15-319 / 15-619
Cloud Computing

Recitation 4

February 04, 2020

Administrative - OH & Piazza

- **Make use of office hours**
  - Make sure that you are able to clearly describe the problem and what you have tried so far to provide the fullest context
  - Piazza Course Staff
  - Google calendar in ET
  - Google calendar in PT

- **Suggestions for using Piazza**
  - Read the Piazza Post Guidelines (@6) before asking questions
  - Read Piazza questions & answers carefully to avoid duplicates
  - Name the subject properly so that others can find your post
  - Try to ask a **public** question if possible so others can also benefit
  - Don’t ask a public question about a quiz question

Administrative - Cloud spending

- Monitor AWS expenses regularly
- Always do the cost calculation before launching services
- **Keep in mind that there is a 6-hour delay for AWS to update their logs on spending**
  - **Accurate and timely expense reports are hard**
    - **The cost logs every 6 hours may be inaccurate**
  - **An item may take days before it is reported in the logs**
  - **By the end of the billing cycle, the CSPs corrects the logs**
- Terminate your instances when not in use
- Stopped instances have EBS costs ($0.1/GB-Month)
- Make sure spot instances are tagged right after launch
- Working within the specified budget is a very important skill to learn

Important - Compromised Accounts

- **DON’T EVER EXPOSE YOUR AWS CREDENTIALS!**
  - Github
  - Bitbucket
  - Anywhere public…
- **DON’T EVER EXPOSE YOUR GCP CREDENTIALS!**
- **DON’T EVER EXPOSE YOUR Azure CREDENTIALS!**
  - ApplicationId, ApplicationKey
  - StorageAccountKey, EndpointUrl

Reflection

- Conceptual content on OLI
  - Modules 3, 4, Quiz 2
- Project theme - **Big data analytics**
  - **Inverted Index:** Implemented an inverted index with MapReduce using TDD
  - **Wiki Data Parallel Processing Analysis:** Use MapReduce to process **36GB** compressed / **128GB** uncompressed wiki data
    - MapReduce application to filter records and calculate aggregate daily pageviews
  - **Data Analytics:** Use Jupyter Notebooks and the pandas library to analyze the data and answer questions

This Week

- **Quiz 3 (OLI Modules 5 & 6)**
  - Due on **Friday**, Feb 7th, 2020, 11:59PM ET
- **Project 2.1 and Reflection**
  - Due on **Sunday**, Feb 9th, 2020, 11:59PM ET
- **Project 1.2 Discussion**
  - Due on **Sunday**, Feb 9th, 2020, 11:59PM ET
- **P1.2 Code Review**
  - Due on **Wednesday**, Feb 12th, 2020, 11:59PM ET
- **Primers released this week**
  - P2.2 - Intro to Containers and Docker
  - P2.2 - Kubernetes and Container Orchestration
  - Code Review

Code Review

- Code review is the systematic examination of source code. The goal of code review is to make sure that the code achieves its objective using a sound approach and to expose students to alternative approaches.
- We want you to develop good coding habits and skills that will be useful for your careers.
- Please read the “Code Review” primer on TheProject.Zone.
- For Project 1.2, completing code review is worth 5 points, and it will contribute toward the total grade of Project 1.2.

OLI Module 5 - Cloud Management

Cloud Software stack - enables provisioning, monitoring and metering of virtual user “resources” on top of the Cloud Service Provider’s (CSP) infrastructure.

- Cloud middleware
- Provisioning
- Metering
- Orchestration and automation
- Case Study: Openstack - Open-source cloud stack implementation

OLI Module 6 - Cloud Software Deployment Considerations

- Programming on the cloud
- Deploying applications on the cloud
  - Build fault-tolerant cloud services
  - Load balancing
  - Scaling resources
  - Dealing with tail latency
  - Economics for cloud applications

Project 2 Overview

Scaling and Elasticity with

- VMs
- Containers
- Functions

- **2.1 Scaling Virtual Machines**
  - Horizontal scaling in / out using AWS APIs
  - Load balancing, failure detection, and cost management on AWS
  - Infrastructure as Code (Terraform)
- **2.2 Scaling with Containers**
  - Building your own container-based microservices
  - Docker containers
  - Manage multiple Kubernetes Cluster
  - Multi Cloud deployments
- **2.3 Functions as a Service**
  - Develop event driven cloud functions
  - Deploy multiple functions to build a video processing pipeline

Project 2.1 Learning Objectives

- **Design** solutions and invoke cloud APIs to programmatically provision and deprovision cloud resources for a dynamic load.
- **Configure** and deploy an Elastic Load Balancer and an Auto Scaling Group on AWS.
- **Develop** solutions that monitor cloud resource metrics to manage cloud resources with the ability to deal with resource failure.
- **Analyze** a workload pattern and develop elasticity policies to maintain the Quality of Service (QoS) of a web service.
- **Account** for cost as a constraint when provisioning cloud resources and analyze the performance tradeoffs due to budget restrictions.
- **Orchestrate** infrastructure on the cloud using Terraform as part of the deployment process.

Overview of Quality of Service (QoS), Latency and Cloud Elasticity

- Quality of Service (QoS)
- Load patterns for web services
- Vertical scaling (Scale up/down)
- Horizontal scaling (Scale out/in)
- Load balancers
- Autoscaling groups
- Resource monitoring (CloudWatch)

Quality of Service (QoS)

