Computing platforms (Spring 2025)
week 4

Exercise 1

Search the websites of **AWS, Google Cloud,** and **Microsoft Azure** and find out answers to the following questions for each 3 providers:

1. What services can you use for free? **All of them**
   - https://aws.amazon.com/free [1]
     Free for 12 months.
   - https://cloud.google.com/free [3]
     Always free.
   - https://azure.microsoft.com/en-us/free/ [4]
     Free for 12 months.
2. How much does it cost to run a virtual machine for one day? (Something other than a possibly free plan.)
   - AWS: t4g.xlarge (4 vCPUs, 16 GB RAM) costs $0.1344/hour, $3.2256/day.
   - Google Cloud: e2-standard-4 (4 vCPUs, 16 GB RAM) costs $0.150924/hour, totaling $3.622176/day.
   - Microsoft Azure: B4ms (4 vCPUs, 16 GB RAM) costs $0.166/hour, totaling $3.984/day.
3. How much does storage cost?
   - AWS: $0.023 per GB per month.
   - Google Cloud: $0.023 per GB per month.
   - Microsoft Azure: $0.021 per GB per month.
4. Compare prices and expected performance of different VM offerings. Does the price increase linearly with the expected performance? If not, what can you observe?
   The price does not increase linearly with performance [2]. Factors such as instance type, underlying hardware, and specific optimizations influence pricing. Compute-optimized instances offer higher performance per vCPU at a lower cost compared to general-purpose instances.
5. Which of the three is best?
   The "best" provider depends on use case:
   - AWS: Broad service range.
   - Google Cloud: Strong in data analytics and machine learning.
   - Azure: Best for Microsoft-integrated environments.
6. Suppose you work in a company that wants to start using cloud computing. Which of the three would you pick and why? The choice depends on company needs:
   - For a Microsoft-centric environment, Azure is preferable.
   - For scalable web applications, AWS offers a broad service range.
   - For data-intensive applications, Google Cloud excels in analytics and AI.

Exercise 2

Would cloud computing have taken off in this manner without virtualization (VMs or containers)? Why or why not?
Cloud computing as we know it today would not have taken off in the same manner without virtualization (VMs and containers). Here's why:

- **Efficient Resource Utilization:** Without virtualization, entire physical machines would have to be allocated to each customer, leading to significant resource waste. Virtualization enables multiple customers to share the same physical server, reducing costs and maximizing hardware utilization.
- **Scalability and Elasticity:** Virtualization allows for on-demand provisioning and scaling of resources.
- **Disaster Recovery and Redundancy:** Virtualization enables snapshotting, live migration, and failover mechanisms, which are critical for disaster recovery.
- **Isolation and Security:** VMs and containers provide isolation between workloads, ensuring that multiple users can run applications on the same physical server without interfering with each other.
- **Cost Reduction:** Cloud computing relies on the economies of scale made possible by virtualization.
- **Portability and Flexibility:** Containers, in particular, allow applications to be easily moved between environments (e.g., development, testing, and production).
- **Rapid Deployment and Automation:** With virtualization, cloud providers can automate deployment, orchestration, and management of services.

Exercise 3

Cloud computing. Read the article "A View of Cloud Computing" by M. Armbrust et al. available at https://dl.acm.org/doi/10.1145/1721654.1721672. The article is written in 2010 and makes 10 "predictions" (obstacles and opportunities) about how cloud computing will develop. Based on the article, your knowledge about cloud computing, and any other material you may find, address each of the 10 points. For each of them, classify them as "mostly true", "partially true", or "mostly untrue" and justify your answer. The classification should reflect the current state of that point in modern cloud computing. Note that in many of the points, several options are justifiable and no correct answers exist.

- **Availability/Business Continuity:**
  Mostly True

  The concern in 2010 was whether cloud providers could offer high availability comparable to traditional IT infrastructure. Today, major cloud providers like AWS, Google Cloud, and Microsoft Azure have multi-region availability zones, automated failover mechanisms, and SLAs guaranteeing 99.9%+ uptime. While cloud outages still occur, they are generally less frequent than on-premise failures.

- **Data Lock-in:** Partially True

  Cloud providers still use proprietary storage APIs and management tools, making it difficult for customers to migrate workloads seamlessly. However, the situation has improved with industry-standard APIs, multi-cloud strategies, and containerization technologies

- **Data Confidentiality and Auditability:** Partially True

  Security in cloud computing has improved significantly with end-to-end encryption, zero-trust architectures, and compliance certifications. However, enterprises still express concerns about data sovereignty and government access to data, particularly in public cloud environments.

Exercise 4

- **Data Transfer Bottlenecks:**
  Partialy True

  In 2010, network bandwidth limitations were a major concern for cloud computing adoption. Today, network speeds have improved significantly.However, moving large datasets (petabytes of data) between clouds or from on-premises environments is still slow and costly.

- **Performance Unpredictability:**
  Mostly True

  Cloud environments share physical resources among multiple tenants, leading to resource contention. This is especially true for network I/O, disk I/O, and CPU allocation on virtual machines. While cloud providers have introduced dedicated instances, custom VM shapes, and optimized scheduling mechanisms, performance variability still exists.

- **Scalable Storage:**
  Mostly True

  Cloud providers have largely solved the problem of scalable storage through object storage, distributed databases and auto-scaling block storage solutions. However, latency-sensitive applications (e.g., real-time processing) may still face challenges with data consistency and retrieval speeds.

Exercise 5

- **Bugs in Large Distributed Systems:**
  Mostly True

  Debugging large-scale distributed systems remains a challenge, as cloud environments introduce complexity, race conditions, and distributed failures that are difficult to reproduce in test environments.

- **Scaling Quickly:**
  Mostly True

  One of the biggest successes of cloud computing is its ability to scale quickly.

- **Reputation Fate Sharing:**
  Partially True

  The concern that one cloud user's bad behavior could impact others remains valid but has been mitigated by network isolation, security policies, and managed services. IP blacklisting and shared infrastructure risks still exist, particularly in multi-tenant environments where one customer's activity can lead to service degradation or reputational damage

- **Software Licensing:**
  Partially True

  In 2010, traditional software licensing models did not align well with cloud computing. Since then, many software vendors have adopted subscription-based and pay-as-you-go pricing models. Still, some enterprise software still has restrictive licensing that complicates cloud migration.

References

[1] Aws free tier, 2025.

[2] Aws vs. azure vs. google cloud platform in 2024, 2025.

[3] Google cloud free tier, 2025.

[4] Microsoft azure free tier, 2025.