

DS684
Cloud Computing
Week 01

Session Agenda

- Course Introduction: Why Cloud Computing
- Cloud Computing Terminology
 - Cloud Computing Models
 - 3 Type of Cloud Computing
- Introduction to Azure
 - Components of Cloud Computing
 - Azure Region/Availability Zone
 - Azure services
- Course Information
- Lab: Accessing Azure

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What is This Course About

In this course, students will be acquainted with the fundamentals and implementation of cloud computing. The curriculum spans from foundational infrastructure and administrative aspects to advanced services and application deployment. The primary emphasis lies in fostering hands-on proficiencies for harnessing cloud services in the creation of expansive and adaptable data analytics applications. Through the utilization of the Microsoft Azure Cloud Platform, participants will gain practical experience in working with various components such as Virtual Machines (VMs), databases, storage systems, microservices, and Artificial Intelligence/Machine Learning (AI/ML) tools. Furthermore, the course delves into the examination of the operational dynamics inherent to cloud computing.

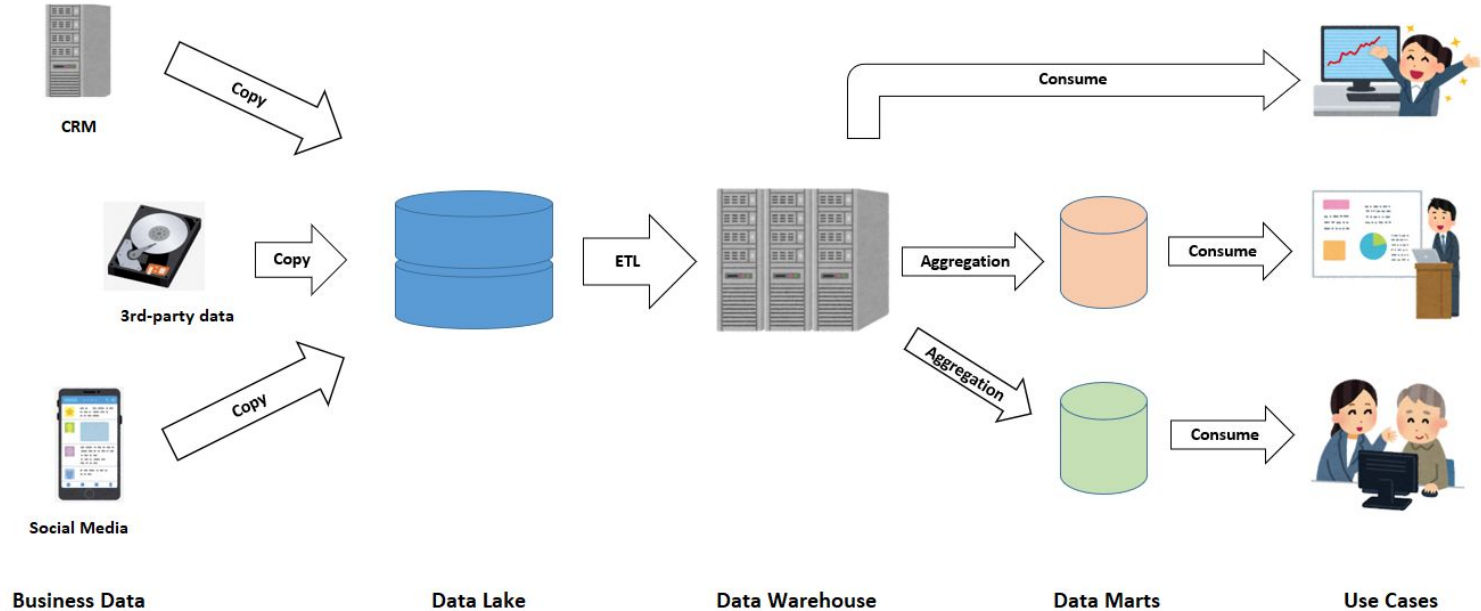
Key concept: Data engineering in Azure

What is Data Engineering

Data engineering is a field within data management that focuses on the practical application of data collection and data processing. It involves designing, building, and maintaining the architecture (hardware and software) and systems that allow organizations to collect, store, and analyze data effectively.

- Extraction and transformation
- Storage
- Analysis

Data Engineering Architecture



Setting up Data Engineering on Your Laptop

Example: Calculate your own monthly spendings

- Source: manual typing, email Excel attachment, bank account download
- Processing: your Jupyter notebook, your Excel, your notepad
- Target: manual upload to online storage, email, USB drive

Setting up Data Engineering on Your Laptop

- Compute: CPU, Memory
- Storage: Hard drive
- Networking: Wifi connectivity
- OS and Application: Windows, Excel, web browser

Corporate Data Engineering Architecture

Servers, servers, servers: separation of duty

- Transactional application servers
- Database servers
- File servers
- Analytical application servers
- Routers/switches/network cables

All with some OS and applications

Corporate Data Engineering Architecture

Traditionally, companies host servers in the same offices as employees

Issue with this approach: The requirements for a machine office are very different from the requirements for human office

- Physical access: Less for servers, More for regular office
- Noise, heat, etc.

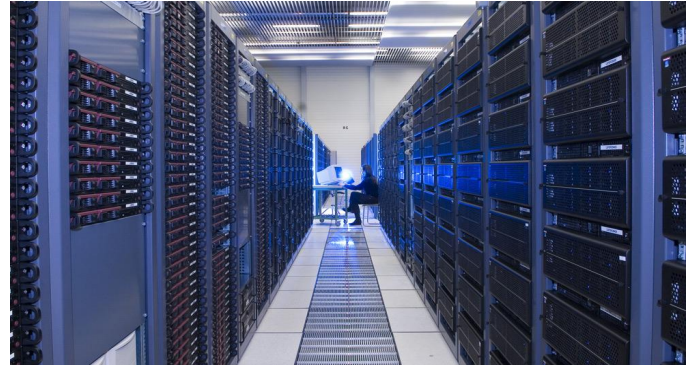
Solution: Put servers in their own office

The Rise of Data Centers

Centralized facilities designed to house and manage a large number of computer systems and associated components.

- Placing all servers and their accessories into one building
- Users accessing the servers via private network between offices
- Hide the IT work from end users

Rack:



Issues with Data Centers (1 of 2)

- High investment
 - Each data center only serves a small number of customers
 - Out of reach for smaller companies
- Capacity is pre-determined and paid in advance
 - Inflexible: hard to change
 - New requirements, new needs
- Concentrated usage (peak and trough)
 - Waste of resource vs out of capacity
 - Scaling up and scaling down

Issues with Data Centers (2 of 2)

- Centralized facility is vulnerable to disasters
 - Natural disaster: Hurricane, earthquake, etc.
 - Fire, attack, etc
- Every company has an IT team
 - Not focusing on core business values
 - Do you need to keep an electrician in your house everyday?

