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# Advanced Sequencing Technologies & Applications

<http://meetings.cshl.edu/courses.html>



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Introduction to cloud computing

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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/\$)

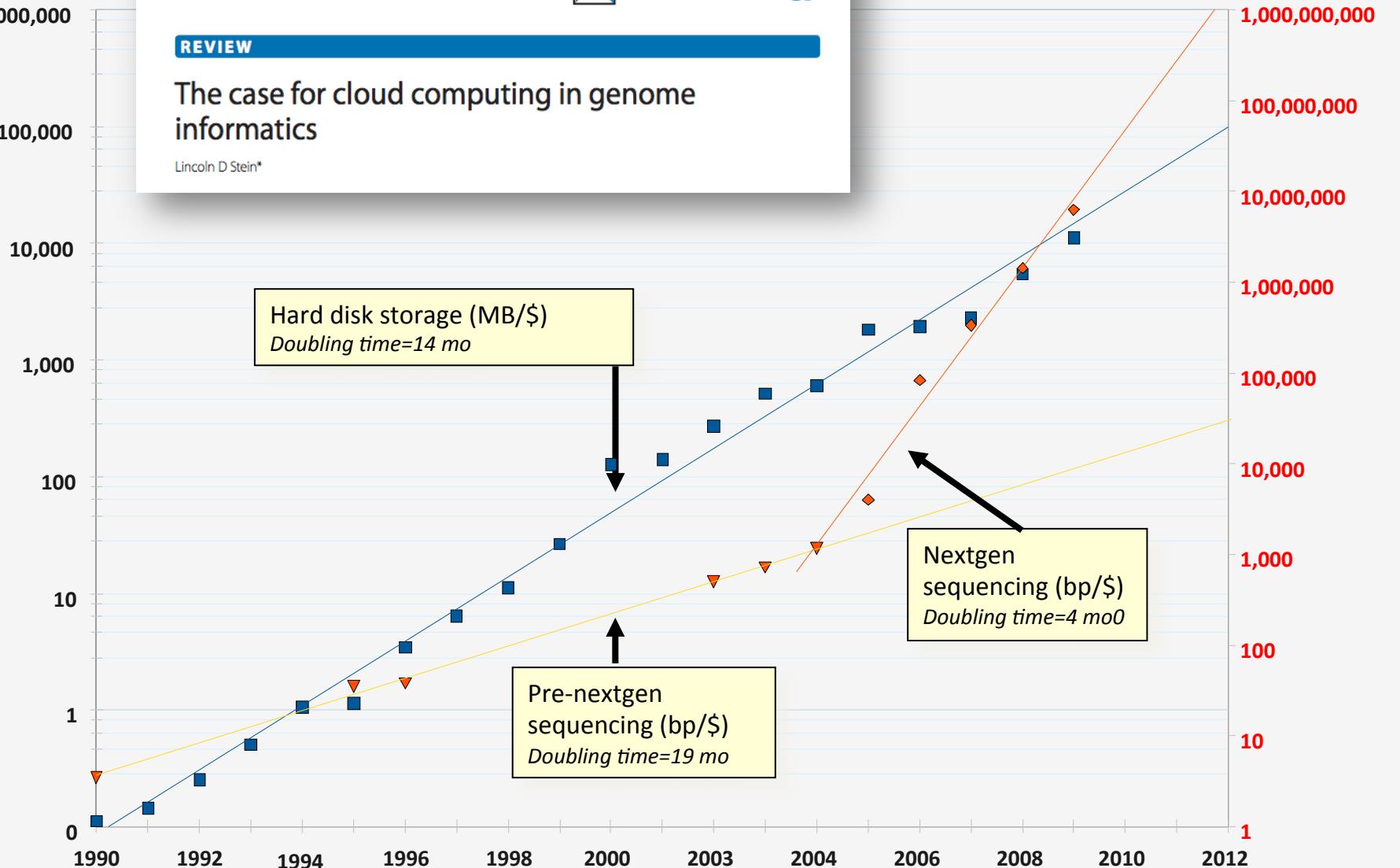
Stein *Genome Biology* 2010, 11:207  
<http://genomebiology.com/2010/11/5/207>



REVIEW

The case for cloud computing in genome informatics

Lincoln D Stein\*



# About DNA and computers

- We'll hit the \$1000 genome during 2015-?, then 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/>
- Others I have not tried:
  - Microsoft Azure (<https://azure.microsoft.com/en-us/>)
  - Rackspace cloud (<http://www.rackspace.com/cloud>)

# 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

# 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 an ftp server
- We brought up an Ubuntu (Linux) instance, and loaded a whole bunch of software for NGS analysis.
- We then cloned this, and made 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.

