



Canadian Bioinformatics Workshops

www.bioinformatics.ca

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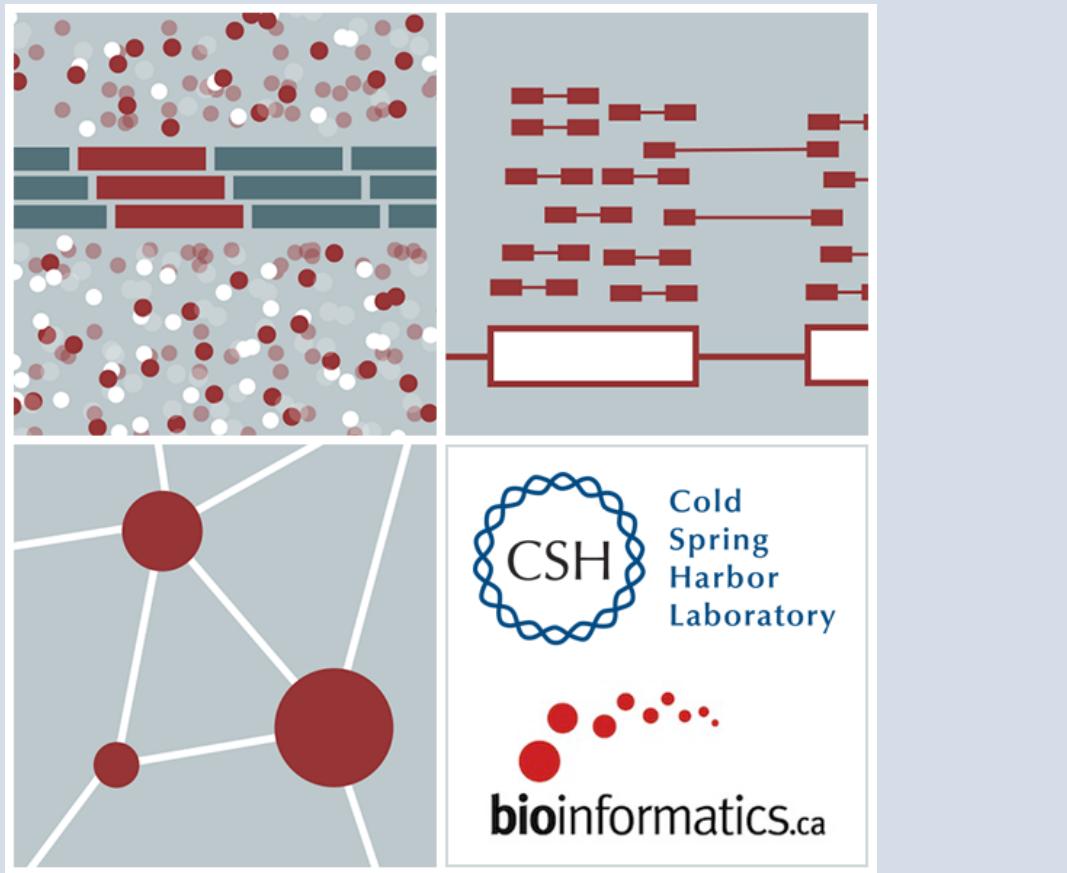
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Introduction to cloud computing

Malachi Griffith, Obi Griffith, Fouad Yousif
Slides courtesy of Francis Ouellette

High-Throughput Biology: From Sequence to Networks
March 20-26, 2017



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/\$)

