UMD DATA605 - Big Data Systems

AWS Overview

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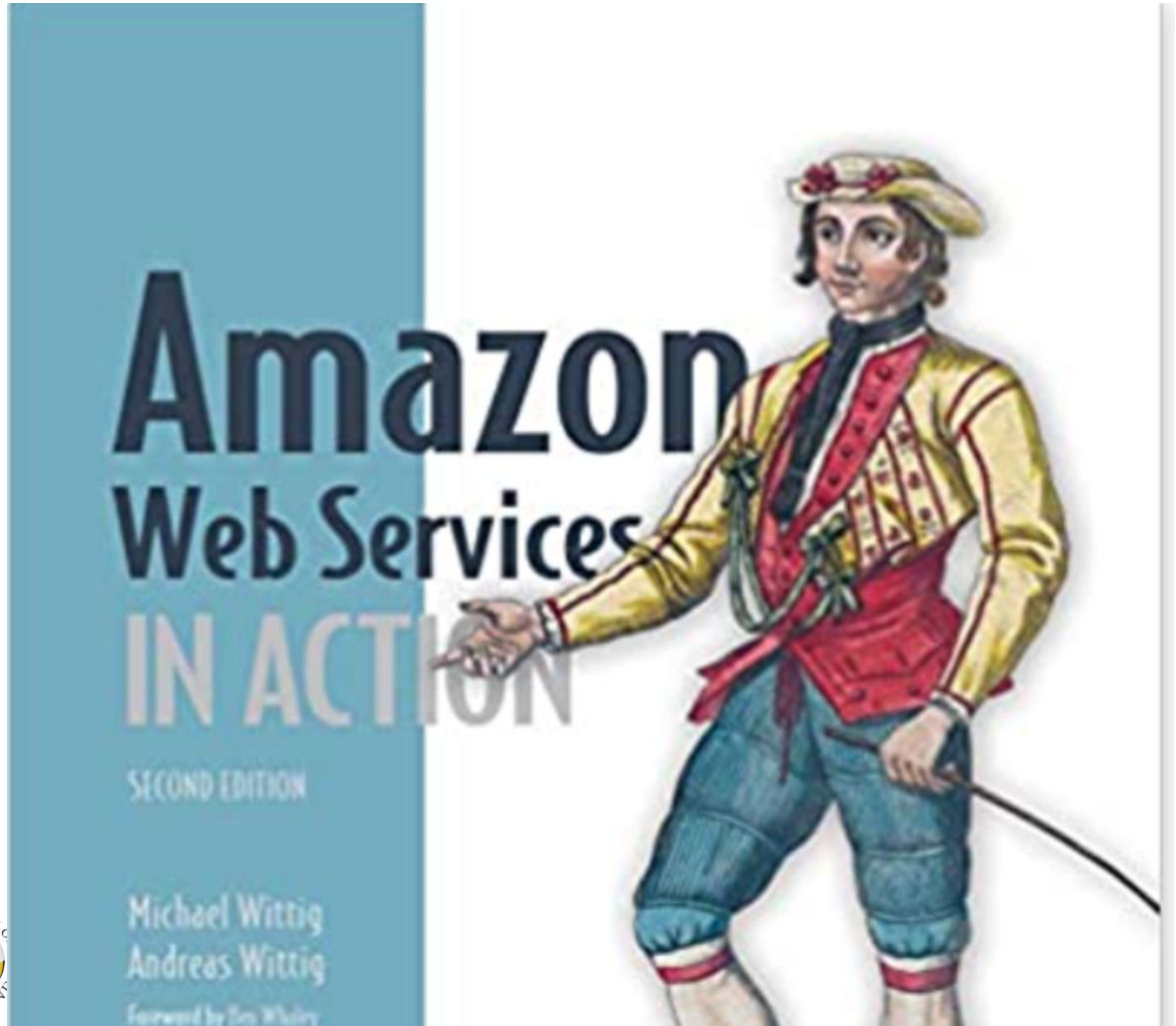
AWS: Resources

- Some basic info in the slides
- Many tutorials on-line
- Mastery
  - Amazon Web Services in Action 3rd Edition



