



Cold
Spring
Harbor
Laboratory

Introduction to cloud computing

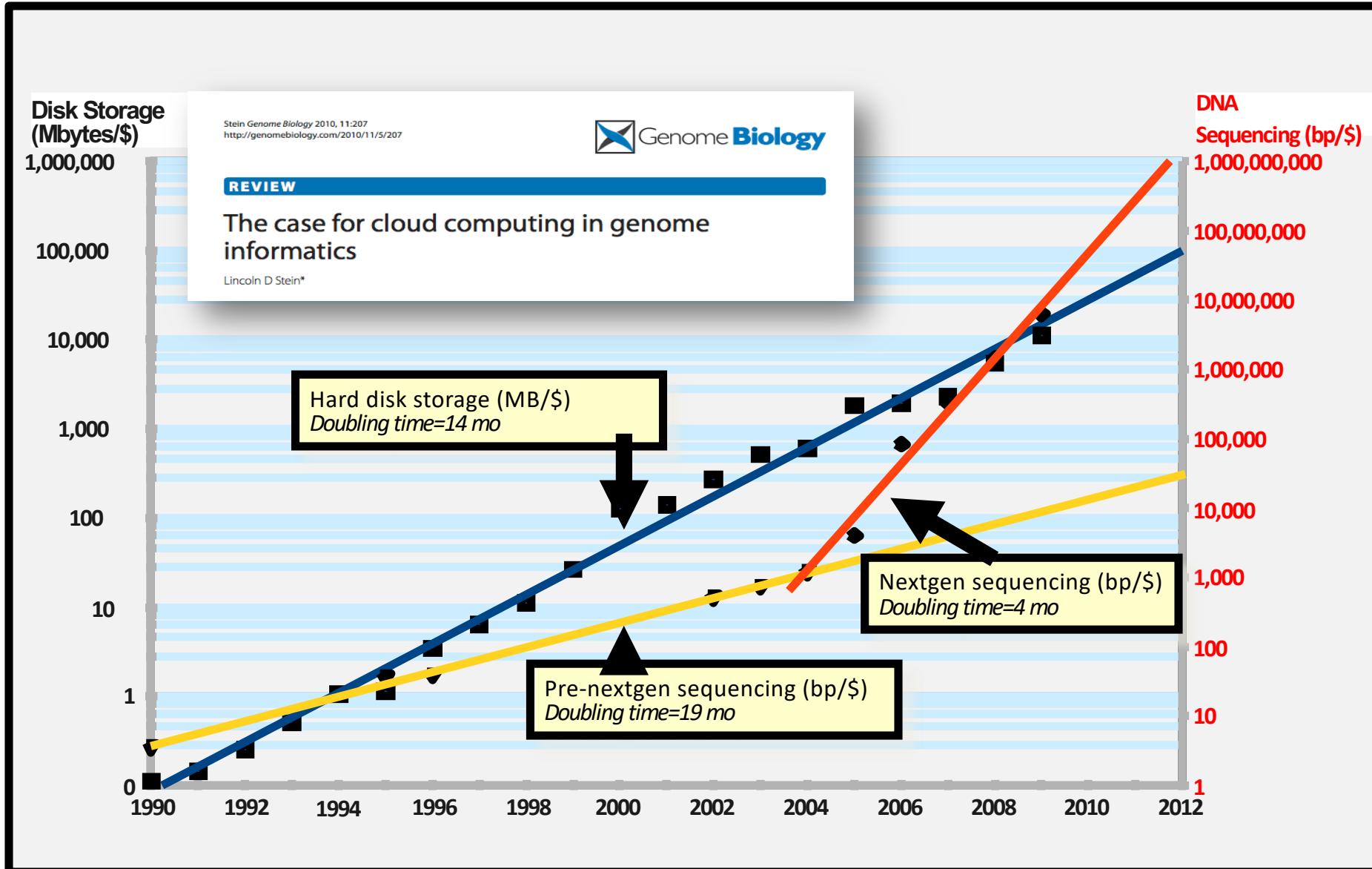
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Advanced Sequencing Technologies & Bioinformatics Analysis November 11-19, 2021



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



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?
- Get bigger hardware?
- Write more grants?

Cloud computing providers

- Amazon AWS
 - <https://aws.amazon.com/>
- Google cloud
 - <https://cloud.google.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



Some of the challenges of cloud computing:

- Not cheap
- Getting files to and from there
- Standardization can be a challenge if you don't control hardware
- 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:

- 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.

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

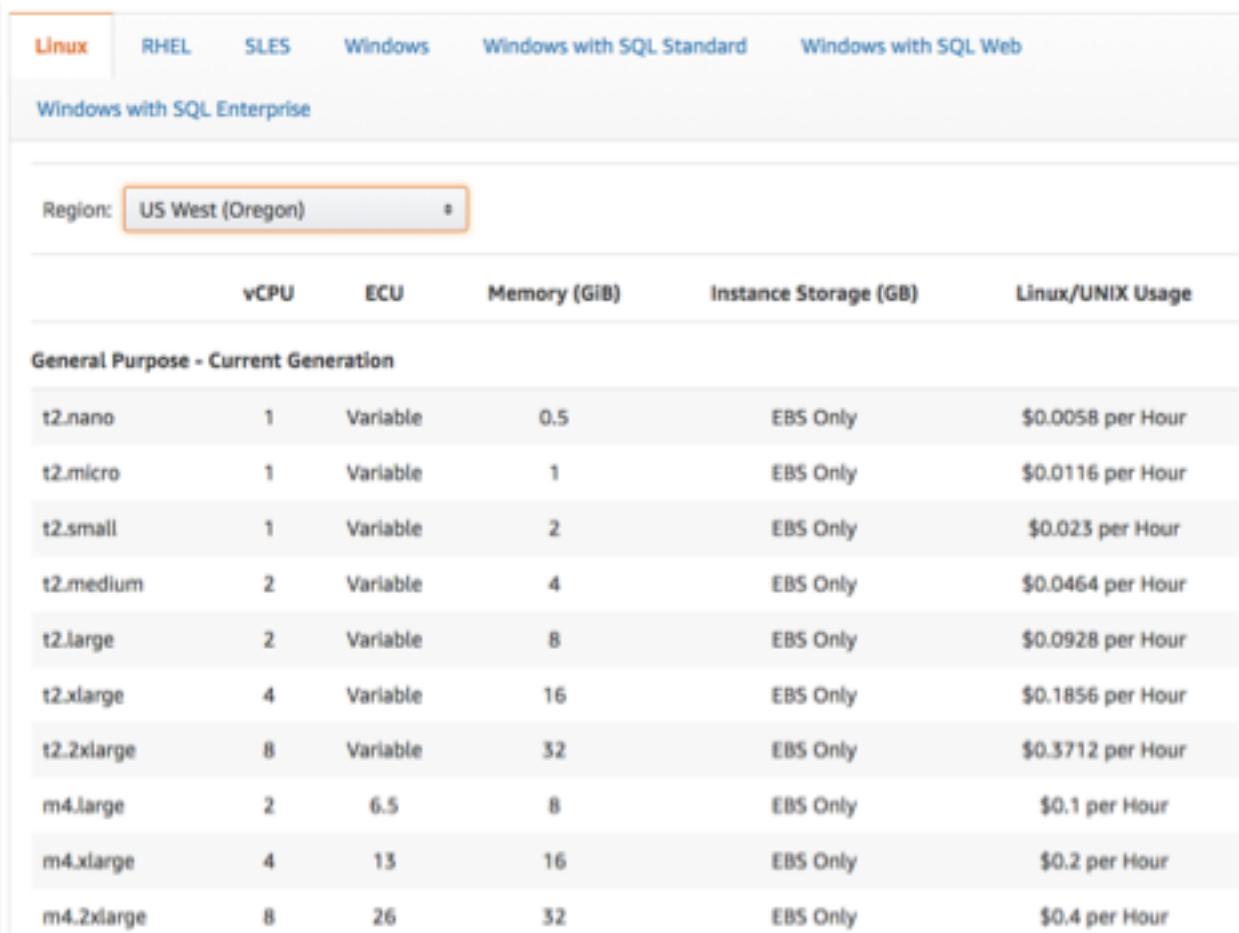
What is an AMI/snapshot?

- 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?



The screenshot shows the AWS CloudWatch Metrics Insights search interface. At the top, there are tabs for different operating systems: Linux (selected), RHEL, SLES, Windows, Windows with SQL Standard, and Windows with SQL Web. Below the tabs, the search bar contains the query: `CloudWatchMetricsFilter(lambda: true) | sort by @version desc | limit 10`. The results table has columns for Metric Name, Value, and Unit. The first few rows show metrics like `ApproximateInvokeCount`, `ApproximateInvokeTime`, and `ApproximateLastExecutionTime` with values ranging from 1 to 1000.

Metric Name	Value	Unit
ApproximateInvokeCount	1	Double
ApproximateInvokeTime	1	Double
ApproximateLastExecutionTime	1	Double
ApproximateLastProcessingTime	1	Double
ApproximateLastInvocationType	1	Double
ApproximateLastStatus	1	Double
ApproximateLastEventSource	1	Double
ApproximateLastEventVersion	1	Double
ApproximateLastEventSourceArn	1	Double

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://rnabio.org/module-00-setup/0000/06/01/Intro_to_AWS/

<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 (genomedata.org)
- 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, “Log into AWS” page



Log into AWS

[« Introduction to AWS](#)

[Course](#)

[Unix »](#)