The Beginning of Cloud Computing

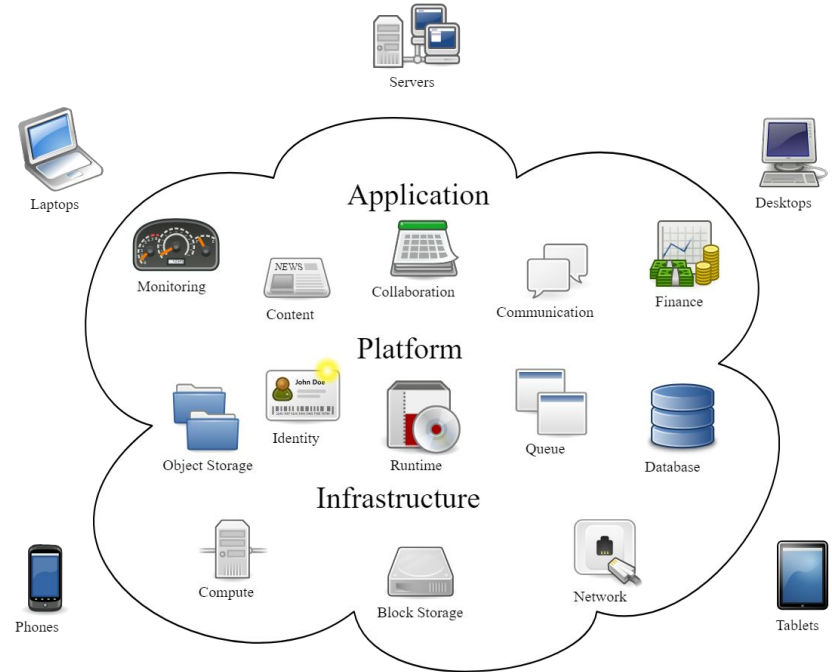
Amazon:

- Vast amount of resources not used so they shared them with users
- The size of Amazon brings cost down
- The size and diversity of users make the usage demand relatively stable
 - Which allows the continuous real-time provisioning and terminating of resources
- A new paradigm of on-demand service thus emerged

Cloud Computing

- On demand provisioning of IT resources
- Pay as you go
- Usage over internet (and/or private network)

Comparing to electricity supply: At one point, every building in lower Manhattan had its own generator.



Cloud Computing

The U.S. National Institute of Standards and Technology (NIST) defines cloud computing as:

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Advantage of Cloud Computing

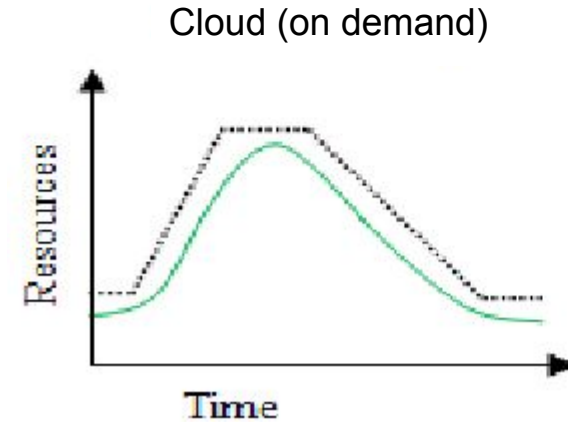
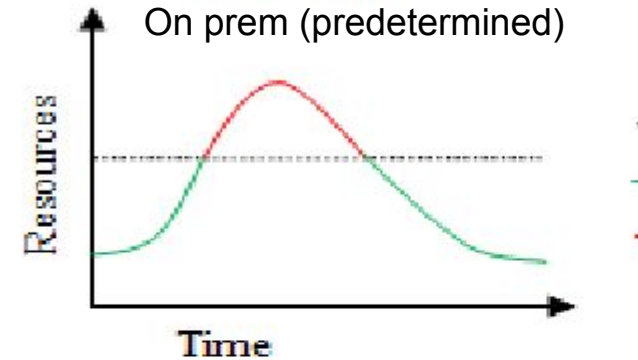
- Scalability/Elasticity
- Agility
- High Availability/Disaster Recovery
- Security
- Cost Saving

Scalability/Elasticity

Demands can go up and down

- By time of day (nightly processing)
- By date in the year (holiday season)
- By any sudden change (pandemic)

Nobody should be forced to predict the future. Instead, we should react and respond.



Agility

Adopt to the latest change in business flow, quickly

- Addition/removal of business process or compliance requirements usually brings in changes in demand for IT capacity, as well as tech stacks
 - The publicity of Generative AI raised the demand for GPU based systems
 - The regulation for healthcare transparency required insurance companies to publish their existing data using JSON formatted Restful API, which may require the companies to use new technologies that they do not use before.

High Availability/Disaster Recovery

Any physical hardware can fail, but the distributed and on-demand nature of cloud computing can help

- Redundant resources
- Remote backup
- Continuous monitoring and automatic responding
- Failover to other machines (automatic)
- Failover site/region (automatic)

Security

Security is a complex topic which requires expertises from different fields in technology, and requires constant monitoring and management. Most companies had limited resources to cover all aspects of security.

- Cloud service providers can afford to establish a wide range of security measures, and offer them to all clients, regardless of their sizes
- Cloud service providers can provide fast response to security vulnerabilities.
 - Log4j vulnerability requires companies to identify affected servers, and apply patch in large scale

Cost Saving

Economy of scale:

