

# Cloud Computing Introduction / Motivation

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CIS437

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*Adapted from Google Cloud Computing Foundations, Overview of Cloud Computing (Wufka & Canonico)*

# Overview

- Welcome!
- Syllabus
- Cloud things

But first, let's play a "read and repeat" game!

*I WILL NOT*

*USE MY CREDIT CARD*

*ON ANY CLOUD SERVICE*

But first, let's play a "read and repeat" game!

*EVEN IF THEY ASK NICELY*

*SO I CAN START A FREE TRIAL*



# What we ***will*** cover

## Wide variety of cloud technologies

- Mostly focused on Google Cloud, but we'll take a look at AWS
  - Azure doesn't give out free education credits and I don't want you to burn your free trials
  - Fortunately, all skills are transferable between cloud environments
- All different points of the cloud stack

# What do you want to cover?



# Knowledge you are **assumed** to have

Ability to program in **some language**

- You will be working on a real project!

Ability to work **individually** and on **teams**

- You're an adult, I also expect maturity and even effort-sharing where necessary

Ability to **talk to me if you have problems**

- Don't be nervous, I am very approachable!

# How class will *generally* work

Our classes are 2 - 1 hr 15min sessions per week

- Classes will be a mix of:
  - Lecture
  - Discussions
  - Labwork
    - Guided/self-guided work

Subject to change based on material, naturally

- But, I want you to get **practical experience**

# PROJECTS

# You will develop a half-semester-long project

Goals of this project:

- 1) Have something portfolio-worthy at the end
- 2) Develop it like a real-world project
  - a) Proposal, updates, presentation, etc.
- 3) More detail around midterm - start thinking of something *now* you'd like to "cloudify"

# Project?

I want you to create something that is **interesting to you**

Are you a software developer with latent tendencies for video game design?

- Make a *cloud-hosted* video game!

Aspiring app developer?

- Make that app (...using cloud technologies)!

Sysadmin?

- Manage a load-balanced server application of some sort!

No clue!?!?

- Let's talk

**It will need to contain a  
handful of cloud services  
though, not just one!**

# Research!

Also, I do research! Sometimes in the cloud!

- Research being exploring something new or interesting and writing academic papers on it

If you are interested, please reach out to me via email/Discord and we can chat

- It would involve a longer term project with the possibility of a publication on your resume/CV
- And probably extra credit since it would be more involved

# Our tech stack

Class is **synchronous in-person**, meaning:

- 1) Class runs at specific days/times
- 2) Office hours are in-person (can be online) as well

**Class website:** Blackboard // <https://efredericks.github.io/gvsu-cis437/>

**Async Chat:** Discord

If you want to get a hold of me for questions:

- Ping me in Discord
- Email me
- Visit office hours (virtual or in-person (generally))

# Syllabus

As always, the syllabus is **worth reading**

Important topics like:

- When is my final exam?
- What is the grading breakdown?
- What time does this class meet?
- Where can I find the nifty textbook?



# Questions so far?



[burgerty:](#)

Tina asking the important questions

Source: burgerty

So...

**What cloud technologies are you familiar with?**

And so...

What do **you** think of when you hear cloud computing?

# FULL DISCLOSURE

99% of my demos will most likely be with Google Cloud

- They have a *really good* education program
  - (Very easy to get credits for teaching others)

AWS is ... OK

Azure is ... non-existent for education

—

But, all skills are 100% transferable (concepts same, syntax different)

[VMs]	Google Cloud Compute Engine (VMs)	== AWS Compute
[Serverless]	Google Cloud Cloud Functions	== AWS Lambda Functions
...etc.		



Virtual Servers

Platform-as-a-Service

Serverless Computing

Docker Management

Kubernetes Management

Object Storage

Archive Storage

File Storage

Global Content Delivery

Managed Data Warehouse

Instances

Elastic Beanstalk

Lambda

ECS

EKS

S3

Glacier

EFS

CloudFront

Redshift

VM Instances

App Engine

Cloud Functions

Container Engine

Kubernetes Engine

Cloud Storage

Coldline

ZFS / Avere

Cloud CDN

Big Query

VMs

Cloud Services

Azure Functions

Container Service

Kubernetes Service

Block Blob

Archive Storage

Azure Files

Delivery Network

SQL Warehouse

# So what *is* cloud computing

Cloud computing has five fundamental characteristics



## On-demand self-service

No human intervention needed to get resources

## Broad network access

Access from anywhere

## Resource pooling

Provider shares resources to consumers

## Rapid elasticity

Get more resources quickly as needed

## Measured service

Pay only for what you consume

and...