Quantitatively Measure QoS

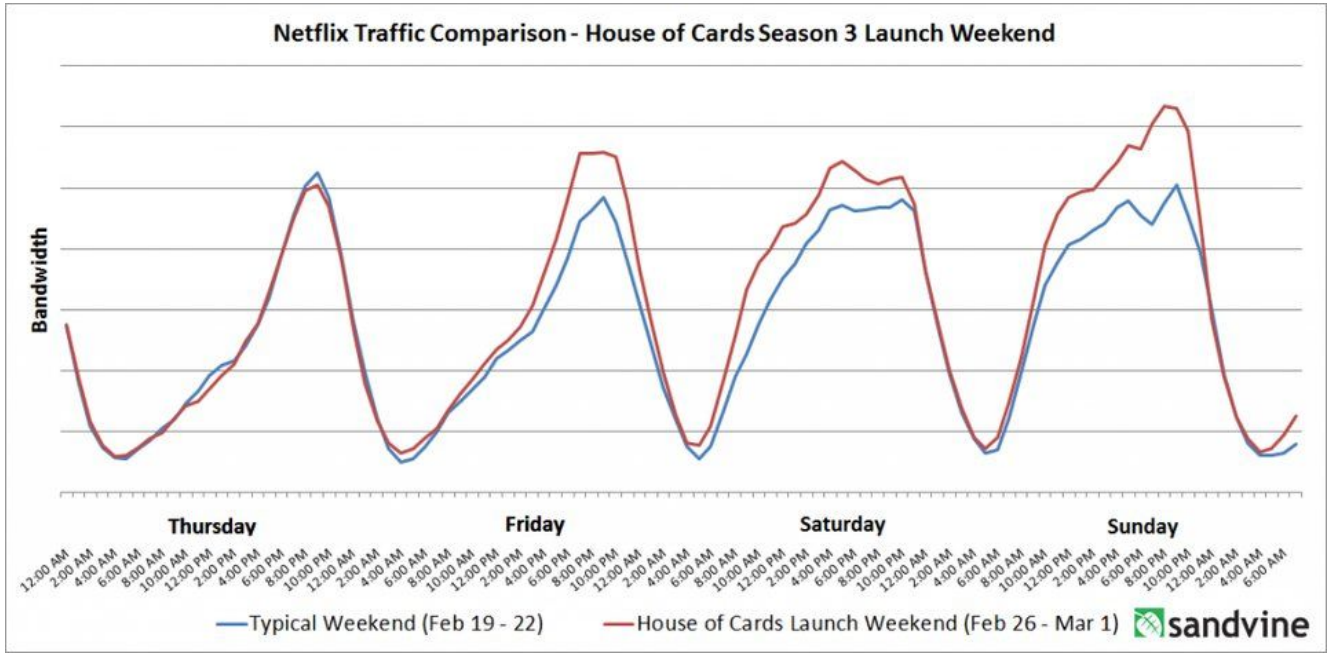
- Performance: Throughput, Latency
  (Very helpful in Project 2 & Team Project)
- Availability: the probability that a system is operational at a given time *(Project 2)*
- Reliability: the probability that a system will produce a correct output up to a given time *(Project 2)*

QoS Matters:

- Amazon found every 100ms of latency cost them 1% in sales (~$1B).

Reality, human patterns...

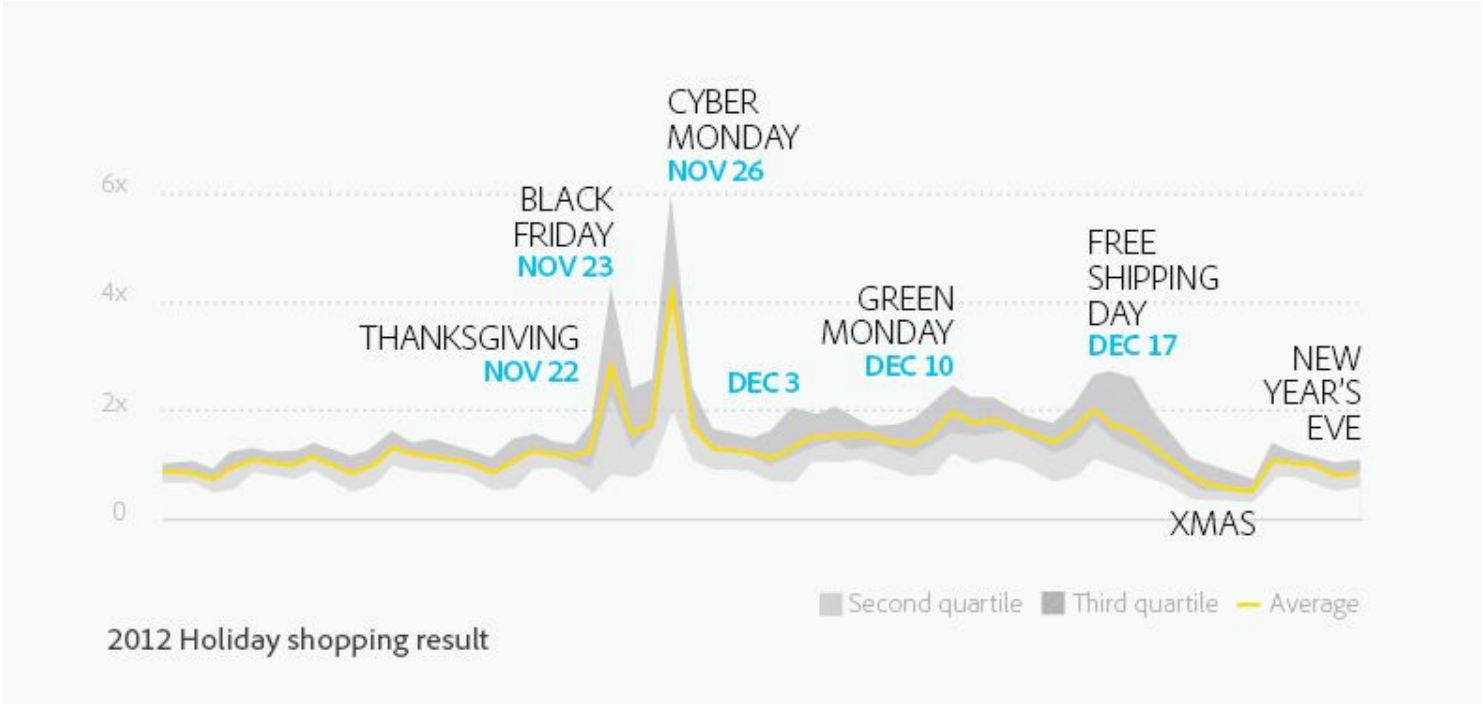
- **Daily**
- **Weekly**
- Monthly
- Yearly
- ...



The Ferenstein Wire

Reality, human patterns...

- Daily
- Weekly
- Monthly
- **Yearly**
- ...