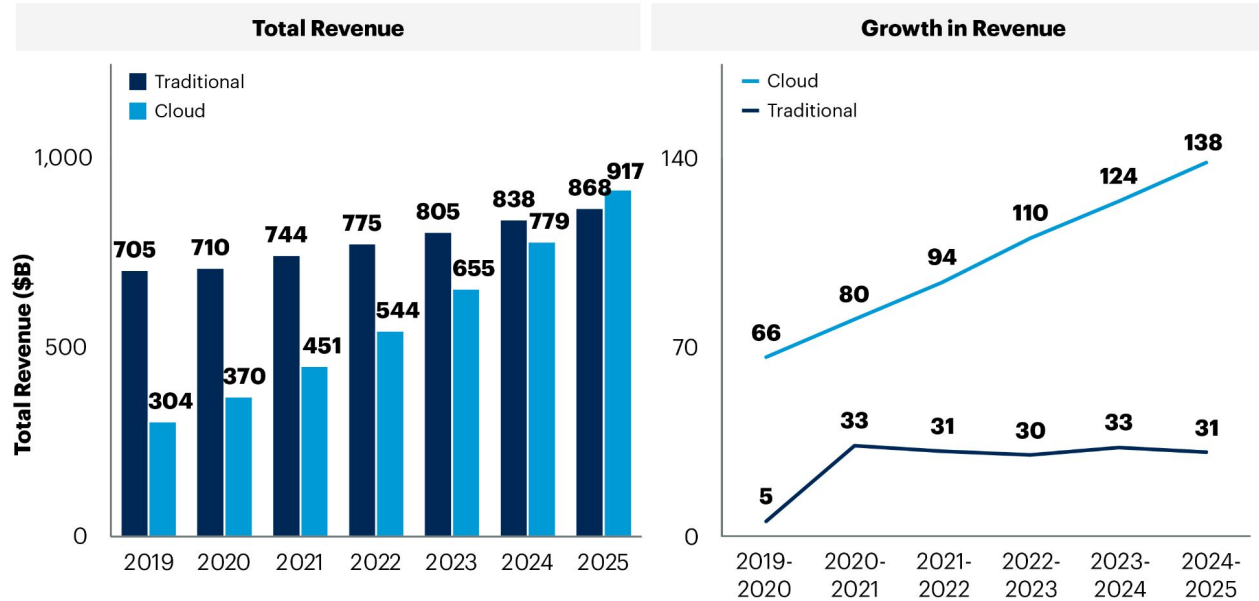
- More efficient (scalability)
- More tools (availability/security)
- More focused on core business process (agility)

Cloud Computing Mindsets

On-demand, pay-as-you-go: Expendable nature of resources

- Immutable deployment: No update. Create new and discard old
 - Herd vs Cattle
- Try often and fail early
- Infrastructure and security in layers
- Start with easy repetitive deployment in mind:
 - future automation
 - scalability

Cloud Computing Trend



Source: Gartner
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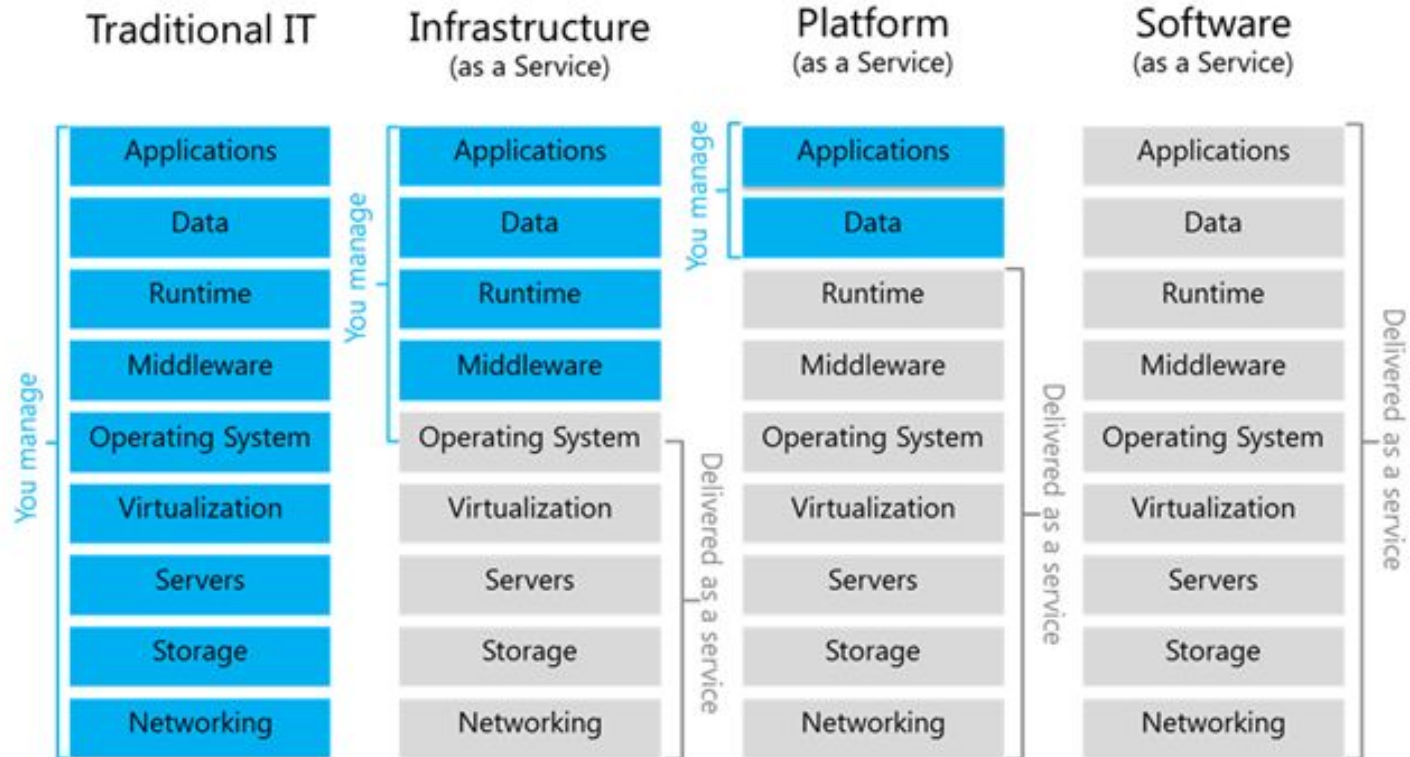
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IaaS vs. PaaS vs. SaaS

Cloud computing has three main cloud service models:

- IaaS (infrastructure as a service),
- PaaS (platform as a service), and
- SaaS (software as a service).

