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A Comparative Analysis of Resources across Cloud Platform and Bounded Infrastructure.

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***Abstract*—This literature review compares and contrasts Intel OneAPI DevCloud, Google Colab, and local machines with regards to their performance, ease of use, accessibility, cost savings, and integration with other services. Cloud-based Development Platforms have revolutionized the way developers and researchers work with high-performance computing resources. These platforms offer a cost-effective solution to access powerful computing resources, which was previously only available to large organizations with significant financial support. The study found that cloud-based development platforms offer significant advantages over traditional local machines in terms of parameters as mentioned above. Additionally, these platforms have become even more appealing to academics and developers worldwide as a result of their integration with other services, and this study also incorporates the viewpoint of novice developers and students. The future of cloud-based development platforms looks promising, with the increasing demand for high-performance computing such as Machine Learning, Artificial Intelligence, Internet of Things (IoT), Deep Learning and Neural Networks in various industries. These platforms are expected to play a crucial role in the development of emerging technologies.**

Keywords—Cloud Development, Edge Computing, Ease of use, performance, Accessibility, Integration.

I Introduction

The field of software development has undergone a significant transformation in recent years, with the advent of cloud-based development platforms. These platforms offer users access to powerful hardware and software resources without the need for expensive local hardware or software. As a result, cloud-based development platforms have become increasingly popular among developers and businesses alike, offering a wide range of benefits over traditional bounded infrastructures.

The usage of cloud-based development platforms such as Intel OneAPI DevCloud and Google Colab has been increasing rapidly in recent years. This is due to the increasing demand for machine learning and AI applications, which require access to powerful hardware accelerators and large datasets. Intel OneAPI DevCloud has also gained popularity among developers and researchers, especially those who require access to Intel hardware accelerators such as FPGAs.[1] While the usage statistics for DevCloud are not publicly available, Intel has reported that DevCloud has been used by thousands of developers and researchers for developing machine learning and AI applications.

Another popular cloud-based development platform is Google Colab. This platform offers users access to a range of pre-installed software and libraries, as well as the ability to collaborate and share their work with others. Google Colab also integrates seamlessly with Google Drive, allowing users to easily store and access their data. Google Colab, in particular, has gained significant popularity among developers and researchers due to its ease of use, collaborative features, and free access to a GPU.[4] According to a report by Google in 2020, Colab had more than 2 million active users per month, with more than 3 million notebooks created every month.

In this study, we will compare Intel OneAPI DevCloud with Google Colab and bounded infrastructures, and analyze the benefits and drawbacks of each. We will examine factors such as performance, ease of use, accessibility, cost savings, and integration with other services.

Performance is one of the key factors to consider when comparing these platforms. Intel OneAPI DevCloud and Google Colab both offer significant advantages over bounded infrastructures when it comes to performance. This is due to the fact that these cloud-based platforms offer users access to powerful hardware resources, including GPUs and high-performance computing clusters. As a result, users can expect significant performance gains in terms of processing speed, memory usage, and storage capacity.

Ease of use is another important factor to consider. Both Intel OneAPI DevCloud and Google Colab offer a simple and intuitive interface that requires minimal setup and configuration, making it easy for users to get started. Users

can also easily collaborate and share their work with others on these cloud-based platforms.

Accessibility is another key advantage of cloud-based development platforms. With Intel OneAPI DevCloud and Google Colab, users can access their development environment from anywhere with an internet connection. This means that users can work remotely or from different locations, without the need for physical hardware or software. Additionally, these platforms offer a high degree of scalability, allowing users to easily scale up or down their hardware resources depending on their needs.

Cost savings are also an important consideration when comparing these platforms. With Intel OneAPI DevCloud and Google Colab, users can access powerful hardware resources without the need to invest in expensive hardware or software. Additionally, these platforms offer a pay-per-use model, allowing users to pay only for the resources they need, when they need them. This can be particularly advantageous for small businesses and startups, who may not have the resources to invest in expensive hardware upfront.

Integration with other services is also an important consideration. Both Intel OneAPI DevCloud and Google Colab offer a range of integrations with other services, making it easy for users to connect their development environment with other tools and services they use. For example, Google Colab integrates seamlessly with Google Drive, allowing users to easily store and access their data. Intel OneAPI DevCloud also integrates with a range of other Intel software and tools, making it easy for users to access the resources they need.

