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Advanced Sequencing Technologies & Applications

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Introduction to cloud computing

Obi Griffith and Alex Wagner
Advanced Sequencing Technologies & Applications
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Learning Objectives

- Introduction to cloud computing concepts
- Introduction to cloud computing providers
- Use the Amazon EC2 console to create an instance for each student
 - Will be used for many hands-on tutorials throughout the course
- How to log into your cloud instance

Disk Capacity vs Sequencing Capacity, 1990-2012

Disk Storage
(Mbytes/\$)

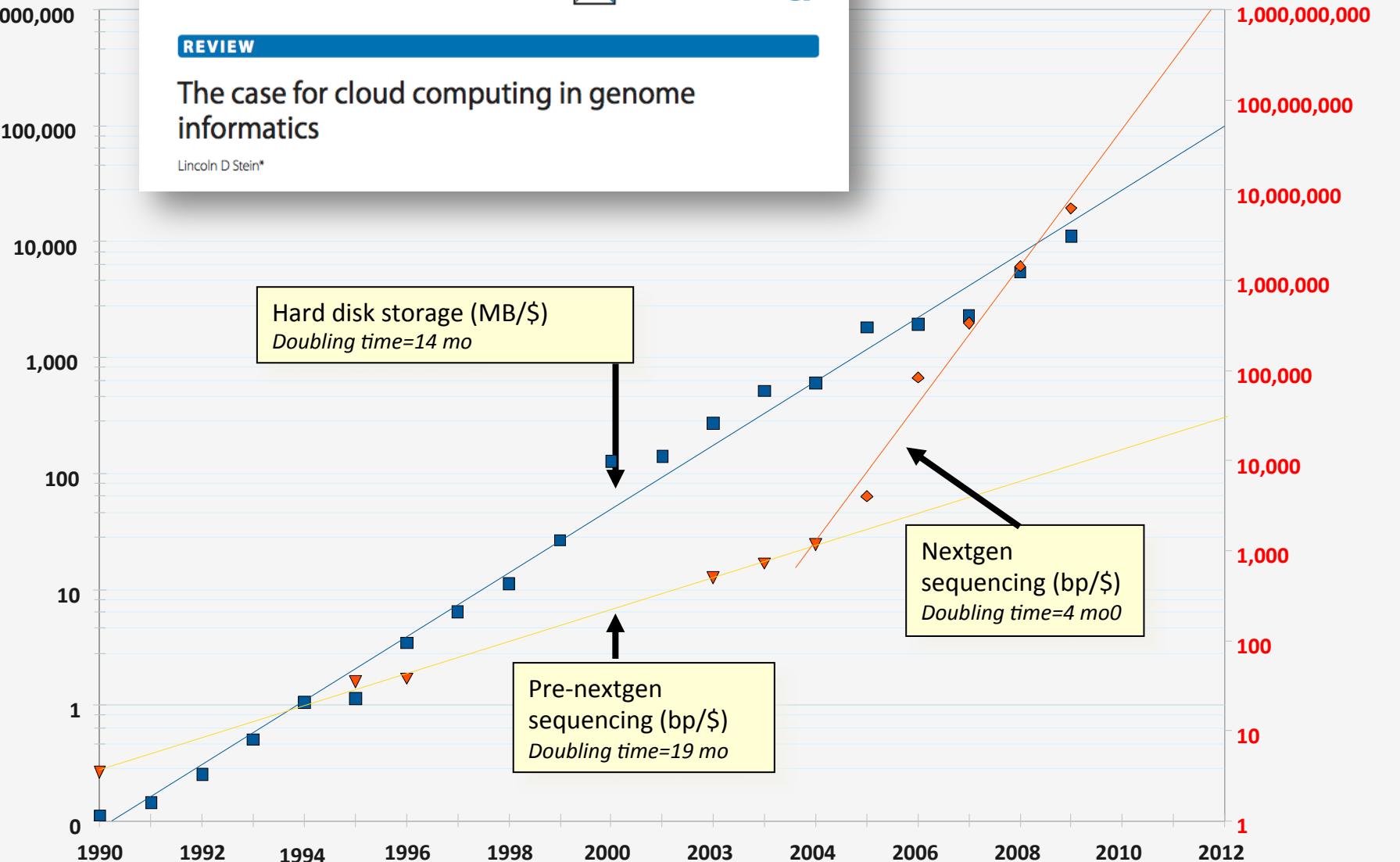
Stein *Genome Biology* 2010, 11:207
<http://genomebiology.com/2010/11/5/207>



REVIEW

The case for cloud computing in genome informatics

Lincoln D Stein*



About DNA and computers

- We hit the \$1000 genome* in ~2016
 - Need to think about the \$100 genome
- The doubling time of sequencing has been ~5-6 months.
- The doubling time of storage and network bandwidth is ~12 months.
- The doubling time of CPU speed is ~18 months.
- The cost of sequencing a base pair will eventually equal the cost of storing a base pair

What is the general biomedical scientist to do?

- Lots of data
- Poor IT infrastructure in many labs
- Where do they go?
- Write more grants?
- Get bigger hardware?

Cloud computing providers

- Amazon AWS
 - <https://aws.amazon.com/>
- Google cloud
 - <https://cloud.google.com/>
- Digital ocean
 - <https://www.digitalocean.com/>
- Microsoft Azure
 - <https://azure.microsoft.com/en-us/>
- More...

Amazon Web Services (AWS)

- Infinite storage (scalable): S3 (simple storage service)
- Compute per hour: EC2 (elastic cloud computing)
- Ready when you are High Performance Computing
- Multiple football fields of HPC throughout the world
- HPC are expanded at one container at a time:



Some of the challenges of cloud computing:

- Not cheap!
- Getting files to and from there
- Not the best solution for everybody
- Standardization
- PHI: personal health information & security concerns
- In the USA: HIPAA act, PSQIA act, HITECH act, Patriot act, CLIA and CAP programs, etc.
 - <http://www.biostars.org/p/70204/>

Some of the advantages of cloud computing:

- We received a grant from Amazon, so supported by ‘AWS in Education grant award’.
- There are better ways of transferring large files, and now AWS makes it free to upload files.
- A number of datasets exist on AWS (e.g. 1000 genome data).
- Many useful bioinformatics AMI’s (Amazon Machine Images) exist on AWS: e.g. cloudbiolinux & CloudMan (Galaxy) – now one for this course!
- Many flavors of cloud available, not just AWS

Key AWS concepts and terminology

- AWS - Amazon Web Services. A collection of cloud computing services provided by Amazon.
- EC2 - Elastic Compute. An AWS service that allows you to configure and rent computers to meet your compute needs on an as needed basis.
- EBS - Elastic Block Storage. A data storage solution that allows you to rent disk storage and associate that storage with your compute resources. EBS volumes are generally backed by SSD devices.