Service Stacks

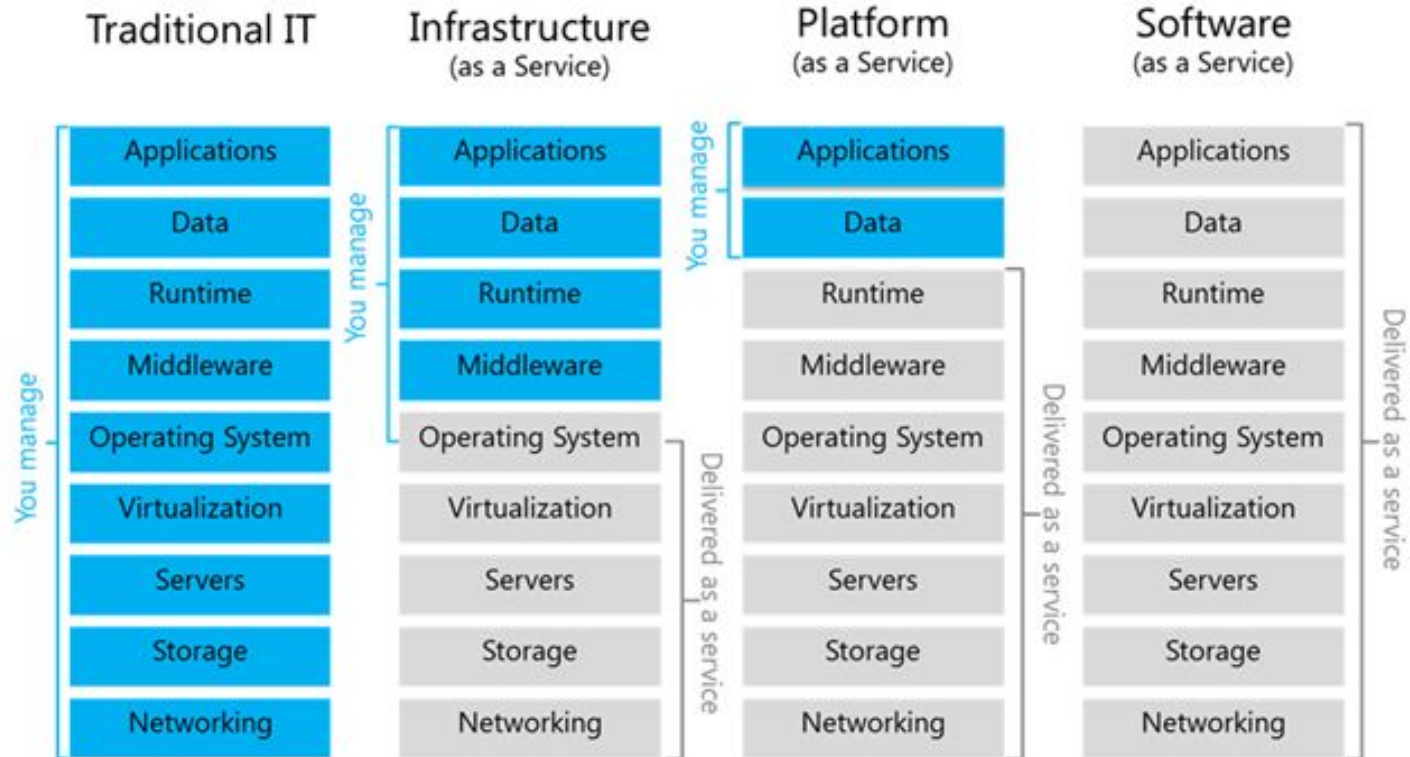


IaaS

A type of cloud computing service that offers essential compute, storage, and networking resources on demand, on a pay-as-you-go basis.

- Virtual machines
- Disk storage
- Networking

IaaS vs. PaaS vs. SaaS

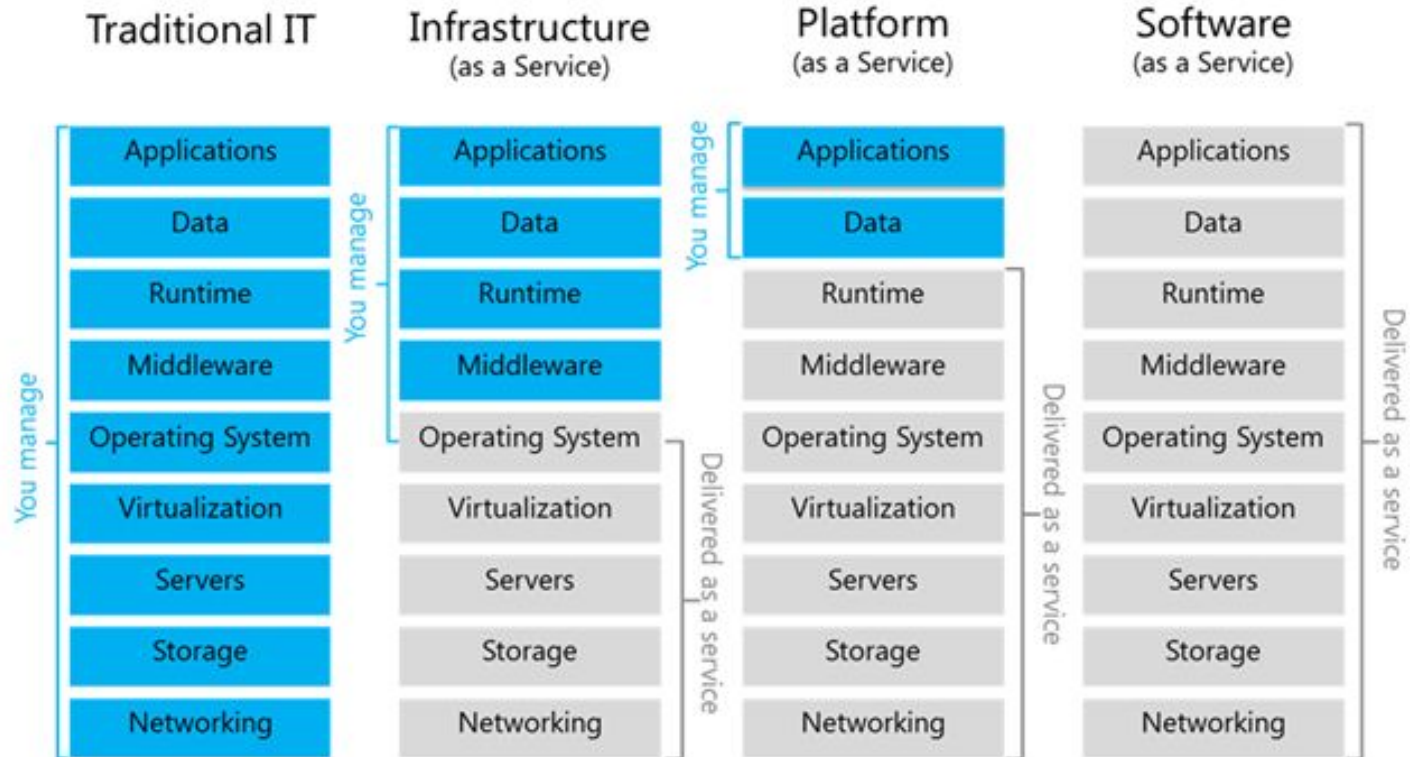


PaaS

A complete development and deployment environment in the cloud, with resources that enable you to deliver everything from simple cloud-based apps to sophisticated, cloud-enabled enterprise applications.