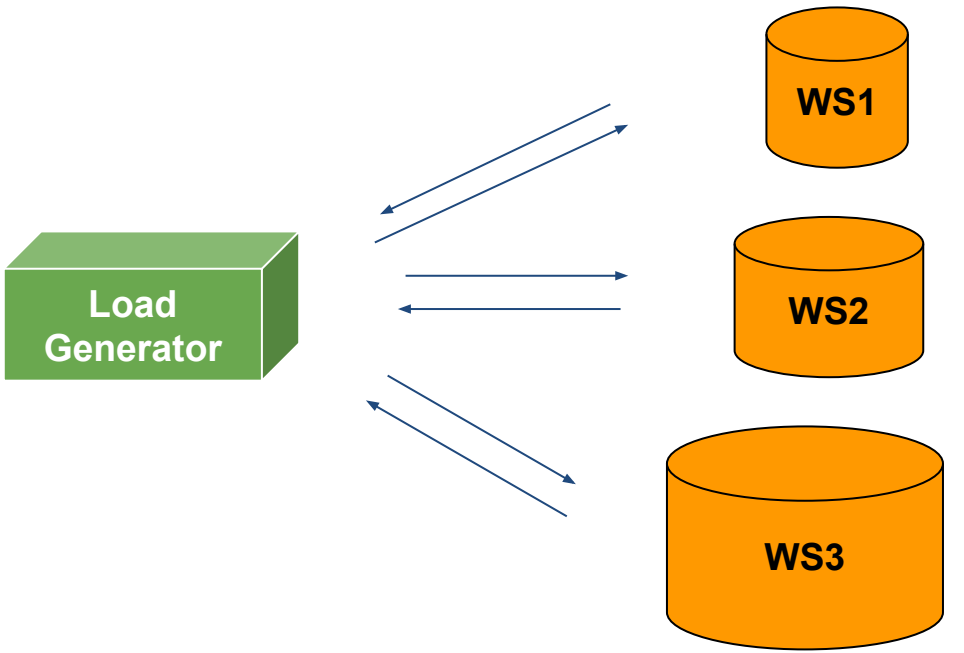


sapient.com

Cloud Comes to the Rescue!

Scaling!

P0: Vertical Scaling



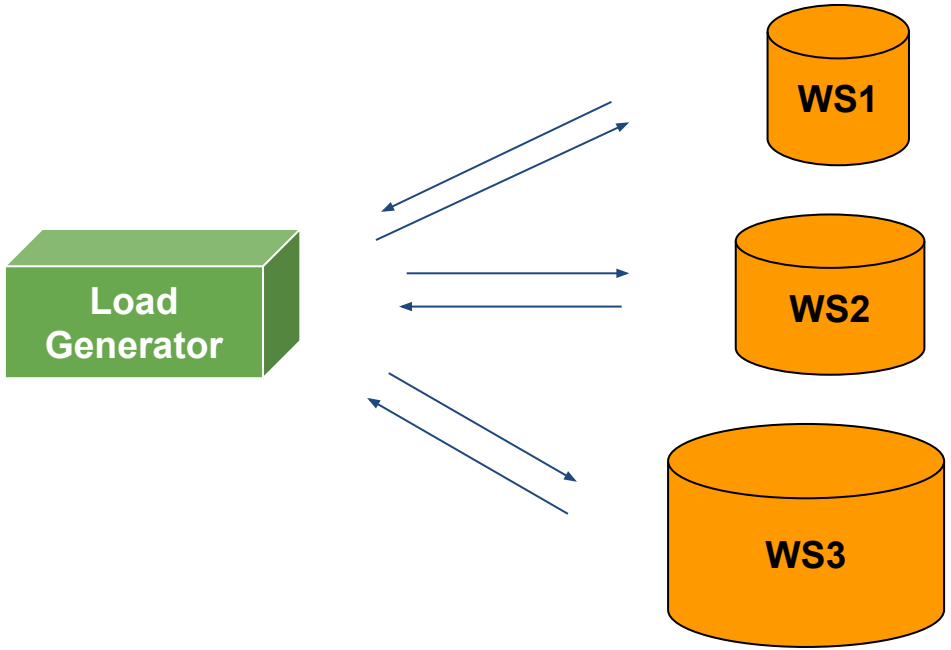
Small Data Center Instance
Serves 100 requests per second

Medium Data Center Instance
Serves 1000 requests per second

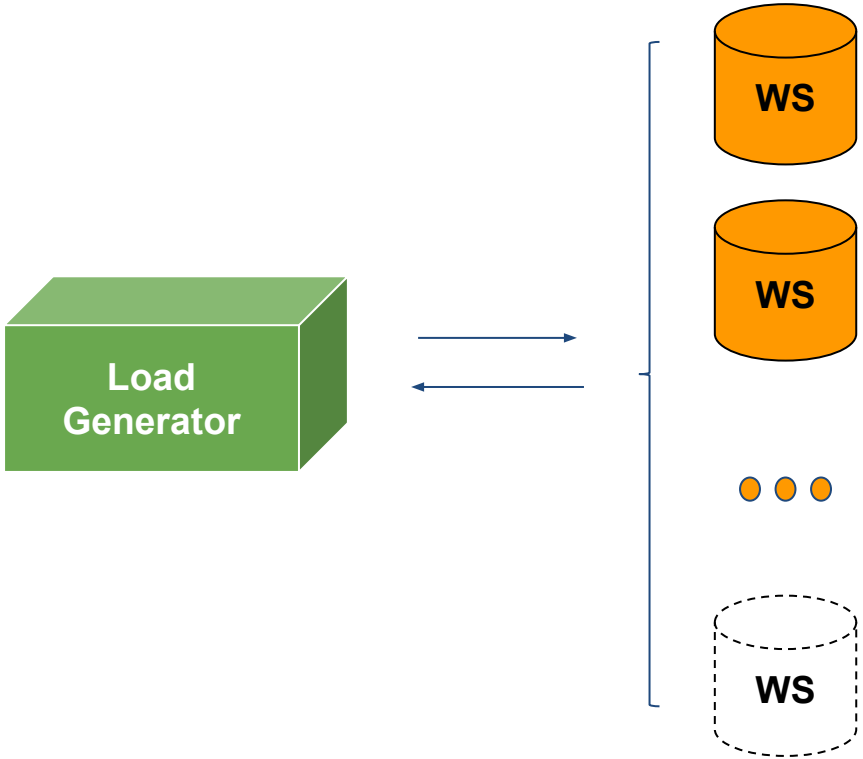
Large Data Center Instance
Serves 10000 requests per second