Amazon Web Services (AWS)

- **AWS is a platform offering complete cloud solutions**
  - Computing (e.g., EC2)
  - Storing (e.g., S3)
  - Networking
- **It offers different levels of abstractions**
  - IAAS, PAAS, SAAS
  - From virtual hardware to applications, e.g.,
    - Host web sites
    - Run enterprise software
    - Run machine learning applications
- **Services can be controlled in different ways**
  - A web interface (aka "console")
  - CLI: **aws** command
  - Programmatically
    - Through language libraries, SDK (e.g., Python **boto3**)

AWS as Business

- Services charge a pay-per-use pricing model
- Data centers are distributed globally
  - US, Europe, Asia, South America
- 500 new services and features every year
- Insanely profitable
  - 91B/year in revenue (2023)
  - Grows 42% year-over-year
  - Controls 30% of cloud business

Types of Cloud Computing

- Cloud computing enables a shared pool of configurable computing resources
  - E.g., servers, storage, networks, applications, services to be used:
  - From everywhere
  - Conveniently
  - On-demand
- Clouds can be:
  - *Public*: open to use by general public (e.g., AWS)
  - *Private*: virtualize and share IT infrastructure within a single organization (e.g., government)
  - *Hybrid*: a mixture of public and private clouds

AWS vs Google Cloud vs Microsoft Azure

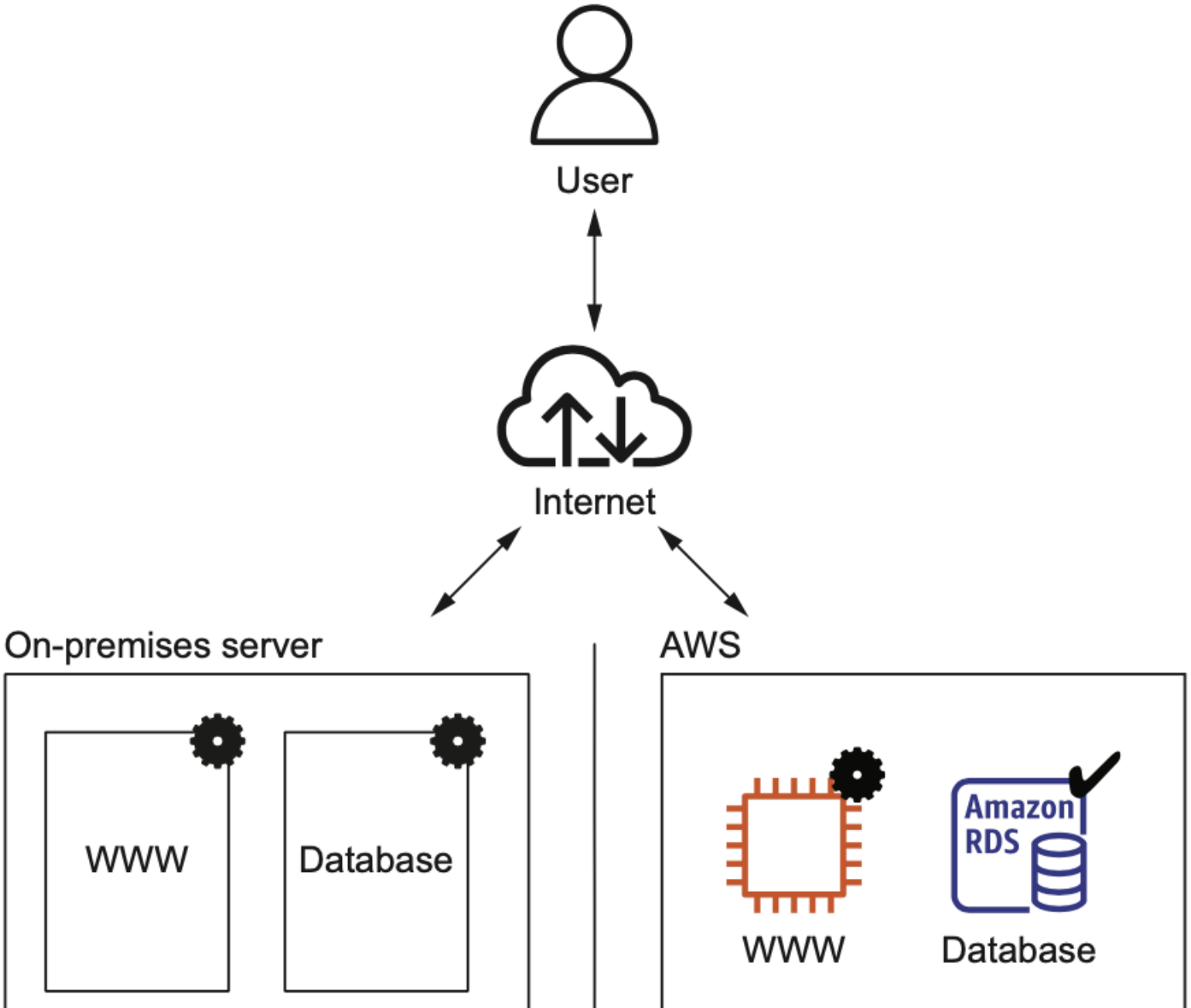
- **Similarities:**
  - Worldwide infrastructure
  - Provide IAAS (computing, networking, storage)
    - AWS EC2 / Google Compute Engine / Azure VMs
    - AWS S3 / Google Cloud Storage / Azure Blob storage
  - Pay-as-you-go pricing model
- **Differences:**
  - AWS
    - Market leader, most mature, and powerful
    - (ab)uses a lot of open source technologies
  - Azure provides Microsoft stack in the cloud
  - Google seems more focused on cloud-native applications rather than migrating local applications to the cloud