# Amazon AWS documentation

[https://github.com/griffithlab/rnaseq\\_tutorial/wiki/Intro-to-AWS-Cloud-Computing](https://github.com/griffithlab/rnaseq_tutorial/wiki/Intro-to-AWS-Cloud-Computing)

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

# **Logging into Amazon AWS**

# Login to AWS console



**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://364840684323.signin.aws.amazon.com/console>

# Select "EC2" service

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

**Amazon Web Services**

- Compute
  - EC2** Virtual Servers in the Cloud
  - EC2 Container Service Run and Manage Docker Containers
  - Elastic Beanstalk Run and Manage Web Apps
  - Lambda Run Code in Response to Events
- Storage & Content Delivery
  - S3 Scalable Storage in the Cloud
  - CloudFront Global Content Delivery Network
  - Elastic File System PREVIEW Fully Managed File System for EC2
  - Glacier Archive Storage in the Cloud
  - Import/Export Snowball Large Scale Data Transport
  - Storage Gateway Integrates On-Premises IT Environments with Cloud Storage
- Database
  - RDS Managed Relational Database Service
  - DynamoDB Predictable and Scalable NoSQL Data Store
  - ElastiCache In-Memory Cache
  - Redshift Managed Petabyte-Scale Data Warehouse Service
- Developer Tools
  - CodeCommit Store Code in Private Git Repositories
  - CodeDeploy Automate Code Deployments
  - CodePipeline Release Software using Continuous Delivery
- Management Tools
  - CloudWatch Monitor Resources and Applications
  - CloudFormation Create and Manage Resources with Templates
  - CloudTrail Track User Activity and API Usage
  - Config Track Resource Inventory and Changes
  - OpsWorks Automate Operations with Chef
  - Service Catalog Create and Use Standardized Products
  - Trusted Advisor Optimize Performance and Security
- Internet of Things
  - AWS IoT BETA Connect Devices to the cloud
- Mobile Services
  - Mobile Hub BETA Build, Test, and Monitor Mobile apps
  - Cognito User Identity and App Data Synchronization
  - Device Farm Test Android, Fire OS, and iOS apps on real Cloud
  - Mobile Analytics Collect, View and Export App Analytics
  - SNS Push Notification Service
- Application Services
  - API Gateway Build, Deploy and Manage APIs
  - AppStream Low Latency Application Streaming
  - CloudSearch Managed Search Service
  - Elastic Transcoder Easy-to-use Scalable Media Transcoding
  - SES Email Sending Service
  - SQS Message Queue Service
  - SWF Workflow Service for Coordinating Application Components
- Security & Identity
  - Identity & Access Management Manage User Access and Encryption Keys
  - Directory Service Host and Manage Active Directory
  - Inspector PREVIEW Analyze Application Security
  - WAF Filter Malicious Web Traffic
- Enterprise Applications

**Resource Groups**

A resource group is a collection of resources that share one or more tags. Create a group for each project, application, or environment

**Make sure you are in Oregon region**

**Getting Started** Read our documentation or view our training to learn more about AWS.

**AWS Console Mobile App** View your resources on the go with our AWS Console mobile app, available from Amazon Appstore, Google Play, or iTunes.

**AWS Marketplace** Find and buy software, launch with 1-Click and pay by the hour.

**AWS re:Invent Announcements** Explore the next generation of AWS cloud capabilities. See what's new

**Service Health**

All services operating normally.

Updated: Nov 13 2015 21:17:00 GMT-0500



# 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 2015 AMI in the Community AMIs

The screenshot shows the AWS 'Choose an AMI' wizard at Step 1. The navigation bar includes 'AWS', 'Services', 'Edit', and user information 'cshl.student @ 3648-4068-4323' for 'Oregon'. The steps are: 1. Choose AMI (highlighted), 2. Choose Instance Type, 3. Configure Instance, 4. Add Storage, 5. Tag Instance, 6. Configure Security Group, 7. Review.