P0: Vertical Scaling Limitation

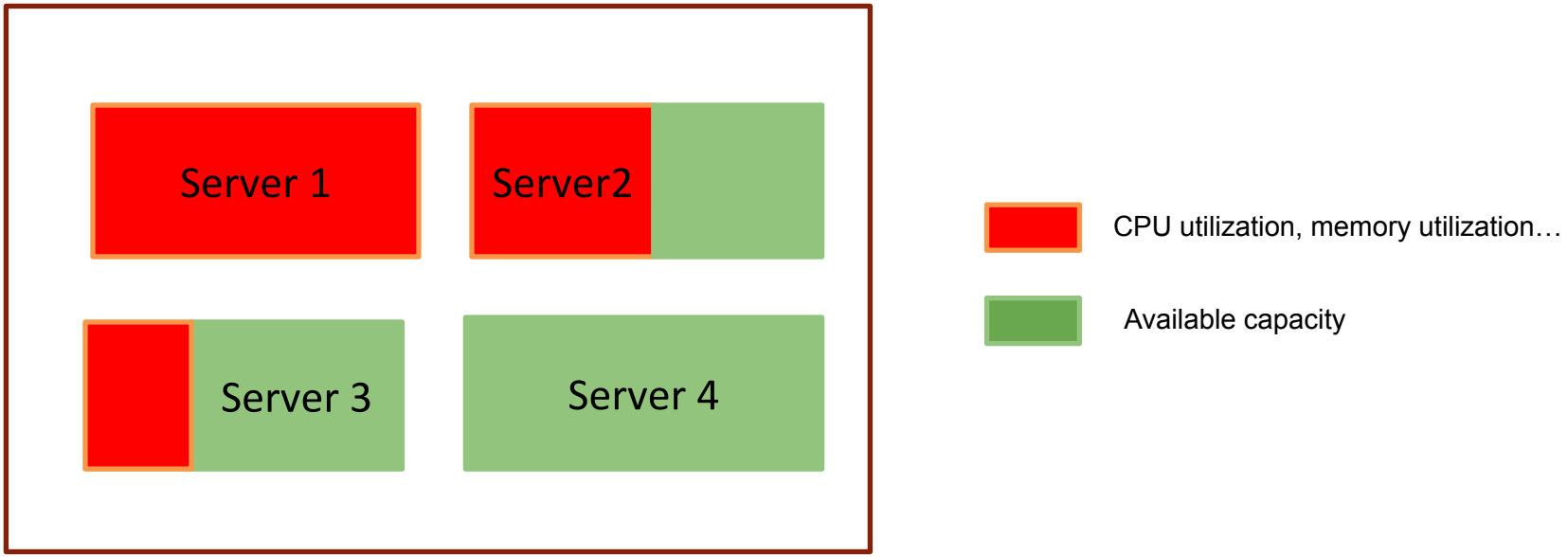
- However, one instance will always have limited resources.
- Reboot/Downtime.



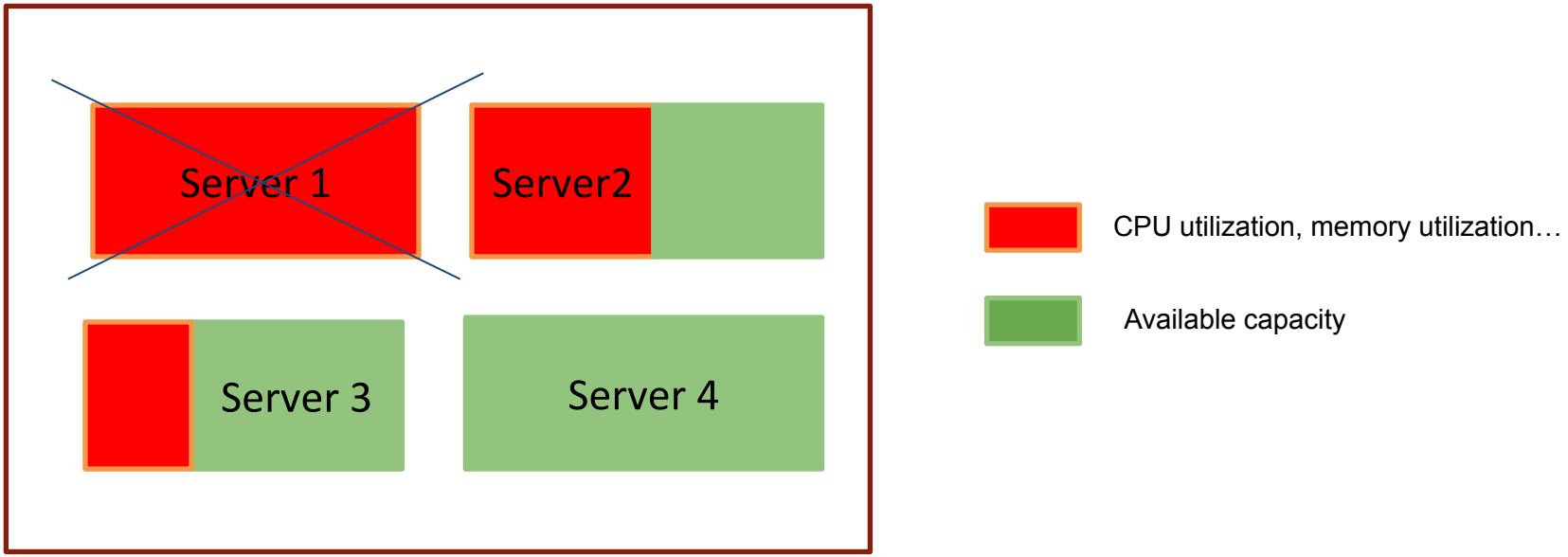
Horizontal Scaling



How do we distribute load?