Key AWS concepts and terminology

- S3 - Simple storage service. Cheaper than EBS and allows for storage of larger amounts of data with some drawbacks compared to EBS. S3 volumes store data as objects that are accessed by an API or command line interface or other application designed to work with S3. EBS volumes on the other hand can be mounted as if they were a local disk drive associated with the Instance.
- SSD - Solid state drive. A particular type of storage hardware that is generally faster and more expensive than traditional hard drives.

Key AWS concepts and terminology

- HDD - Hard disk drive. A particular type of storage hardware that is generally cheaper and larger but slower than SSD. HDD drives are traditional hard drives that access data on a spinning magnetic disk.
- Ephemeral storage - Also known as Instance Store storage. Data storage associated with an EC2 instance that is local to the host computer. This storage does not persist when the instance is stopped or terminated. In other words, anything you store in this way will be lost if the system is stopped or terminated. Instance store volumes may be backed by SSD or HDD devices.

What is a Region?

- An AWS Region is set of compute resources that Amazon maintains (like the Data Center image shown before)
- Each Region corresponds to a physical warehouse of compute hardware (computers, storage, networking, etc.).
- At the time of writing there are 14 regions: (US East (N.Virginia), US East (Ohio), US West (Oregon), US West (N. California), Canada (Central), EU (Ireland), EU (Frankfurt), EU (London), Asia Pacific (Singapore), Asia Pacific (Sydney), Asia Pacific (Seoul), Asia Pacific (Tokyo), Asia Pacific (Mumbai) and South America (Sao Paulo)).
- When you are logged into the AWS EC2 console you are always operating in one of these regions.

What is a Region?

- Current region shown in the upper right corner of console
- It is important to pay attention to what region you are using for several reasons.
 - When you create an EC2 instance (EBS volume, etc) in one region you won't see it in another region.
 - The cost to use many AWS resources varies by region.
 - The region may influence network performance when you are accessing the instance, especially if you need to transfer large amounts of data in or out.
 - Billing is tracked separately for each region
 - Generally you should choose a region that is close to you or your users. But cost is also a consideration.

What is difference between the 'Start', 'Stop', 'Reboot', and 'Terminate' (Instance States)?

- Start – turn on an EC2 instance that you have previously created
- Stop – turn off an EC2 instance that you have previously created
- Reboot – restart an EC2 instance
- Terminate – permanently stop and destroy an EC2 instance. Any associated EBS volumes may also be destroyed at this time depending on configuration

What is an AMI/snapshot?

- AMI (Amazon Machine Image) – a template that specifies how to launch EC2 instances
 - Root volume with operating system (OS), pre-installed applications, etc
 - Launch permissions determine who can use the AMI
 - Specification of (data) volumes to attach when launched
- You can create an AMI for any instance you have created/configured
- AMI can be made public for sharing (region-specific)
- Creating an AMI involves creating a snapshot of the root and any attached volumes. You will be charged to store this snapshot.

I can not log into my EC2 instance, what might have gone wrong?

- Is your instance running?
- Are you providing the correct path to your key file?
- Is it the correct key file?
- Have you set the permissions for your key file correctly?
- Did you specify a valid user for your AMI (e.g., ubuntu)?
- Did you specify the correct IP address?
- Does the Security Group for the instance allow access for your connection protocol (e.g., SSH) and location?

How much does it cost to use AWS EC2 resources?

Linux	RHEL	SLES	Windows	Windows with SQL Standard	Windows with SQL Web
Windows with SQL Enterprise					
Region: US West (Oregon)					
vCPU	ECU	Memory (GiB)	Instance Storage (GB)	Linux/UNIX Usage	
General Purpose - Current Generation					
t2.nano	1	Variable	0.5	EBS Only	\$0.0058 per Hour
t2.micro	1	Variable	1	EBS Only	\$0.0116 per Hour
t2.small	1	Variable	2	EBS Only	\$0.023 per Hour
t2.medium	2	Variable	4	EBS Only	\$0.0464 per Hour
t2.large	2	Variable	8	EBS Only	\$0.0928 per Hour
t2.xlarge	4	Variable	16	EBS Only	\$0.1856 per Hour
t2.2xlarge	8	Variable	32	EBS Only	\$0.3712 per Hour
m4.large	2	6.5	8	EBS Only	\$0.1 per Hour
m4.xlarge	4	13	16	EBS Only	\$0.2 per Hour
m4.2xlarge	8	26	32	EBS Only	\$0.4 per Hour

Data transfer (GB): In: free or \$0.01; Out: free, \$0.01 or \$0.02

EBS storage (GB/Month): \$0.10

S3 storage (GB/Month): \$0.023 standard, \$0.0125 infrequent access, or
\$0.004 glacier

Why am I still getting a monthly bill?

- Generally you get an accounting of usage and cost on a 30 day cycle
 - Pricing is per instance-hour (now instance-second!) consumed for each instance type.
 - Also charges for storage, transfers, etc
- Be aware of regions!
- Even when an instance is stopped, storage for root or other EBS volumes persist
- Creating AMIs/snapshots requires storage
- Explore the billing and cost management tools of AWS to track your spending, set warnings, etc

Amazon AWS documentation

https://github.com/griffithlab/rnaseq_tutorial/wiki/Intro-to-AWS-Cloud-Computing

<http://aws.amazon.com/console/>

In this workshop:

- Some tools (data) are
 - on your computer
 - on the web
 - on the cloud.
- You will become efficient at traversing these various spaces, and finding resources you need, and using what is best for you.
- There are different ways of using the cloud:
 1. Command line (like your own very powerful Unix box)
 2. With a web-browser (e.g. Galaxy): not in this workshop

Things we have set up:

- Loaded data files to a web server
- We brought up an Ubuntu (Linux) instance, and loaded a whole bunch of software for NGS analysis.
- We will clone this and create separate instances for everybody in the class.
- We've simplified the security: you basically all have the same login and file access, and opened ports. In your own world you would be more secure.