From On-premise to AWS

- **Aka "Cloud-transformation"**
- **Move a medium-sized e-commerce site from on-premise to the cloud**
- **Architecture**
  - **Web-server**: handle requests from customers
  - **DB**: store product information and orders
  - **Static content** (e.g., JPEG image)
    - Delivered over a content delivery network (CDN)
    - Reduce load on company services
  - **Dynamic content** (e.g., HTML pages)
    - E.g., products and prices
    - Delivered by web server

From On-premise to AWS

- **Step 1: Move to cloud**



Optimizing Costs

- **On-demand instances**
  - Maximum flexibility, no restrictions
  - You start and stop VMs when you want
  - Pay by hour
- **EC2 / Compute saving plans**
  - 1 yr vs 3 yrs
  - Commit to a certain number of hours
  - Payment options: all, partial, no upfront
  - Discount: up to 3x cheaper than on-demand price
  - Useful for dev servers
- **Capacity reservation**
  - Get machines even in peak hours
- **Spot instances**
  - Bid for unused capacity
  - Price based on supply / demand
  - Discount: up to 10x cheaper than on-demand price
  - Useful for running asynchronous tasks

Programming the Infrastructure

- On AWS *everything* can be controlled via an API over HTTPS
  - Start a VM
  - Create 1TB of storage
  - Start Hadoop cluster
- Jeff Bezos 2002 API mandate
  - An email worth $100B/yr
  - HackerNews
  - An eye-witness from Google about it
- You can use:
  - AWS console
  - HTTP requests to the API
  - CLI (Command Line Interface)
    - Call AWS API from your terminal
  - SDK (Software Development Kit)
    - Call AWS API from your code
  - CloudFormation: templates that describe the state of the infrastructure and are translated into API calls