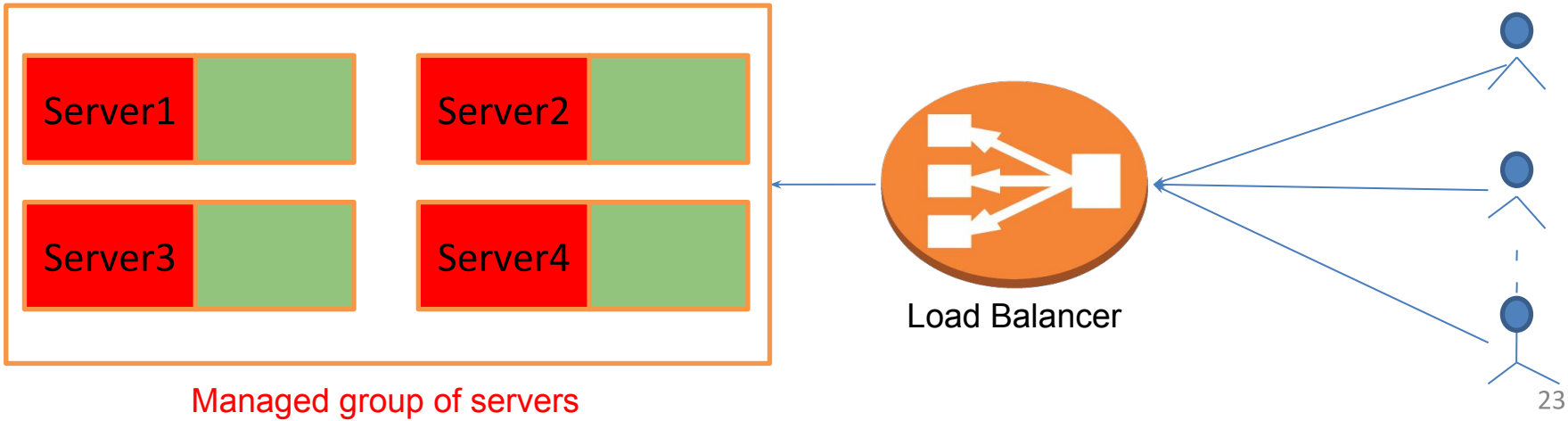
Instance Failure?



What You Need

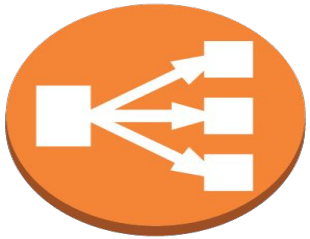
- Make sure that the workload is even on each server
- Do not assign a load to servers that are down
- Increase/Remove servers according to a changing load

How does a cloud service help solve these problems?



Load balancer

- “Evenly” distribute the load
- A simple distribution strategy
  - Round Robin
- Load check
- Health check



Load Balancer

- What if the Load Balancer becomes the bottleneck?
  - Elastic Load Balancer (ELB)
    - Could scale up based on load
  - Elastic, but it still takes time
    - Through the warm-up process

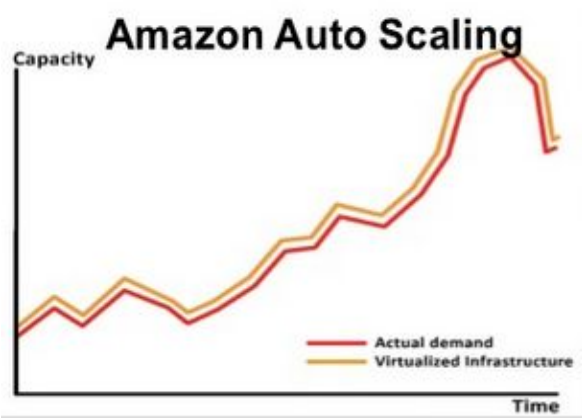
Scaling

Manual Scaling:

- Over provisioning and low utilization
- Expensive on manpower
- Lose customers

Autoscaling:

- Automatically adjust the size based on demand
- Flexible capacity and scaling sets
- Save cost