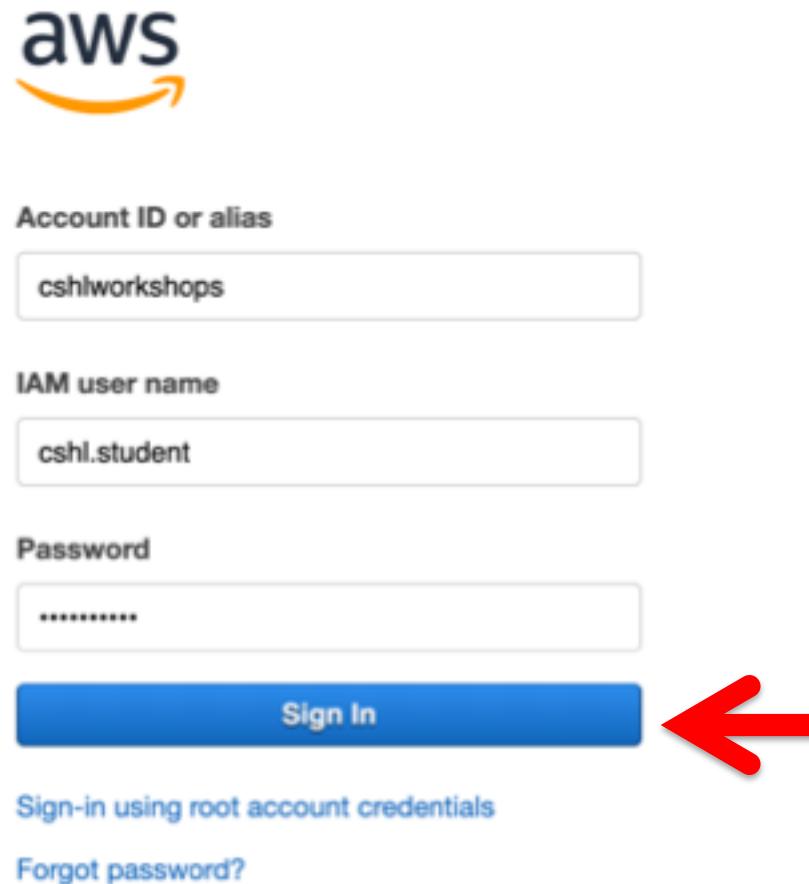
Using cloud computing to complete this course involves two major components: (1) Launching an instance on the cloud (essentially renting a virtual computer by the hour and turning it on) and (2) logging into that instance).

Covered in this section: logging into AWS EC2 console, starting an instance from the course AMI, configuring it in the console (select instance AMI, instance type, instance details, storage volumes, tags, security group, and key pairs).



https://rnabio.org/module-00-setup/0000/07/01/Log_into_AWS/

Login to AWS console



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

Select "EC2" service

AWS Management Console

AWS services

Find Services

You can enter names, keywords or acronym

EC2

Recently visited services

- EC2
- Billing
- IAM

All services

Build a solution

Get started with simple wizards and automated workflows.

Stay con resource

Download the AWS Console Mobile App to your iOS or Android mobile device. [Learn more](#)

Explore AWS

Amazon SageMaker Autopilot

Get hands-on with AutoML. [Learn more](#)

AWS Storage Gateway

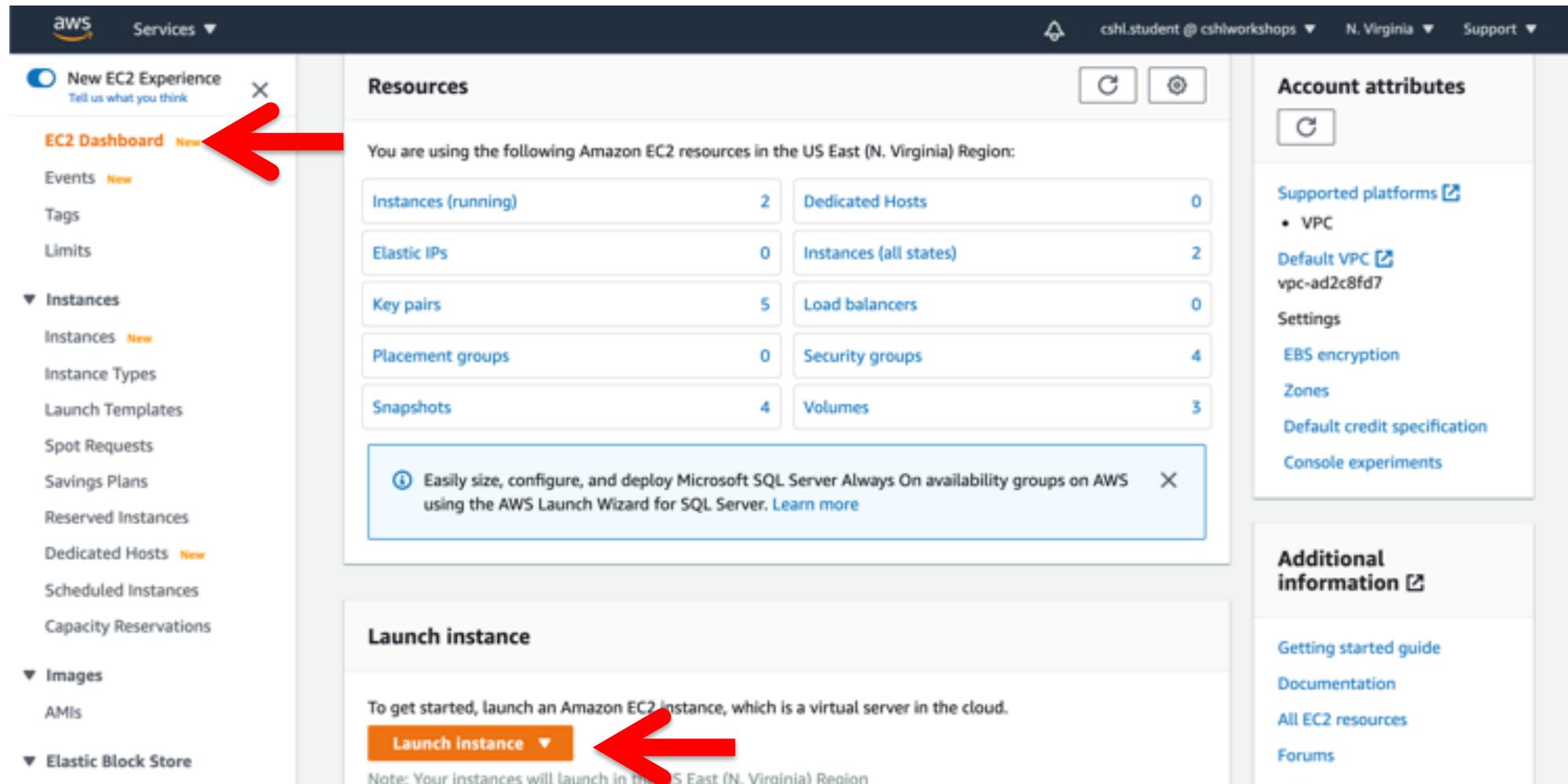
Get on-premises low latency access to virtually unlimited cloud storage with this hybrid cloud storage service. [Learn more](#)

Make sure you are in Virginia region

Search for EC2

A red arrow points to the search bar with the text "Search for EC2". A red arrow also points to the "N. Virginia" region selector with the text "Make sure you are in Virginia region".

From EC2 Dashboard, launch a new Instance



Choose an AMI – Find the CSHL SEQTEC 2021 AMI in the My 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.

Q Search for an AMI by entering a search term e.g. "Windows"

Search by Systems Manager parameter

Quick Start

My AMIs **Select**

AWS Marketplace

Community AMIs

1 to 2 of 2 AMIs

cshi-seqtech-2021 - ami-07524de9e52dbd348

Root device type: ebs Virtualization type: hvm Owner: 577255725291 ENA Enabled: Yes

64-bit (x86)

cshi-seqtech-2020 - ami-09ecbedc3b79937e3

Root device type: ebs Virtualization type: hvm Owner: 577255725291 ENA Enabled: Yes

64-bit (x86)

Ownership

Owned by me Shared with me

Architecture

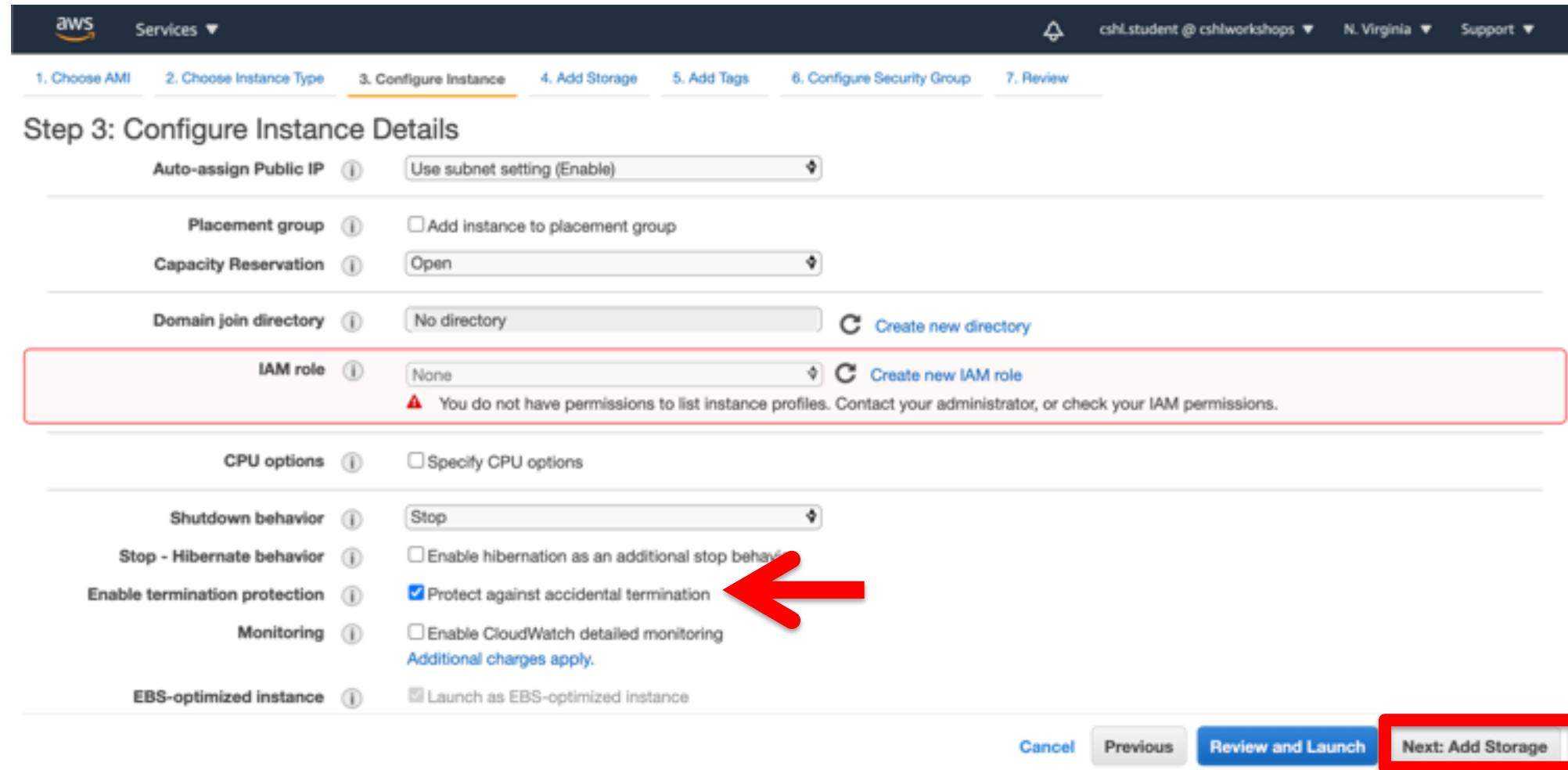
32-bit (x86) 64-bit (x86) 64-bit (Arm) 64-bit (Mac)

Choose “m5.2xlarge” instance type, then “Next: Configure Instance Details”.