**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 left sidebar shows categories: Quick Start, My AMIs, AWS Marketplace, and **Community AMIs** (highlighted with a red arrow). The main area shows search results:

- cshl\_seqtec\_2015\_v2 - ami-28130249**  
Root device type: ebs Virtualization type: hvm  
**Select** button (highlighted with a red arrow)
- cshl\_seqtec\_2015\_v2\_noworkspace - ami-e9100188**  
Root device type: ebs Virtualization type: hvm  
**Select** button (highlighted with a red arrow)  
64-bit

**Search for: cshl\_seqtec\_2015\_v3 - ami-58031239 (US West - Oregon)**

# Choose "m3.2xlarge" instance type, then "Next: Configure Instance Details".

Screenshot of the AWS Step 2: Choose an Instance Type page. The m3.2xlarge row is highlighted with a blue selection bar and has a red arrow pointing to it from the left. The "Review and Launch" button is highlighted with a red box at the bottom right.

	Instance Type	Cores	Memory (GiB)	Storage	Network	RAM	Volume Type
<input 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
<input type="checkbox"/>	General purpose	m4.10xlarge	40	160	EBS only	Yes	10 Gigabit
<input type="checkbox"/>	General purpose	m3.medium	1	3.75	1 x 4 (SSD)	-	Moderate
<input type="checkbox"/>	General purpose	m3.large	2	7.5	1 x 32 (SSD)	-	Moderate
<input type="checkbox"/>	General purpose	m3.xlarge	4	15	2 x 40 (SSD)	Yes	High
<input checked="" type="checkbox"/>	General purpose	m3.2xlarge	8	30	2 x 80 (SSD)		High
<input type="checkbox"/>	Compute optimized	c4.large	2	3.75	EBS only	Yes	Moderate
<input type="checkbox"/>	Compute optimized	c4.xlarge	4	7.5	EBS only	Yes	High
<input type="checkbox"/>	Compute optimized	c4.2xlarge	8	15	EBS only	Yes	High
<input type="checkbox"/>	Compute optimized	c4.4xlarge	16	30	EBS only	Yes	High
<input type="checkbox"/>	Compute optimized	c4.8xlarge	36	60	EBS only	Yes	10 Gigabit

Step 2: Choose an Instance Type

1. Choose AMI    2. Choose Instance Type    3. Configure Instance    4. Add Storage    5. Tag Instance    6. Configure Security Group    7. Review

Cancel Previous Review and Launch Next: Configure Instance Details

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

The screenshot shows the AWS Launch Wizard interface for creating a new Amazon EC2 instance. The top navigation bar includes links for AWS services, user information (cshl.student @ 3648-4068-4323), and regions (Oregon). Below the navigation, a progress bar indicates the current step is "3. Configure Instance".

**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.

The configuration fields shown include:

- Number of instances:** 1
- Purchasing option:** Request Spot instances (unchecked)
- Network:** vpc-ebcc188e (172.31.0.0/16) (default) - Create new VPC
- Subnet:** No preference (default subnet in any Availability Zone) - Create new subnet
- Auto-assign Public IP:** Use subnet setting (Enable)
- IAM role:** None - Create new IAM role
- Shutdown behavior:** Stop
- Enable termination protection:** Protect against accidental termination (checked, highlighted with a red arrow)
- Monitoring:** Enable CloudWatch detailed monitoring (unchecked)
- Tenancy:** Shared tenancy (multi-tenant hardware)

At the bottom right, there are buttons for **Cancel**, **Previous**, **Review and Launch**, and **Next: Add Storage**. The **Next: Add Storage** button is highlighted with a red box.

You should see "snap-xxxxxxx" (32GB) and "snap-xxxxxxx" (500GB) 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.