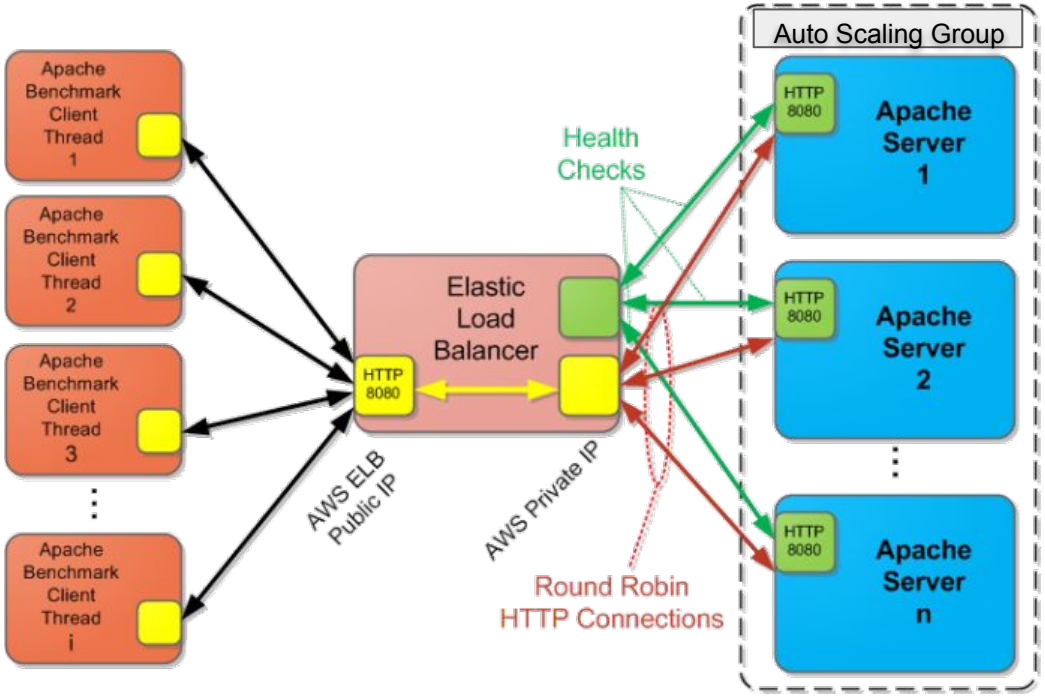
AWS Autoscaling

Auto Scaling on AWS

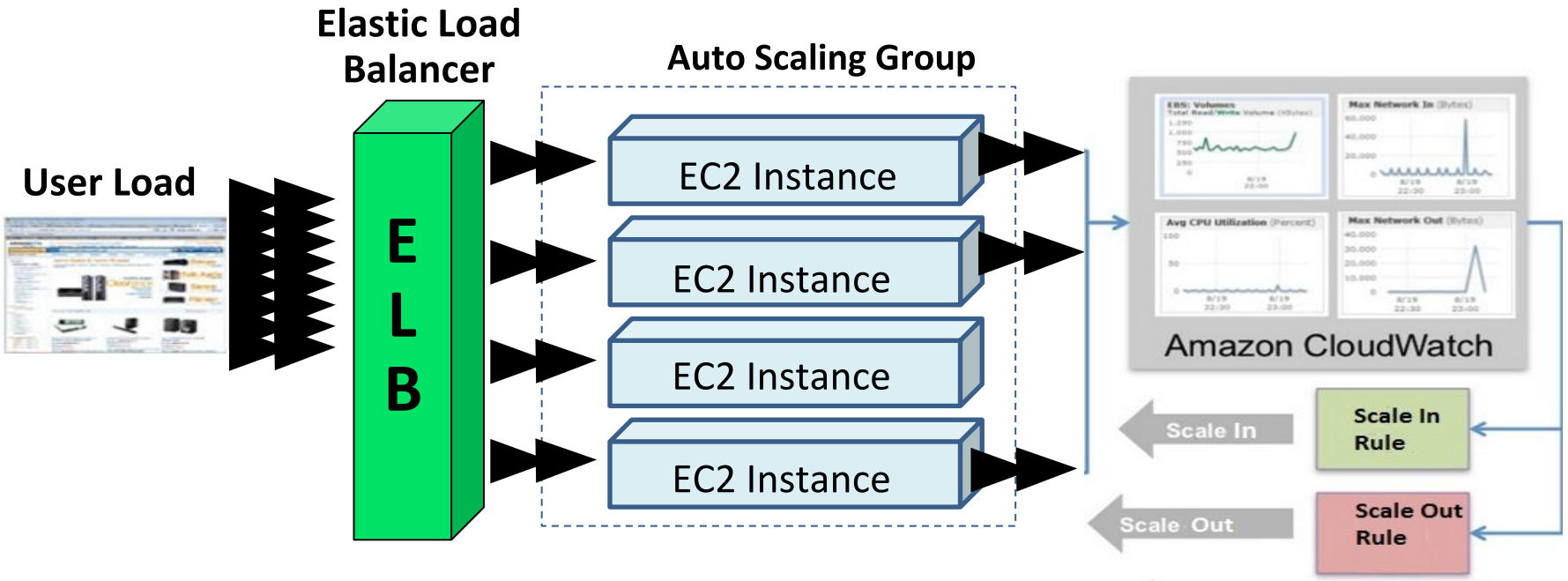
Using the AWS APIs:

- **ELB**
- **Auto Scaling Group**
- **EC2**
- **CloudWatch**
- **Auto Scaling Policy**

You can build a load balanced auto-scaled web service.

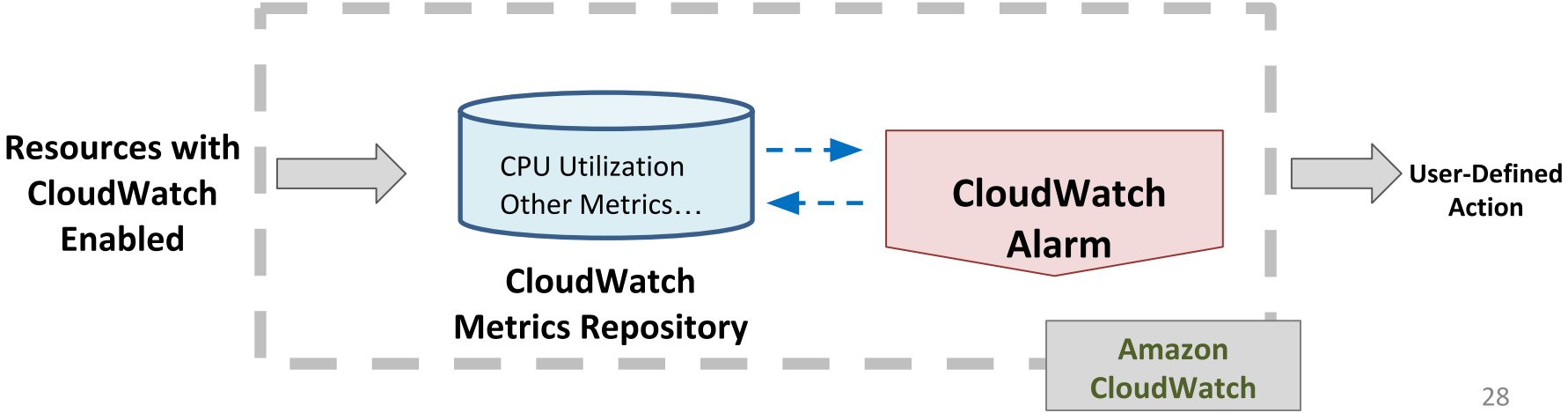


Amazon Auto Scaling Group



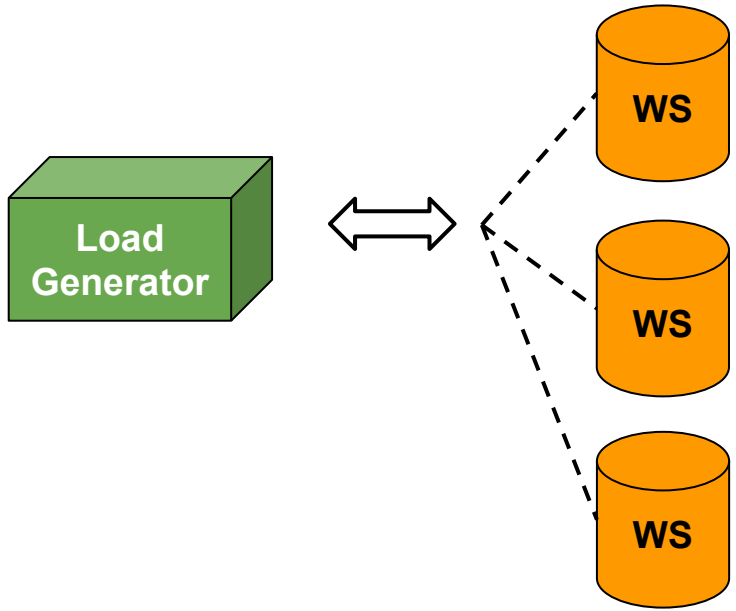
Amazon CloudWatch Alarm

- Monitor CloudWatch metrics for some specified alarm conditions
- Take automated action when the condition is met