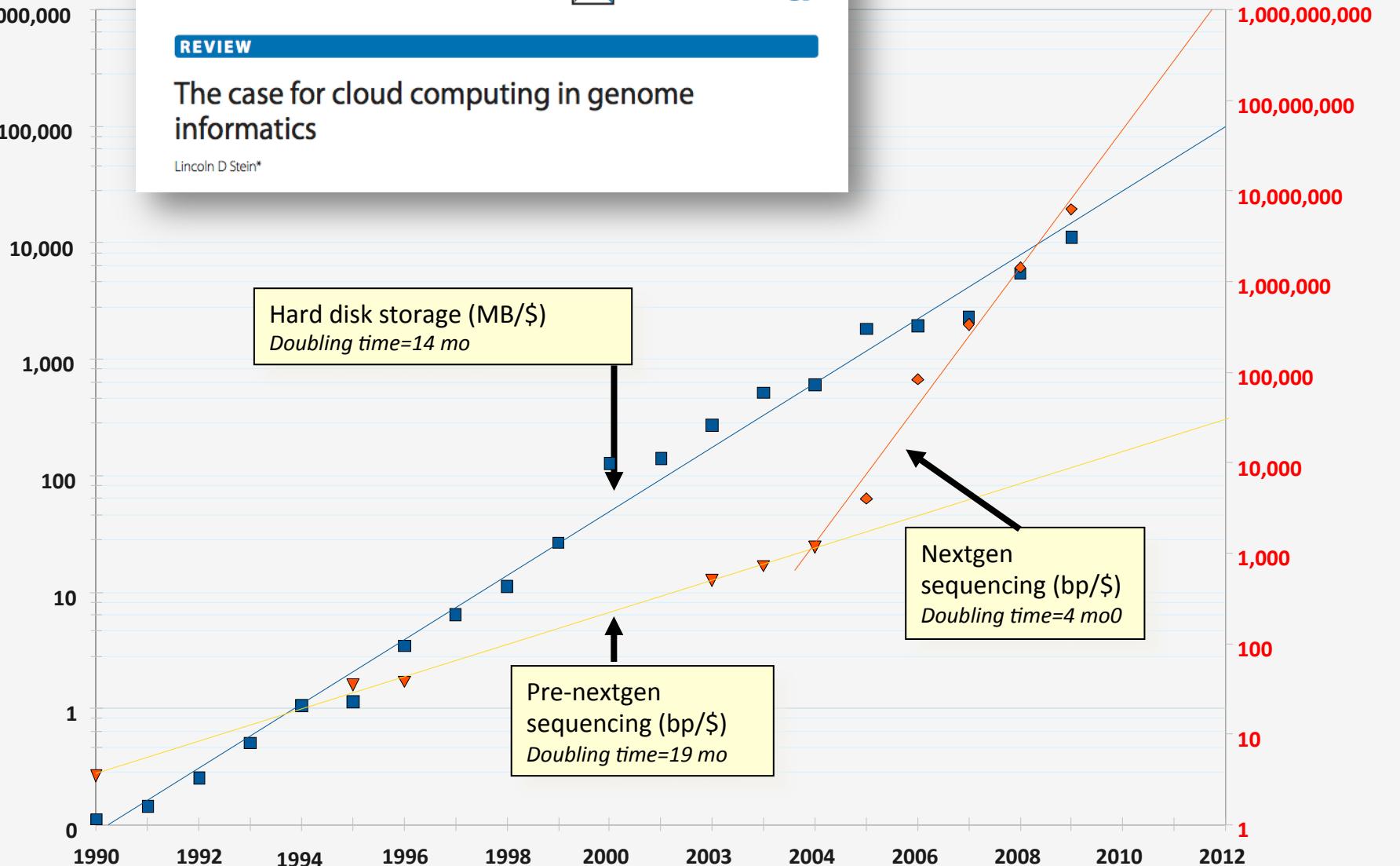
Stein *Genome Biology* 2010, 11:207
<http://genomebiology.com/2010/11/5/207>



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 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.

Amazon AWS documentation

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

The screenshot shows the AWS Management Console homepage. At the top, there is a navigation bar with icons for AWS, Services, Edit, and user information (cshl.student @ 3648-4068-4323, Oregon, Support). Below the navigation bar is a section titled "Shortcuts and Recently Viewed Services" featuring two boxes: one for IAM (with a key icon) and one for EC2 (with a server icon). A large red arrow points from the text "Select 'EC2' service" 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 second red arrow points upwards from the "Oregon" region label to the "Oregon" link in the top navigation bar. The main content area contains sections for "Quick Starts" (Build a web app, Launch a Virtual Machine (EC2 Instance), Back up your files, Build a back end for your mobile app, Host a static website, Analyze big data) and "AWS Services" (Compute, Storage & Content Delivery, Database, Developer Tools, Management Tools, Security & Identity, Internet of Things, Game Development, Mobile Services, Application Services). On the right side, there is a callout "Make sure you are in Oregon region" with a red arrow pointing to the "Oregon" link.