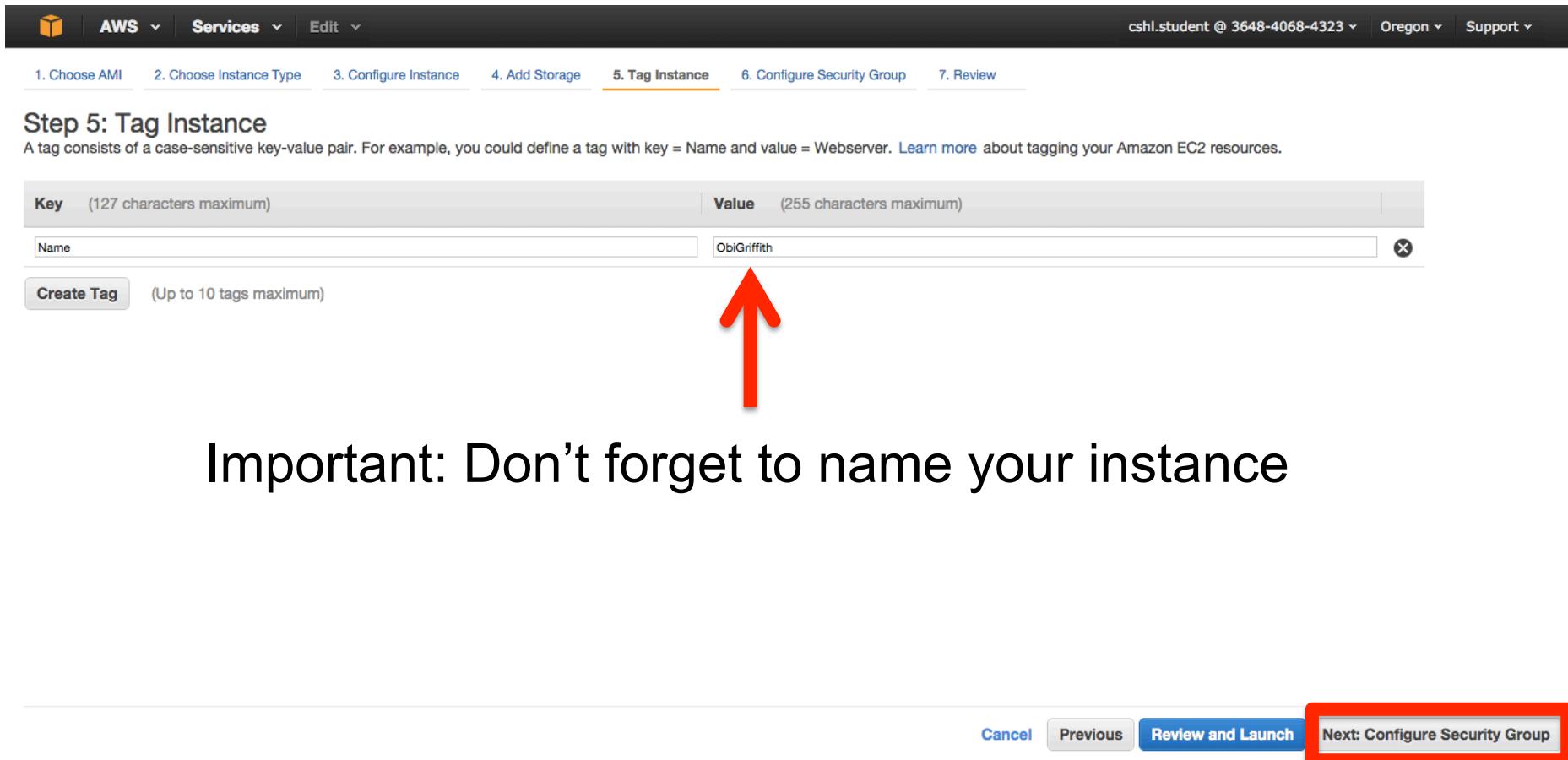
Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Delete on Termination	Encrypted
Root	/dev/sda1	snap-6f450833	32	General Purpose (SSD)	96 / 3000	<input checked="" type="checkbox"/>	Not Encrypted
EBS	/dev/sdb	snap-11e6954e	500	General Purpose (SSD)	1500 / 3000	<input checked="" type="checkbox"/>	Not Encrypted

Add New Volume

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 wizard at Step 5: Tag Instance. The top navigation bar includes links for Choose AMI, Choose Instance Type, Configure Instance, Add Storage, Tag Instance (which is highlighted in orange), Configure Security Group, and Review. The main section is titled "Step 5: Tag Instance" with the sub-instruction: "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." Below this, there are two input fields: "Key" (Name) and "Value" (ObiGriffith). A "Create Tag" button is visible below the Value field. At the bottom, there are buttons for Cancel, Previous, Review and Launch (which is highlighted in blue), and Next: Configure Security Group.

Select an Existing Security Group, choose "SSH\_HTTP\_8081\_IN\_ALL\_OUT". Then hit "Review and Launch".

Screenshot of the AWS EC2 instance creation wizard, Step 6: Configure Security Group.

The screenshot shows the configuration of a security group for a new EC2 instance. The security group selected is "SSH\_HTTP\_8081\_IN\_ALL\_OUT", which allows incoming traffic on ports 80, 22, and 8081 and all outgoing traffic. Red arrows point to the "Select an existing security group" radio button and the selected security group row in the list.