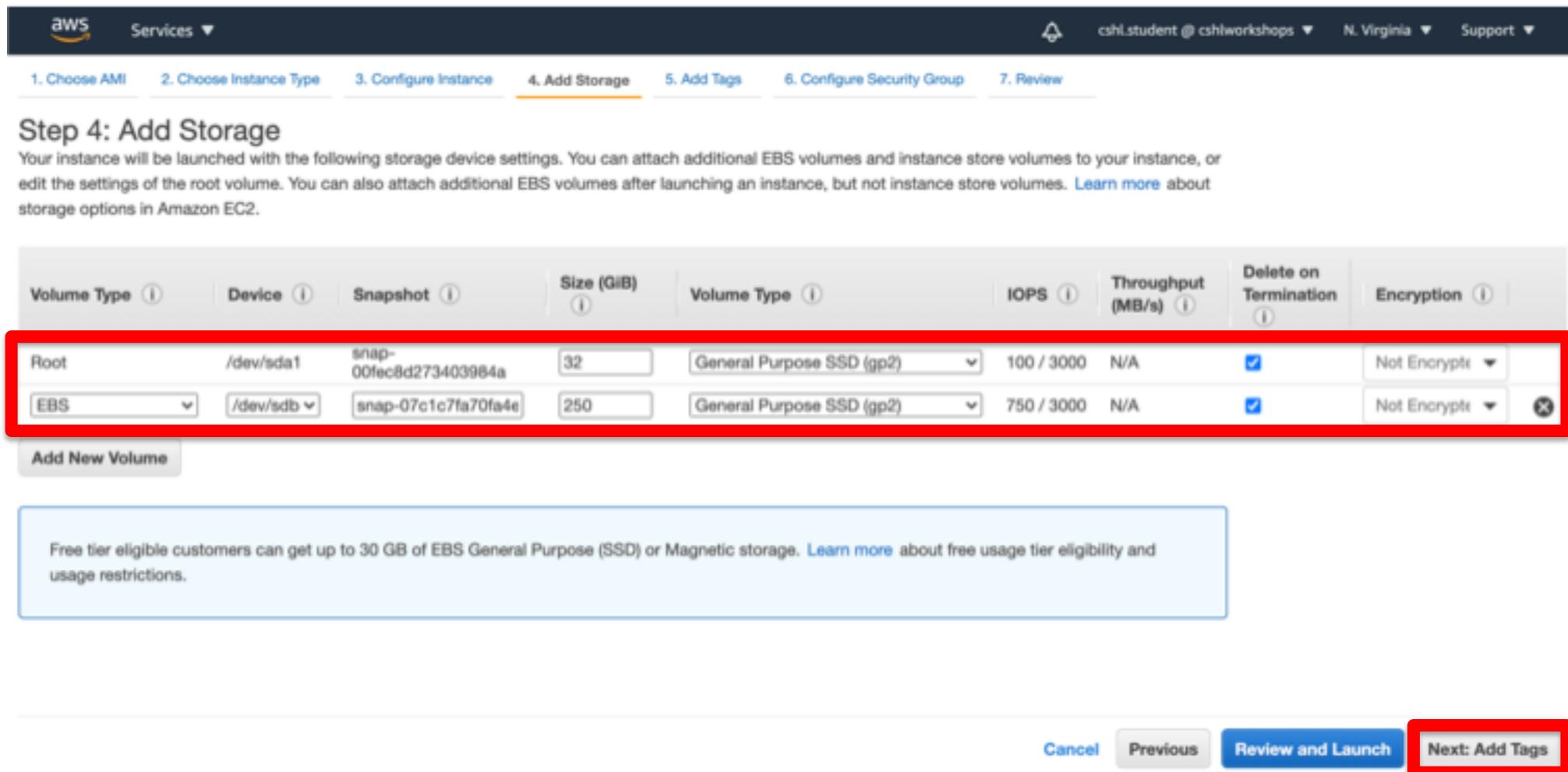
The screenshot shows the AWS CloudFormation console interface for creating a new stack. The top navigation bar includes the AWS logo, Services dropdown, user information (cshl.student @ cshlworkshops), region (N. Virginia), and Support. Below the navigation is a progress bar with steps 1 through 7. Step 2, "Choose Instance Type", is currently active and highlighted in orange. The main content area is titled "Step 2: Choose an Instance Type". A table lists various AWS Lambda instance types with their details. The "m5.2xlarge" row is selected, indicated by a blue background and a checked checkbox in the first column. A large red arrow points to the "EBS only" column for the selected row. At the bottom of the page are buttons for "Cancel", "Previous", "Review and Launch" (which is highlighted in blue), and "Next: Configure Instance Details" (which is enclosed in a red box).

<input type="checkbox"/>	m5	m5.large	2	8	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.xlarge	4	16	EBS only	Yes	Up to 10 Gigabit	Yes
<input checked="" type="checkbox"/>	m5	m5.2xlarge	8	32	EBS only		Up to 10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.4xlarge	16	64	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.8xlarge	32	128	EBS only	Yes	10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.12xlarge	48	192	EBS only	Yes	10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.16xlarge	64	256	EBS only	Yes	20 Gigabit	Yes
<input type="checkbox"/>	m5	m5.24xlarge	96	384	EBS only	Yes	25 Gigabit	Yes
<input type="checkbox"/>	m5	m5.metal	96	384	EBS only	Yes	25 Gigabit	Yes
<input type="checkbox"/>	m5a	m5a.large	2	8	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	m5a	m5a.xlarge	4	16	EBS only	Yes	Up to 10 Gigabit	Yes

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



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



The screenshot shows the AWS EC2 instance creation wizard at Step 4: Add Storage. The '4. Add Storage' tab is active. Two EBS volumes are listed:

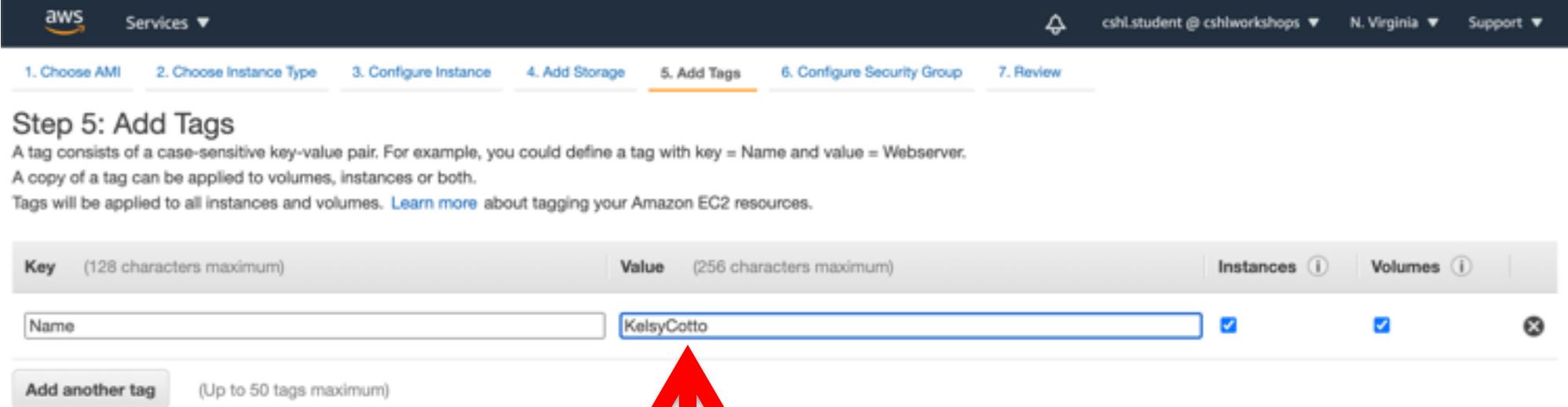
Volume Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Throughput (MB/s)	Delete on Termination	Encryption
Root	/dev/sda1	snap-00fec8d273403984a	32	General Purpose SSD (gp2)	100 / 3000	N/A	<input checked="" type="checkbox"/>	Not Encrypted
EBS	/dev/sdb	snap-07c1c7fa70fa4e	250	General Purpose SSD (gp2)	750 / 3000	N/A	<input checked="" type="checkbox"/>	Not Encrypted

A red box highlights the second volume row. Below the table is a note about free tier usage:

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.

At the bottom right, the 'Next: Add Tags' button is highlighted with a red box.

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



The screenshot shows the AWS EC2 instance creation wizard at Step 5: Add Tags. The navigation bar includes links for Choose AMI, Choose Instance Type, Configure Instance, Add Storage, Add Tags (which is highlighted), Configure Security Group, and Review. The main section is titled "Step 5: Add Tags" with instructions about tag key-value pairs. It shows a table with one tag entry: Key "Name" and Value "KelsyCotto". There are checkboxes for Instances and Volumes, both of which are checked. Below the table is a button to "Add another tag" and a note about the maximum of 50 tags. At the bottom, there are "Cancel", "Previous", "Review and Launch" (disabled), and "Next: Configure Security Group" buttons. A large red arrow points to the Value input field containing "KelsyCotto".