Shortcuts and Recently Viewed Services

AWS Services

Services

Edit

cshl.student @ 3648-4068-4323

Oregon

Support

Service Health

All services are operating normally.

Updated Nov 10 2016 15:34:00 GMT-0600

View Dashboard

Quick Starts Hide

Build a web app Start now

Launch a Virtual Machine (EC2 Instance)

Back up your files Learn more

Build a back end for your mobile app Start now

Host a static website

Analyze big data Learn more

AWS Services Show categories

Search services

Compute

EC2

EC2 Container Service

Elastic Beanstalk

Lambda

Server Migration

Storage & Content Delivery

S3

CloudFront

Elastic File System

Glacier

Snowball

Storage Gateway

Database

Developer Tools

CodeCommit

CodeDeploy

CodePipeline

Management Tools

CloudWatch

CloudFormation

CloudTrail

Config

OpsWorks

Service Catalog

Trusted Advisor

Internet of Things

AWS IoT

Game Development

GameLift

Mobile Services

Mobile Hub

Cognito

Device Farm

Mobile Analytics

SNS

Application Services

API Gateway

AppStream

Security & Identity

IAM

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

Screenshot of the AWS EC2 Dashboard showing the 'Create Instance' section. A red arrow points to the 'Launch Instance' button.

The dashboard shows the following resource counts:

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

A message box suggests using Chef recipes and OpsWorks.

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

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 ★★★★☆

Choose an AMI – Find the CSHL SEQTEC 2016 AMI in the Community AMIs

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.

Quick Start

My AMIs

AWS Marketplace

Community AMIs

Operating system

- Amazon Linux
- Cent OS
- Debian
- Fedora
- Gentoo
- OpenSUSE
- Other Linux
- Red Hat
- SUSE Linux
- Ubuntu
- Windows

cshl_seqtec_2015_v2 - ami-28130249

Root device type: ebs Virtualization type: hvm

cshl_seqtec_2015_v2_noworkspace - ami-e9100188

Root device type: ebs Virtualization type: hvm

Cancel and Exit

1 to 2 of 2 AMIs

Select

64-bit

Select

64-bit

Search for: cshl_seqtec_2016_v3 (US West - Oregon)

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

Screenshot of the AWS EC2 instance creation wizard, Step 2: Choose an Instance Type. The instance type **m4.2xlarge** is selected. A red arrow points to the **m4.2xlarge** row in the table, and a red box highlights the **Next: Configure Instance Details** button.

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".

The screenshot shows the AWS Launch Wizard interface for launching an Amazon Linux 2 AMI 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 steps: 1. Choose AMI, 2. Choose Instance Type, 3. Configure Instance (highlighted in orange), 4. Add Storage, 5. Tag Instance, 6. Configure Security Group, and 7. Review.

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 (highlighted with a red arrow)

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** (button highlighted with a red box)

You should see "snap-xxxxxxx" (32GB) and "snap-yyyyyyy" (80GB) 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 icons for Home, AWS Services, Edit, and account information (cshl.student @ 3648-4068-4323, Oregon, Support). Below the navigation is a progress bar with steps 1 through 7. Step 5, "Tag Instance", is highlighted with an orange underline. The main area 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." It features two input fields: "Key" (127 characters maximum) and "Value" (255 characters maximum). The "Value" field contains the text "ObiGriffith". A red arrow points upwards from the bottom of the page towards this value field. At the bottom are buttons for "Create Tag" (disabled), "Cancel", "Previous", "Review and Launch" (highlighted in blue), and "Next: Configure Security Group" (surrounded by a red box).

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

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

The screenshot shows the configuration of an existing security group named "SSH_HTTP". A red arrow points to the "Select an existing security group" radio button, and another red arrow points to the selected security group "SSH_HTTP".

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

At the bottom right, the "Review and Launch" button is highlighted with a red box.

