Table of Contents

1. Introduction: Google Cloud and Microsoft Azure

With Major participants in the cloud computing market, Google Cloud Platform (GCP) and Microsoft Azure provide a variety of services for companies and developers to deploy and manage applications and infrastructure in the cloud. Moreover, Virtual machines, storage, databases, networking, machine learning, and other features are all available on both platforms. Azure is a cloud computing platform provided by Microsoft, whereas GCP is a collection of cloud computing services provided by Google (Alluri, 2022). It's critical for organisations to assess which platform is most suited to their requirements because each platform has its own features and capabilities. Like Google Cloud, Microsoft Azure offers a variety of cloud computing services, including, but not limited to, virtual machines, databases, storage, networking, and machine learning. Azure is based on Microsoft's extensive global network of data centres, giving it the ability to give enterprises a dependable and scalable platform to create and deploy their applications (MS, 2022). Microsoft Azure and Google Cloud both offer advantages and disadvantages. Businesses may use Google Cloud's extensive machine learning capabilities to create and implement AI-driven apps. In contrast, Microsoft Azure offers tight integration with the company's current ecosystem, making it an obvious choice for companies that depend on its products. Furthermore, when it comes to networking, each platform has its own advantages.

In contrast to Microsoft Azure's Azure Virtual Network (VNet), which enables customers to separate and secure their cloud resources, Google Cloud's Virtual Private Cloud (VPC) gives users the ability to build and control their own network architecture (Li, 2022).

Their approaches to pricing are one of the main distinctions between Google Cloud and Microsoft Azure. The pricing structure for Google Cloud is more adaptable, including pay-as-you-go and committed use savings. On the other hand, Microsoft Azure provides a variety of payment methods, such as pay-as-you-go, prepaid, and reserved instances. The degree of service integration between the two platforms is another significant distinction. Google Cloud is a fantastic option for companies utilising Google services currently because of its close connection with other Google services like G Suite and Google Analytics. Microsoft Azure is a fantastic option for companies who currently use Microsoft services because of its tight integration with products like Office 365 and Dynamics 365 (Brummel, 2019).

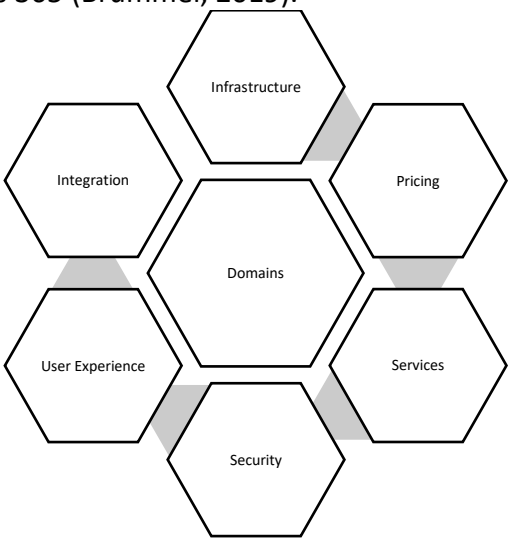

Figure 1: Domains of Google Cloud and Microsoft Azure

Both Google Cloud and Microsoft Azure provide a variety of choices for businesses to construct and deploy machine learning models when it comes to their respective cloud computing platforms. TensorFlow, a machine learning platform offered by Google Cloud, is popular and offers a variety of tools for developing and deploying machine learning models. Similar features are offered by Microsoft Azure's machine learning platform, Azure Machine Learning, which also connects with other Microsoft services like Power BI and Excel (Becker, 2019). Similarly, these prioritise security and provide a variety of security features and capabilities. Security features provided by Google Cloud include data encryption, identity and access management, and DDoS defence. Similar security features offered by Microsoft Azure include data encryption, DDoS protection, identity and access management, and Azure Security Centre, which offers sophisticated threat prevention for cloud workloads (De Tender, 2019).