- Development tools (IDE)
- Database management
- Application hosting: Azure App Service

IaaS vs. PaaS vs. SaaS

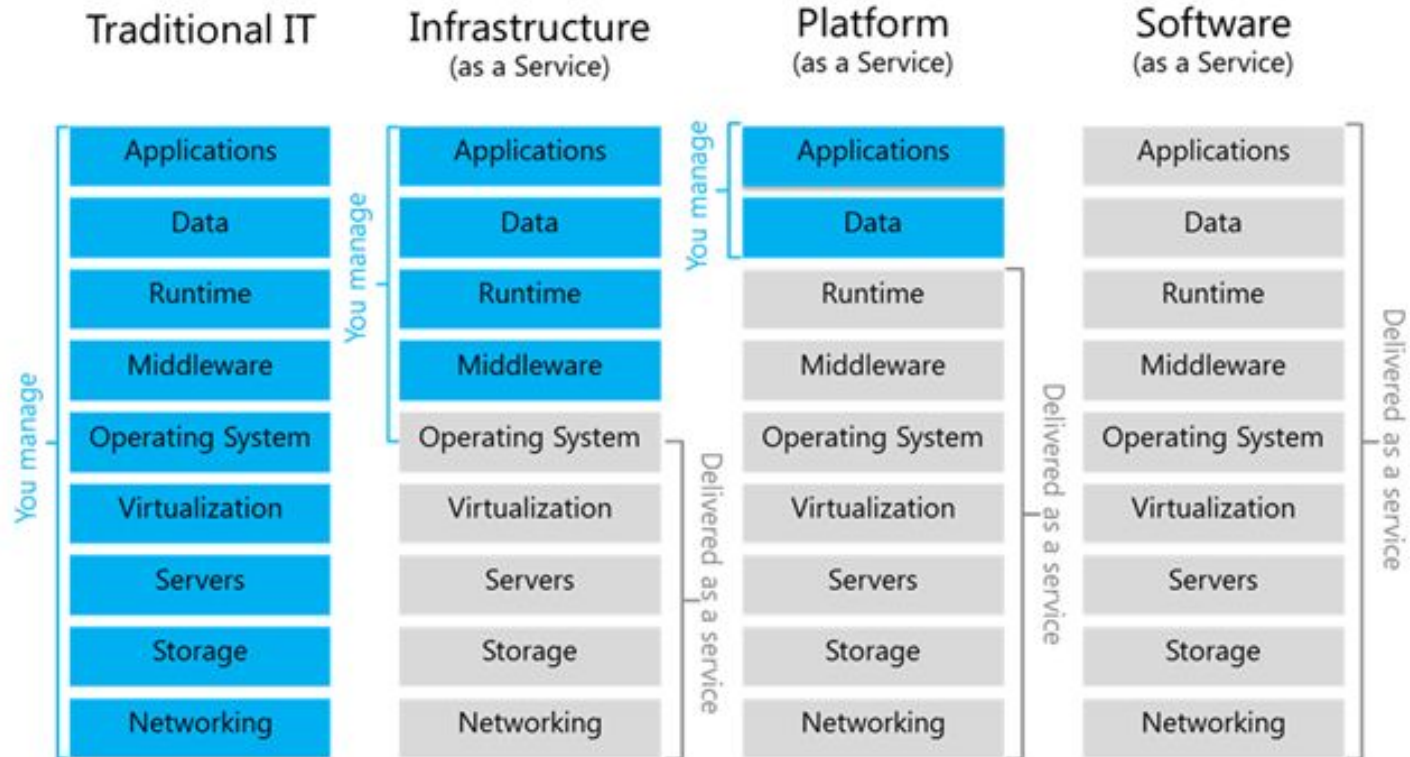


SaaS

A complete software solution that you purchase on a pay-as-you-go basis

- email,
- calendaring, and
- office tools (such as Microsoft Office 365).

IaaS vs. PaaS vs. SaaS



Advantage of IaaS vs. PaaS vs. SaaS

- Reduced effort to maintain technical infrastructures and stacks
- Reduced size and complexity of IT team
- Utilize the cost saving, scalability, agility, availability, security, etc offered by cloud service

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Type of Clouds

- Public
- Private
- Hybrid

Public Cloud

Public cloud: provides IT resources and services over the internet to the general public or multiple organizations

Major players:

- Amazon Web Services (AWS)
- Microsoft Azure
- Google Cloud platform (GCP)

Figure 1: Magic Quadrant for Cloud Infrastructure and Platform Services



Private Cloud

Private: cloud computing environment that is exclusively dedicated to a single organization or a group of organizations that shares the same characteristics