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-64d8be01	default	default VPC security group	<a href="#">Copy to new</a>
sg-5a53633f	SSH_HTTP_8081_IN_ALL_OUT	Allow web, ssh, and GMS class viewer incoming and all outgoing	<a href="#">Copy to new</a>

Inbound rules for sg-5a53633f (Selected security groups: sg-5a53633f)

Type	Protocol	Port Range	Source
HTTP	TCP	80	0.0.0.0/0
SSH	TCP	22	0.0.0.0/0
Custom TCP Rule	TCP	8081	0.0.0.0/0

Buttons at the bottom:

- 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 <span style="color: red;">←</span>		High

**Security Groups**

[Edit security groups](#)

Cancel Previous Launch

# Choose an existing key pair: "CSHL" and then Launch.

The screenshot shows the AWS Step 7: Review Instance Launch interface. On the left, there are several informational boxes: one about instance configuration being not eligible for free tier, another about improving security by opening ports, and a third about AMI details (cshl\_seqtec\_2015\_v2 - ami-281302). Below these are sections for Instance Type (m3.2xlarge) and Security Groups. A large central modal dialog is open, titled "Select an existing key pair or create a new key pair". It contains instructions about key pairs, a note about selected key pairs being added to the instance's authorized keys, and a checkbox for acknowledging access to the private key file. Red arrows point to the "Choose an existing key pair" dropdown, the "Select a key pair" dropdown containing "CSHL", and the checkbox. The "Launch Instances" button at the bottom right of the modal is also highlighted with a red box. The background shows the rest of the AWS interface with tabs for Step 1 through Step 7.

# 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, and Support, along with user information (cshl.student @ 3648-4068-4323) and location (Oregon). Below the navigation is a section titled "Launch Status" with a green checkmark icon and the message "Your instances are now launching". It also shows the instance ID i-45e4089f and a link to "View launch log". There's a "Get notified of estimated charges" section with a speech bubble icon, explaining how to create billing alerts for estimated charges. The main content area has a heading "How to connect to your instances" followed by instructions and helpful resources. A red call-to-action button at the bottom right says "View Instances".

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

## 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

The screenshot shows the AWS EC2 Instances page. The 'Connect' button in the top navigation bar is highlighted with a red box and an arrow points to the selected instance, 'ObiGriffith'. The instance details are displayed below, including its Public DNS and IP address.

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 IP address 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.

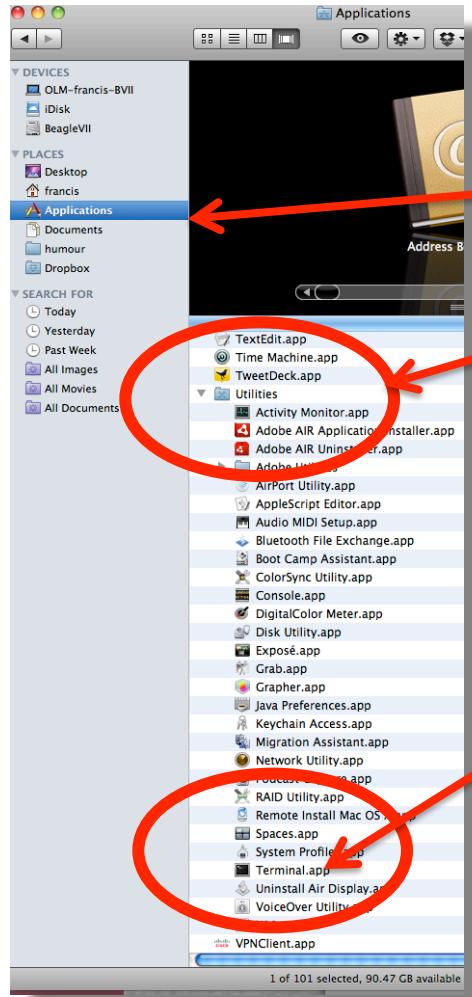
If you need any assistance connecting to your instance, please see our [connection documentation](#).

Close

On the right side of the dashboard, a table lists several instances with their Public DNS and Public IP addresses. The table includes columns for Public DNS, Public IP, and Status.