Logging into Amazon AWS

Go to course wiki, “Accessing the cloud” page

The screenshot shows a web-based wiki interface for the C-SEQTEC 2017 workshop. The left sidebar contains a navigation menu with links to Home, Wiki (which is currently selected), Resources, Roster, Announcements, Drop Box, Polls, Forums, Chat Room, Email Archive, Meetings & Courses, CSHL RSS, Statistics, Site Info, and Help. The main content area is titled "Accessing The Cloud". At the top of the content area, there are several buttons: Home, View, Edit, Info, History, Watch, and a search bar. To the right of the search bar are links for "Recently visited" and a user icon. Below the title, a sub-header reads "Accessing The Cloud last modified by Obi Griffith on November 10, 2017 11:43:40 AM EST". The main content of the page is titled "Instructions for students to access their AWC EC2 cloud instance". It contains text explaining that most hands-on components will be performed on Amazon AWS EC2 instances and provides instructions for logging in via the AWS Console. It also includes terminal commands for connecting to the AWS instance via SSH.

Accessing The Cloud

Accessing The Cloud last modified by Obi Griffith on November 10, 2017 11:43:40 AM EST

Instructions for students to access their AWC EC2 cloud instance

Most hands on components of this workshop will be performed on Amazon AWS EC2 instances. Each student is assigned their own instance (instance type) running the Ubuntu operating system. Use the following instructions to log in.

Visit AWS Console to create instance:

- AWS Console Signin: <https://workshops.signin.aws.amazon.com/console>
- User Name: cshl.student
- Password: seqtec2017

Connect to AWS instance via Terminal:

```
wget genomedata.org/seq-tec-workshop/cshl_2017.pem
chmod 400 cshl_2017.pem
ssh -i cshl_2017.pem ubuntu@YOUR_IP_ADDRESS
```

Be the first to comment

Login to AWS console



i Coming Soon: Changes to Multi-Factor Authentication (MFA)

Entry of an MFA security code for IAM users will move from this sign-in page to a subsequent page

Account: 364840684323

User Name: cshl.student

Password:
 I have an MFA Token (more info)

Sign In

[Sign-in using root account credentials](#)



<https://workshops.signin.aws.amazon.com/console>

Select "EC2" service

The screenshot shows the AWS Management Console homepage. At the top, there's a navigation bar with icons for AWS, Services, Edit, and user information (cshl.student @ 3648-4068-4323, Oregon, Support). Below the navigation is a section titled "Shortcuts and Recently Viewed Services" featuring IAM and EC2 icons. A large red arrow points to the EC2 icon. To the right of this section is a "Service Health" status bar indicating all services are operating normally, updated Nov 10 2016 15:34:00 GMT-0600. A red arrow also points to the "Oregon" region selection. The main content area includes "Quick Starts" for building web apps, launching VMs, backing up files, creating mobile backends, hosting static websites, and analyzing big data. Below this is a "AWS Services" section with categories like Compute, Storage & Content Delivery, Database, Developer Tools, Management Tools, Security & Identity, Internet of Things, Game Development, Mobile Services, Application Services, and various AWS IoT, Config, and Analytics services. A search bar labeled "Search services" is also present.

Service Health [View Dashboard](#)

All services are operating normally.
Updated Nov 10 2016 15:34:00 GMT-0600

Make sure you are in Oregon region

Amazon Appstore, Google Play, or iTunes.

AWS Marketplace
[Find and buy software](#), launch with 1-Click, and pay by the hour.

Feedback
[Tell us what you think](#) about the new console home page.

Launch a new Instance

AWS Services Edit cshl.student @ 3648-4068-4323 ▾ Oregon ▾ Support ▾

EC2 Dashboard

- Events
- Tags
- Reports
- Limits

INSTANCES

- Instances
- Spot Requests
- Reserved Instances
- Commands

IMAGES

- AMIs
- Bundle Tasks

ELASTIC BLOCK STORE

- Volumes
- Snapshots

NETWORK & SECURITY

- Security Groups
- Elastic IPs
- Placement Groups
- Key Pairs
- Network Interfaces

LOAD BALANCING

- Load Balancers

AUTO SCALING

Resources

You are using the following Amazon EC2 resources in the US West (Oregon) region:

4 Running Instances	0 Elastic IPs
7 Volumes	9 Snapshots
3 Key Pairs	0 Load Balancers
0 Placement Groups	2 Security Groups

Easily deploy and operate applications - use Chef recipes, manage SSH users, and more. Try OpsWorks now. Hide

Create Instance

To start using Amazon EC2 you will want to launch a virtual server, known as an Amazon EC2 instance.

Launch Instance 

Note: Your instances will launch in the US West (Oregon) region

Service Health

Service Status:

- US West (Oregon): This service is operating normally

Availability Zone Status:

- us-west-2a: Availability zone is operating normally
- us-west-2b: Availability zone is operating normally
- us-west-2c: Availability zone is operating normally

Scheduled Events

US West (Oregon): No events

Account Attributes

Supported Platforms
VPC
Default VPC
vpc-ebcc188e

Additional Information

Getting Started Guide
Documentation
All EC2 Resources
Forums
Pricing
Contact Us

AWS Marketplace

Find free software trial products in the AWS Marketplace from the [EC2 Launch Wizard](#). Or try these popular AMIs:

- Tableau Server (10 users)
Provided by Tableau
Rating ★★★★☆
Pay by the hour for Tableau software and AWS usage
[View all Business Intelligence](#)
- SAP HANA One 244GiB
Provided by SAP America, Inc
Rating ★★★★☆

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Choose an AMI – Find the CSHL SEQTEC 2017 AMI in the Community AMIs

The screenshot shows the AWS 'Choose an AMI' wizard interface. The top navigation bar includes 'AWS', 'Services', 'Edit', and user information 'cshl.student @ 3648-4068-4323' with dropdowns for 'Oregon' and 'Support'. Below the navigation is a progress bar with steps 1 through 7. Step 1, 'Choose AMI', is highlighted.

Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

The main area shows a search bar with 'cshl_seqtec_2015_v2' typed in. A red arrow points to this search term. To the left, a sidebar menu highlights 'Community AMIs' (another red arrow). The search results list two items:

- cshl_seqtec_2015_v2 - ami-28130249**
Root device type: ebs Virtualization type: hvm
Select button (red arrow)
64-bit
- cshl_seqtec_2015_v2_noworkspace - ami-e9100188**
Root device type: ebs Virtualization type: hvm
Select button
64-bit

Search for: "cshl_seqtec_2017_v1" (US West - Oregon)

Choose “m4.2xlarge” instance type, then “Next: Configure Instance Details”.