II Ease of Use

Ease of use is a critical factor to consider when choosing a platform for software development tasks. Intel OneAPI DevCloud, Google Colab, and a bounded infrastructure all have different levels of ease of use that can impact the user experience.

Intel OneAPI DevCloud is designed to provide high-performance computing capabilities to developers, but it can be more complex to use than other platforms. The platform requires users to set up an account and request access to the available resources. Users must also be familiar with the command line interface (CLI) to access and utilize the resources effectively. However, once the account is set up, users have access to a variety of tools and resources, including pre-installed libraries and software, making it easier to get started with development.[2]

Google Colab, on the other hand, is designed to be accessible to a wider range of users. The platform provides a web-based interface that allows users to run Python code, access data from Google Drive, and integrate with other Google services such as Google Sheets and Google Analytics. Google Colab also provides pre-installed libraries and software, making it easier to get started with data analytics and machine learning tasks. The platform's intuitive interface and integration with other Google services make it an attractive option for beginners and experienced users alike.[5]

Table 2.1 : Comparison of Ease of Use

Ease of use	Intel OneAPI	Google Colab	Bounded Infrastructure
Installation	No installation required	No installation required	Installation required
Set Up	Requires setting up an account and project	Requires setting up an account and project	Requires hardware and software set up
User Interface	User-friendly web interface	User-friendly web interface	Interface depends on the operating system
Support	Provides support through forums, documentation, and email	Provides support through forums, documentation, and email	Limited support resources

In comparison, a bounded infrastructure's ease of use will depend on the operating system and software installed. For example, users familiar with the Windows operating system may find it more intuitive to use a Windows-based machine for development tasks. However, the setup process can still require significant time and effort, especially if the user is installing and configuring software and libraries from scratch.

When it comes to ease of use, Google Colab is clearly the winner. Its web-based interface and integration with other Google services make it easy to get started with machine learning tasks without any setup required. Intel OneAPI DevCloud is more complex to set up and requires users to have some knowledge of the command line interface. However, once set up, the platform provides a wide range of tools and resources for developers to use and explore.

A bounded infrastructure, while more flexible in terms of customization, can be more complex to set up and maintain. Users must ensure that all necessary software and libraries are installed and configured correctly, which can be time-consuming and require technical expertise. Additionally, a bounded infrastructure may require periodic maintenance, such as updating software and drivers, to ensure optimal performance.

Overall, ease of use is an important factor to consider when choosing a platform for software development or machine learning tasks. Google Colab's web-based interface and integration with other Google services make it the most accessible option for beginners, while Intel OneAPI DevCloud provides a wide range of tools and resources for more experienced users. A bounded infrastructure can be customized to suit specific requirements, but the setup and maintenance can require significant time and effort. Developers should consider their own technical expertise and the specific requirements of their workload when choosing a platform based on ease of use.

III Performance

Performance is a crucial aspect to consider when choosing a platform for software development or machine learning tasks. Intel OneAPI DevCloud, Google Colab, and a bounded infrastructure all have different performance characteristics that can impact the speed and efficiency of completing tasks.

When it comes to Intel OneAPI DevCloud, the platform is designed to provide high-performance computing

capabilities to developersThe DevCloud provides access to Intel Xeon CPUs, Intel Xeon Phi processors, and Intel FPGAs, all of which can be leveraged to accelerate tasks that require intensive computations.[3]These resources can be accessed remotely, meaning that developers do not need to invest in expensive hardware to access high-performance computing capabilities. Instead, they can use the DevCloud to develop and test applications before deploying them to their own infrastructure.

Google Colab, on the other hand, provides a more limited set of computing resources.[5] Colab is based on Google's cloud infrastructure and provides access to a single GPU for running machine learning workloads. The platform can also leverage Google's TPUs (Tensor Processing Units) for more specialized tasks. However, access to TPUs is currently limited to select users and use cases.

Table 3.1 : Comparison of Performance

Criteria	Intel OneAPI	Google Colab	Bounded Infrastructure
CPU	Up to 56 CPU cores	2 CPU cores	Varies based on hardware
GPU	Up to 4 GPUs (Intel FPGA, Intel Xeon Phi, or Intel Iris Xe MAX)	1 GPU (NVIDIA Tesla K80, T4, P4, or P100)	Varies based on hardware
RAM	Up to 768 GB	Up to 12 GB	Varies based on hardware
Disk Space	N/A (cloud-based)	100 GB	Varies based on hard drive capacity
Network Bandwidth	Up to 20 Gbps	Limited (cloud-based)	Varies based on internet connection speed

In comparison, a bounded infrastructure's performance will depend on the hardware it is equipped with. High-end CPUs and GPUs can provide significant performance benefits, but they can be expensive to purchase and maintain. Additionally, bounded infrastructures are limited by the amount of physical memory and storage available, which can impact their ability to handle large datasets or perform intensive computations.