Public DNS	Public IP	Status
ec2-52-33-240-196.us-west-2.compute.amazonaws.com	52.33.240.196	C
ec2-52-34-44-168.us-west-2.compute.amazonaws.com	52.34.44.168	in
ec2-52-10-59-49.us-west-2.compute.amazonaws.com	52.10.59.49	C
ec2-52-34-43-79.us-west-2.compute.amazonaws.com	52.34.43.79	C
ec2-52-11-219-138.us-west-2.compute.amazonaws.com	52.11.219.138	in

# Opening a ‘terminal session’ on a Mac

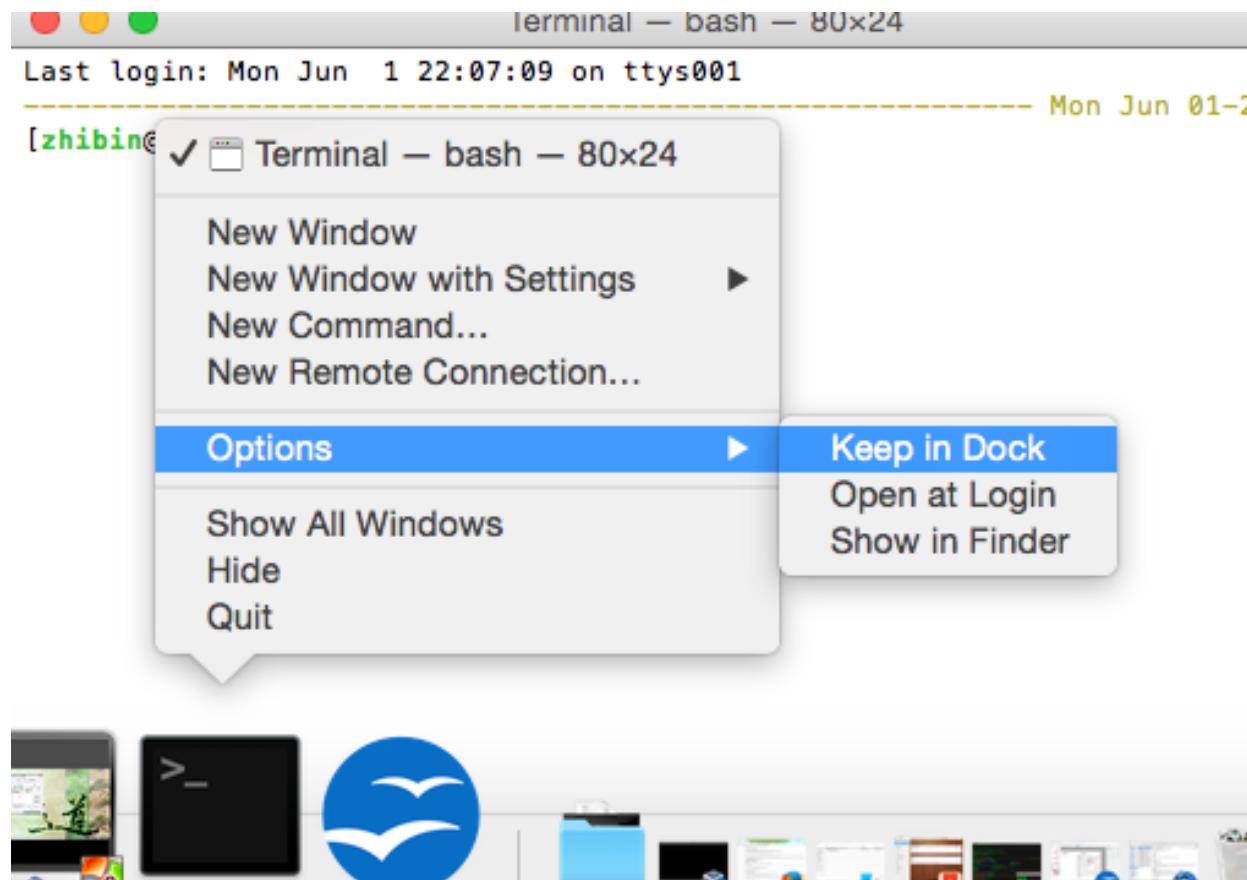


In a Finder window  
'Applications' -> 'Utilities' -> 'Terminal'