SIX

Cloud computing has ~~five~~ fundamental characteristics



On-demand self-service

No human intervention needed to get resources



Broad network access

Access from anywhere



Resource pooling

Provider shares resources to consumers



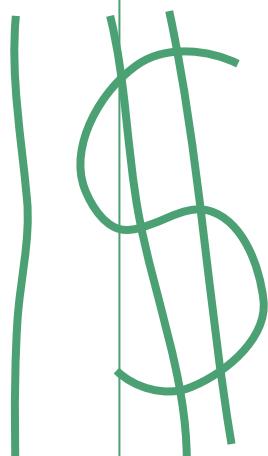
Rapid elasticity

Get more resources quickly as needed



Measured service

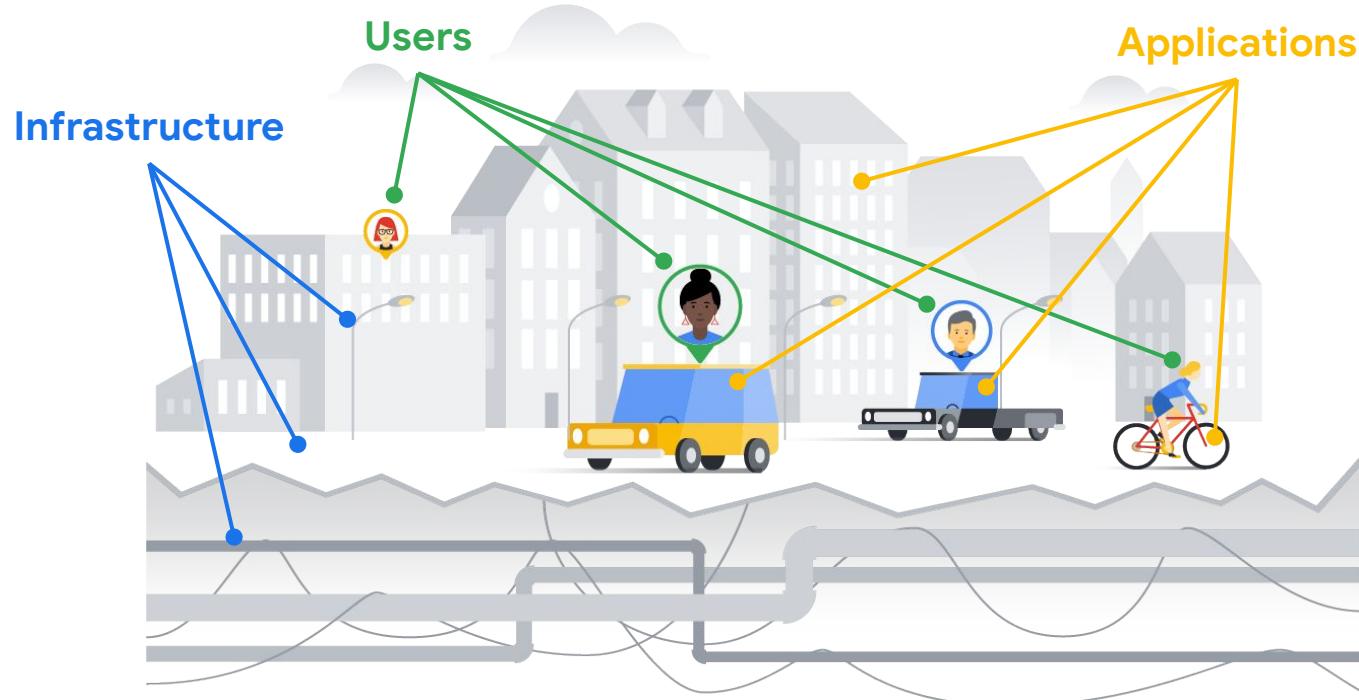
Pay only for what you consume



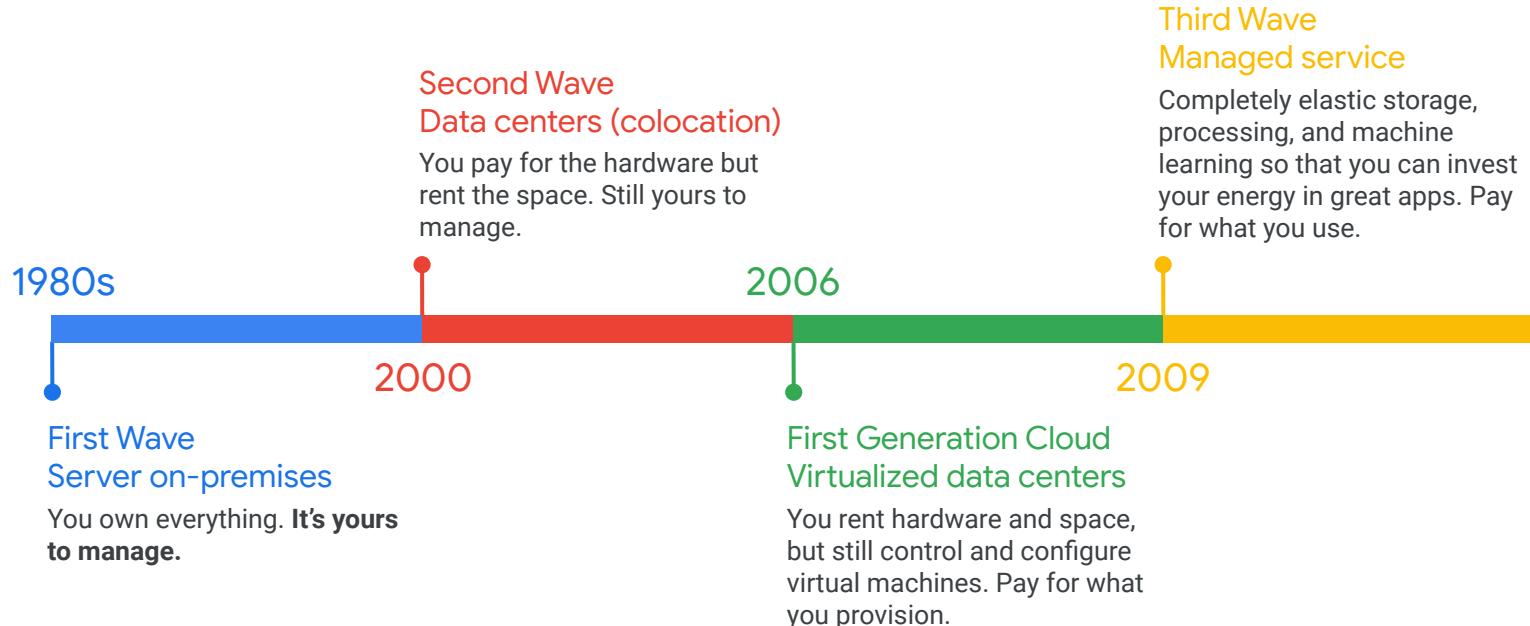
Unexpected costs



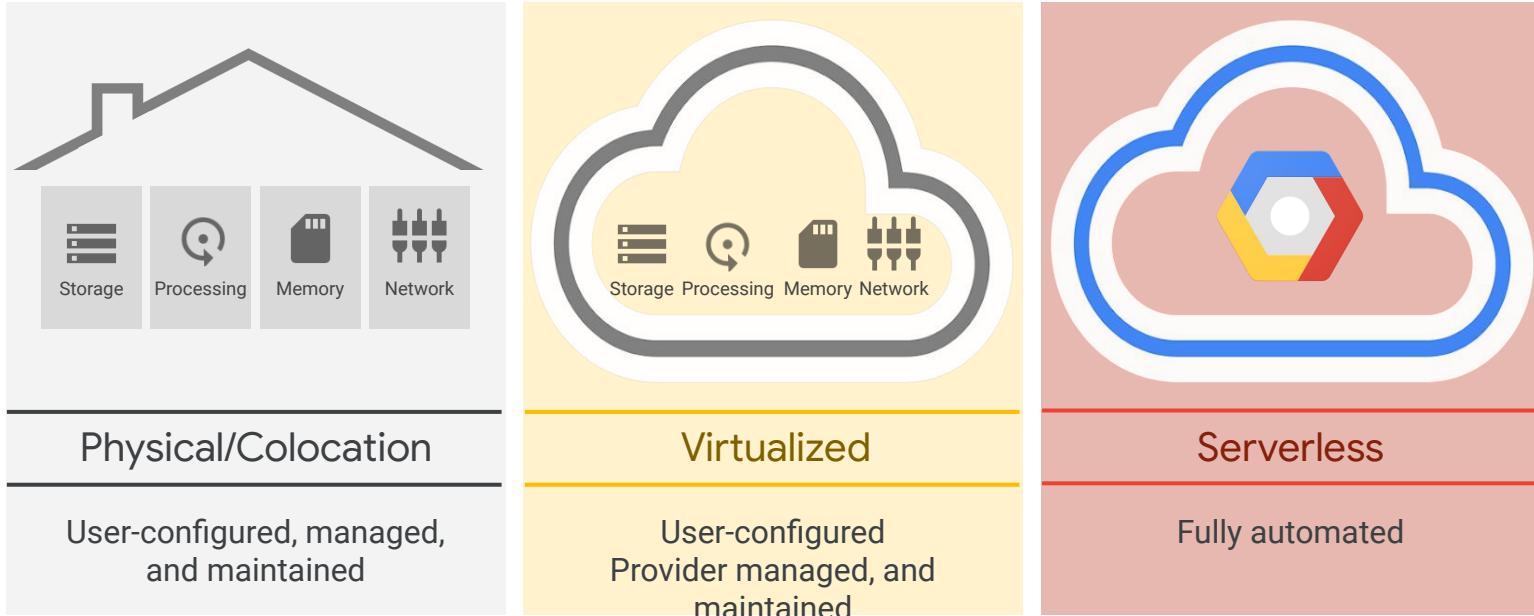
# An IT infrastructure is like a "city infrastructure"



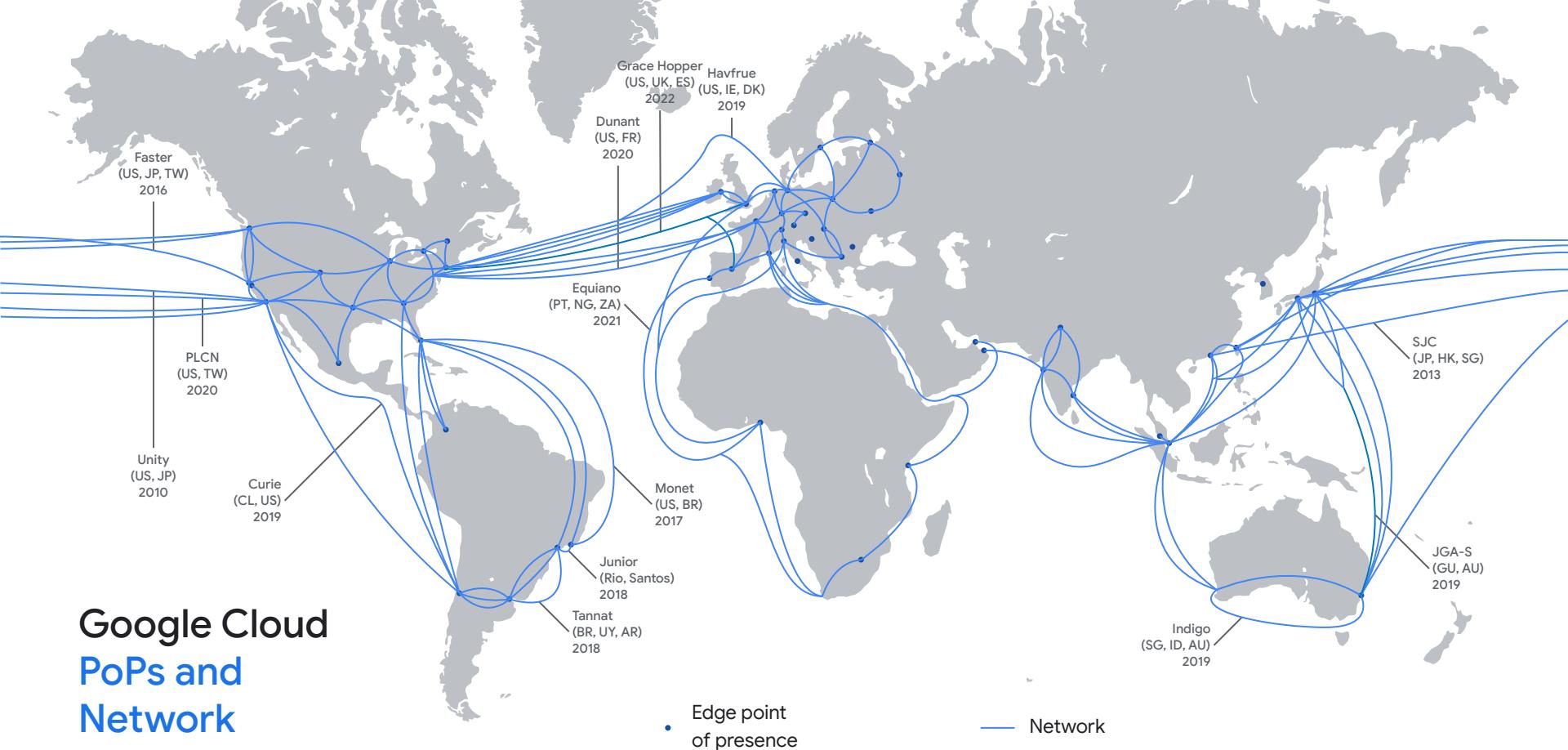
# Cloud computing is a continuation of a long-term shift in how computing resources are managed