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

The screenshot shows the AWS Step 7: Review Instance Launch interface. At the top, there's a navigation bar with tabs: 1. Choose AMI, 2. Choose Instance Type, 3. Configure Instance, 4. Add Storage, 5. Tag Instance, 6. Configure Security Group, and 7. Review. The 7. Review tab is highlighted.

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](#)

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

Choose an existing key pair: "CSHL_2016" and then Launch.

Screenshot of the AWS Step 7: Review Instance Launch page. The "Select an existing key pair or create a new key pair" modal is open, showing the "CSHL_2016" key pair selected. Red arrows point to the "Select a key pair" dropdown and the "Launch Instances" button. The "Launch" button is highlighted with a red box.

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 using a security group 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

Instance Type

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

Security Groups

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

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. The status bar indicates the user is at 3648-4068-4323 in Oregon.

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 Dashboard. The 'Instances' section is selected in the sidebar. The main area displays a table of running instances. A red arrow points to the 'ObiGriffith' instance, which is highlighted with a blue selection bar. Above the table, there are tabs for 'Launch Instance', 'Connect' (which is highlighted with a red box), and 'Actions'. Below the table, a detailed view of the selected instance (i-45e4089f) is shown, including its Public DNS, Instance ID, Instance state, Instance type, Private DNS, Public IP, and Availability zone.

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 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](#).

At the bottom right of the modal is a 'Close' button.

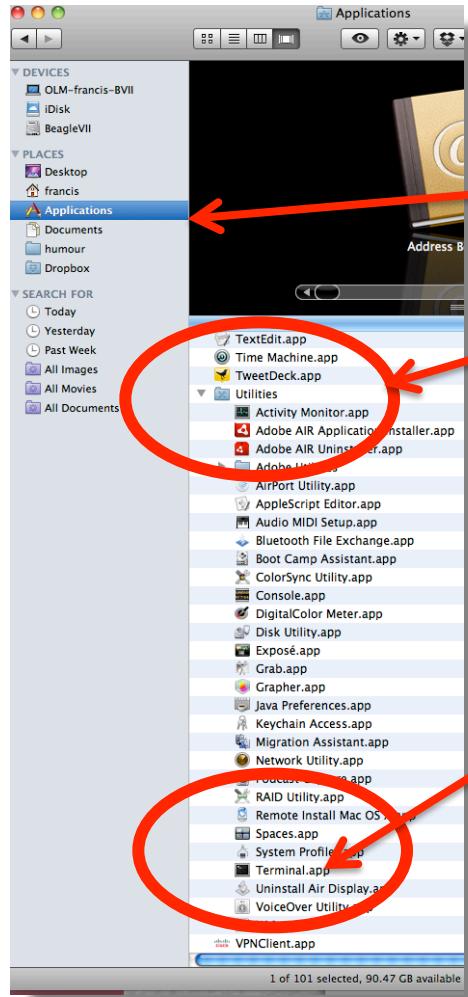
Below the modal, the EC2 dashboard shows a list of instances with columns for Public DNS, Public IP, and Status. One instance is highlighted: ec2-52-33-240-196.us-west-2.compute.amazonaws.com (Public DNS: 52.33.240.196, Public IP: 52.33.240.196, Status: in).

Navigation bar at the top: AWS Services Edit cshl.student @ 3648-4068-4323 Oregon Support

Left sidebar menu: EC2 Dashboard, Events, Tags, Reports, Limits, Instances, Instances (selected), Spot Requests, Reserved Instances, Commands, AMIs, AMIs, Bundle Tasks, Elastic Block Store, Volumes, Snapshots, Network & Security, Security Groups, Elastic IPs, Placement Groups, Key Pairs, Network Interfaces, Load Balancing, Load Balancers.