The screenshot shows the AWS EC2 instance creation wizard at Step 2: Choose an Instance Type. A red arrow points to the 'm4.2xlarge' row in the table, which is highlighted with a blue selection bar. The 'Review and Launch' button is also highlighted with a red box.

Step 2: Choose an Instance Type

Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instances are virtual servers that can run applications. They have varying combinations of CPU, memory, storage, and networking capacity, and give you the flexibility to choose the appropriate mix of resources for your applications. [Learn more](#) about instance types and how they can meet your computing needs.

Filter by: All instance types ▾ Current generation ▾ Show/Hide Columns

Currently selected: m4.2xlarge (26 ECUs, 8 vCPUs, 2.4 GHz, Intel Xeon E5-2676v3, 32 GiB memory, EBS only)

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
<input type="checkbox"/>	General purpose	t2.micro <small>Free tier eligible</small>	1	1	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.small	1	2	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.medium	2	4	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.large	2	8	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	m4.large	2	8	EBS only	Yes	Moderate
<input type="checkbox"/>	General purpose	m4.xlarge	4	16	EBS only	Yes	High
<input checked="" type="checkbox"/>	General purpose	m4.2xlarge	8	32	EBS only	Yes	High
<input type="checkbox"/>	General purpose	m4.4xlarge	16	64	EBS only	Yes	High

Cancel Previous Review and Launch Next: Configure Instance Details

Select "Protect against accidental termination", then "Next: Add Storage".

Screenshot of the AWS Launch Wizard Step 3: Configure Instance Details page. The page shows configuration options for launching an instance, including network settings, IAM role, shutdown behavior, and termination protection. A red arrow points to the 'Protect against accidental termination' checkbox, which is checked. A red box highlights the 'Next: Add Storage' button at the bottom right.

Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances: 1

Purchasing option: Request Spot instances

Network: vpc-ebcc188e (172.31.0.0/16) (default)

Subnet: No preference (default subnet in any Availability Zone)

Auto-assign Public IP: Use subnet setting (Enable)

IAM role: None

Shutdown behavior: Stop

Enable termination protection: Protect against accidental termination

Monitoring: Enable CloudWatch detailed monitoring
Additional charges apply.

Tenancy: Shared tenancy (multi-tenant hardware)
Additional charges will apply for dedicated tenancy.

Advanced Details

Cancel Previous Review and Launch **Next: Add Storage**

You should see "snap-xxxxxxx" (32GB) and "snap-xxxxxxx" (250GB) as the two storage volumes selected. Then, "Next: Tag Instance"

Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. [Learn more](#) about storage options in Amazon EC2.

Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Delete on Termination	Encrypted
Root	/dev/sda1	snap-6f450833	32	General Purpose (SSD)	96 / 3000	<input checked="" type="checkbox"/>	Not Encrypted
EBS	/dev/sdb	snap-11e6954e	500	General Purpose (SSD)	1500 / 3000	<input checked="" type="checkbox"/>	Not Encrypted

Add New Volume

Info icon Free tier eligible customers can get up to 30 GB of EBS General Purpose (SSD) or Magnetic storage. [Learn more](#) about free usage tier eligibility and usage restrictions.

Cancel Previous Review and Launch **Next: Tag Instance**

Create a tag like “Name=ObiGriffith” [use your own name]. Then hit "Next: Configure Security Group".

The screenshot shows the AWS EC2 instance creation process at Step 5: Tag Instance. The 'Key' field is set to 'Name'. The 'Value' field contains 'ObiGriffith'. A large red arrow points upwards from the bottom of the page towards the 'Value' field. At the bottom right, there are buttons for 'Cancel', 'Previous', 'Review and Launch', and 'Next: Configure Security Group', with the 'Next...' button highlighted by a red box.

Step 5: Tag Instance

A tag consists of a case-sensitive key-value pair. For example, you could define a tag with key = Name and value = Webserver. [Learn more](#) about tagging your Amazon EC2 resources.

Key (127 characters maximum) | Value (255 characters maximum)

Name ObiGriffith X

Create Tag (Up to 10 tags maximum)

Cancel Previous Review and Launch **Next: Configure Security Group**

Select an Existing Security Group, choose "SSH_HTTP". Then hit "Review and Launch".

Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. [Learn more](#) about Amazon EC2 security groups.

Assign a security group: Create a new security group Select an existing security group

Security Group ID	Name	Description	Actions
sg-fcf10585	civic-dev	security group for the civic dev environment	Copy to new
sg-64d8be01	default	default VPC security group	Copy to new
sg-dd2666a4	launch-wizard-8	launch-wizard-8 created 2016-11-09T15:26:54Z-06:00	Copy to new
sg-4e1b6128	SSH_HTTP	SSH and HTTP from anywhere	Copy to new
sg-28ad924c	SSH_HTTP_8080	custom security group for oregano server	Copy to new
sg-5a53633f	SSH_HTTP_8081_IN_ALL_OUT	Allow web, ssh, and GMS class viewer incoming and all outgoing	Copy to new
sg-67cf8c00	SSH_only	launch-wizard-1 created 2016-04-05T17:15:03.947-05:00	Copy to new

Inbound rules for sg-4e1b6128 (Selected security groups: sg-4e1b6128)

Type	Protocol	Port Range	Source
HTTP	TCP	80	0.0.0.0/0
SSH	TCP	22	0.0.0.0/0

[Cancel](#) [Previous](#) [Review and Launch](#)

Review the details of your instance, note the warnings, then hit Launch

The screenshot shows the AWS Step 7: Review Instance Launch page. At the top, there's a navigation bar with AWS, Services, Edit, and other account details. Below it, a progress bar shows steps 1 through 7, with step 7 being the current one.

Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

Your instance configuration is not eligible for the free usage tier

To launch an instance that's eligible for the free usage tier, check your AMI selection, instance type, configuration options, or storage devices. Learn more about [free usage tier eligibility and usage restrictions](#).

Don't show me this again

Improve your instances' security. Your security group, SSH_HTTP_8081_IN_ALL_OUT, is open to the world.

Your instances may be accessible from any IP address. We recommend that you update your security group rules to allow access from known IP addresses only. You can also open additional ports in your security group to facilitate access to the application or service you're running, e.g., HTTP (80) for web servers. [Edit security groups](#)

AMI Details

cshl_seqtec_2015_v2 - ami-28130249 ←

Root Device Type: ebs Virtualization type: hvm

Instance Type

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
m3.2xlarge	26	8	30	2 x 80 ←		High

Security Groups

[Edit security groups](#)

Launch ←

Choose an existing key pair: "cshl_2017" and then Launch.

