it to the Linux kernel for further processing. The container engine makes an API call to the host machine's Linux kernel to start the container process. The latter is just another Linux process running for the host machine. The container image is there before the inspection of the container; this image is turned into the container upon its execution by the container engine. OCI (Open Container Initiative) is a Linux Foundation project which is equipped to design open standards for operating system-level virtualizations; this includes containers. There are several container engines, and some of the popular names are Docker, OpenVZ, CoreOS, and runc.

Networking

Networking within containers has always been an integral part of virtualization. This is one of the reasons why containers were so openly accepted by the software development community. A similar service is provided by Docker. With Docker networking, you can connect either multiple containers to one another or non-Docker workloads to Docker container workloads. Docker manipulates iptables rules on Linux to provide container network isolation.

Network drivers in Docker are responsible for managing the network and providing core network functionalities. There are six network drivers associated with Docker: none, bridge, host, ipvlan, macvlan, and overlay.

None: This disables all the networking within the Docker container.

Bridge: This is the default networking driver provided by Docker to the running containers. With bridged networking, the Docker container can communicate with other running containers connected to the same software bridge.

Host: Containers using host network drivers can use the Docker host networking directly. With this driver, the isolation between the container and the Docker host is removed.

Ipvlan: With Ipvlan, the user gets total control over both IPv4 and IPv6 addressing. It removes the software bridge that traditionally resided between the Docker host NIC and the container interface; instead, the container interface is directly attached to the Docker host interface.

Macvlan: This allows users to set up a MAC address in a container. The container can then appear as a physical device over the network.

Overlay: This allows multiple Docker daemons running over separate host machines to be connected. With the overlay network, users can allow communication between swarm service and standalone containers, or between standalone containers running over different Docker daemons.

Container runtime

Container runtime is another piece of software responsible for running and managing the component that is required to run containers. It can be categorised into two sets — low-level container runtimes and high-level container runtimes.

Low-level container runtime is responsible for just running the containers. This is done by setting up name spaces and cgroups for containers, and there isn't a wide spectrum of features.

High-level container runtime supports more high-level features such as image management, sharing, unpacking, and web APIs or remote procedure calls.

Container runtime also supports the following:

- The image registry is set in the configuration file. From this, the provided registry images are pulled if they are not available locally.
- Images are created as an overlay of various layers. Each layer adds value to the previous existent layer, and together they create a merged file system.
- A container mount point is prepared.
- Metadata is retrieved and applied from the container image. Various settings are configured such as CMD, and ENTRYPOINT.
- The kernel is notified to allocate isolation for processes, networking, and file system to the applicable container (name spaces).
- The kernel is also notified to keep a check on various resource limits like CPU or memory limits to this container (cgroups).
- A system call (syscall) is passed to the kernel to start the container.
- SELinux/AppArmor is set up.

Orchestration

It's easy to manage, say, 10 containers that are running the microservices of an application. You can manually handle the life cycle of these containers. But the task becomes complicated and tedious when we talk about thousands or even hundreds of containers. The manual process of deploying and managing these containers becomes cumbersome. To handle this life cycle of containers and to automate them we use orchestration.

Container orchestration's primary role is to handle containerized applications' deployment, management, scaling, networking, and availability. With container orchestration, enterprises can handle hundreds or even thousands of containers with ease. It can help in

managing and automating tasks such as:

- Deployment and provisioning of the network and storage resources
- Container availability
- Automated rollouts and rollbacks
- Load balancing and traffic routing
- Upscaling and downscaling containers across the infrastructure
- Provisioning security and configuration management

Many tools help with the above-mentioned tasks of container orchestration. They manage users' containers and provide them with resources. Some of the popular container orchestration tools are Kubernetes, Docker Swarm, and Apache Mesos. In the third article in the series, we will dig deeper into one such orchestration tool. We will look into Kubernetes architecture and its various components. Kubernetes will be installed via minikube and also over KVM nodes with some common container runtimes such as CRI-O, Docker Engine, and Containerd. END

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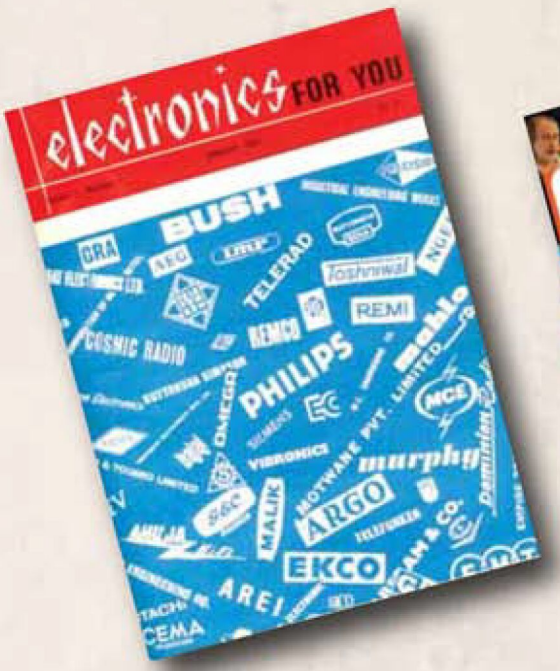

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