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Opening a ‘terminal session’ on a Mac

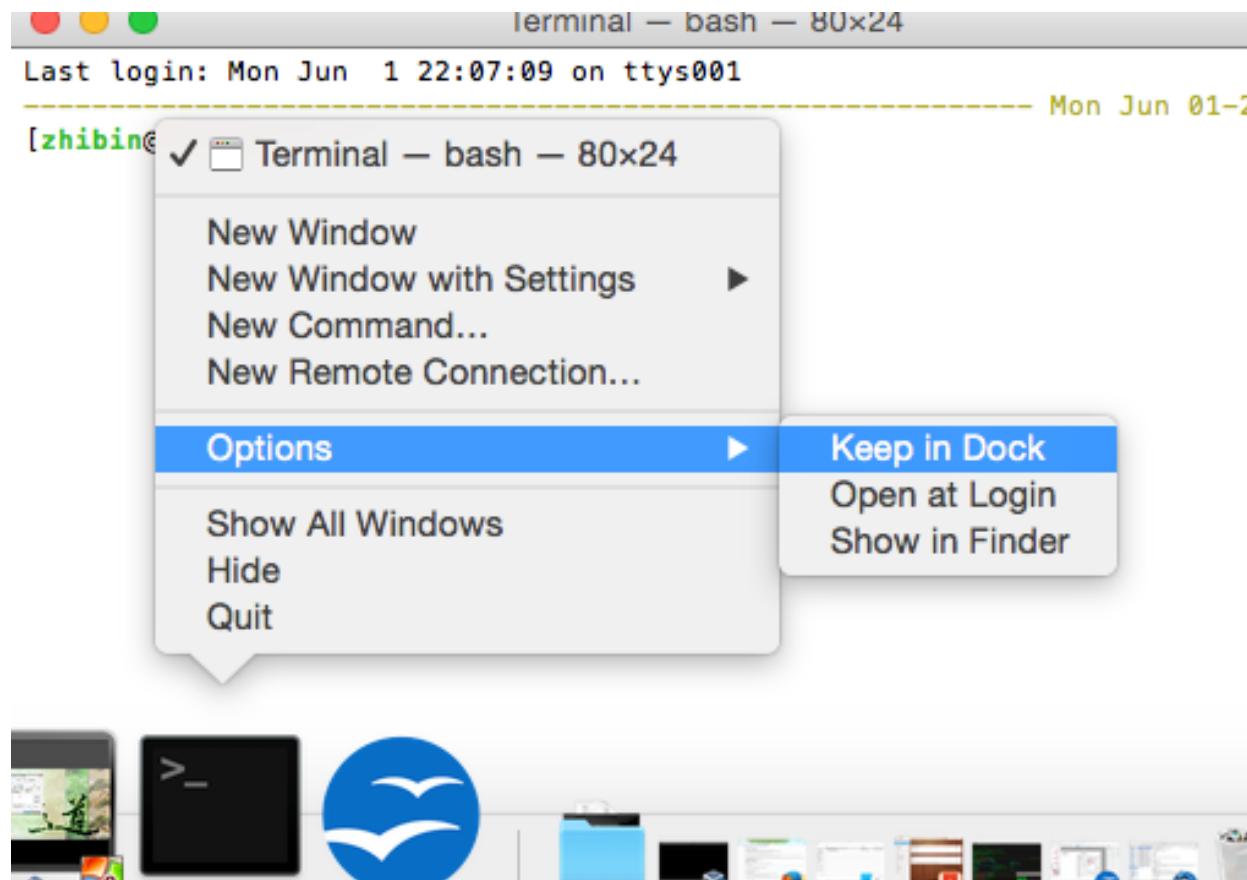


In a Finder window
‘Applications’ -> ‘Utilities’ -> ‘Terminal’



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

Obtain your AWS ‘key’ file from course wiki

 Resources
 Roster
 Forums
 Drop Box
 Chat Room
 Email Archive
 Meetings & Courses
 CSHL RSS
 Statistics
 Site Info
 Help

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: Intro to Cloud Computing](#)