The screenshot shows the AWS Step 7: Review Instance Launch interface. The main page displays instance launch details, including an AMI selection (cshl_seqtec_2015_v4 - ami-b3a3b3d2), an instance type (t2.micro), and a security group (sg-4e1b6128). A modal dialog box titled "Select an existing key pair or create a new key pair" is overlaid on the page. The dialog contains instructions about key pairs and a note about selecting a key pair for the instance. It features a dropdown menu for selecting an existing key pair, which has "CSHL_2016" selected. A checkbox for acknowledging access to the private key file is checked. Red arrows point from the text "Choose an existing key pair" to the dropdown menu, from "Select a key pair" to the dropdown menu, and from the acknowledgement note to the checkbox. A red box highlights the "Launch Instances" button at the bottom right of the dialog.

Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

⚠ Your instance configuration is not eligible for the free usage tier
To launch an instance that's eligible for the free usage tier, check your AMI selection, instance type, configuration options, or storage devices. Learn more about [free usage tier](#) eligibility and usage restrictions.

⚠ Improve your instances' security. Your security group,
Your instances may be accessible from any IP address. We recommend you change your security group's inbound rules to restrict access. You can also open additional ports in your security group to facilitate this.

AMI Details

cshl_seqtec_2015_v4 - ami-b3a3b3d2
Final CSHL 2015 Image root and workspace after course clean up
Root Device Type: ebs Virtualization type: hvm

Edit AMI

Instance Type

Instance Type	ECUs	vCPUs	Memory (GiB)
t2.micro	Variable	1	1

Edit instance type

Security Groups

Security Group ID	Name	Description
sg-4e1b6128	SSH_HTTP	SSH and HTTP from anywhere

All selected security groups inbound rules

Security Group ID	Type	Protocol	Port Range	Source
sg-4e1b6128	HTTP	TCP	80	0.0.0.0/0

Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about [removing existing key pairs from a public AMI](#).

Choose an existing key pair
Select a key pair
CSHL_2016
 I acknowledge that I have access to the selected private key file (CSHL_2016.pem), and that without this file, I won't be able to log into my instance.

Cancel Launch Instances

View Instances to see your new instance spinning up!

The screenshot shows the AWS CloudWatch Launch Status page. At the top, there's a navigation bar with icons for CloudWatch Metrics, AWS Lambda, Services, Edit, and Support. On the right, it shows the user's email (cshl.student @ 3648-4068-4323), location (Oregon), and account ID.

Launch Status

Your instances are now launching
The following instance launches have been initiated: i-45e4089f [View launch log](#)

Get notified of estimated charges
Create billing alerts to get an email notification when estimated charges on your AWS bill exceed an amount you define (for example, if you exceed the free usage tier).

How to connect to your instances

Your instances are launching, and it may take a few minutes until they are in the running state, when they will be ready for you to use. Usage hours on your new instances will start immediately and continue to accrue until you stop or terminate your instances.

Click [View Instances](#) to monitor your instances' status. Once your instances are in the running state, you can [connect](#) to them from the Instances screen. [Find out](#) how to connect to your instances.

▼ Here are some helpful resources to get you started

- [How to connect to your Linux instance](#)
- [Amazon EC2: User Guide](#)
- [Learn about AWS Free Usage Tier](#)
- [Amazon EC2: Discussion Forum](#)

While your instances are launching you can also

[Create status check alarms](#) to be notified when these instances fail status checks. (Additional charges may apply)
[Create and attach additional EBS volumes](#) (Additional charges may apply)
[Manage security groups](#)

[View Instances](#)

Find YOUR instance, select it, and then hit connect for instructions on how to connect (It may take some time for your instance to be ready)

The screenshot shows the AWS EC2 Dashboard. The left sidebar lists navigation options: EC2 Dashboard, Events, Tags, Reports, Limits, INSTANCES (selected), Instances, Spot Requests, Reserved Instances, Commands, IMAGES (AMIs, Bundle Tasks), ELASTIC BLOCK STORE (Volumes, Snapshots), NETWORK & SECURITY (Security Groups, Elastic IPs, Placement Groups, Key Pairs, Network Interfaces), and LOAD BALANCING (Load Balancers). The main content area displays a table of instances. The 'Connect' button in the top navigation bar is highlighted with a red box and an arrow points to the 'ObiGriffith' instance in the list, which is also highlighted with a blue box.

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS	Public IP	K
ObiGriffith	i-45e4089f	m3.2xlarge	us-west-2c	running	Initializing	None	ec2-52-33-240-196.us-west-2.compute.amazonaws.com	52.33.240.196	C
instructor_test2	i-068e6cdc	m3.2xlarge	us-west-2c	running	2/2 checks ...	None	ec2-52-34-44-168.us-west-2.compute.amazonaws.com	52.34.44.168	in
Jason's Insta...	i-00967ada	m3.2xlarge	us-west-2c	running	2/2 checks ...	None	ec2-52-10-59-49.us-west-2.compute.amazonaws.com	52.10.59.49	C
Obi's instance	i-15836fcf	m3.2xlarge	us-west-2c	running	2/2 checks ...	None	ec2-52-34-43-79.us-west-2.compute.amazonaws.com	52.34.43.79	C
instructor_test1	i-66463ea0	m3.2xlarge	us-west-2a	running	2/2 checks ...	None	ec2-52-11-219-138.us-west-2.compute.amazonaws.com	52.11.219.138	in

Instance: i-45e4089f (ObiGriffith) Public DNS: ec2-52-33-240-196.us-west-2.compute.amazonaws.com

Description	Status Checks	Monitoring	Tags
Instance ID: i-45e4089f			
Instance state: running			
Instance type: m3.2xlarge			
Private DNS: ip-172-31-4-176.us-west-2.compute.internal			
Public DNS: ec2-52-33-240-196.us-west-2.compute.amazonaws.com			
Public IP: 52.33.240.196			
Elastic IP: -			
Availability zone: us-west-2c			

Take note of your Public DNS/IP and the instructions on changing permissions for the key file (Note, we will login as ubuntu NOT root)

The screenshot shows the AWS EC2 Dashboard with the 'Instances' section selected. A modal window titled 'Connect To Your Instance' is open, providing instructions for connecting to the instance. The modal includes the following content:

I would like to connect with A standalone SSH client A Java SSH Client directly from my browser (Java required)

To access your instance:

1. Open an SSH client. (find out how to connect using PuTTY)
2. Locate your private key file (CSHL.pem). The wizard automatically detects the key you used to launch the instance.
3. Your key must not be publicly viewable for SSH to work. Use this command if needed:
`chmod 400 CSHL.pem`
4. Connect to your instance using its Public IP:
52.33.240.196

Example:

```
ssh -i "CSHL.pem" root@52.33.240.196
```

Please note that in most cases the username above will be correct, however please ensure that you read your AMI usage instructions to ensure that the AMI owner has not changed the default AMI username.