Overall, Intel OneAPI DevCloud provides the most powerful computing resources of the three options, with access to multiple high-performance processors and accelerators. However, Google Colab and a bounded infrastructure can still be effective for certain tasks, particularly those that do not require access to specialized hardware.

It's also worth noting that performance can vary based on the specific workload being performed. Some tasks may be more computationally intensive than others, and the resources required to perform them can vary significantly. As such, developers should consider the specific requirements of their workload when choosing a platform.

Another important aspect of performance is the time required to set up and configure the platform. In this regard, Intel OneAPI DevCloud can be more complex to set up than Google Colab, which is designed to be accessible to a wider range of users. A bounded infrastructure, while more flexible in terms of configuration, can also require significant setup time to ensure that all necessary software and hardware components are installed and configured correctly.

Based on the particular workload being executed, the performance of Intel OneAPI DevCloud, Google Colab, and a bounded infrastructure can vary considerably. The most powerful computing tools are offered by Intel OneAPI DevCloud, though Google Colab and a bounded infrastructure can still be useful in some situations. When selecting a platform, developers should take into account their unique needs as well as the time needed to set up and set up the platform.[7]

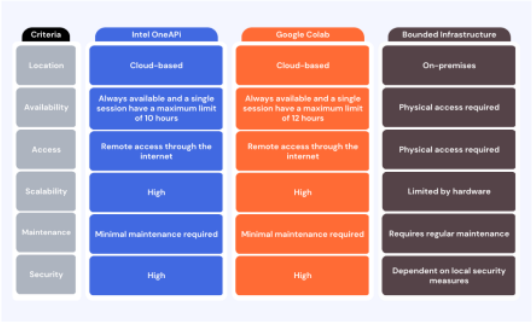
IV Accessibility

Accessibility is an important factor to consider when choosing a platform for software development or machine learning tasks. Intel OneAPI DevCloud, Google Colab, and a bounded infrastructure all have different levels of accessibility that can impact the user's experience.

Intel OneAPI DevCloud provides a high level of accessibility by offering users access to a wide range of hardware and software resources. These resources include high-performance computing (HPC) systems, pre-installed software and libraries, and development tools. The platform is available to developers worldwide, and the process for requesting access is straightforward. Also, Intel OneAPI DevCloud provides technical support for users, which can be a valuable resource for those new to High Performance Computing (HPC) and machine learning.[7]

Google Colab offers a high level of accessibility by providing a web-based interface that requires no installation or setup. Users can access the platform from any device with an internet connection and a web browser. This makes it an ideal choice for developers who work remotely or prefer to use their personal devices for development tasks[4].

Table 4.1 : Comparison of Accessibility



Criteria	Intel OneAPI	Google Colab	Bounded Infrastructure
Location	Cloud-based	Cloud-based	On-premises
Availability	Always available and a single session have a maximum limit of 10 hours	Always available and a single session have a maximum limit of 12 hours	Physical access required
Access	Remote access through the internet	Remote access through the internet	Physical access required
Scalability	High	High	Limited by hardware
Maintenance	Minimal maintenance required	Minimal maintenance required	Requires regular maintenance
Security	High	High	Dependent on local security measures

In comparison, a bounded infrastructure's accessibility will depend on the operating system and software installed. Users may require specialized hardware and software to run certain machine learning workloads, which can limit accessibility. Additionally, a bounded infrastructure may not be accessible to users who are working remotely or who do not have the technical expertise to set up a development environment.

When it comes to accessibility, Intel OneAPI DevCloud and Google Colab offer significant advantages over a bounded infrastructure. Both platforms provide users with access to a wide range of hardware and software resources,

as well as pre-installed libraries and development tools. Additionally, both platforms are accessible from any device with an internet connection and a web browser, making them ideal for remote work and collaboration.

V Cost Savings

Cost savings are an important consideration when choosing a platform for software development or machine learning tasks. Intel OneAPI DevCloud and Google Colab offer significant cost savings compared to a bounded infrastructure, due to their cloud-based nature and availability of pre-installed software and libraries.