# The cloud has seen a similar progression



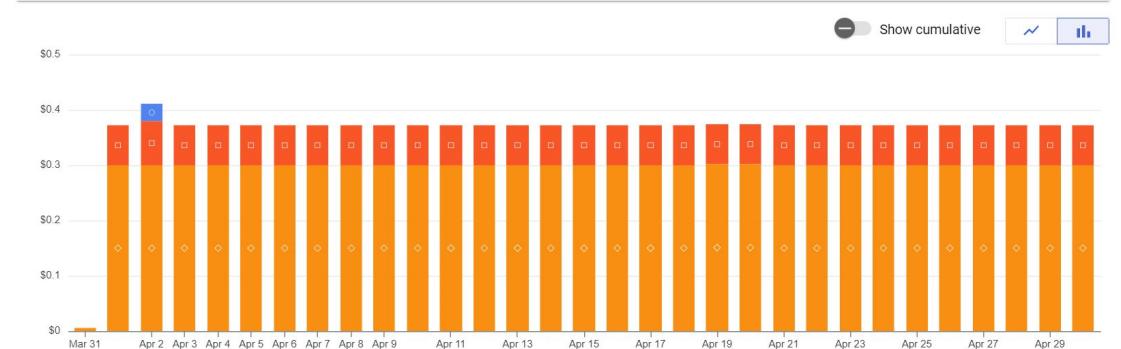
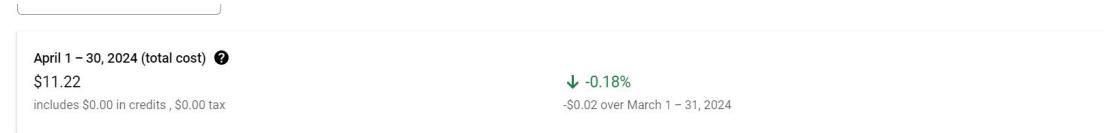
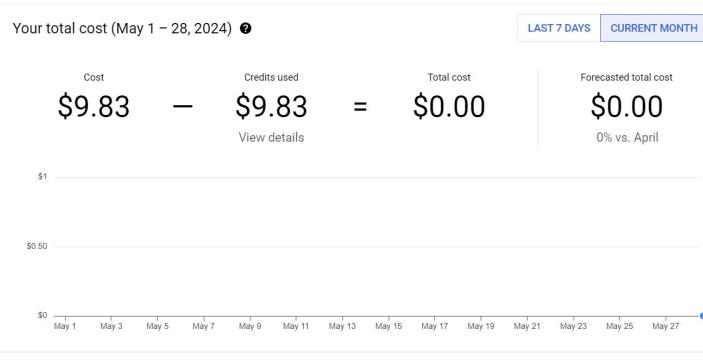
# Google Cloud PoPs and Network



But first...



# ALWAYS CHECK YOUR BILLING STATEMENT



I didn't even realize I had charges...