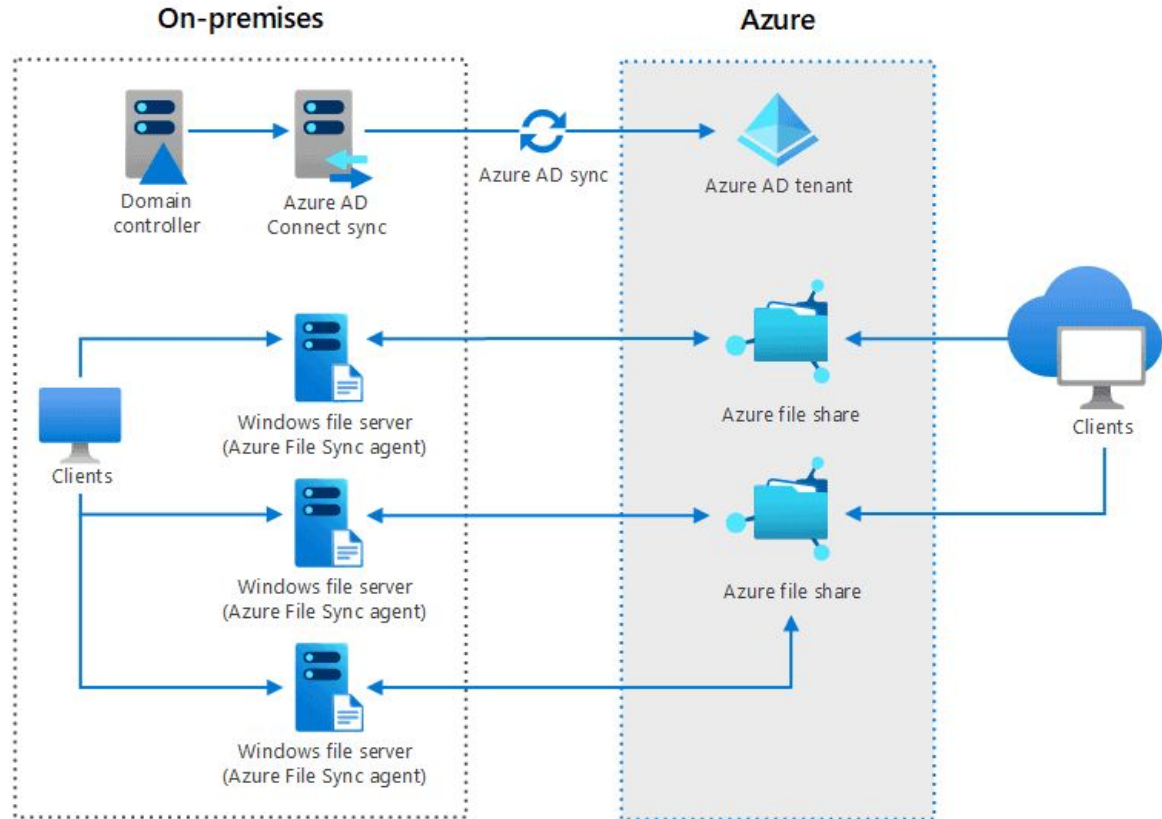
- On Premise: hosting and running software applications, data, and IT infrastructure within an organization's physical location or premises (traditional data center)
- Hosted private cloud: hosting and managing the private cloud infrastructure in secure, off-site data centers provided by cloud vendors (similar to traditional data center, usually with higher capacity)

Comparing to Public: who are the users?

Hybrid Cloud

Hybrid: combines elements of both private cloud and public cloud infrastructure

Likely what you will use at work: existing (legacy) IT data centers + new cloud implementations

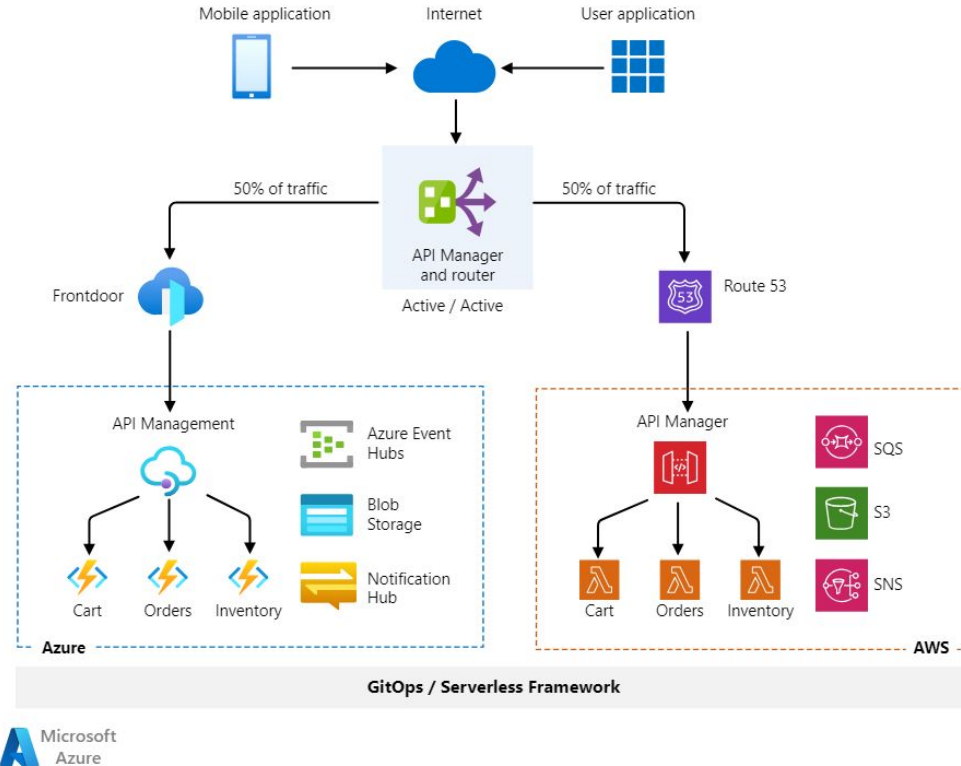


Multi Cloud

Multi-cloud: using services and resources from multiple cloud service providers

Not mature yet, but is definitely the future state

- Advantage of certain cloud products
- Merger and acquisition
- Cost saving



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What is Azure

Microsoft Azure, commonly referred to as Azure, is a cloud computing platform and service offered by Microsoft. Azure provides a wide range of cloud services that enable organizations to build, deploy, and manage applications, services, and infrastructure through Microsoft's global network of data centers. It is one of the leading cloud platforms and is used by businesses, developers, and IT professionals for various cloud-related tasks.

What is Azure

<https://azure.microsoft.com/>

☰ Azure



Sign in

[Home](#) / [Resources](#) / [Cloud computing dictionary](#) / What is Azure?

What is Azure?

The Azure cloud platform is more than 200 products and cloud services designed to help you bring new solutions to life—to solve today's challenges and create the future. Build, run, and manage applications across multiple clouds, on-premises, and at the edge, with the tools and frameworks of your choice.

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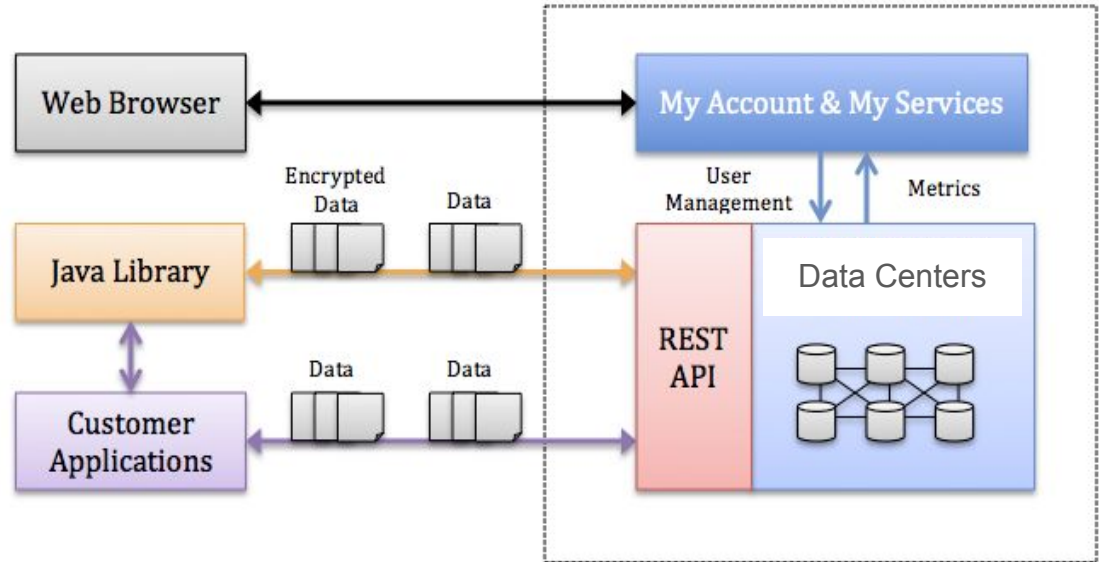
Components of Cloud Computing