Table 1: Comparison of Google Cloud and Microsoft Azure

Category	Google Cloud	Microsoft Azure
Market Share	Third largest cloud provider with around 9% market share	Second largest cloud provider with around 20% market share
Computing Services	Offers similar computing services to Azure, including virtual machines, Kubernetes Engine, and App Engine	Offers a wide range of computing services including virtual machines, container services, and serverless computing
Storage Services	Offers storage services like Cloud Storage, Cloud Filestore, and Persistent Disk	Provides scalable storage options such as Azure Blob Storage, Azure File Storage, and Azure Disk Storage
Machine Learning Services	Provides machine learning services including Google Cloud AI, Google Cloud Dataflow, and TensorFlow	Offers a range of machine learning services such as Azure Machine Learning, Azure Databricks, and Cognitive Services
Internet of Things (IoT)	Google Cloud IoT provides a secure and scalable platform for IoT data management, device management, and analytics	Azure IoT Hub provides device-to-cloud and cloud-to-device messaging, device management, and IoT solution accelerators
Pricing Model	Offers a pay-as-you-go pricing model with per-second billing, sustained use discounts, and committed use discounts	Offers a pay-as-you-go pricing model with no upfront costs and provides discounts for reserved instances and hybrid usage
Integration with Other Tools	Has strong integration with Google tools and technologies such as Kubernetes and TensorFlow	Has strong integration with Microsoft tools and technologies such as .NET and Visual Studio
Security	Provides security measures such as Google Cloud Identity, Cloud IAM, and Cloud Security Command Center	Provides robust security measures such as Azure Active Directory, Azure Security Center, and Azure Key Vault

2. Technology 1- NoSQL Storage

The horizontal scaling and autonomous data sharing feature of DocumentDB, now known as Azure Cosmos DB, guarantee excellent availability and scalability. A NoSQL key-value store that can manage enormous volumes of structured data is Azure Table Storage, which is another option. It is a cost-effective method of storing structured data that does not necessitate a relational database's full capability. Numerous NoSQL storage choices are available on Google Cloud Platform. A petabyte-scale NoSQL database called Cloud Bigtable is made to manage massive amounts of structured and semi-structured data (Bisong, 2019).

It is appropriate for real-time analytics and IoT use cases and can handle high-speed readings and writes. Strong consistency, real-time updates, and automatic scaling are all features of Firestore, a multi-region, multi-master, NoSQL document database. It is a document-based, serverless database that enables quick data retrieval and searching. A globally distributed, relational database that supports SQL queries and ACID transactions is called Google Cloud Spanner (Sabharwal, 2019). It's critical to take the type of NoSQL database and the use case into account when contrasting the NoSQL storage options offered by Microsoft Azure and Google Cloud. There are several NoSQL databases available from Azure and GCP to meet different needs. Google Cloud does, however, provide more specialised databases, such as Cloud Spanner for globally distributed SQL transactions and Cloud Bigtable for data at the petabyte scale.

A multi-model database from Azure, on the other hand, supports document, graph, key-value, and column-family data models (Paz, 2018). Pricing is another aspect to take into account. these have flexible pricing schemes, but Azure has per-hour charging and a wider choice of pricing tiers, making it more specific. Although it can be more expensive for some use cases, Google Cloud provides a more straightforward price structure. Additionally, both cloud providers provide serverless choices for event-driven applications, namely Azure Functions and Google Cloud Functions (Kim, 2019). Last but not least, but equally significant, is the degree of integration with other cloud services. A variety of cloud services, including machine learning, storage, and analytics, are provided by both Azure and GCP. But Azure offers more comprehensive interaction with Microsoft products, such Office 365. With open-source technologies like TensorFlow and Kubernetes, GCP offers improved integration.

NoSQL storage on Google Cloud and Microsoft Azure has a number of advantages, including support for unstructured data, scalability, and high availability. A variety of NoSQL databases are available from both cloud providers to accommodate various use cases (Strauch, 2011). There are some restrictions to take into account, though. It is more difficult to guarantee data consistency and integrity with NoSQL databases because they lack the relational features of SQL databases. NoSQL databases also require a higher level of technical expertise to manage and run. Unstructured data can be stored in Microsoft Azure and Google Cloud using NoSQL storage, which offers scalable, highly available, and adaptable choices. A variety of NoSQL databases are available from both cloud providers to accommodate various use cases (Han, 2011). Table 2, provide an overview of key feature of NoSQL storage for both of these technologies.

Table 2: Comparison of Key Features of NoSQL Storage in Microsoft Azure and Google Cloud

	Google Cloud	Microsoft Azure
NoSQL Services	Cloud Datastore, Cloud Firestore, Bigtable	Cosmos DB, Azure Table Storage
Data Model	Document-based (Firestore), Key-value (Datastore), Wide column (Bigtable)	Document-based (Cosmos DB), Key-value (Azure Table Storage)
Consistency Model	Strong and eventual (Firestore), Eventual (Datastore), Consistent (Bigtable)	Strong and eventual (Cosmos DB), Strong (Azure Table Storage)
Indexing	Automatic, based on data type (Firestore), Composite and single-property (Datastore), Custom (Bigtable)	Automatic, based on data type and partition key (Cosmos DB), Secondary (Azure Table Storage)
Query Language	GQL (Firestore), GQL and GQL-like (Datastore), APIs (Bigtable)	SQL and NoSQL APIs (Cosmos DB), OData (Azure Table Storage)
Scalability	Horizontally scalable (all services)	Horizontally scalable (Cosmos DB), horizontally and vertically scalable (Azure Table Storage)