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$ █
```

# Obtain your AWS ‘key’ file from course wiki

<a href="#"> Resources</a>
<a href="#"> Roster</a>
<a href="#"> Forums</a>
<a href="#"> Drop Box</a>
<a href="#"> Chat Room</a>
<a href="#"> Email Archive</a>
<a href="#"> Meetings &amp; Courses</a>
<a href="#"> CSHL RSS</a>
<a href="#"> Statistics</a>
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## Presentations

20th November (Friday)

19th November (Thursday)

18th November (Wednesday)

17th November (Tuesday)

- ↗ [Informatics for RNA-seq: A web resource for analysis on the cloud](#)

16th November (Monday)

- ↗ [Obi, Malachi & Jason: Informatics for RNA-seq: A web resource for analysis on the cloud](#)

15th November (Sunday)

14th November (Saturday)

↗ [Malachi Griffith & Obi Griffith: Introducing AWS](#)

↗ [AWS Sign In Console](#)

- Username : cshl.student
- Password : seqtec

Connect to AWS via Terminal

- ↗ [Download CSHL.pem](#)
- chmod 400 CSHL.pem
- ssh -i CSHL.pem ubuntu@YOUR\_IP\_ADDRESS

↗ [Jason Walker: Unix Command-line Bootcamp](#)

Go to course wiki,  
“Presentations”  
page

On Mac:  
Control+  
Save Link As

Save key file to  
your new ‘cshl’  
directory

# Viewing the ‘key’ file once downloaded

```
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+jj0kSF0yNinitoB32DgrmVhgNhyheEqH5XMn28szxUj1Eu0NXAogNuY7mWMo6MoWssSW
Rqy+rj19vMGQn5rsnMLjCM1smebPoqY0L8EPa1ccRbdGXG1dMTlCC1ho/Hk9bZweamGiZLaAWVm
z0K/L0zxgY3K4cwaL48HV6oGuMh5lTDpnobxXghQ4oC5Mej+DpCRF8C+EG2uNDuyuLzRJfQmFBV2
GKDWDwhdgGmKmX9IpMT9ubvNoQPy0vYLvM80eG3cMbZ1ZpaNryihwIDAQABoIBAQCZYT0TvF04
a3DdCEEC/rN9HmA+S+bjFkm0kp9RTi15XJhTPvBmptjzibA6gWJfDaXgKIQGbzxrEkxwCR2IB03v
0LV7jEcomZ2ggRMDPeJitFoUCuDnkZTivppSk2az0zeaD+0/ZeqPx0L+Yr+7HSbpVLVoxEV/l5a
xDuCawBMSY2cnGWKfEB1SPnB6fGZj8luGzv0aP/CETx/K78TIS56m4yrTIQIeEPfFt/PQr/EUqoL
7co5oy9K3sD1noPLDhk3vJa1VNrMjHkMZLkbZua0HPzgSQHninm80Ca25WWTGsSZ8vQsBIUTlGI1
W7lzXH3wD1jJNd+03QK4bnKaZ+DZAoGBAPVpisa49JY/6K2f9B8naqtX/ljzVWTl3Q7r6t6uh21Y
oexmC8eJ2wQwd0qNjZWVxSMVksIwdM6xcsBIJRm1tWTvdmD0fkDv0fjd8CM4nctH76tvSvZz02e
qI9wSshHY1fh+09CoLZeefFSURxqWbkJfREjoZ4UGUWMi3k1rxC9AoGBAMTB1BB0WQ+5ojzQYu0L
Q4YrsIPg1/ni0WmJ+05vcTCJ2aeI88VhK5c2PoXPWWiJ9CdD2VFZDiCm2XuJA5iwJmnhuwGGHHEn
BFBqEF/ueJrW+r43pRcYRuRIXjiH4mQQLK4Zemecym5fAHvxZxq4fs2kWfMPySFaVufcP0VC7X6T
AoGBAMhra0xbxFQwaU0yh9oRhMneGPhn8WtvVjNjc/LcMfmZEtRPGnuhF965/hJCvEhXgiH+8lXo
4NwUixBVtXnA/P0WX5Ea2ykIth2Kkx0Qlb14SEGhQH7RZ0saRiLqmcZ9gXFpkm6rimByrDMezVr
nU7CcwNWSB0ja0gluZoJv6k5AoGBAJJuFsmD5ZhkaS+lTtpn1ZtXDIK5XsMkYQGQpS0clzqufQPI
UtPEm3Jv9lwTktDQSpmTifShUcbpaPgtoJ+JjiKvGhH7QbxKK7II00kULG760SD+SOU972Rdj3Q
M1aRWHWxlH1kH0vDXFLhuAAU6poVBLR2PRPLbf4k1hmvt05xtAoGBAJVQy1GF8uVNwk0CNzLIqmky
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.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>**