# \$\$ for this class

Everything in this class is **free to you**

- Do **not** put your credit card into ANY service
  - That is a great way to find auto-charges in a year when you forgot to shut things off
- If you run out of credits **ask me for more**
  - I get them for free through Google

# If it is on, it is costing you money

Any time *anything* is active in the cloud, you are being charged for it

- Virtual machine exists but off?
  - Charge for the hard drive storage
- Serverless function active?
  - Charge for the build/deploy activities
  - Charge for any invocations
- Look at the cloud funny?
  - Probably a charge for that too

# Intention is to **scare** you into paying attention

Unless if otherwise specified, **turn things off when you're done**

You do not want to be out of credits the night a homework assignment is due

- Note: I typically don't respond to emails the evenings that assignments are due, **start early**

I can get you more credits if you let me know **ahead of time**

- Sometimes a credits request can take more time than expected

# Cost reduction suggestions

1. Shut down all virtual machines when not in use
2. Set up access rights for all services
3. Do not publish any keys, API information, passwords, etc. to any form of version control
4. Set quotas for all users

The screenshot shows the Google Cloud Platform Compute Engine interface for creating a new instance. The 'Name' field is set to 'instance-1'. A red box highlights the 'Monthly estimate' section, which shows '\$24.86 monthly estimate' and 'That's about \$0.034 hourly'. Below this, it says 'Pay for what you use: No upfront costs and per second billing'. The 'Region' is set to 'us-central1 (Iowa)' and the 'Zone' is 'us-central1-a'. Under 'Machine configuration', the 'Machine family' is 'General-purpose' (selected), and the 'Series' is 'E2'. The 'Machine type' is 'e2-medium (2 vCPU, 4 GB memory)'. At the bottom, there is a link 'CPU platform and GPU'.

Name ⓘ  
Name is permanent  
instance-1

Labels ⓘ (Optional)  
+ Add label

Region ⓘ Region is permanent  
us-central1 (Iowa)

Zone ⓘ Zone is permanent  
us-central1-a

Machine configuration

Machine family  
General-purpose Compute-optimized Memory-optimized GPU

Machine types for common workloads, optimized for cost and flexibility

Series  
E2

CPU platform selection based on availability

Machine type  
e2-medium (2 vCPU, 4 GB memory)

vCPU  
1 shared core

Memory  
4 GB

GPUs  
-

\$24.86 monthly estimate  
That's about \$0.034 hourly  
Pay for what you use: No upfront costs and per second billing

▼ Details

▼ CPU platform and GPU

# How billing works



Billing account pays for project resources.



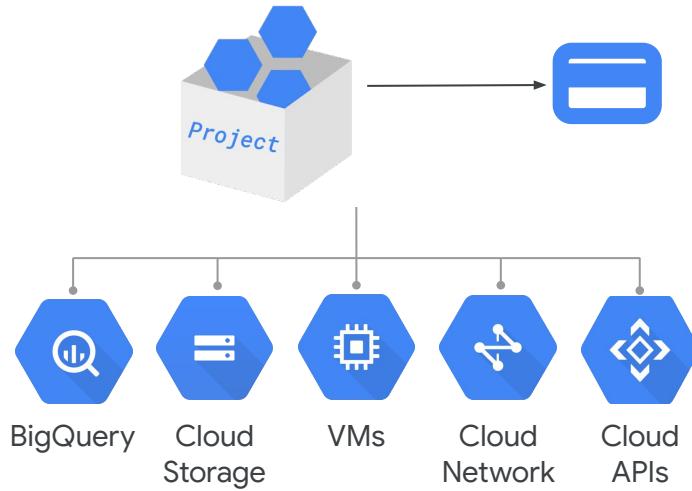
A billing account is linked to zero or more projects.



Accounts are charged automatically, invoiced monthly, or invoiced at the threshold limit.



Sub accounts can be used for separate billing for projects.



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# How to keep your billing under control

- 1 Budgets and alerts
- 2 Billing export
- 3 Reports
- 4 Quotas

# Budgets and alerts keep your billing under control

The screenshot shows the Google Cloud Platform Billing interface. The top navigation bar includes the Google Cloud logo, a menu icon, the text "Google Cloud Platform", a "Project" dropdown, and several icons for search, notifications, and user account.

The main content area has a left sidebar with the following options:

- Billing** (selected)
- Overview**
- Budgets & alerts** (selected)
- Transactions
- Billing export
- Payment settings

The main panel title is "Budgets & alerts" and it specifies "Corporate Billing Account". It includes a "CREATE BUDGET" button and a "DELETE" button. A descriptive text explains that budgets track expenses within a project or billing account and can be based on previous spend, with alerts for exceeding specified amounts.

A table lists existing budgets:

Budget name	Budget type	Applies to	Trigger alerts at	Spend and budget amount
Trial budget 1	Specified amount	This billing account	50%, 90%, and 100%	<div style="width: 80%; background-color: orange;"></div> \$86.34 / \$75.00

# Billing export allows you to store detailed billing information

The screenshot shows the 'Billing export' settings page in the Google Cloud console. A green arrow points from the 'BigQuery' icon at the top left to the 'BigQuery export' tab in the navigation bar. Another green arrow points from the 'Cloud Storage' icon at the top right to the 'File export' tab in the navigation bar. The 'BigQuery export' tab is selected, indicated by a blue underline.

**BigQuery**

**Cloud Storage**

**Billing export**      BTS-Billing ▾

**BigQuery export**      File export

BigQuery export sends your billing data to a BigQuery dataset  
[BigQuery ↗](#)