1. All teams will henceforth expose their data and functionality through service interfaces.

Infrastructure-As-Code

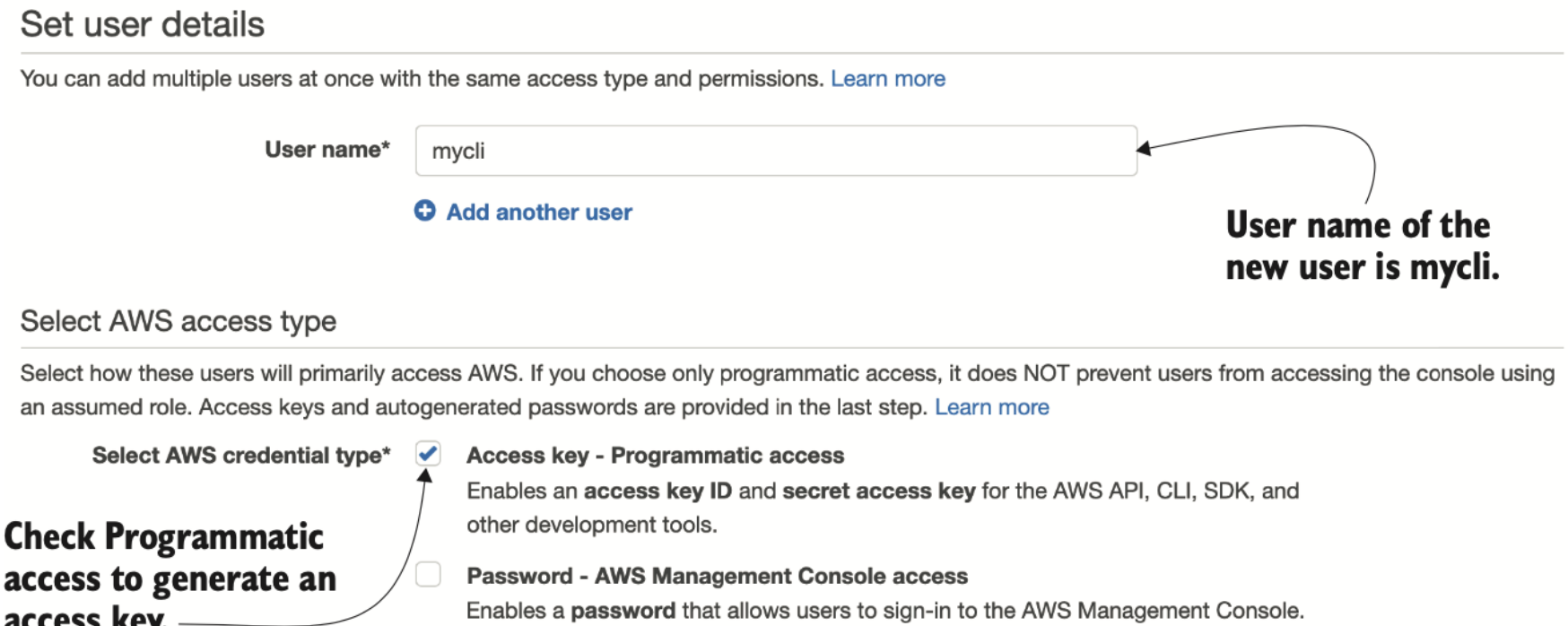
- **Use high-level programming language to control IT systems**
- You can apply software development to infra
  - Code repository
  - Automated tests
  - Continuous integration
- **DevOps (SRE in Google parlance)**
  - Mix devs and ops in the same team
  - Use software to bring development and operations closer together
  - Switch roles to experience each others' pain
    - Devs -> responsible for operational tasks (e.g., being on-call)
    - Ops -> involved in software development, making system easier to operate
  - Foster communication and collaboration

Infrastructure-as-Code: Advantages

- **Save time**
  - Reusing scripts or ready-to-use blueprints
  - Automating tasks done regularly
  - Copy-paste vs click-click-click
- **Fewer mistakes**
  - Push button flow
- **Consistency of actions**
  - Multiple deploys per day
- **Deployment pipeline**
  - Commit changes to source code in the repo
  - Application is built from source code
  - Automatic tests (e.g., integration tests)
  - Build testing environment
  - Run acceptance tests in isolation
  - Changes are propagated to production
  - Monitor production
- **The script is a detailed documentation**
  - It explains what and how, but not why (not a design document)

Create User Account

- Do not to use AWS root account for all development
- Create a new user
  - IAM = Identity and Access Management
- Access key ID + secret access key
- Access control
  - Enable programmatic access
  - Enable console access
  - Limit what an user can do through policies



AWS Command Line Interface (CLI)