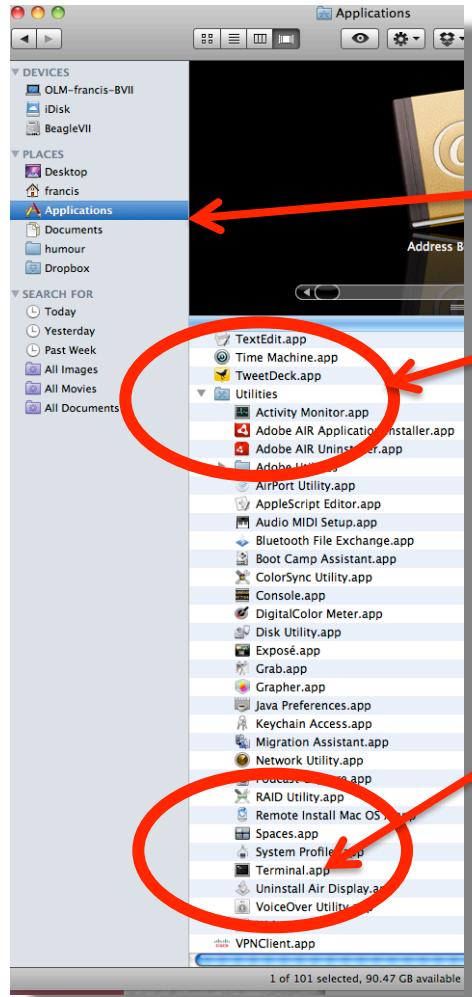
If you need any assistance connecting to your instance, please see our [connection documentation](#).

Close

On the right side of the dashboard, a table lists instances with columns for Public DNS, Public IP, and Status. One instance is highlighted with a blue border: ec2-52-33-240-196.us-west-2.compute.amazonaws.com (Public IP 52.33.240.196).

Public DNS	Public IP	Status
ec2-52-33-240-196.us...	52.33.240.196	C
ec2-52-34-44-168.us-w...	52.34.44.168	in
ec2-52-10-59-49.us-we...	52.10.59.49	C
ec2-52-34-43-79.us-we...	52.34.43.79	C
ec2-52-11-219-138.us...	52.11.219.138	in

Opening a ‘terminal session’ on a Mac

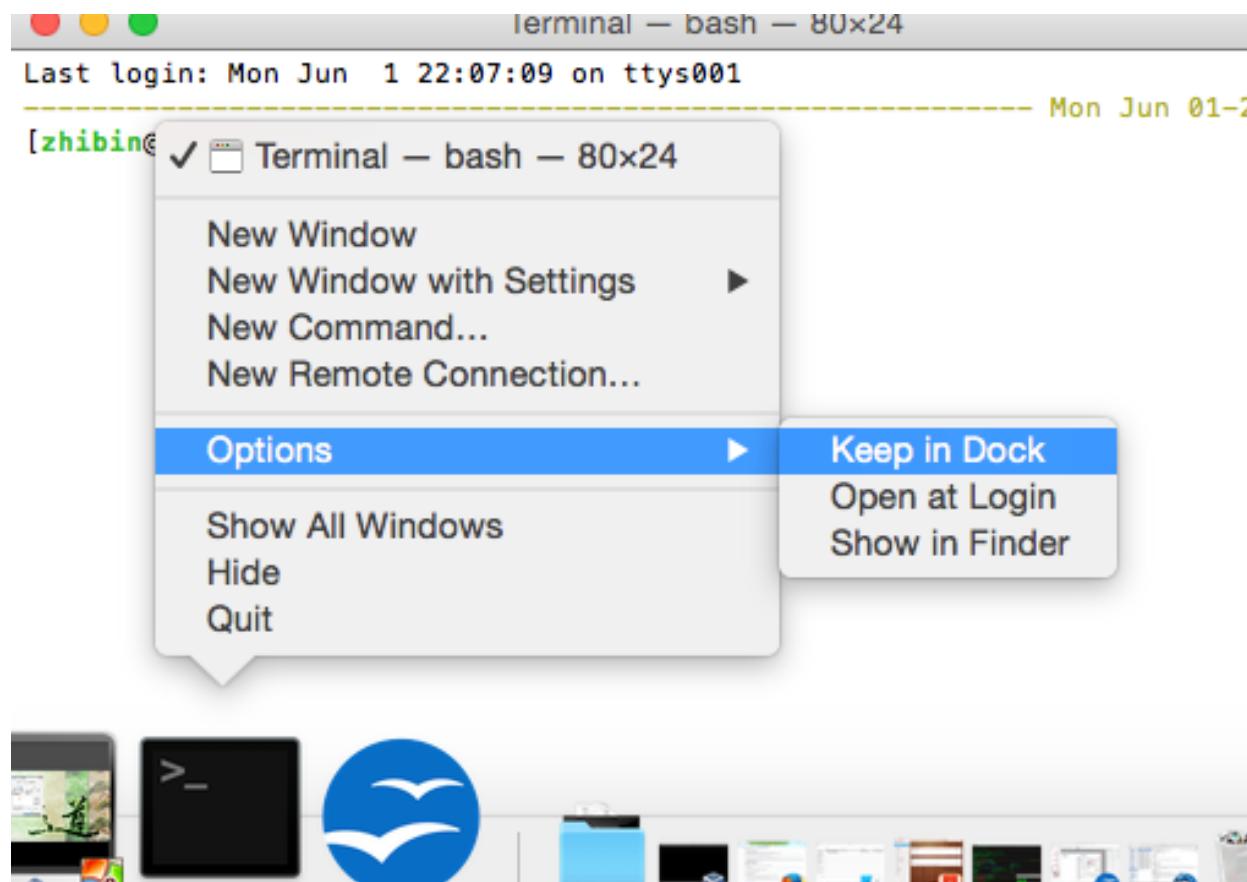


In a Finder window
‘Applications’ -> ‘Utilities’ -> ‘Terminal’