Important: Don't forget to name your instance!
(FirstnameLastname)

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

AWS Services ▾ cshl.student @ cshlworkshops ▾ N. Virginia ▾ Support ▾

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

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

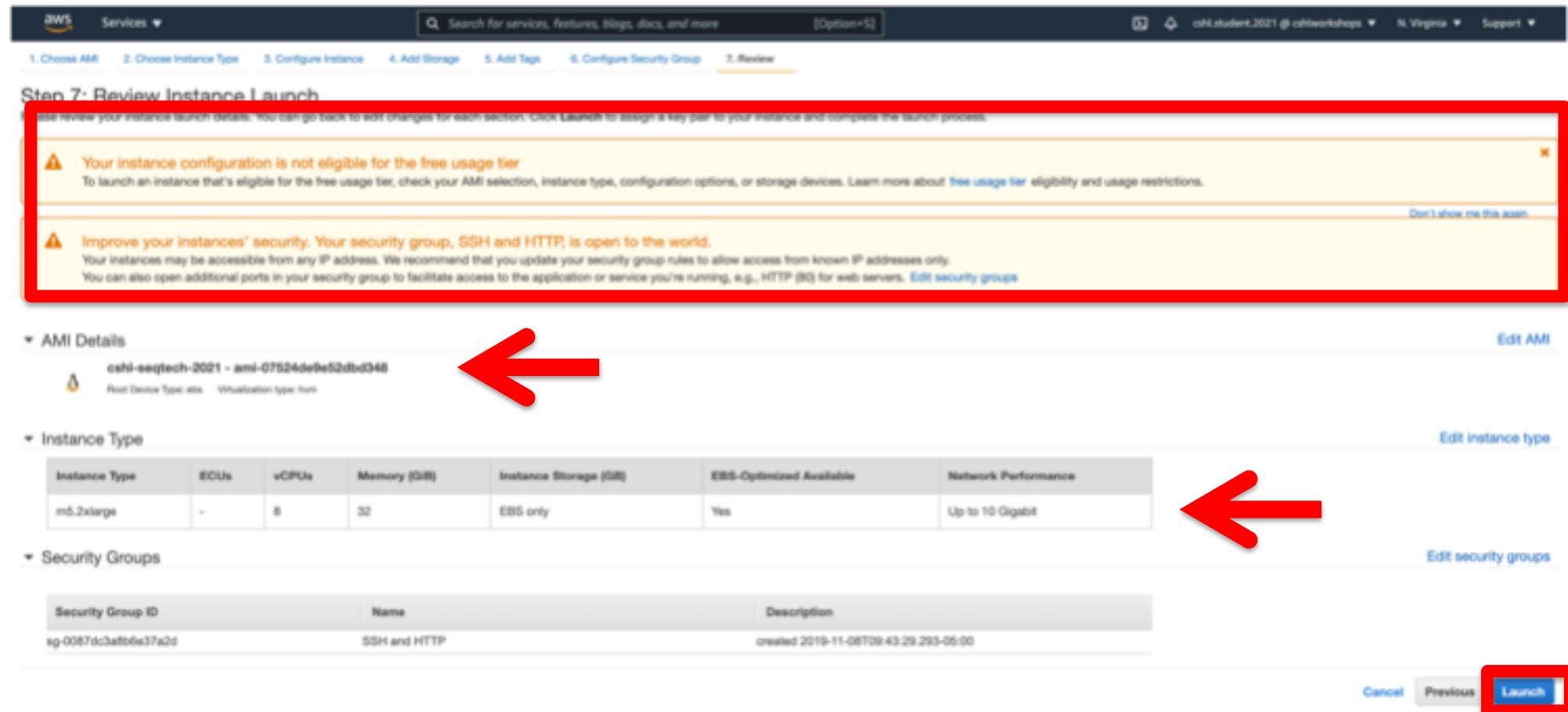
Security Group ID	Name	Description	Actions
sg-384f5b79	default	default VPC security group	Copy to new
sg-0087dc3a8b6e37a2d	SSH and HTTP	created 2019-11-08T09:43:29.293-05:00	Copy to new

Inbound rules for sg-0087dc3a8b6e37a2d (Selected security groups: sg-0087dc3a8b6e37a2d)

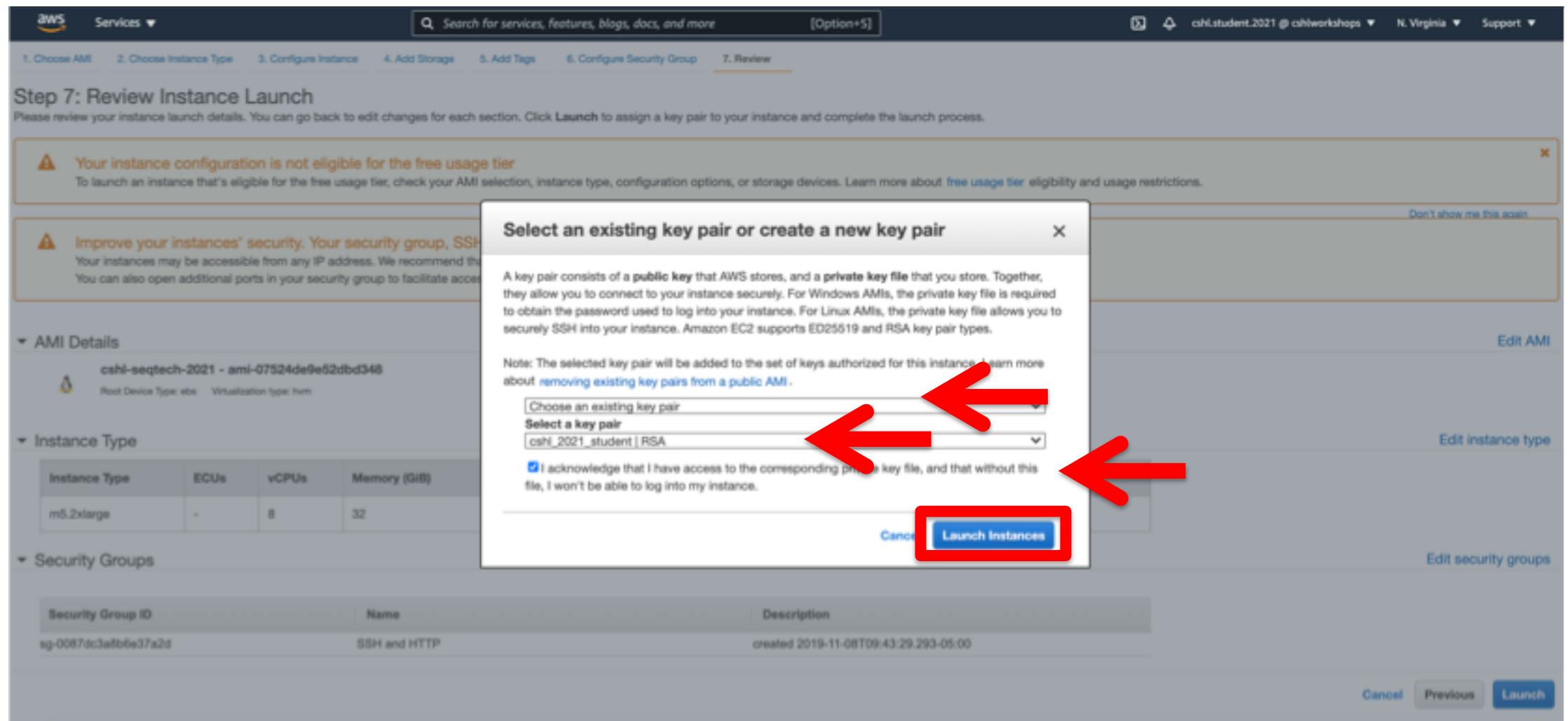
Type	Protocol	Port Range	Source	Description
HTTP	TCP	80	0.0.0.0/0	
HTTP	TCP	80	::/0	
SSH	TCP	22	0.0.0.0/0	

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

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



Choose an existing key pair: "cshl_2020_student" and then Launch.



View Instances to see your new instance spinning up!

The screenshot shows the AWS Launch Status page. At the top, there's a navigation bar with the AWS logo, 'Services', 'Resource Groups', and a star icon. On the right, it shows the user 'cshi.student @ cshiworkshops', 'N. Virginia', and 'Support'. Below the navigation, the title 'Launch Status' is displayed. A green box contains a checkmark icon and the text 'Your instances are now launching'. It also mentions 'The following instance launches have been initiated: i-08e73e43f17783273' and a 'View launch log' link. A blue box contains an info icon and the text 'Get notified of estimated charges'. It includes a link to 'Create billing alerts' and a note about getting email notifications for estimated charges exceeding a defined amount. Below these boxes, under 'How to connect to your instances', it says '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.' It also says '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.' A section titled 'Here are some helpful resources to get you started' lists links to 'How to connect to your Linux instance', 'Amazon EC2: User Guide', 'Learn about AWS Free Usage Tier', and 'Amazon EC2: Discussion Forum'. At the bottom, it says 'While your instances are launching you can also' and lists '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)', and 'Manage security groups'. A red button at the bottom right is labeled 'View Instances'.

AWS Services Resource Groups

cshi.student @ cshiworkshops N. Virginia Support

Launch Status

Your instances are now launching

The following instance launches have been initiated: [i-08e73e43f17783273](#) [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 Instances page. On the left, there's a sidebar with various navigation links like EC2 Dashboard, Events, Tags, Limits, Instances, Images, and Elastic Block Store. The 'Instances' link is highlighted. The main area shows a table of instances with columns for Name, Instance ID, Instance state, Instance type, Status check, Alarm status, Availability Zone, and Public IPv4 DNS. One row is selected, highlighted with a blue border and a red arrow pointing to it from the left. At the top right of the table, there's a 'Connect' button, which is also highlighted with a red box and a red arrow pointing to it from the top. Below the table, a detailed view for the selected instance (i-0b012943b3ce51aee, named 'KelsyCotto') is shown. This view includes tabs for Details, Security, Networking, Storage, Status Checks, Monitoring, and Tags. The 'Details' tab is active. Under 'Instance summary', there are fields for Instance ID (i-0b012943b3ce51aee), Instance state (Running), and Instance type (m5.2xlarge). To the right, there are sections for Public IPv4 address (100.24.122.188) and Private IPv4 addresses (172.31.72.162). Other sections include Public IPv4 DNS, Private IPv4 DNS, Elastic IP addresses, and VPC ID.

Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS
test_login_in...	i-061dc4cf116f108b5	Running	t2.micro	2/2 checks ...	No alarms	us-east-1e	ec2-54-208-183-137.c...
instructor_in...	i-01f3e5ef76ace3f48	Running	m5.2xlarge	2/2 checks ...	No alarms	us-east-1f	ec2-3-83-35-210.com...
KelsyCotto	i-0b012943b3ce51aee	Running	m5.2xlarge	2/2 checks ...	No alarms	us-east-1f	ec2-100-24-122-188.c...

Instance: i-0b012943b3ce51aee (KelsyCotto)

Details Security Networking Storage Status Checks Monitoring Tags

Instance summary

Instance ID i-0b012943b3ce51aee (KelsyCotto)	Public IPv4 address 100.24.122.188 open address	Private IPv4 addresses 172.31.72.162
Instance state Running	Public IPv4 DNS ec2-100-24-122-188.compute-1.amazonaws.com open address	Private IPv4 DNS ip-172-31-72-162.ec2.internal
Instance type m5.2xlarge	Elastic IP addresses -	VPC ID vpc-ad2c8fd7

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 'Connect to instance' interface. At the top, there's a navigation bar with the AWS logo, 'Services ▾', a notification bell, the email 'cshl.student@cshlworkshops ▾', the region 'N. Virginia ▾', and 'Support ▾'. Below the navigation, the path 'EC2 > Instances > i-0b012943b3ce51aee > Connect to instance' is visible. The main content area has a title 'Connect to instance' with a blue 'Info' link. It says 'Connect to your instance i-0b012943b3ce51aee (KelsyCotto) using any of these options'. There are three tabs: 'EC2 Instance Connect', 'Session Manager', and 'SSH client', with 'SSH client' being the active one and highlighted with a red arrow. Below the tabs, the 'Instance ID' is listed as 'i-0b012943b3ce51aee (KelsyCotto)'. Step-by-step instructions follow:

1. Open an SSH client.
2. Locate your private key file. The key used to launch this instance is `cshl_2020_student.pem`.
3. Run this command, if necessary, to ensure your key is not publicly viewable.
`chmod 400 cshl_2020_student.pem`
4. Connect to your instance using its Public DNS:
`ec2-3-237-46-215.compute-1.amazonaws.com`

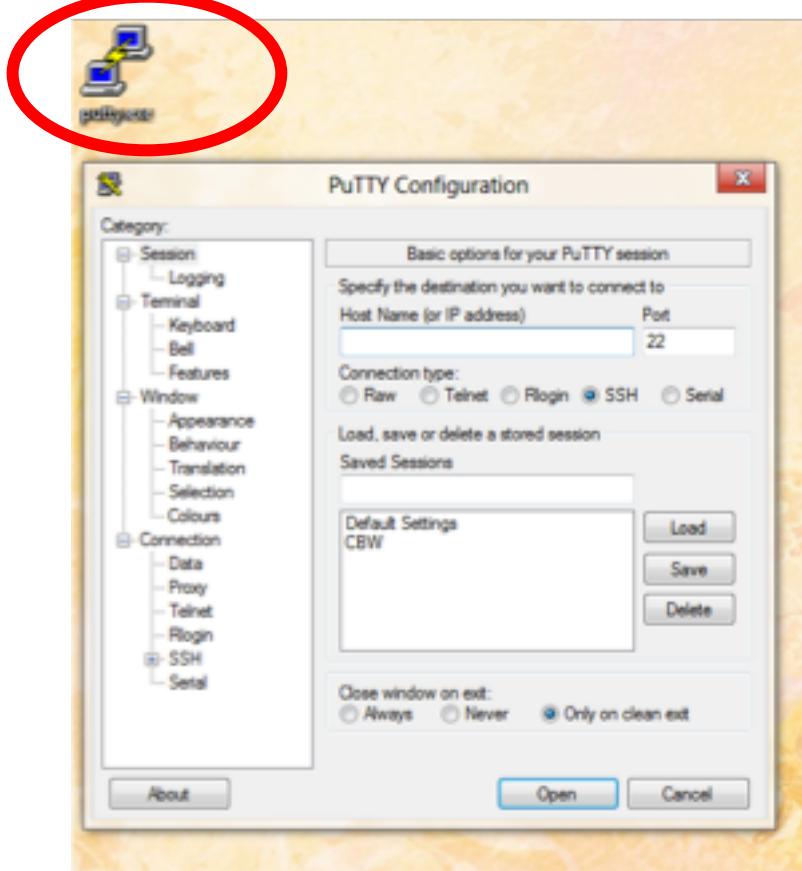
Below the instructions is an 'Example:' section with a copy link:

`ssh -i "cshl_2020_student.pem" root@ec2-3-237-46-215.compute-1.amazonaws.com`

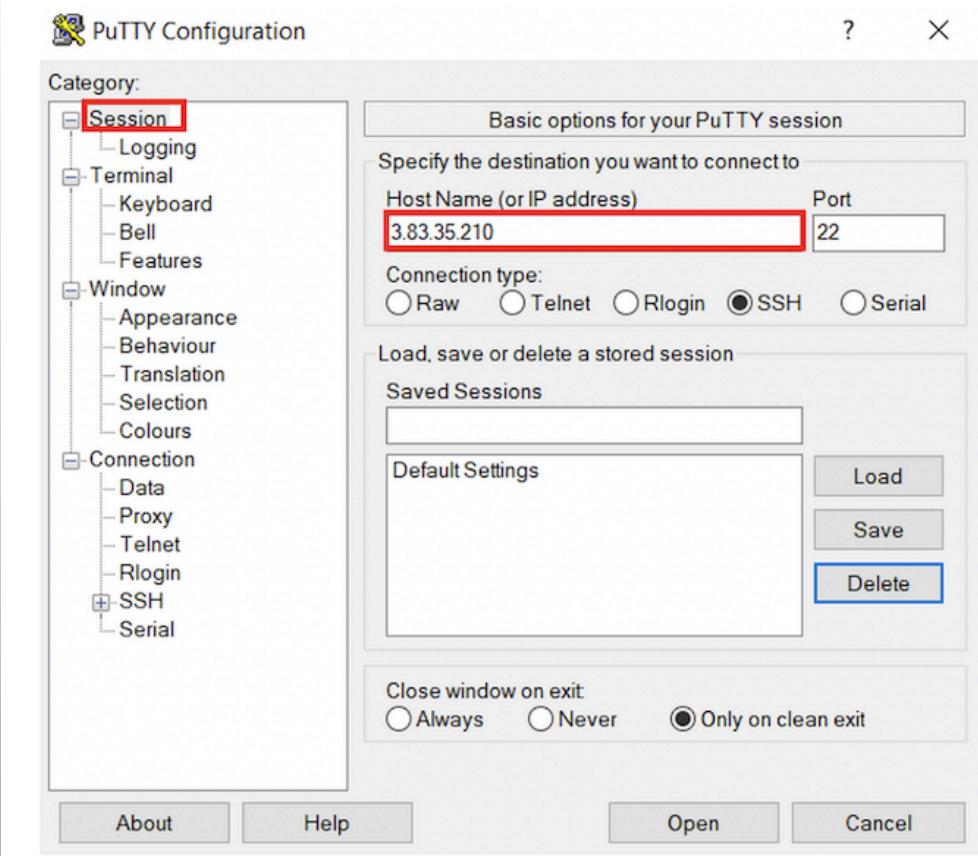
At the bottom right of the main content area is a 'Cancel' button.

Logging into your instance (Windows)

Open PuTTY

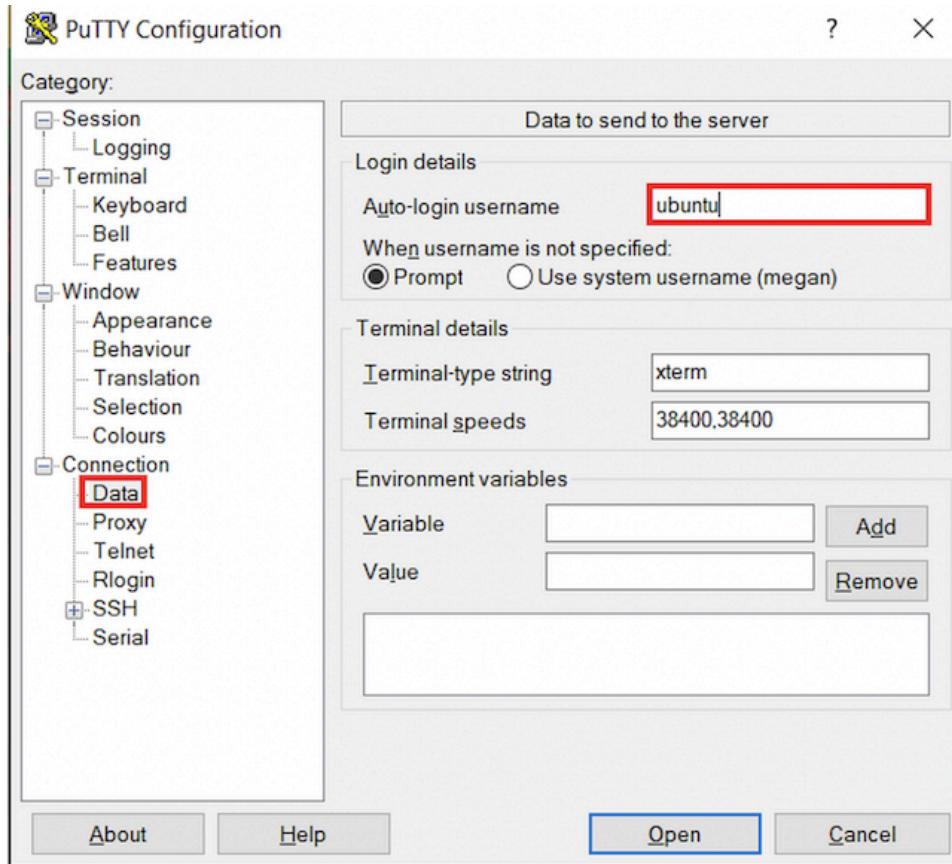


Enter the Host Name (IP address)