Project 2.1 Scaling on AWS

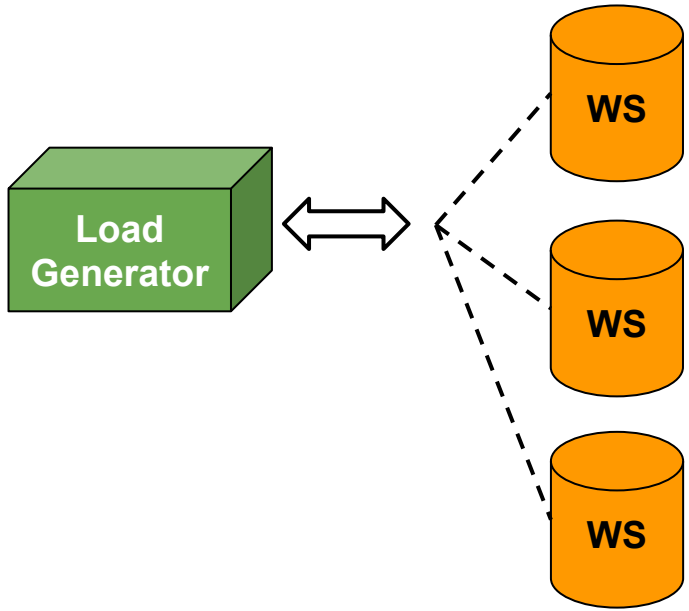
- **Task 1**
  - **AWS Horizontal Scaling**
- Task 2
  - AWS Auto Scaling
- Task 3
  - AWS Auto Scaling with Terraform



Project 2.1 Scaling on AWS

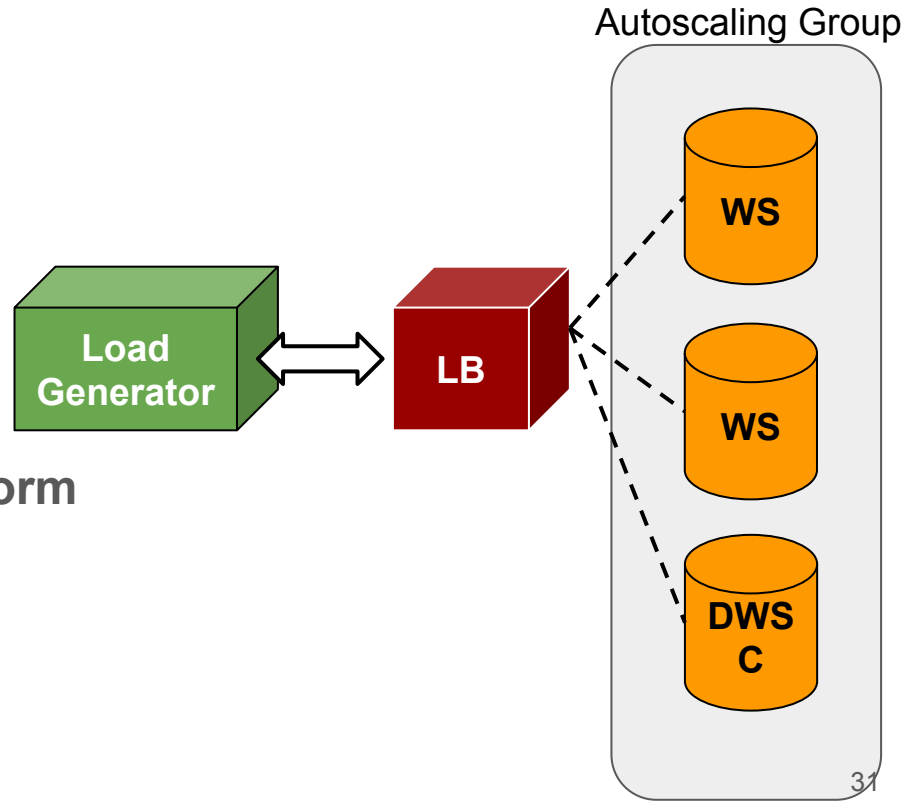
Task 1 - AWS Horizontal Scaling:

- Implement Horizontal Scaling in AWS.
- Write a program that launches the web service instances and ensures that the target total RPS is reached.
- Your program should be fully automated: launch LG → submit password → Launch WS → start test → check log → add more WS...



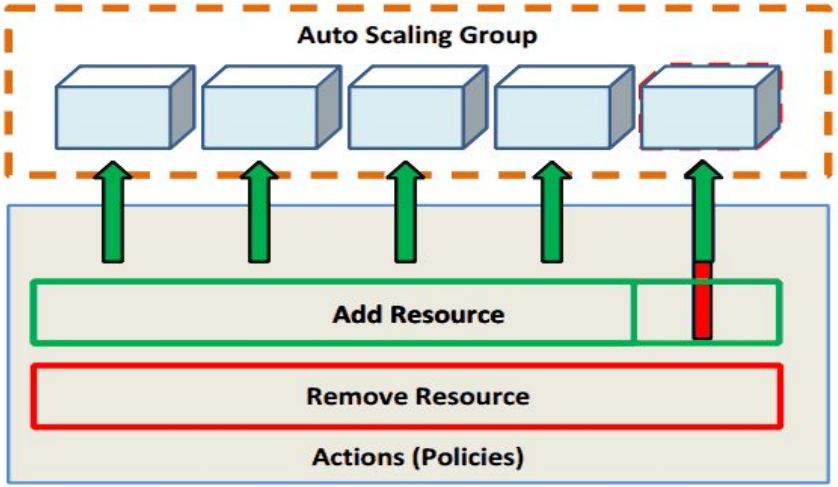
Project 2.1 Scaling on AWS

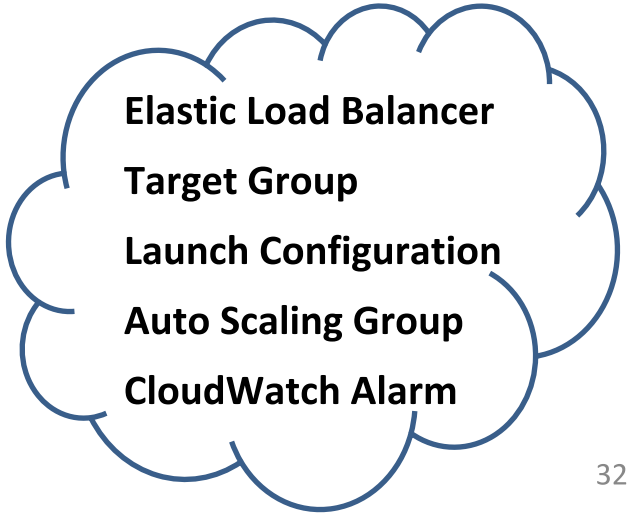
- Task 1
  - AWS Horizontal Scaling
- Task 2
  - AWS Auto Scaling
- Task 3
  - AWS Auto Scaling with Terraform