↗ [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
0LV7jEcomZ2ggRMDPeJitFoUCuDnkZztivppSk2az0zeaD+0/ZeqPx0L+Yr+7HSbpVLVoxEV/l5a
xDuCawBMSY2cnGWKfEB1SPnB6fGZj8luGzv0aP/CETx/K78TIS56m4yrTIQIeEPfFt/PQr/EUqoL
7co5oy9K3sD1noPLDhk3vJa1VNMrMjHkMZLkbZua0HPzgSQHninm80Ca25WWTGsSZ8vQsBIUTlGI1
W7lzXH3wD1jJNd+03QK4bnKaZ+DZAoGBAPVpisa49JY/6K2f9B8naqtX/ljzVWTl3Q7r6t6uh21Y
oexmC8eJ2wQwd0qNjZWVxSMVksIwdM6xcsBIJRmlltWTVdmD0fkDv0fjd8CM4nctH76tvSvZz02e
qI9wSshHY1fh+09CoLZeefFSURxqWbkJfREjoZ4UGUWMi3k1rxC9AoGBAMTB1BB0WQ+5ojzQYu0L
Q4YrsIPg1/ni0WmJ+05vcTCJ2aeI88VhK5c2PoXPWWiJ9CdD2VFZDiCm2XuJA5iwJmnhuwGGHHEn
BFBqEF/ueJrW+r43pRcYRuRIXjiH4mQQLK4Zemecym5fAHvxZxq4fs2kWfMPySFaVufcP0VC7X6T
AoGBAMhra0xbxFQwaU0yh9oRhMneGPhn8WtvVjNjc/LcMfmZEtRPGnuhF965/hJCvEhXgiH+8lXo
4NwUixBVtXnA/P0WX5Ea2ykIth2Kkx0Qlb14SEGhQH7RZ0saRiLqmcZ9gXFpkm6rimByrDMezVr
nU7CcwNWSB0ja0gluZoJv6k5AoGBAJJuFsmD5ZhkaS+lTtpnlZtXDIK5XsMkYQGQpS0clzqufQPI
UtPEm3Jv9lwTktDQSpmTifShUcbpaPgtoJ+JjiKvGhH7QbxKK7II00kULG760SD+SOU972Rdj3Q
M1aRWHWxlH1kH0vDXFLhuAAU6poVBLR2PRPLbf4k1hmv05xtAoGBAJVQy1GF8uVNwk0CNzLIqmKY
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>

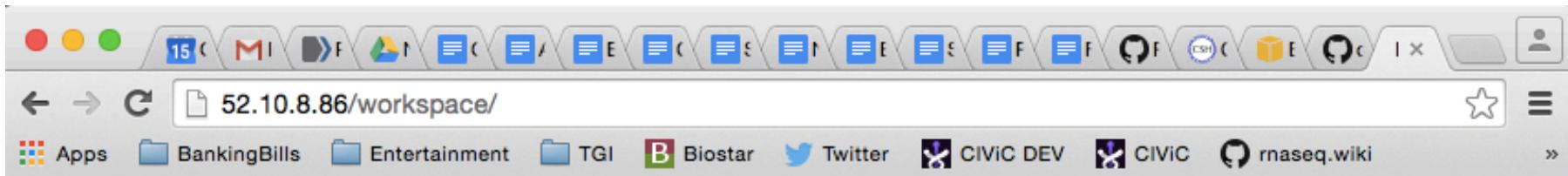
It is “r” for the the file owner **only**

Logging into your instance

Mac/Linux

```
cd cshl/  
chmod 400 CSHL.pem  
ssh -i CSHL.pem ubuntu@[YOUR PUBLIC DNS]
```

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]/`

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, 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' link in the sidebar. In the main content area, there's a table of instances. One instance named 'JasonWalker' is highlighted with a red box and has a context menu open over it. The context menu has several options: Connect, Get Windows Password, Launch More Like This, Instance State, Instance Settings, Image, Networking, CloudWatch Monitoring, and Terminate. The 'Instance State' option is expanded, and its sub-option 'Start' is also highlighted with a red arrow. Below the table, there's a status bar showing 'Instance: i-3246aae8 (JasonWalker)' and 'Private IP: 172.31.5.175'. A large red box encloses the entire central area of the dashboard.

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, Instance state, Public DNS, and Public IP. A second red arrow points to the 'Public IP' field, which contains '52.10.8.86'. The status bar at the bottom indicates the Public DNS is 'ec2-52-10-8-86.us-west-2.compute.amazonaws.com'.

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

We are on a Coffee Break &
Networking Session