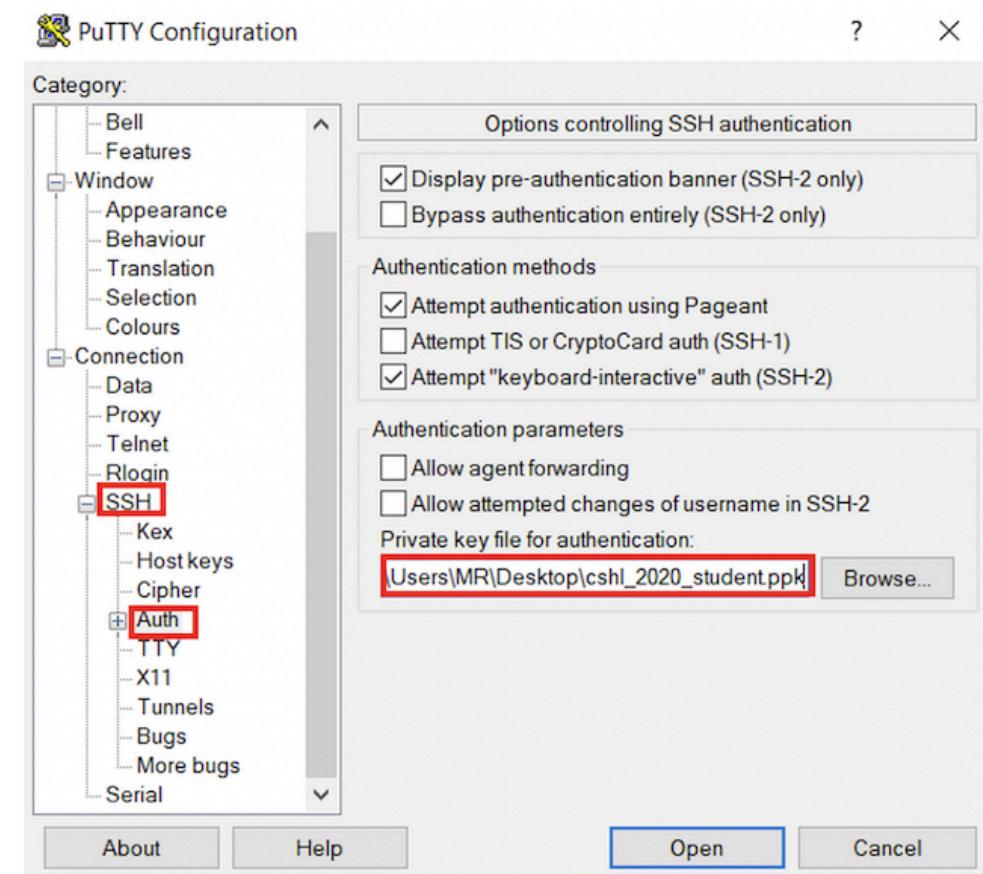


Logging into your instance (Windows)

Choose Connection -> Data
Enter the username 'ubuntu'



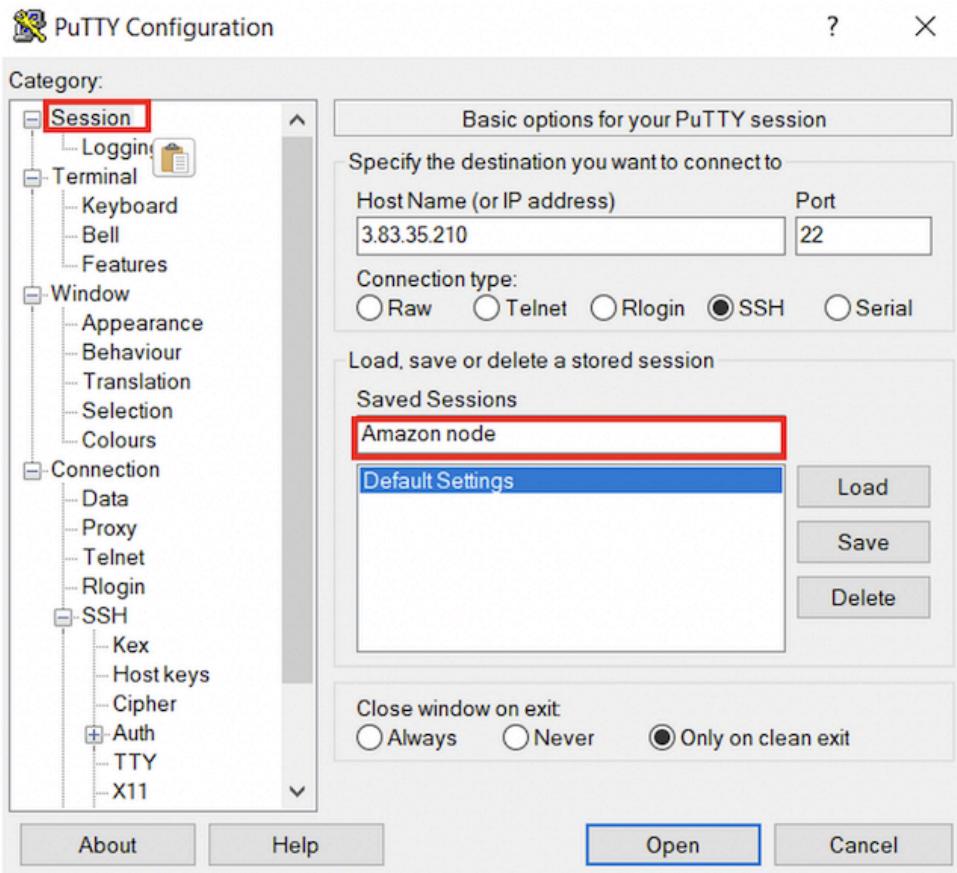
Choose SSH -> Auth
Browse to Private key (ppk) file



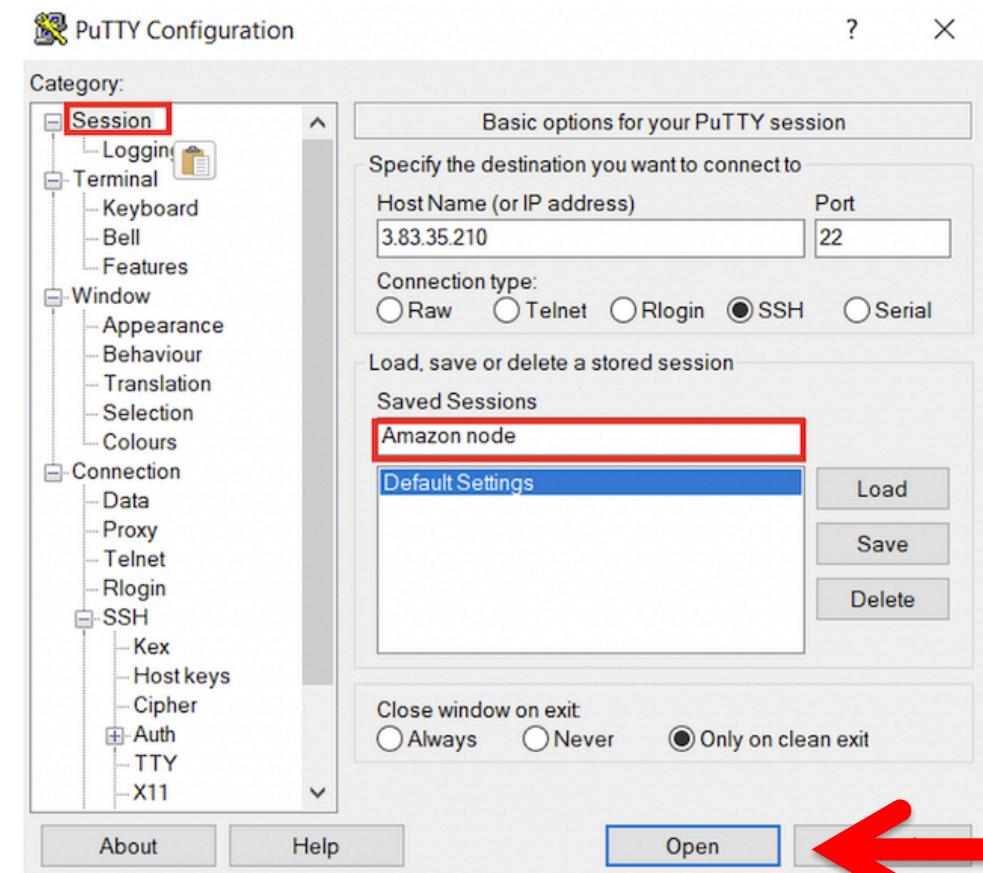
Logging into your instance (Windows)

Choose Session

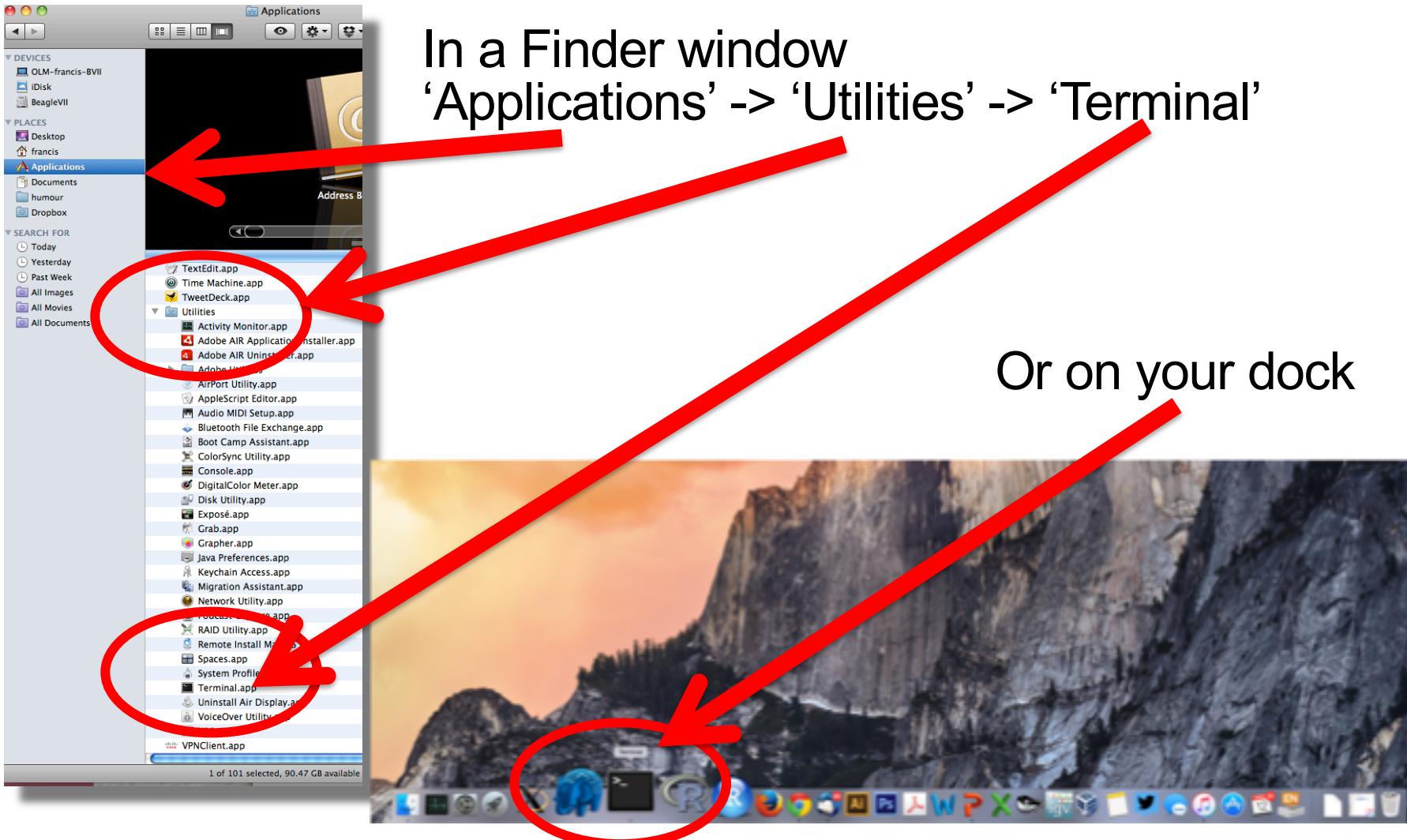
Save your session as "Amazon Node"