Or on your dock

Add the terminal App to your dock



Creating a working directory on your Mac called ‘cshl’

```
obis-air:~ ogriffit$ pwd
/Users/ogriffit
obis-air:~ ogriffit$ ls
Applications   Desktop          Dropbox        Movies       Public      gittemp     temp
Attachments    Documents         Google Drive   Music        bin         igv
Box Sync       Downloads        Library        Pictures    git         ncbi
obis-air:~ ogriffit$ mkdir cshl
obis-air:~ ogriffit$ cd cshl
obis-air:cshl ogriffit$ ls -la
total 0
drwxr-xr-x  2 ogriffit  staff   68 Nov 13 22:18 .
drwxr-xr-x+ 58 ogriffit  staff  1972 Nov 13 22:18 ..
obis-air:cshl ogriffit$ █
```

mkdir cshl
cd cshl

Use ‘wget’ at command line to download pem file

```
Obis-MacBook-Air:~ ogriffit$ cd cshl/
Obis-MacBook-Air:cshl ogriffit$ wget http://genomedata.org/seq-tec-workshop/cshl_2017.pem
--2017-11-10 11:29:03--  http://genomedata.org/seq-tec-workshop/cshl_2017.pem
Resolving genomedata.org... 34.210.251.2
Connecting to genomedata.org|34.210.251.2|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1696 (1.7K)
Saving to: 'cshl_2017.pem'

cshl_2017.pem          100%[=====] 1.66K --.-KB/s in 0s

2017-11-10 11:29:03 (116 MB/s) - 'cshl_2017.pem' saved [1696/1696]
```

```
cd ~/cshl
wget genomedata.org/seq-tec-workshop/cshl_2017.pem
```

Viewing the ‘key’ file once downloaded

```
cat cshl_2017.pem
```

```
obis-air:cshl ogriffit$ cd ~/cshl/
obis-air:cshl ogriffit$ ls -la
total 8
drwxr-xr-x  3 ogriffit  staff   102 Nov 13 22:21 .
drwxr-xr-x+ 58 ogriffit  staff  1972 Nov 13 22:18 ..
-rw-r-----@ 1 ogriffit  staff  1696 Nov 13 22:21 CSHL.pem
obis-air:cshl ogriffit$ cat CSHL.pem
-----BEGIN RSA PRIVATE KEY-----
MIIEpgIBAAKCAQEAvJ5gwmtby9QZ2Idz+ugiEQQHW6Ps0ZAZFvr+mWDnM4pKpccaVmDh7XjcE0LF
0kJzaP9+jj0kSF0yNinitoB32DgrmVhgNhymeEqH5XMn28szxUj1Eu0XAogNuY7mWMo6MoWssSW
Rqy+rj19vMGQn5rsnMLjCM1smebPoqY0L8EPa1ccRbdGXG1dMTlCC1ho/Hk9bZweamGiZLaAWVm
z0K/L0zsgY3K4cwaL48HV6oGuMh5lTDpnobxXghQ4oC5Mej+DpCRF8C+EG2uNDuyuLzRJfQmFBV2
GKDWDwhdgGmKmX9IpMT9ubvNoQPy0vYLvM80eG3cMbZ2IzpaNryihwIDAQABoIBAQCZYT0TvF04
a3DdCEE/C/rN9HMaS+bjFkm0kp9RTi15XJhTPvBmptjzibA6gWJfDaXgKIQGbzxJrEkxwCR2IB03v
0LV7jEcomZ2ggRMDPeJitFoUCuDnkZZtivppSk2az0zeaD+0/ZeqPx0L+Yr+7HSbpVLVoxEV/l5a
xDuCawBMSY2cnGWkfEBLSnPnB6fGZj8luGzv0aP/CETx/K78TIS56m4yrTIQIeEPfFt/PQr/EUqoL
7co5oy9K3sD1noPLDhk3vJa1VNrMjHkMZLkbZua0HPzgSQHninm80Ca25WWTGsSZ8vQsBIUTlGI1
W7lzXH3wD1jJNd+03QK4bnKaZ+DZAoGBAPVpisa49JY/6K2f9B8naqtX/ljzVWTl3Q7r6t6uh21Y
oexmC8ej2wQwd0qNjZWVxSMVksIwdM6xcsBIJRMmltWTVdmD0fkDv0fjd8CM4nctH76tvSvZz02e
qI9wSshHY1fh+09CoLZeefFSURxqWbkJfREjoZ4UGUWMi3k1rxC9AoGBAMTB1BB0WQ+5ojzQYu0L
Q4YrsIPg1/ni0WmJ+05vcTCJ2aeI88VhK5c2PoXPWWiJ9CdD2VFZDiCm2XuJA5iwJmnhuwGGHHe
BFBqEF/ueJrW+r43pRcYRuRIXjih4mQQLK4Zemecym5fAHvxZxq4fs2kWfMPySfaVufcP0VC7X6T
AoGBAMhro0xbxFQwaU0yh9oRhMneGPhn8WtvVjNjc/LcMfmZEtRPGnuhF965/hJCvEhXgiH+8lXo
4NwUixBVtXnA/P0WX5Ea2ykIth2Kkx0Qlb14SEGh7RZ0saRiLqmcZ9gXFpkm6rimByrDMezVr
nU7CcwNWSB0jaOgluZoJv6k5AoGAJJuFsmD5ZhkaS+lTpnlZtXDIk5XsMkYQGQpS0clzqufQPI
UtPEm3Jv9lwTktDQSpqmTifShUcbpaPgtoJ+JjiKvGh7QbxKK7II00kULG760SD+S0U972Rdj3Q
M1aRWHWx1h1kH0vDXFLhuAAU6poVBLR2PRPLbf4k1hmvt05xtAoGBAJVQy1GF8uVNwkOCNzLIqmkY
uk9M24hfqn3N2GY3Zgqf43bD4kdYgL4rvsgp08QzotPf+19kVlCv0ciolSjEHLyUdlyPGzj4CTTH
1f1RoGHmYzVn9VuFTu4hJ17J+uwgXgIr9Sx/UTjwkmCjPf7CEyIuGxaThG/ZoR9stufZB5db
-----END RSA PRIVATE KEY-----obis-air:cshl ogriffit$
```

Changing file permissions of your ‘key’ file (Mac/Linux)

ls -l (long listing)

```
drwx-----+ 67 ogriffit staff 2278 22 May 21:25 ../  
-rw-r--r--@ 1 ogriffit staff 1696 22 May 21:31 cshl_2017.pem  
rwx : owner  
rwx : group  
rwx: world  
r read (4)  
w write (2)  
x execute (1)
```

Whichever way you add these 3 numbers, you know which integers were used (6 is always 4+2, 5 is 4+1, 4 is by itself, 0 is none of them etc ...)