Comparison based on codes:

NoSQL storage Example in Google Cloud:

```
gcloud firestore instances create [INSTANCE_ID] --project=[PROJECT_ID] --region=[REGION]
gcloud firestore collections create [COLLECTION_PATH] --instance=[INSTANCE_ID]
gcloud firestore documents create [DOCUMENT_PATH] --collection=[COLLECTION_PATH] --data-file=[JSON_FILE]
gcloud firestore documents list --collection=[COLLECTION_PATH]
```

NoSQL storage Example in Microsoft Azure:

```
az cosmosdb create --name [ACCOUNT_NAME] --kind GlobalDocumentDB --resource-group
[RESOURCE_GROUP_NAME] --location [LOCATION]
az cosmosdb database create --db-name [DATABASE_NAME] --name [ACCOUNT_NAME] --resource-group
[RESOURCE_GROUP_NAME]
az cosmosdb collection create --collection-name [COLLECTION_NAME] --db-name [DATABASE_NAME] --name
[ACCOUNT_NAME] --resource-group [RESOURCE_GROUP_NAME]
az cosmosdb document create --collection-name [COLLECTION_NAME] --db-name [DATABASE_NAME] --name
[ACCOUNT_NAME] --resource-group [RESOURCE_GROUP_NAME] --body [JSON_DOCUMENT]
az cosmosdb sql query --query "[SQL_QUERY]" --db-name [DATABASE_NAME] --name [ACCOUNT_NAME] --
resource-group [RESOURCE_GROUP_NAME]
```

3. Technology 2- Vertex AI and Auto ML

Machine learning is a potent tool for deciphering complex data and using it to generate predictions. In order to generate precise predictions for fresh data, an algorithm must be trained on a dataset. However, creating machine learning models from scratch can be difficult and time-consuming. As a result, many cloud service providers, such as Microsoft Azure and Google Cloud,

provide Machine Learning as a Service (MLaaS) solutions. This post will examine and contrast the Vertex AI and Auto ML technologies offered by Google Cloud and Microsoft Azure (Opera, 2022). Building, deploying, and managing machine learning models is made possible via the cloud-based machine learning platform known as Microsoft Azure Machine Learning (Azure ML). The drag-and-drop interface, Jupyter Notebooks, and Visual Studio Code are just a few of the tools offered by Azure ML for creating models with well-known frameworks like TensorFlow, PyTorch, and scikit-learn (Berg, 2022). A single platform for creating and deploying machine learning models at scale is called Vertex AI. It offers a variety of tools for creating, honing, and deploying models and is built on top of the robust infrastructure of Google Cloud. Vertex AI offers pre-built models for typical use cases like image and language recognition and lets developers work with well-liked frameworks like TensorFlow and PyTorch (Walsh, 2022).

Auto ML, on the other hand, is a technology offered by both Microsoft Azure and Google Cloud that allows developers and data scientists to build machine learning models automatically (He, 2021). Auto ML eliminates the need for extensive machine learning understanding and can save significant time when compared to manually developing models. In Azure ML, Auto ML offers a variety of capabilities, including Automated ML, which automates model selection and optimisation. Google Cloud's Auto ML, on the other hand, is a collection of solutions that provide pre-built models for specific tasks such as image recognition, natural language processing, and translation (Karmaker, 2021).

For constructing, training, and deploying machine learning models, Azure ML and Vertex AI offer similar capabilities. Both platforms enable developers to work with prominent frameworks such as TensorFlow and PyTorch, as well as tools for constructing models with drag-and-drop interfaces or Jupyter Notebooks. Vertex AI's connection with Google Cloud's robust infrastructure provides large computational resources for training and deploying models, which is one of its primary advantages. Vertex AI also offers a library of pre-built models for typical use cases, which can save developers a lot of work. However, the user interface of Vertex AI may be more sophisticated than that of Azure ML, making it more difficult for inexperienced users to get started.

The user interface of Azure ML, on the other hand, is more straightforward and user-friendly than that of Vertex AI. Azure ML also supports a broader range of data sources, including data stored in Azure SQL Database, Azure Data Lake Storage, and Azure Blob Storage. However, the infrastructure of Azure ML is not as powerful as that of Google Cloud, which may limit the scale of models that can be generated and deployed (Chappel, 2015).