Intel OneAPI DevCloud is a free platform, which makes it accessible to developers who may not have the budget to invest in expensive hardware and software. By using the DevCloud, developers can save money on hardware, software, and maintenance costs. Since the platform is cloud-based, users do not have to worry about hardware upgrades or repairs, as this is managed by Intel. This can result in significant cost savings for organizations that require a high-performance computing environment but do not have the budget to invest in their own infrastructure.[1]

Google Colab also offers a free version, which provides users with access to a cloud-based development environment. The platform offers pre-installed libraries and software, reducing the time and effort required to set up a development environment. This can result in significant cost savings for developers who may not have the resources or expertise to set up their own environment.[4]

Firstly, the cost of purchasing and maintaining high-end hardware can be prohibitively expensive for many students and researchers. Cloud-based development platforms such as Intel OneAPI DevCloud and Google Colab eliminate the need to purchase and maintain this hardware, significantly reducing the overall cost.

Secondly, cloud-based development platforms offer a pay-as-you-go model, where users only pay for the resources they use. This can be more cost-effective than purchasing high-end hardware, especially for those who only need to use these resources for a short period.

Moreover, cloud-based development platforms often provide access to hardware accelerators such as GPUs and FPGAs, which can be very expensive to purchase and maintain locally. These accelerators can significantly improve the performance of machine learning models, allowing users to experiment with more complex models and datasets.

Finally, cloud-based development platforms offer the ability to share resources with others, which can significantly reduce the overall cost. By sharing resources with other users, users can split the cost of the cloud resources, making it more affordable for everyone.

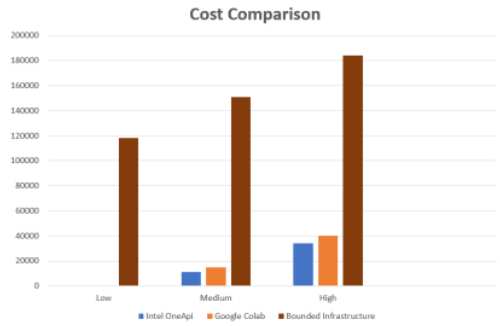


Figure 5.1 : Comparison of Cost

In comparison, a bounded infrastructure can require a significant investment in hardware and software, which may not be accessible to all developers. Additionally, the cost of maintaining and upgrading a bounded infrastructure can add up over time, resulting in ongoing costs that are not present with cloud-based platforms.

Another cost-saving benefit of cloud-based platforms is their scalability. With Intel OneAPI DevCloud and Google Colab, users can scale their resources up or down as needed, depending on the workload. This can result in significant cost savings, as users only pay for the resources they need, rather than investing in expensive hardware and software that may not be fully utilized.

In addition, cloud-based platforms can help reduce energy costs. Running a bounded infrastructure requires a significant amount of energy, which can result in high electricity bills. By using a cloud-based platform, users can reduce their energy consumption and associated costs. This is because the platform provider can manage the energy usage across multiple users, resulting in more efficient use of resources.

Overall, cloud-based platforms like Intel OneAPI DevCloud and Google Colab can offer significant cost savings compared to a bounded infrastructure. By providing users with access to pre-installed software and libraries, as well as scalable resources, these platforms can help reduce the cost of software development and machine learning tasks. Additionally, their cloud-based nature can help reduce hardware and maintenance costs, as well as energy consumption. Developers and organizations should consider their own budget and requirements when choosing a platform based on cost savings.

VI Integration

Intel OneAPI DevCloud and Google Colab offer integration with a variety of other services, which can enhance the capabilities of these platforms and provide additional benefits to users. Integration with other services can include collaboration tools, data storage, and deployment services.