So, when you have:

chmod 400 <file name>

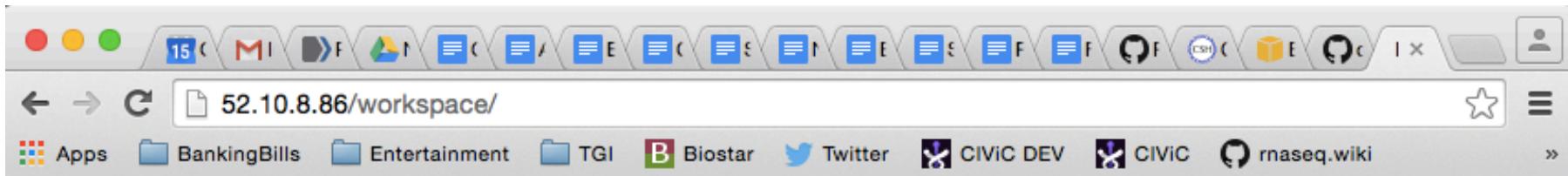
It is “r” for the the file owner **only**

Logging into your instance

Mac/Linux

```
cd ~/cshl  
chmod 400 cshl_2017.pem  
ssh -i cshl_2017.pem ubuntu@[YOUR PUBLIC IP]
```

Copying files from AWS to your computer (using a web browser)



Index of /workspace

	Name	Last modified	Size	Description
	Parent Directory		-	
	Homo sapiens/	2015-11-13 06:45	-	
	README.txt	2014-06-17 23:53	5.3K	
	bam-demo/	2015-11-14 21:03	-	
	data/	2015-11-13 01:39	-	
	scratch/	2015-11-13 19:43	-	
	tools/	2015-11-13 01:54	-	

Apache/2.4.7 (Ubuntu) Server at 52.10.8.86 Port 80

http://[YOUR PUBLIC DNS OR IP]/

Logging out of your instance

Mac/Linux – simply type exit

exit

Note, this disconnects the terminal session (ssh connection) to your cloud instance. But, your cloud instance is still running! See next slide for how to stop your instance.

When you are done for the day you can “Stop” your instance – Don’t Terminate!

The screenshot shows the AWS EC2 Dashboard. On the left, there's a sidebar with various navigation options like EC2 Dashboard, Events, Tags, Reports, Limits, Instances, Images, AMIs, and more. A red arrow points to the 'Instances' tab. In the main area, a table lists several instances. One instance, 'instructor_test2', is selected. A context menu is open over this instance, with 'Instance State' expanded. Under 'Instance State', another red arrow points to the 'Stop' option, which is highlighted. The table columns include Name, Instance ID, Instance Type, Availability Zone, Instance State, Status Checks, Alarm Status, and Public DNS. The 'Instance State' column shows the status of each instance (e.g., running, stopped). The 'Public DNS' column shows the public IP address for each instance.

Go to AWS EC2 Dashboard, select “Instances” tab, then find your instance. Right-click and chose ‘Instance State’ -> ‘Stop’

Next morning, you can “Start” your instance again

The screenshot shows the AWS EC2 Dashboard. On the left sidebar, the 'Instances' tab is selected, indicated by a red arrow. In the main content area, a list of instances is displayed. One instance, named 'JasonWalker' with Instance ID i-3246aae8, is shown as 'stopped'. A context menu is open over this instance, with 'Start' highlighted and another red arrow pointing to it. The menu also includes options like Connect, Get Windows Password, Launch More Like This, Instance Settings, Image, Networking, and CloudWatch Monitoring.

Go to AWS EC2 Dashboard, select “Instances” tab, then find your instance. Right-click and chose ‘Instance State’ -> ‘Start’

When you restart your instance you will need to find your new Public DNS or IP address. Select your instance and “Connect” or look in Description tab. Then go back to instructions for “Logging into your instance”

The screenshot shows the AWS EC2 Instances page. On the left, there's a sidebar with navigation links like EC2 Dashboard, Events, Tags, Reports, Limits, Instances, AMIs, and more. The main area displays a table of instances with columns for Name, Instance ID, Instance Type, Availability Zone, Instance State, Status Checks, Alarm Status, and Public DNS. A red arrow points to the 'Connect' button at the top of the table. Below the table, a specific instance is selected: 'instructor_test2' (Instance ID: i-068e6cdc). The 'Description' tab is active, showing details such as Instance ID, Public DNS (ec2-52-10-8-86.us-west-2.compute.amazonaws.com), Instance state (running), and Public IP (52.10.8.86). Another red arrow points to the Public IP address.

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS
instructor_test2	i-068e6cdc	m3.2xlarge	us-west-2c	running	2/2 checks ...	None	ec2-52-10-8-86.us-wes...
JasonWalker	i-3246aae8	m3.2xlarge	us-west-2c	stopped		None	
pengpeng	i-6740acbd	m3.2xlarge	us-west-2c	stopped		None	
ALesiak	i-0d42aed7	m3.2xlarge	us-west-2c	stopped		None	
djcoughlin	i-3540acef	m3.2xlarge	us-west-2c	stopped		None	
jakesaunders	i-a747ab7d	m3.2xlarge	us-west-2c	stopped		None	
YunjuSung	i-6540acb	m3.2xlarge	us-west-2c	stopped		None	
Jonathan.Wan	i-6640acbc	m3.2xlarge	us-west-2c	stopped		None	
KateD	i-a241ad78	m3.2xlarge	us-west-2c	stopped		None	
JenTudor	i-0e42aed4	m3.2xlarge	us-west-2c	stopped		None	
YanZhang	i-0342aed9	m3.2xlarge	us-west-2c	stopped		None	
ArenMarshall	i-0242aed8	m3.2xlarge	us-west-2c	stopped		None	

Instance: i-068e6cdc (instructor_test2) Public DNS: ec2-52-10-8-86.us-west-2.compute.amazonaws.com

Description Status Checks Monitoring Tags

Instance ID: i-068e6cdc Public DNS: ec2-52-10-8-86.us-west-2.compute.amazonaws.com
Instance state: running Public IP: 52.10.8.86

So, at this point:

- Your Mac desktop is ready for the workshop
- If it is not, you know where to get the information you need
- You know how to login to AWS
- The next step is to login to your linux machine on AWS and learn the basics of a linux command line

Break