Microsoft Azure and Google Cloud both offer robust solutions for developing, training, and deploying machine learning models. Depending on their individual requirements, Azure ML and Vertex AI are both viable solutions for developers and data scientists. For individuals that require simpler user interfaces and support for several data sources, Azure ML may be a better option (Barnes, 2015). Vertex AI, on the other hand, may be a better option for individuals that require more powerful infrastructure and pre-built models for popular use cases. Finally, the choice between the two platforms will be determined by the users' individual requirements. Here, Table 3, provides a very comprehensive comparison of Vertex AI and Auto ML for both Google Cloud and Microsoft Azure. This table compares the features i.e., AutoML, platform, deployment options, data ingestion, programming languages etc.

Table 3: Comparison of Vertex AI and Auto ML for Google Cloud and Microsoft Azure

Feature	Microsoft Azure	Google Cloud
AutoML Service	Azure AutoML	AutoML
Platform	Azure Machine Learning	Vertex AI
Deployment Options	Azure Kubernetes Service, Azure Container Instances, Azure Functions, Azure Stream Analytics, Azure Logic Apps	Google Kubernetes Engine, Compute Engine, App Engine, Cloud Functions, Cloud Run
Data Ingestion	Azure Data Factory, Azure Event Hubs, Azure Stream Analytics	Cloud Storage, BigQuery, Cloud Pub/Sub, Cloud IoT Core
Languages	Python, R, Java, .NET, REST API	Python, Java, Go, Node.js
Pre-built Models	Image classification, Object detection, Text classification, Regression, Forecasting	Image classification, Object detection, Speech recognition, Translation
AutoML Capabilities	Automated feature engineering, AutoML Tables, AutoML Vision, AutoML Natural Language	AutoML Tables, AutoML Vision, AutoML Video Intelligence, AutoML Translation
Integrations	Power BI, Excel, Azure DevOps, GitHub	BigQuery, Looker, Google Sheets, Google Drive, Google Cloud Storage
Pricing	Pay-as-you-go, free trial available	Pay-as-you-go, free trial available

Comparison based on code

- **Text classification through Natural Language API in Google Cloud Vertex AI's Auto ML**

```
from google.cloud import automl_v1beta1 as automl
client = automl.AutoMlClient()
model_id = "1234567890"
text = "This is some example text."
payload = {"text_snippet": {"content": text, "mime_type": "text/plain"}}
response = client.predict(model_id=model_id, payload=payload)
for annotation_payload in response.payload:
  print(annotation_payload.display_name)
```

- **Text classification through Microsoft Azure AutoML**

```
from azureml.core import Workspace, Dataset
from azureml.train.automl import AutoMLConfig
ws = Workspace.from_config()
dataset_name = "text-dataset"
dataset = Dataset.get_by_name(ws, name=dataset_name)
automl_config = AutoMLConfig(
  task='classification',  primary_metric='accuracy',  max_time_seconds=30,
  iterations=10,  n_cross_validations=5,  enable_voting_ensemble=False)
best_run, fitted_model = automl_config.fit(dataset)
text = "This is some example text."
```

4. Conclusion

Google Cloud and Microsoft Azure both provide robust cloud-based solutions for developing, training, and deploying machine learning models. Vertex AI from Google Cloud is a single platform that offers pre-built models for common use cases, robust infrastructure, and the flexibility to integrate with popular frameworks like TensorFlow and PyTorch. Microsoft Azure's Azure ML, on the other hand, offers a variety of modelling tools like as drag-and-drop interfaces, Jupyter Notebooks, and Visual Studio Code, as well as significant support for various data sources.
In this report, I have critically analysed these technologies in the perspective of Google Cloud and Microsoft Azure. Google Cloud and Microsoft Azure both offer NoSQL storage solutions in addition to machine learning services. Both Google Cloud Firestore and Azure Cosmos DB are highly scalable and offer real-time data access. Firestore has more straightforward pricing and a wider range of integration possibilities, whereas Cosmos DB offers a variety of data types, including SQL, MongoDB, Cassandra, and others. Auto ML features are available on both Google Cloud and Microsoft Azure, and they automate the process of generating machine learning models. Automated ML from Azure ML automates model selection and tuning, whereas Auto ML from Google Cloud delivers pre-built models for specific tasks including image recognition, natural language processing, and translation. To summarise, both Google Cloud and Microsoft Azure offer robust cloud-based solutions for developing, training, and deploying machine learning models, as well as NoSQL storage solutions. The user's individual demands, including infrastructure, pre-built models, data sources, pricing, and integration possibilities, will determine which platform is best for them.

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Azure AutoML Code Samples:
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