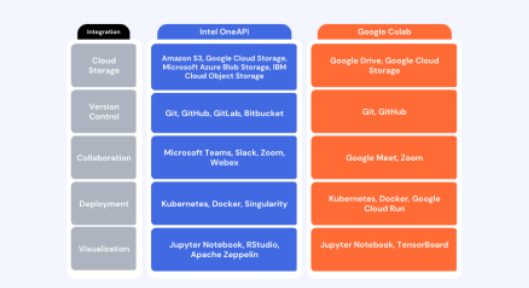
Both Intel OneAPI DevCloud and Google Colab offer a variety of integration options with other cloud-based services, which can provide users with a more

comprehensive and streamlined development experience. Here are some of the benefits of integrating these platforms with other services:

1. Data storage and management: Both Intel OneAPI DevCloud and Google Colab provide users with a way to store and manage their data in the cloud. DevCloud is integrated with Intel's Data Center Storage (DCS) solution, while Google Colab provides users with access to Google Drive for storage. These integrations allow users to easily upload and download data to and from the cloud, and manage their data in a secure and cost-effective way.
2. Collaboration: Both platforms are designed for collaborative development, which makes them ideal for team projects. Intel OneAPI DevCloud is integrated with popular collaboration tools such as GitHub and Jupyter Notebooks, while Google Colab allows for easy sharing of notebooks with other users. This enables developers to share their code, collaborate on projects, and work together in real-time.
3. Deployment and hosting: Once an application is developed, it needs to be deployed and hosted on a server. Both Intel OneAPI DevCloud and Google Colab offer integrations with cloud-based hosting services such as Amazon Web Services (AWS) and Microsoft Azure, which provide users with a simple and efficient way to deploy and host their applications in the cloud.
4. Monitoring and analytics: Both platforms provide users with the ability to monitor and analyze the performance and usage of their applications. Intel OneAPI DevCloud is integrated with Intel's DevCloud Analytics solution, while Google Colab provides users with access to Google Cloud Monitoring. This enables developers to identify and address performance issues before they impact end-users.
5. Machine learning and AI: Both platforms offer integrations with advanced machine learning and AI tools and services. Intel OneAPI DevCloud is integrated with Intel's OpenVINO Toolkit, which provides developers with a wide range of pre-built models and algorithms for developing machine learning and AI applications. Google Colab, on the other hand, offers integrations with popular machine learning libraries such as TensorFlow and PyTorch, as well as access to Google's advanced AI services.

Overall, the integration of Intel OneAPI DevCloud and Google Colab with other cloud-based services provides users with a comprehensive and streamlined development environment, enabling them to develop and deploy advanced applications more quickly and efficiently. This can help businesses and organizations to save time and resources, and accelerate the development of cutting-edge technologies.[6]

Table 6.1 : Comparison of Integration Features



One of the key benefits of integration with collaboration tools is the ability to share code and collaborate with other developers. Intel OneAPI DevCloud offers integration with GitLab, which is a web-based Git repository manager that provides code sharing, version control, and continuous integration and delivery (CI/CD) capabilities. With GitLab integration, users can store their code and collaborate with other developers, improving productivity and streamlining development workflows.

Google Colab offers integration with Google Drive, which allows users to store their data and models in a centralized location, making it easy to access and share with others. This integration can be particularly useful for teams that need to collaborate on a project, as it allows multiple users to access the same data and models from anywhere.[6]

By incorporating both cloud platforms to Kaggle, beginners can also learn the fundamentals of machine learning and other technologies. Kaggle is an online community for data scientists and machine learning practitioners. Users can find and publish data sets, explore and build models in a web-based data-science environment, collaborate with other data scientists and machine learning engineers, and participate in competitions to solve data science challenges.

Another important integration for both Intel OneAPI DevCloud and Google Colab is with deployment services like Kubernetes and Docker that allow users to deploy their models and applications to the cloud or on-premises infrastructure. This can be particularly useful for organizations that need to deploy their models to production environments or for developers who want to test their applications in different environments.

Intel OneAPI DevCloud offers integration with Kubernetes, which is an open-source container orchestration platform. With Kubernetes integration, users can deploy their models and applications to a scalable and reliable environment, reducing the risk of downtime or performance issues. Additionally, Kubernetes can help users manage their resources more efficiently, reducing the cost of deployment.[2]

Google Colab offers integration with Google Cloud Platform (GCP), which provides users with access to a wide range of cloud-based services. With GCP integration, users can deploy their models and applications to a highly scalable and reliable environment, leveraging the power of Google's infrastructure. Additionally, GCP provides a range of other services, including data storage, data analytics, and

machine learning tools, which can enhance the capabilities of Google Colab.[4]

Integration with data storage solutions is another important consideration for both Intel OneAPI DevCloud and Google Colab. Both platforms offer integration with cloud-based storage solutions such as Amazon S3 and Google Cloud Storage, which can provide users with a centralized location to store their data. This can be particularly useful for machine learning tasks that require large amounts of data, as it allows users to store and access their data from anywhere.