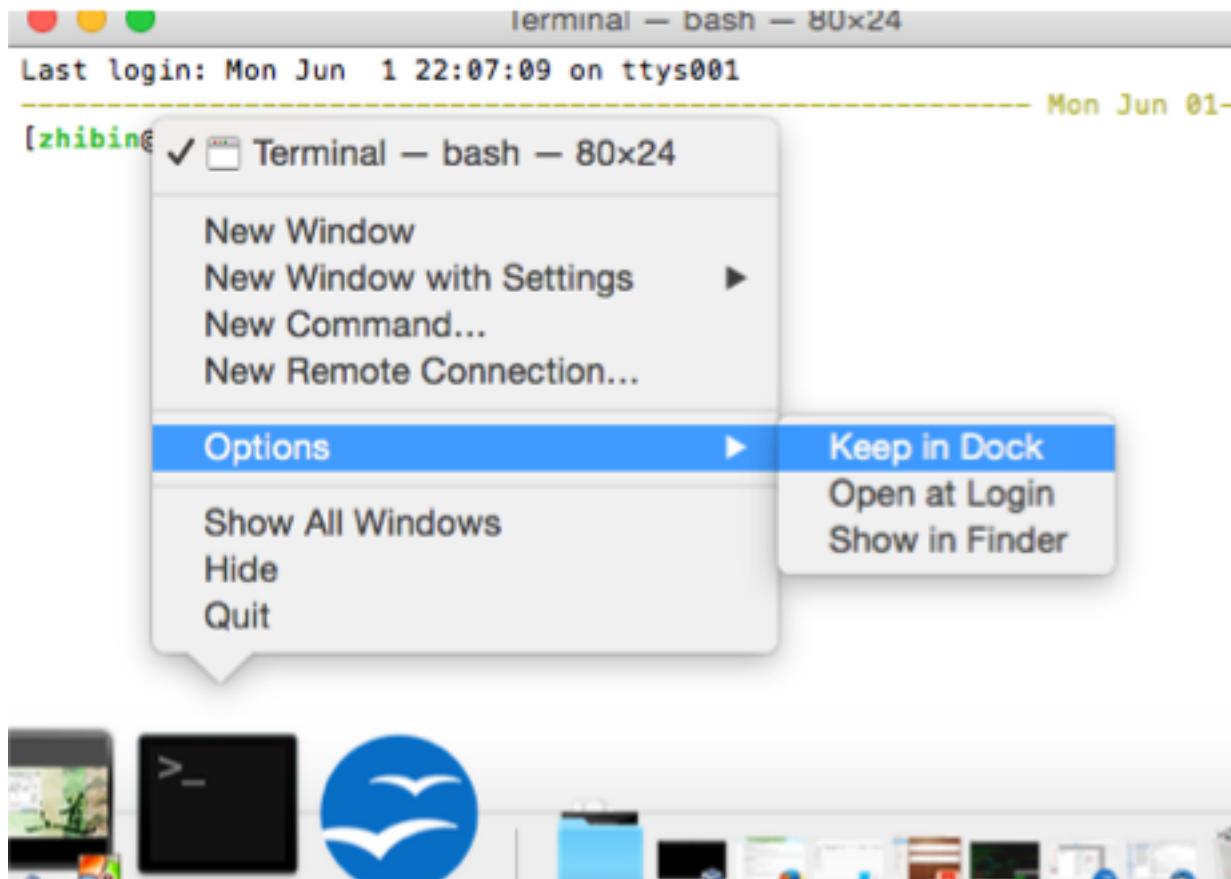
Double-click saved "Amazon Node" session OR
Select "Amazon Node" session and click Open



Logging into your instance (Mac)



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 the course SSH key file

- NOTE for Mac users. You will need to use a “.pem” file
- **NOTE for Windows Users.** You will need to use a “.ppk” file instead.
 - This is created from the “.pem” file.
 - <https://aws.amazon.com/premiumsupport/knowledge-center/convert-pem-file-into-ppk/>
- The SSH key file will be used to securely login to your student instance on the cloud

Save the pem/ppk file you received via email/slack to your new cshl folder

Viewing the ‘key’ file once downloaded

cat cshl_2021_student.pem

```
Kelsys-MacBook-Pro:keys kcotto$ cat cshl_2019_student.pem
-----BEGIN RSA PRIVATE KEY-----
MIIEpAIBAAKCAQEAgGtpnqERtEu/SCmeF2r1HMEsMao0fEJiAwQwk2/SNXX8izr0IH0zTVvmE1D
VUwWq7pkvhjh05pDb+2U9HiZe3sxLv3S1NrkATYF/NsrpwB+q1vwqzGW9sQ6uj45RWrPkjZlsaj
TQZmyFRu+t1JTRU3hQDqA0MRWTx1Wxv0gFzuZy/qb+DALuFQsInrEKnijrwdLmd6usaBTvhc0gFS
B9oEelH0bZHJTZFw/wP+Z0uZq0Ujir7Qw0LTm45QH/L0dBdUl3k/mBeez00yvnKMwj8E4Xi0rQ0t
hHtQ7F9iSILK80W1rRH0qwxwt9ycEH1JtNMQmUTif0vE2XJ6l06chQIDAQABAoIBABG7P/FHu/Qp
WFgg+89myuqR6GvA2X55CFSzFzYg0a0yrj5jDleFtdu2uXiISG8gUBZYvlzxx82aOC0P5j04SBq0
xD/qRlukY/jyXyPn77w/ExmaNoLjj1W9RUSH0JYLIzVpFPGes3u5zGSGDTSDNh3sSdWhq1FX3l
7vY5b6UAQgahXf0dpGFxt6P6qb/BKFQFsThXk7GXMyS/kr4w7ZlhPWHRMSu2UBd5/a/beAVN76qUE/10HR30oAuqghusZabpbX7MJl00VcvIAQgeF8Z+xf2uugDEAKut1PxW0+yvGM4SpZZ0skFZz6YI
pBnX4ELWPhCeMzq4Ml8QY6ptR2UCgYEAc6YfNlymg24NJu8PANx8navTi50WYuXWXrj0mrLr3SR
/XY+w26cgipM+K5eQfXSr4Yb8BQKjRktMzBzf5nKdaX4pzYIquQH02B0HDhTooHAhkbTMTmKukv4
oEW06wcEE6RQi fw4xbMEnfQfHJBI21am+jwI8Xb7idwMG4pU/nsCgYEAtD0x4bNC1X3A5by50uY0
WXrtgQszCYCbkrbpjRET12f9hgz9MRMHY/xH/XGvMutZSFV2rCZRwd71m+QNGadk/MQS0kouzW6
gSasyjFq+MKCkqYnS3/JTbx8yrLZmzl0LtX6pwmwg0Zy8aJjYHo9a2/EI8Tjh2d0SxeadIRVYP8C
gYAToiXww1Vdu+dj/7TDLqYCtdHOVAxJX/utI9Q03yoIryuh+bWmFvEIvAmIGXyyQZRyoZwgIS4A
PNH03+bEa+69wbzlhksiK5g8GKgISVdLC4rZXBX5ehgTmW7IgJ89y/SF4G/Ityo30K0ohALh597
NcvNEzzqruTja1IIMvTKMwKBgQCkM+QP1Tqc0TbVlfvClviXuJBLsiJLCImYeZL0nZVmIMusbhxX
b8ZQYG5yUz09nulXau1GlQDvXvf089CzWL1SomxB0HFJQvGwa9FFYQRIVPHuqut8rs4oPGn0QzCh7M7QCJcr00oAcrSLLkQmgz+phIw7BzFr039J4HFiRIInjQKBgQCtdEvcbytk8Jh4WH3z0wpkc43f
U8DZhZwjRQpGWLD8CPj9RgRnE4+1PCH6s/RLQf7SiE1ZjX/0Ud0WPExr0j5sVjy0IujohRbty0CM
oqWeSeUb1sLogRvMrTfCEpl/rz3GpoQ1SC/5s6XvjnnKK8RN8s7MseLuuJ63T/CRBpIs8A==
-----END RSA PRIVATE KEY-----Kelsys-MacBook-Pro:keys kcotto$
```

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

ls -l (long listing)

```
-rw-r--r--@ 1 kcotto staff 1696 Nov 9 09:19 cshl_2020_student.pem
```

 rwx : owner

 rwx : group

 rwx: world

 r read (4)

 w write (2)

 x execute (1)