P2.1 - Task 2

- Programmatically create two securities groups, LG, Application Load Balancer (ALB), Auto-Scaling Group (ASG) along with Auto Scaling Policy, launch configuration, and target group.
- Adjust Scale-Out and Scale-In policies if necessary
- Your solution also needs to be fault tolerant
- Health configurations are important





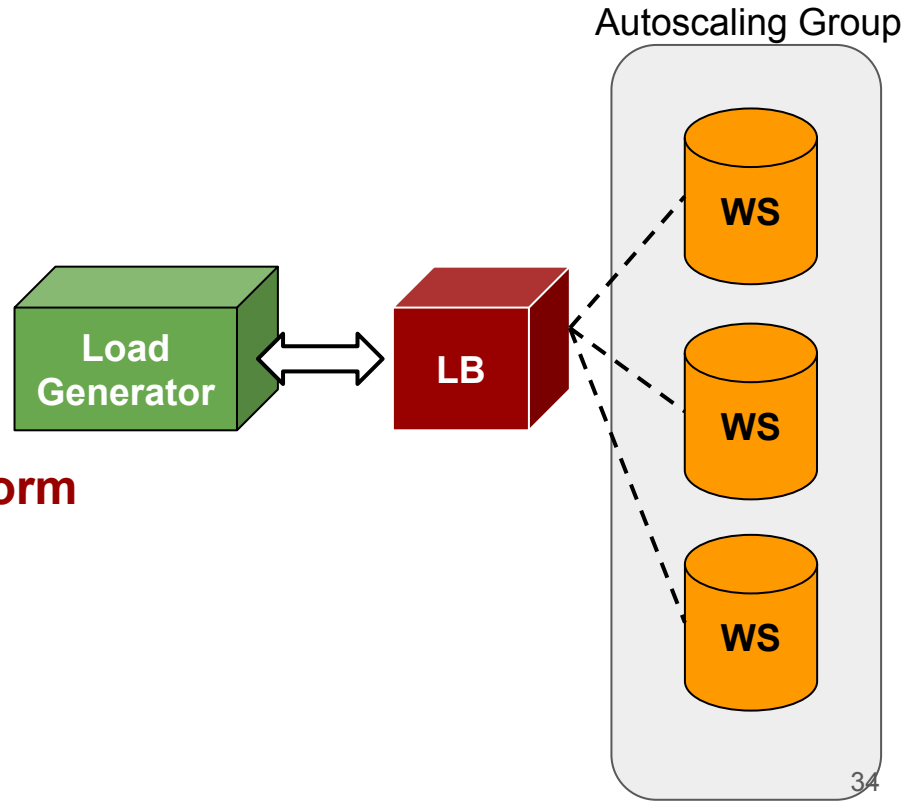
Hints for Project 2.1 AWS Autoscaling

Task 2 - AWS Auto Scaling

- Do a dry run via the console to make sure you understand the workflow completely before you implement the workflow programmatically.
- The Autoscaling test could be very expensive!
  - On-demand, charged by per second, do not blindly launch tests
- CloudWatch monitoring is helpful for policy tuning.
- Observe and analyze the pattern, experiment with a policy, collect data to verify why it achieved a certain performance, and iterate until you achieve your goal.
- Explore ways to check if your instance is ready.
- **You will need spend a lot of time understand the API documents.**

Project 2.1 Scaling on AWS

- Task 1
  - AWS Horizontal Scaling
- Task 2
  - AWS Auto Scaling
- **Task 3**
  - **AWS Auto Scaling with Terraform**



Project 2.1 Scaling on AWS

Task 3 - AWS Auto Scaling with Terraform:

- Read the Infrastructure as Code primer to learn about infrastructure automation
- Make sure that **`terraform plan`** generates the expected resource
- Make sure that all the variables (AMI ID, CloudWatch thresholds, Security Group names, etc.) are manually specified in the terraform main file

Project 2.1 Code Submission

- At the end of each task, you need to submit your code for that task to TheProject.Zone.
- We will grade your code for each task **separately**.
- You will execute the the submitter corresponding to each task in their respective folders.

Penalties for Project 2.1

Violation	Penalty of the project grade
Spending more than $20 for this project phase on AWS	-10%
Spending more than $40 for this project phase on AWS	-100%
Failing to tag all your resources in either parts (EC2 instances, ELB, ASG) for this project with the tag: key=Project, value=2.1	-10%
Submitting your AWS/Andrew credentials in your code for grading	-100%
Using instances other than t3.micro (testing only) or m5.large for Horizontal scaling on AWS	-100%
Using instances other than t3.micro (testing only), m5.large for Autoscaling on AWS	-100%
Submitting executables (.jar, .pyc, etc.) instead of human-readable code (.py,.java, .sh, etc.)	-100%

Penalties for Project 2.1 cont.

Violation	Penalty of the project grade
Attempting to hack/tamper the autograder in any way	-200%
Cheating, plagiarism or unauthorized assistance (please refer to the university policy on academic integrity and our syllabus)	-200%

AWS Cloud APIs

- AWS CLI (link)
- AWS Java SDK (link)
- AWS Python SDK (link)

This Week

- **Quiz 3 (OLI Modules 5 & 6)**
  - Due on **Friday**, Feb 7th, 2020, 11:59PM ET
- **Project 2.1 and Reflection**
  - Due on **Sunday**, Feb 9th, 2020, 11:59PM ET
- **Project 1.2 Discussion**
  - Due on **Sunday**, Feb 9th, 2020, 11:59PM ET
- **P1.2 Code Review**
  - Due on **Wednesday**, Feb 12th, 2020, 11:59PM ET
- **Primers released this week**
  - P2.2 - Intro to Containers and Docker
  - P2.2 - Kubernetes and Container Orchestration
  - Code Review

Questions?