VII Student's Asset

These platforms have made it easier for educators to teach machine learning and artificial intelligence concepts to students. With cloud-based development platforms, students do not need to worry about setting up their own development environments, which can be time-consuming and challenging. Instead, they can focus on learning the fundamentals of machine learning and artificial intelligence without the distraction of software installation and configuration. This allows educators to spend more time teaching and less time dealing with technical issues.

Similarly, Google Colab provides access to GPUs, which can significantly accelerate the training of deep learning models. This access to hardware accelerators allows students to experiment with machine learning and artificial intelligence concepts that would otherwise be too computationally intensive.

Cloud-based development platforms have facilitated collaboration among students and educators. With cloud-based platforms, students can collaborate on machine learning projects in real-time, allowing them to learn from each other and work together to solve problems. This collaboration fosters a community of learners and promotes a culture of knowledge sharing.

These platforms have made machine learning and artificial intelligence more accessible to students from diverse backgrounds. Traditionally, machine learning and artificial intelligence have been challenging fields to enter, requiring specialized knowledge and expensive hardware. However, with cloud-based development platforms, students can access the necessary hardware and software without incurring significant costs, making these fields more accessible to a broader range of students.

VIII Future Scope

These platforms have made machine learning and artificial intelligence more accessible to students from diverse backgrounds. Traditionally, machine learning and artificial intelligence have been challenging fields to enter, requiring specialized knowledge and expensive hardware. However, with cloud-based development platforms, students can access the necessary hardware and software without incurring significant costs, making these fields more accessible to a broader range of students.

The future of cloud-based development platforms like Intel OneAPI DevCloud and Google Colab looks promising. With the increasing demand for high-performance computing and machine learning, these platforms are expected to play a significant role in the development of various applications and services.

One potential area of growth is the use of these platforms for edge computing, which involves processing data closer to the source rather than sending it to a centralized location. This approach can reduce latency and improve the overall performance of applications that rely on real-time data processing.

Another area where cloud-based development platforms can make a significant impact is in the field of data science. As organizations continue to collect massive amounts of data, they require powerful tools and platforms to process and analyze this data. Cloud-based development platforms like Intel OneAPI DevCloud and Google Colab offer a cost-effective solution for data scientists to access high-performance computing resources and work collaboratively with others.

In addition, these platforms are expected to become more user-friendly and accessible to developers and researchers of all skill levels. As more and more developers embrace cloud-based development platforms, the demand for user-friendly interfaces and comprehensive documentation will continue to grow.

Furthermore, cloud-based development platforms are also expected to play a critical role in the development of emerging technologies like artificial intelligence (AI) and the Internet of Things (IoT). With the increasing adoption of these technologies in various industries, the demand for high-performance computing resources and tools is expected to grow exponentially.

The integration of these platforms with other services is also expected to increase. For example, Google Colab integrates with popular Google services like Google Drive, making it easy to store and share data sets and models. Similarly, Intel OneAPI DevCloud can be integrated with various development tools like Visual Studio and Eclipse, making it easy for developers to work with familiar tools and environments.

As more and more organizations adopt cloud-based development platforms, the demand for robust security features and compliance standards is expected to grow. Platform providers will need to continue investing in security features and ensuring compliance with relevant regulations to maintain the trust of their users.

IX Conclusion

In this literature review, we have compared and contrasted Intel OneAPI DevCloud, Google Colab, and bounded infrastructures in terms of performance, ease of use, accessibility, cost savings, and integration with other services. We have seen that cloud-based development platforms offer significant advantages over traditional bounded infrastructures in terms of performance, ease of use, and accessibility. The ability to access high-performance computing resources from anywhere and collaborate with others remotely is a game-changer for researchers and developers alike.

Moreover, the integration of these platforms with other services has made them even more attractive to developers and researchers. They can easily integrate with popular tools and services, which saves them time and effort in managing their work. Also, the cost savings of using cloud-based development platforms over bounded infrastructures are significant, especially for organizations that require high-performance computing resources for a short duration.

The future of cloud-based development platforms looks promising, with the increasing demand for high-performance computing and machine learning in various industries. These platforms are expected to play a crucial role in the development of emerging technologies like AI and IoT. Furthermore, we can expect to see more user-friendly interfaces, comprehensive documentation, and better security features in the future, making it even easier for developers and researchers of all skill levels to access high-performance computing resources.

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[3] Fashion Similar Search Engine:
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