Which ever 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>

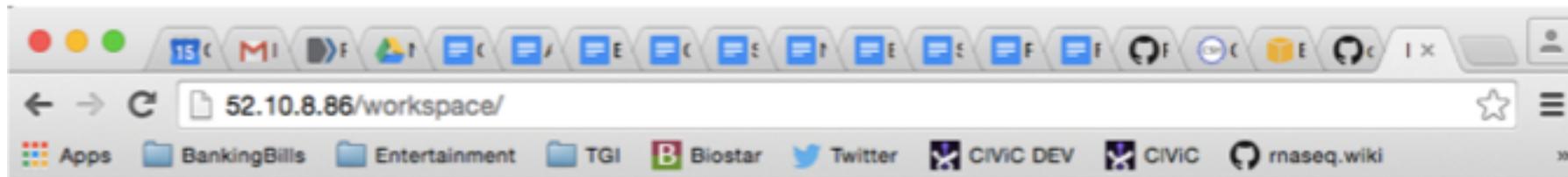
It is “r” for the the file owner **only**

Logging into your instance

Mac/Linux

```
cd ~/cshl  
chmod 400 cshl_2021_student.pem  
ssh -i cshl_2021_student.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://\[YOUR PUBLIC DNS OR IP\]/](http://[YOUR PUBLIC DNS OR IP]/)

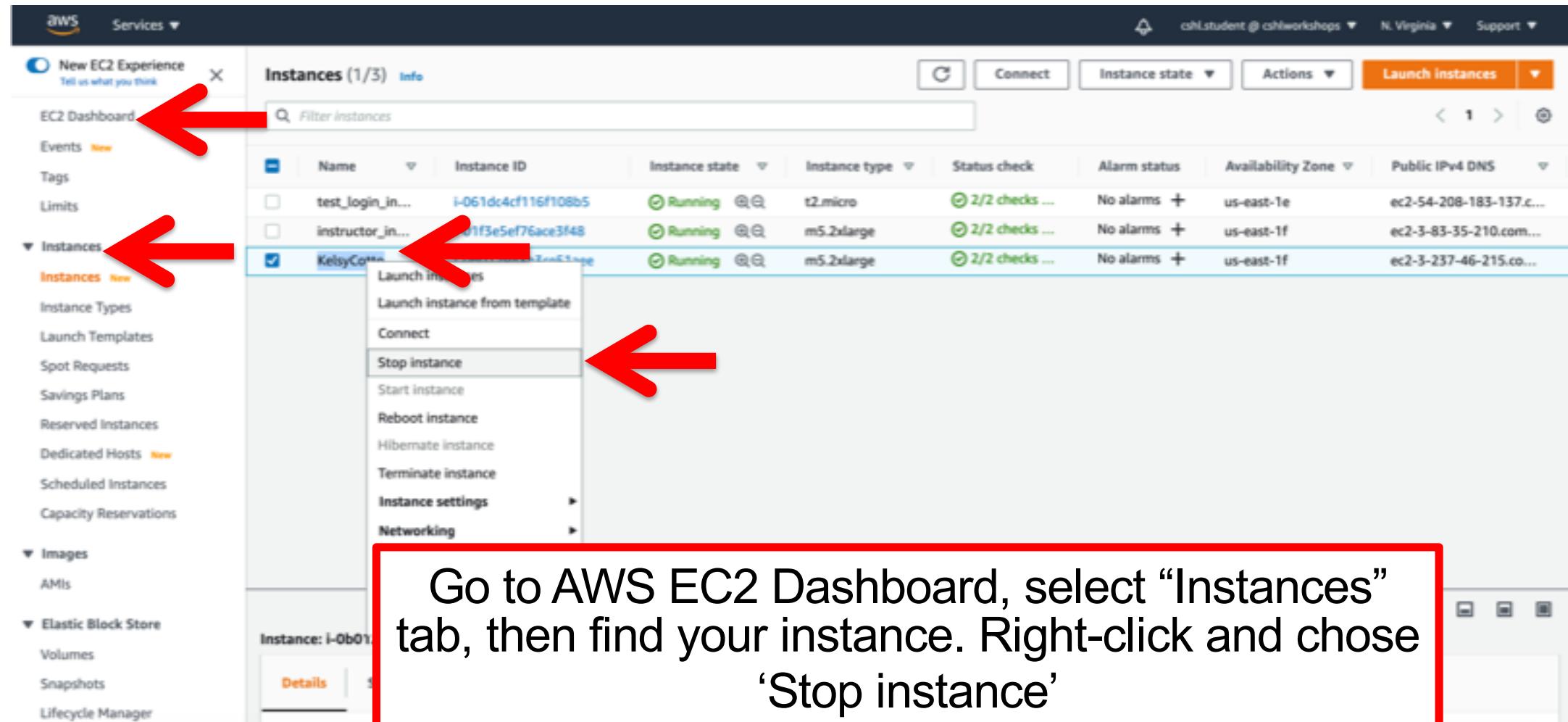
Logging out of your instance

Mac/Linux – simply type exit

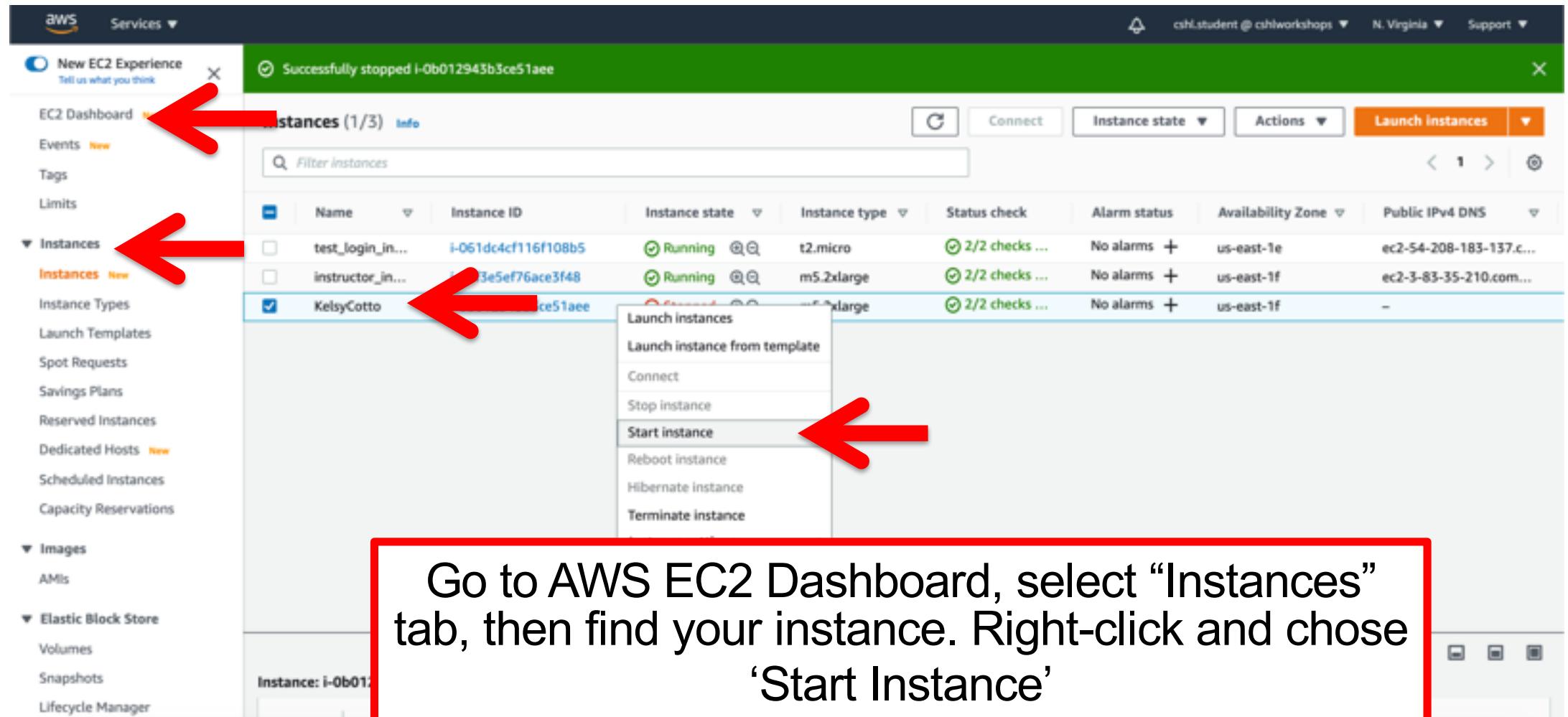
```
exit
```

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!



Next morning, you can “Start” your instance again



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. A red arrow points to the 'Connect' button in the top navigation bar. Another red arrow points to the Public IPv4 address listed in the Instance Details section.

AWS EC2 Instances (1/3) - Instances

Instances

Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS
test_login_in...	i-061dc4cf116f108b5	Running	t2.micro	2/2 checks ...	No alarms	us-east-1e	ec2-54-208-183-137.c...
instructor_in...	i-01f3e5ef76ace3f48	Running	m5.2xlarge	2/2 checks ...	No alarms	us-east-1f	ec2-3-83-35-210.com...
KelsyCotto	i-0b012943b3ce51aee	Running	m5.2xlarge	2/2 checks ...	No alarms	us-east-1f	ec2-100-24-122-188.c...

Instance: i-0b012943b3ce51aee (KelsyCotto)

Details | Security | Networking | Storage | Status Checks | Monitoring | Tags

Instance summary

Instance ID i-0b012943b3ce51aee (KelsyCotto)	Public IPv4 address 100.24.122.188 open address	Private IPv4 addresses 172.31.72.162
Instance state Running	Public IPv4 DNS ec2-100-24-122-188.compute-1.amazonaws.com open address	Private IPv4 DNS ip-172-31-72-162.ec2.internal
Instance type m5.2xlarge	Elastic IP addresses -	VPC ID vpc-ad2c8fd7

So, at this point:

- Your laptop/pc 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

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 22 regions: (US East (N.Virginia), US East (Ohio), US West (Oregon), US West (N. California), GovCloud (US-West), GovCloud (US-East), Canada (Montreal), EU (Ireland), EU (Frankfurt), EU (London), EU (Paris), EU (Milan), EU (Stockholm), Middle East (Bahrain), Asia Pacific (Singapore), Asia Pacific (Sydney), Asia Pacific (Seoul), Asia Pacific (Tokyo), Asia Pacific (Mumbai), Asia Pacific (Hong Kong), Asia Pacific (Beijing), 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.