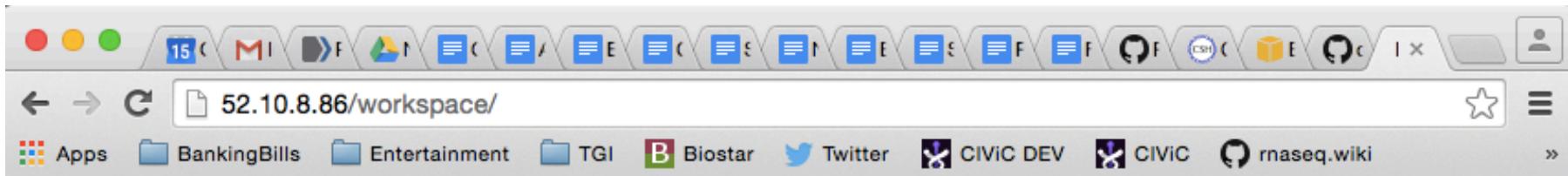
It is “r” for the the file owner **only**

# Logging into your instance

## Mac/Linux

```
cd cshl/  
chmod 400 CSHL.pem  
ssh -i CSHL.pem ubuntu@[YOUR INSTANCE IP ADDRESS]
```

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



## Index of /workspace

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

*Apache/2.4.7 (Ubuntu) Server at 52.10.8.86 Port 80*

**http://[YOUR INSTANCE IP ADDRESS]/**

# 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 navigation links like EC2 Dashboard, Events, Tags, Reports, Limits, Instances, Images, and Network & Security. 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 specific instance, 'instructor\_test2', is selected. A context menu is open over this instance, with 'Instance State' expanded to show options: Connect, Get Windows Password, Launch More Like This, Start, Stop, Reboot, and Terminate. A red arrow points to the 'Stop' option. At the bottom of the dashboard, there's a red box containing the text: 'Find your instance in the AWS EC2 Dashboard Right-click and chose 'Instance State' -> 'Stop''.

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-0242aed8	m3.2xlarge	us-west-2c	stopped		None	
pengpeng	i-0342aed9	m3.2xlarge	us-west-2c	stopped		None	
ALesiak	i-0e42aed4	m3.2xlarge	us-west-2c	stopped		None	
djcoughlin	i-a241ad78	m3.2xlarge	us-west-2c	stopped		None	
jakesaunders	i-6640acbc	m3.2xlarge	us-west-2c	stopped		None	
YunjuSung		m3.2xlarge	us-west-2c	stopped		None	
Jonathan.Wan		m3.2xlarge	us-west-2c	stopped		None	
KateD		m3.2xlarge	us-west-2c	stopped		None	
JenTudor		m3.2xlarge	us-west-2c	stopped		None	
YanZhang		m3.2xlarge	us-west-2c	stopped		None	
ArenMarshall		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

Find your instance in the AWS EC2 Dashboard  
Right-click and chose 'Instance State' -> 'Stop'

# Next morning, you can “Start” your instance again

The screenshot shows the AWS EC2 Dashboard with the 'Instances' section selected. A context menu is open over an instance named 'JasonWalker' which is currently 'stopped'. The menu is titled 'Instance State' and includes options: Start, Stop, Reboot, Terminate, and CloudWatch Monitoring. A red arrow points to the 'Start' option. Below the table, a callout box contains the text: 'Find your instance in the AWS EC2 Dashboard Right-click and chose 'Instance State' -> 'Start''. The table lists various instances with their names, instance IDs, types, availability zones, states, and public DNS addresses.

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-0cbdbd	m3.2xlarge	us-west-2c	stopped		None	
ALesiak	i-0ed7	m3.2xlarge	us-west-2c	stopped		None	
djcoughlin	i-0fcd7e	m3.2xlarge	us-west-2c	stopped		None	
jakesaunders	i-0fcd7f	m3.2xlarge	us-west-2c	stopped		None	
YunjuSung	i-0fcd7g	m3.2xlarge	us-west-2c	stopped		None	
Jonathan.Wan	i-0fcd7h	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-3246aae8 (JasonWalker) Private IP: 172.31.5.175

Find your instance in the AWS EC2 Dashboard  
Right-click and chose 'Instance State' -> 'Start'

**When you restart your instance you will need to find your new 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 for EC2 Dashboard, Events, Tags, Reports, Limits, Instances, AMIs, Elastic Block Store, Network & Security, Load Balancing, and Auto Scaling. The main area displays a table of instances. A red arrow points to the 'Connect' button at the top of the table header. Another red arrow points to the 'Public IP' field in the instance details section at the bottom right.

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-west-2...
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