- Servers in data centers:
 - Servers: No matter what name it is called, there is always a server running its workload
 - Data centers
- Clients
- Connections: internet, or direct link to cloud data centers

Accessing Cloud Computing

How to access cloud computing (not limited to Azure)

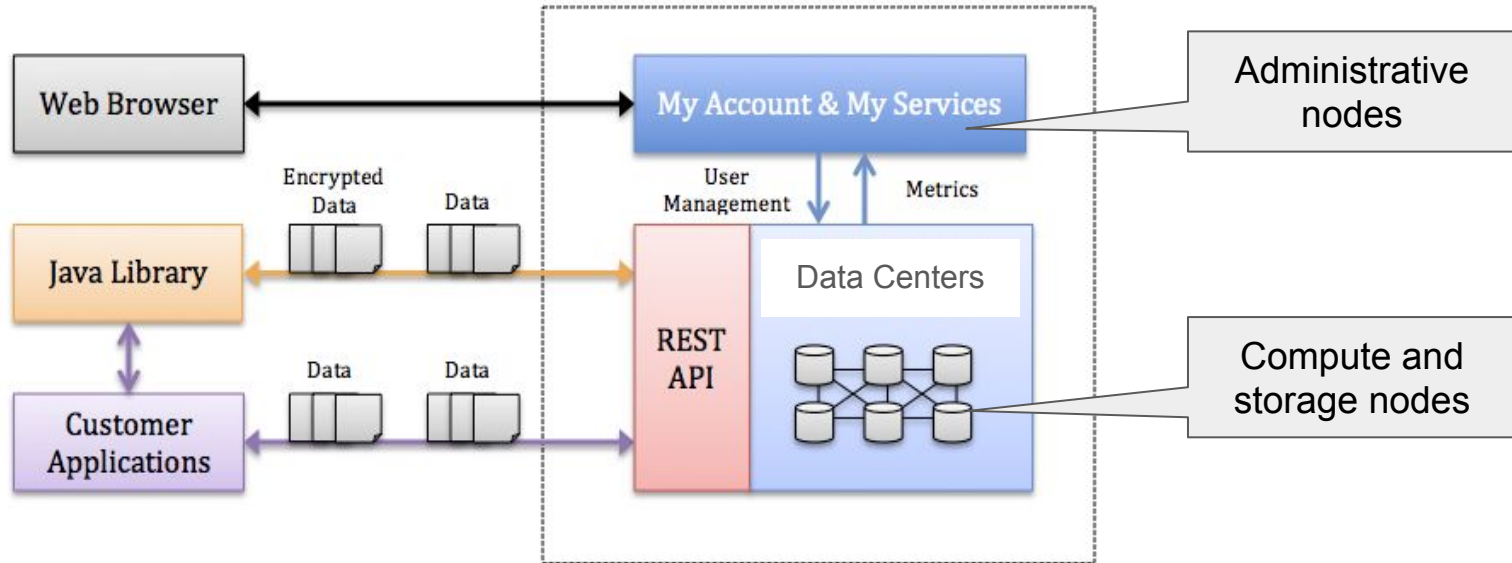
- Service API
- Browser
- Scripts



Servers

- Compute nodes
- Storage nodes
- Administrative nodes

Accessing Cloud Computing



Cloud Data Centers

Where the servers are hosted. Essentially providing the same functionalities as traditional data centers.

- Large scale, larger than most traditional data centers
- Large number of data centers offered by each cloud service provider
- Geographically distributed

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Azure Global Network

Azure data centers are located across the world.

Microsoft is continuously adding new data centers



Azure Region

An Azure region is a geographical area where Microsoft Azure, Microsoft's cloud computing platform, operates data centers to provide cloud services to customers. Each Azure region consists of one or more data centers that are strategically located in close proximity to one another. These regions are distributed across the world to ensure redundancy, availability, and low-latency access to Azure services.

Azure Availability Zone

Azure Availability Zones are unique physical locations within an Azure region that are designed to provide high availability and fault tolerance for cloud-based applications and services. Each Azure region consists of multiple Availability Zones, which are interconnected by high-speed, low-latency networking, and are separated by a significant physical distance to minimize the risk of simultaneous failures. .

Azure Region/Availability Zone

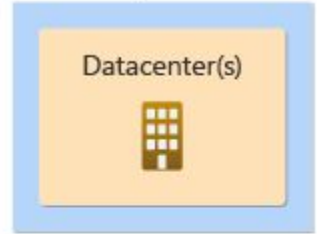
Azure region 1



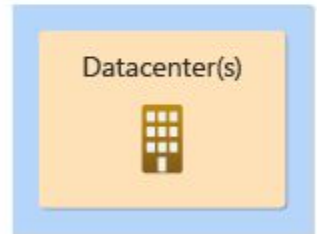
Azure region 2



Azure region 3



Azure region 4



Azure Region/Availability Zone

- Some services are provided at availability zone (data center) level, such as Virtual Machines
- Some services are provided at region level, which means they are duplicated across multiple availability zones in the same region, such as Key Vault
- Some services are provided globally (cross region), such as user management.
- Some services allow multiple layers of redundancy, for example, Local, Zone, Region redundancy options for Azure Storage Account

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Common Cloud Services

- Machines: IaaS
- Storage: IaaS
- Databases: PaaS
- Applications: PaaS or SaaS

Platform Services

Security and Management

-  Portal
-  Active Directory
-  Multi-Factor Authentication
-  Automation
-  Key Vault
-  Store/Marketplace
-  VM Image Gallery and VM Depot