**Project** ?  
orbitera-dm-test

**Billing export dataset** ?  
orbitera\_dm\_test

**Update BigQuery export settings**

**Billing**

**Overview**

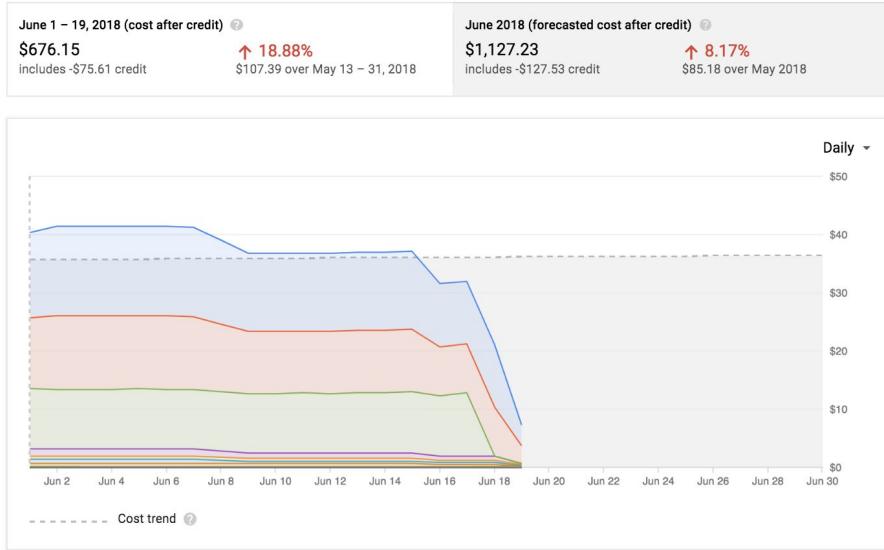
**Budgets & alerts**

**Transactions**

**Billing export**

**Payment settings**

# Reports is a visual tool to monitor expenditure



PROJECT	PROJECT ID	COST BEFORE CREDIT	CREDIT	COST AFTER CREDIT
● My Project 194	my-project-194-1378	\$287.07	-\$36.11	\$250.96
● My Project 301	my-project-301-1492	\$233.12	-\$31.00	\$202.12
● My Project 315	my-project-315-9812	\$175.00	\$0.00	\$175.00



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# Quotas are helpful limits



## Rate quota

GKE API: 1,000 requests per  
100 seconds

## Allocation quota

5 networks per project

## Many quotas are changeable

# Cloud service models (more on this later)

## Infrastructure as a service (IaaS)

- Physical devices virtualized (e.g., virtual machines)

## Platform as a service (PaaS)

- Environments virtualized (e.g., LAMP stack)

## Software as a service (SaaS)

- Applications virtualized (e.g., Office365)

# The interface (Google Cloud)



# Google Cloud Interface (console.cloud.google.com)

The screenshot shows the Google Cloud Interface homepage. Key highlighted areas include:

- Header:** The top navigation bar with the URL "console.cloud.google.com/welcome?project=cloud-apps-demos-w24".
- Project Selector:** A dropdown menu showing "cloud-apps-demos-w24" with a red box around it.
- Search Bar:** A search input field "Search (/) for resources, docs, products, and more" with a red box around it.
- User Profile:** A user profile icon in the top right corner with a red box around it.
- Welcome Section:** A central "Welcome" area with a red box around it, containing:
  - A "Welcome" icon.
  - The message "You're working in cloud-apps-demos-w24".
  - Project details: "Project number: 630329882835" and "Project ID: cloud-apps-demos-w24".
  - Navigation links: "Dashboard" and "Recommendations".
- Call-to-Action Boxes:** Two light blue call-to-action boxes:
  - "Try our most advanced model: Gemini 1.5 Pro".
  - "Try Gemini" with a right-pointing arrow.
- Quick Access Grid:** A grid of 8 cards under the "Quick access" heading:
  - API APIs & Services
  - IAM & Admin
  - Billing
  - Compute Engine
  - Cloud Storage
  - BigQuery
  - VPC network
  - Kubernetes Engine
- Bottom Navigation:** A "VIEW ALL PRODUCTS" button at the bottom left.

The screenshot shows the Google Cloud Platform dashboard with a sidebar on the left. The sidebar has sections for 'Cloud overview', 'Solutions', 'PINNED PRODUCTS' (which includes APIs & Services, Billing, IAM & Admin, Marketplace, Compute Engine, Kubernetes Engine, Cloud Storage, BigQuery, VPC network, Cloud Run, SQL, Logging, and Security), and a 'VIEW ALL PRODUCTS' button. A dropdown menu is open under 'Cloud overview', showing options for 'Dashboard' and 'Recommendations'. The main area of the dashboard displays various service icons and names.

- Cloud overview
- Solutions

PINNED PRODUCTS

- APIs & Services
- Billing
- IAM & Admin
- Marketplace
- Compute Engine
- Kubernetes Engine
- Cloud Storage
- BigQuery
- VPC network
- Cloud Run
- SQL
- Logging
- Security

VIEW ALL PRODUCTS

With Google Cloud credits:

- All products are available to you!
- (and I can get you more *when you run out*)
  - NEVER PUT IN YOUR CREDIT CARD (AGAIN)

AWS - you're limited to the pre-baked labs

Azure - ...

# First...

Let's talk about Projects in Google Cloud

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# Every Google Cloud service you use is associated with a project

- Enable services and APIs.
- Enable billing.
- Manage permissions and credentials.
- Track resource and quota usage.
- Programmatically manage your projects in Google Cloud.



# Projects have three identifying attributes

Project ID	Project name	Project number
Globally unique	Need not be unique	Globally unique
Assigned by Google Cloud but mutable during creation	Chosen by you	Assigned by Google Cloud
Immutable after creation	Mutable	Immutable

# Creating a project

The screenshot shows the Google Cloud Platform dashboard. A red box highlights the 'Project' dropdown menu in the top navigation bar. The dashboard features several cards: 'Project info' (with project name nth-skyline-247917), 'API APIs' (showing requests per second from 7:15 to 8 AM), 'Google Cloud Platform status' (all services normal), 'Billing' (estimated charges USD \$0.00 for Jul 1 – 30, 2019), and 'Error Reporting' (no errors found). Navigation links like 'Go to project settings', 'Go to APIs overview', 'View detailed charges', and 'Learn how to set up Error Reporting' are also visible.