- Provide unified interface to all AWS services
- Output is in JSON format > **apt-get install awscli**
- Authenticate > **aws configure**
  - AWS access key ID
    - E.g., **AKIAIRUR3YLPOSVD7ZCA**
  - AWS secret access key
    - E.g., **SSKIng7jkA...enqBj7**
  - Default region name
    - E.g., **us-east-1**
- Execute command > **aws <service> <action> –key value**

Software Development Kit (SDK)

- SDK is a library that calls into AWS API from your favorite programming language
  - E.g., Python, Go, Ruby, C++, JavaScript
- **Pros:** it handles
  - Authentication
  - Retry on error
  - HTTPS communication
  - XML / JSON de-/serialization
- **Cons**
  - Imperative approach
  - Need to deal with dependencies

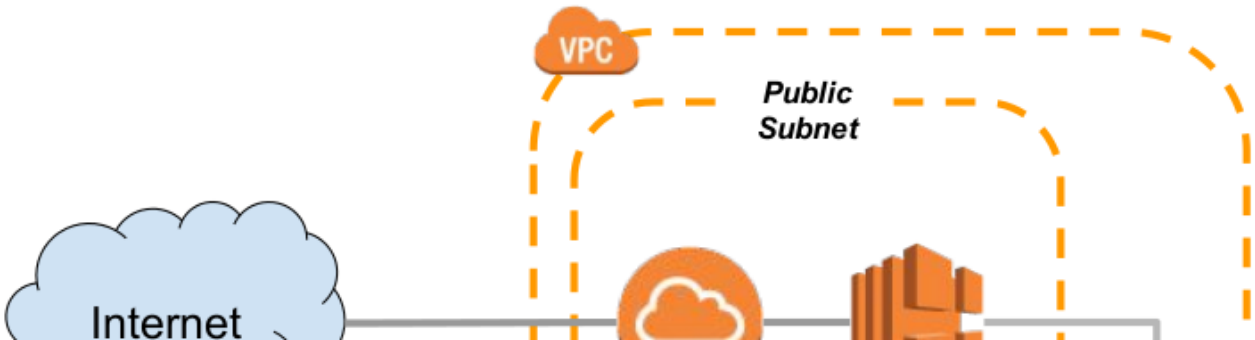
```python
import boto3

# Get the service resource.
dynamodb = boto3.resource('dynamodb')

# Create the DynamoDB table.
table = dynamodb.create_table(
    TableName='users',
    KeySchema=[
        {
            'AttributeName': 'username',
            'KeyType': 'HASH'
        },
        {
            'AttributeName': 'last_name',
            'KeyType': 'RANGE'
```

AWS CloudFormation

- **Use templates (e.g., JSON, YAML) to describe infrastructure**
- **Declarative vs imperative approach**
  - Declare the system, rather than listing the steps to build the system
- **AWS Stacks processes CloudFormation templates**
- **Pros**
  - Consistent way to describe the infrastructure
    - People implement same thing in a different way
  - Handle dependencies
  - Customizable
    - Inject custom parameters to customize templates
  - Testable
    - Create infra from a template, test, and shut down
  - Updatable
    - If you update the template, Stacks automatically applies changes to the infrastructure
  - It serves as documentation
    - Use it as code in source control

Securing Your System

- **Always install software updates**
  - New security vulnerabilities are found and fixed every day
- **Restrict access to AWS account**
  - Multiple persons and scripts should use different AWS account
  - Principle of "least privilege": grant only permissions needed to perform a job
- **Restrict network traffic**
  - Leave open only the ports that you strictly need
    - E.g., 80 for HTTP traffic, 443 for HTTPS
  - Close everything else
  - Encrypt traffic and data
- **Create a private network**
  - Subnets that are not reachable from the Internet



AWS Shared-responsibility Principle

- AWS is responsible for:
  - Protect network through monitoring Internet access
    - E.g., prevent DDoS attacks
  - Ensuring physical security of data centers
  - Decommissioning storage devices after end of life
- You are responsible for:
  - Restrict access using IAM
  - Encrypting network traffic (e.g., HTTPS)
  - Configuring firewall for VPN
  - Encrypting data
  - Updating OS (kernel, libs) and software
- More info here