Compute

-  Cloud Services
-  Service Fabric
-  Batch
-  Remote App

Web and mobile

-  Web Apps
-  API Apps
-  API Management
-  Mobile Apps
-  Logic Apps
-  Notification Hubs

Developer services

-  Visual Studio
-  Azure SDK
-  Team Project
-  Application Insights

Hybrid Operations

-  Azure AD Connect Health
-  AD Privileged Identity Management
-  Backup
-  Operational Insights
-  Import/Export
-  Site Recovery
-  StorSimple

Integration

-  Storage Queues
-  BizTalk Services
-  Hybrid Connections
-  Service Bus

Analytics and IoT

-  HDInsight
-  Machine Learning
-  Data Factory
-  Event Hubs
-  Stream Analytics
-  Mobile Engagement

Data

-  SQL Database
-  SQL Data Warehouse
-  Redis Cache
-  Search
-  Cosmos DB
-  Tables

Media and CDN

-  Media Services
-  Content Delivery Network (CDN)

Infrastructure Services

Compute

-  Virtual Machine
-  Containers

Storage

-  BLOB Storage
-  Azure Files
-  Premium Storage

Networking

-  Virtual Network
-  Load Balancer
-  DNS
-  Express Route
-  Traffic Manager
-  VPN Gateway
-  Application Gateway

Azure Services

DEMO:

<https://azure.microsoft.com/en-us/products>

- Client: your browser
- Portal: a web server running in Azure data center (administrative node)
- Virtual machine service: a compute node in Azure data center

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Course Instructor



Jun Shan (He/Him)

 [Verify now](#)

Principal Solution Architect

New York, New York, United States · [Contact info](#)

Course Schedule

Week	Content
1	Introduction
2	Compute in Azure
3	Azure management and storage
4	Relational databases
5	Big data and NoSQL databases
6	Final project introduction. Midterm
7	Data Warehouse and Data Lakehouse
8	Extraction, Transformation, and Loading
9	Data visualization
10	Machine Learning and Artificial Intelligence
11	Final project presentation

Teaching Format: Virtual Learning

Remote learning, with instructor led sessions during fixed times.

- Each session consists of lectures and labs that must be completed and submitted on time,
- followed by assignments that must be completed and submitted on time.

This format will provide you with the flexibility of virtual learning and the discipline of instructor led learning.

Teaching Format: Virtual

- 3hr lecture + lab (6-9P), 0.5hr Q&A afterwards
 - Lecture
 - Lab: Hands-on
 - Must click on submit button
 - Need to share your screen upon request
 - Assignment after each class
 - Must click on submit button

Teaching Format: Virtual Learning

- Week 6: 1.5hr instruction + 2hr mid-term exam
- Week 11: 3.5hr project presentation
 - Will discuss final project after midterm

Labs and Assignments

- Course is designed to have this learning cycle: Lecture > Lab > Assignment > Midterm/Final
 - Labs are designed to get you familiar with basic technology.
 - Assignments are deeper dives.
- Strongly encourage you to start working on them ASAP

Grade

1. Attendance	20 points	2 points per attendance.
2. Labs	18 points	2 points per submission.
3. Assignments	18 points	2 points per submission.
4. Midterm Exam	24 points	
5. Final Project	20 points	

Late submission/multiple submission is allowed with proper written request.

No makeup for attendance, mid-term, and final project

Regarding Labs and Assignments

- If you have to miss a class, must send written request (**email**).
- Class participation means more than Zoom attendance. You must actively participate in the discussion and labs, and answer questions.
- Must hit Submit button, otherwise no grade
- If you need extension in time, must send written request (**email**). Otherwise no grade and no makeup. Requests sent over Zoom chat do not count.
- For any technical difficulty (installation, Azure access, etc), you must send written explanation (**email**) before the deadline. Otherwise no grade and no makeup.

Attendance Requirements

You must:

- Show up at 6pm: Email me if you can't make it
- Participate in lectures and be ready to share your work
- Complete labs and assignments before next class
- Take midterm and final presentation on time
- Again: Written request with justified reasons for exceptions
- Again: No makeup for attendance, mid-term, and final

Blackboard

- All course materials are posted on Blackboard
 - Lecture PPT (PDF)
 - Lecture recording video
 - Labs
 - Assignments
 - Sample files/supporting files

Textbook

- Microsoft website
 - <https://azure.microsoft.com/>
 - <https://learn.microsoft.com/en-us/training/azure/>
- Internet: Google, ChatGPT, etc.

Key skill to use cloud computing in real world

Additional Help

- Contact email: jshan@saintpeters.edu

Feel free to let me know if you need help. If you need to have a discussion with me, send me an email with 3-4 time slots that work for you. I will pick one and setup a zoom session.

School Policies

Instructional Continuity Plan

This course will be conducted continuously online even if Saint Peter's University closes its campus access.

Students with Special Needs

Students requiring special accommodations should present the appropriate paperwork after having their accommodations determined by the Academic Dean's Office.

Note: This is also applicable to financial issues, visa issues, and any issue that is out of the scope of this class.

Title IX Compliance

In the event that you choose to write or speak about having survived sexualized violence, including rape, sexual assault, dating violence, domestic violence, or stalking, Saint Peter's University policies require that, as your instructor, I share this information with the Title IX Coordinator, Elena Serra. Elena or a trained member of her team will contact you to let you know about support services at Saint Peter's as well as options for holding accountable the person who harmed you. Whereas, you are not required to speak with them, they will share resources with you.

Academic Conduct

In order to maintain academic integrity at Saint Peter's University, the University community will not tolerate any forms of academic dishonesty. Examples of unacceptable forms of dishonesty include cheating, copying, fabrication, plagiarism, unauthorized collaboration, submitting someone else's work as one's own; dishonesty through the use of technology such as sharing disks, files, or programs; access to, modification of, or transfer of electronic data, system software or computing facilities. The intent of this policy is to promote academic integrity, and to arrest all forms of academic dishonesty.

When incidents of academic dishonesty occur and the faculty member chooses to submit a formal complaint of the incident to the Academic Dean, the Dean will refer the complaint to the Academic Integrity Review Board, which is composed of faculty, academic administrators, and the Dean of Student Development.

The Academic Integrity Review Board will review the circumstances surrounding the incident and make a recommendation of appropriate disciplinary action. Penalties imposed on the student who violates this policy may vary from failing the unit of work to expulsion from the University.

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Lab: Accessing Azure

- Confirm your access to Azure portal
- Confirm your privilege to Azure subscription

Click on the Submit button!

Assignment