Google Cloud Platform

Project

DASHBOARD ACTIVITY CUSTOMIZE

Project info

Project name  
Project  
Project ID  
nth-skyline-247917  
Project number  
467846512270

Go to project settings

Resources

This project has no resources

Trace

No trace data from the past 7 days

API APIs

Requests (requests/sec)

7:15 7:30 7:45 8 AM

0.035  
0.034  
0.033  
0.032  
0.031

Requests: 0.033

Go to APIs overview

Google Cloud Platform status

All services normal

Go to Cloud status dashboard

Billing

Estimated charges USD \$0.00  
For the billing period Jul 1 – 30, 2019

View detailed charges

Error Reporting

No sign of any errors. Have you set up Error Reporting?

Learn how to set up Error Reporting



# Creating a project

The screenshot shows the 'New Project' dialog box from the Google Cloud Platform. The dialog has a blue header bar with the Google Cloud logo and a search icon. Below the header, the title 'New Project' is centered. On the left, there's a sidebar with 'Select from' and a dropdown menu showing 'NO ORGANIZATION'. A red box highlights the 'NEW PROJECT' button. To the right of the sidebar is a search bar with the placeholder 'Search projects and folders' and two tabs: 'RECENT' and 'ALL'. A green arrow points from the 'RECENT' tab to the 'Project name' field. The main form area contains several input fields: 'Project name \*' with 'Project Example' typed in, 'Billing account \*' with 'My Billing Account' selected, 'Organization' (empty), and 'Location \*' with a dropdown menu open. A red box highlights the 'EDIT' link next to the Project ID. At the bottom are 'CREATE' and 'CANCEL' buttons. A large green arrow points from the top right towards the 'CREATE' button.



# Deleting a project

Often you may be spinning up a project for class with the intention of deleting it when you're done

- For example, codelabs that require App Engine...



Select a project

Search projects and folders

RECENT STARRED ALL

Name	ID
cloud-apps-demos-w24 ⓘ	cloud-apps-demos-w24

NEW PROJECT

[Manage resources](#)[CREATE PROJECT](#)[CREATE FOLDER](#)[SHOW INFO PANEL](#)

## Resources

[Filter](#) [Filter](#)

<input type="checkbox"/>	Name	ID	Last accessed	Status	Ch
<input type="checkbox"/>	▼  No organization		August 20, 2024		
<input type="checkbox"/>	cloud-apps-demos-w24	cloud-apps-de...	August 20, 2024		

# One other thing

At some point, you may receive a message that you have **too many projects and can't create another**

- At this point, **you** need to put in a request with Google to increase your capacity
- (I don't have control over your account!)

# Another point re billing/projects

Each project is tied to a billing account

Meaning, if billing account has \$0, then project is inactive

- Can't be used
- Or edited
- Or any source code downloaded for storage
  - So back up anything critical often!
  - Examples of critical things to backup?

Eventually, projects with no billing account are deleted and **not recoverable**

# Demo: Spinning up a (free) VM

Your first assignment will have you setup your cloud accounts and create a web server, let's look at the VM+web server part of it

Assignment is in Blackboard!

# Demo: Spinning up a (free) VM

First, a look at the free tiers: <https://cloud.google.com/free>

[Compute Engine](#)

- 1 non-preemptible e2-micro VM instance per month in one of the following US regions:
  - Oregon: us-west1
  - Iowa: us-central1
  - South Carolina: us-east1
- 30 GB-months standard persistent disk
- 1 GB of outbound data transfer from North America to all region destinations (excluding China and Australia) per month

Your Free Tier e2-micro instance limit is by time, not by instance. Each month, eligible use of all of your e2-micro instances is free until you have used a number of hours equal to the total hours in the current month. Usage calculations are combined across the supported [regions](#).

Compute Engine free tier does not charge for an external IP address.

GPUs and TPUs are not included in the Free Tier offer. You are always charged for GPUs and TPUs that you add to VM instances.

[Learn more](#)

# Welcome

You're working in [cloud-apps-demos-w24](#)

Project number: 630329882835

Project ID: cloud-apps-demos-w24

[Dashboard](#)

[Recommendations](#)

[Create a VM](#)

[Run a query in BigQuery](#)

[Create a GKE cluster](#)

[Create a storage bucket](#)

Try our most advanced  
model: Gemini 1.5 Pro

Try Gemini



## Quick access

[API APIs & Services](#)

[IAM & Admin](#)

[Billing](#)

[Compute Engine](#)

[Cloud Storage](#)

[BigQuery](#)

[VPC network](#)

[Kubernetes Engine](#)

[VIEW ALL PRODUCTS](#)



# Active project

You're working in [cloud-apps-demos-w24](#)

Project number: 630329882835



Project ID: cloud-apps-demos-w24

[Dashboard](#)

[Recommendations](#)

[Create a VM](#)

[Run a query in BigQuery](#)

[Create a GKE cluster](#)

[Create a storage bucket](#)

Try our most advanced  
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Try Gemini



## Quick access

API APIs & Services

IAM & Admin

Billing

Compute Engine

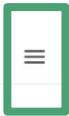
Cloud Storage

BigQuery

VPC network

Kubernetes Engine

[VIEW ALL PRODUCTS](#)



Google Cloud

cloud-apps-demos-w24 ▾

Search (/) for resources, docs, products, and more

Search



1



## Where to find things

You're working in [cloud-apps-demos-w24](#)

Project number: 630329882835



Project ID: cloud-apps-demos-w24



[Dashboard](#)

[Recommendations](#)

[Create a VM](#)

[Run a query in BigQuery](#)

[Create a GKE cluster](#)

[Create a storage bucket](#)

Try our most advanced  
model: Gemini 1.5 Pro

Try Gemini



### Quick access

[API APIs & Services](#)

[IAM & Admin](#)

[Billing](#)

[Compute Engine](#)

[Cloud Storage](#)

[BigQuery](#)

[VPC network](#)

[Kubernetes Engine](#)

[VIEW ALL PRODUCTS](#)

[Create an instance](#)

EQUIVALENT CODE

[New VM instance](#)

Create a single VM instance from scratch

[New VM instance from template](#)

Create a single VM instance from an existing template

[New VM instance from machine image](#)

Create a single VM instance from an existing machine image

[Marketplace](#)

Deploy a ready-to-go solution onto a VM instance

Name \*  
instance-20240528-212102

## Monthly estimate

\$25.46

That's about \$0.03 hourly

Pay for what you use: no upfront costs and per second billing

## ▼ MANAGE TAGS AND LABELS

Region \*

us-central1 (Iowa)

Region is permanent

Zone \*

us-central1-a

Zone is permanent



## Machine configuration

 General purpose

Compute optimized

Memory optimized

Storage optimized

NEW

GPUs

Machine types for common workloads, optimized for cost and flexibility

[Compute Engine pricing](#)

▲ LESS

Series	Description	vCPUs	Memory	Platform
<input type="radio"/>	N4	Flexible & cost-optimized	2 - 80	4 - 640 GB
<input type="radio"/>	C3	Consistently high performance	4 - 176	8 - 1,408 GB
<input type="radio"/>	C3D	Consistently high performance	4 - 360	8 - 2,880 GB
<input checked="" type="radio"/>	E2	Low cost, day-to-day computing	0.25 - 32	1 - 128 GB
<input type="radio"/>	N2	Balanced price & performance	2 - 128	2 - 864 GB
<input type="radio"/>	N2D	Balanced price & performance	2 - 224	2 - 896 GB
<input type="radio"/>	T2A	Scale-out workloads	1 - 48	4 - 192 GB
<input type="radio"/>	T2D	Scale-out workloads	1 - 60	4 - 240 GB
<input type="radio"/>	N1	Balanced price & performance	0.25 - 96	0.6 - 624 GB

## Machine type

Choose a machine type with preset amounts of vCPUs and memory that suit most workloads. Or, you can create a custom machine for your workload's particular needs. [Learn more](#)

PRESET

CUSTOM

e2-medium (2 vCPU, 1 core, 4 GB memory)

CREATE

CANCEL

EQUIVALENT CODE

Fill out with free tier reqs!

# Then, install a LAMP stack

Typically the servers will be running Linux

- Much cheaper than Windows Server
- Get comfortable with Linux commands if you aren't!
  - <https://www.geeksforgeeks.org/linux-commands-cheat-sheet/>

(I'll be running them with Ubuntu mainly, but any install is valid as long as you know how to use it)

- AND SECURE IT
  - ....why?



# Ok, LAMP

L : Linux  
A : Apache  
M : MySQL  
P : PHP

<https://www.digitalocean.com/community/tutorials/how-to-install-lamp-stack-on-ubuntu>

# And then, open ports in the firewalls

More than 1 firewall?

Inner firewall → your virtual machine

- YOUR RESPONSIBILITY TO MANAGE

Outer firewall → VPC network

- Provider's responsibility (though you specify ports)

## **MAKE SURE YOU OPEN UP SSH AS WELL**

- If you don't, you will lose the ability to remote into your machine
- Recovery instructions: <https://www.youtube.com/watch?v=8cKnIkYYsDQ>

# What's the difference?

Internal IP	External IP
10.142.0.2 ( <a href="#">nic0</a> )	35.231.243.61 ( <a href="#">nic0</a> )

# Make a website?

Going to cheat, let's just clone a Minesweeper game I worked on over the summer

- For fun!
- Hooray!

```
$ cd /var/www/html  
$ git clone https://github.com/efredericks/p5-minesweeper
```

# Now...

Visit the **external IP address**

- Should access the /var/www/html folder by default (default Apache page)
- sub-folder for cloned site

Easy peasy "free" website

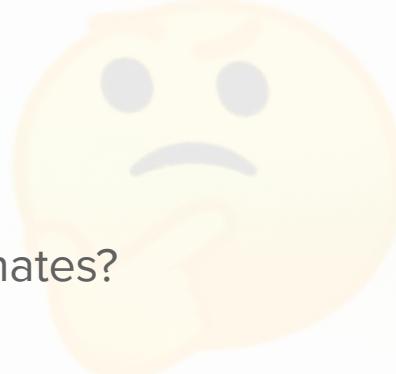
Didn't use the M or P aspects of LAMP - but they are there for your storage/server-side scripting needs

# ChatGPT Discussion

First off, how many of you use ChatGPT/etc. to help with assignments?  
(no judgements, yet)

How do you use it?

And do you know that it hallucinates?  
(here, have some paper)



# ChatGPT Discussion

So should we use it or not use it?

Well, the genie's out of the bottle and it is probably here to stay (unless if that lawsuit is successful...)

- Just be aware that its output *may* not be completely correct

...and don't copy and paste it directly into your answers either ☹\_☹

# HOMEWORK

Homework posted -- accounts setup and web server setup