

Cloud computing: Running your Python code on Amazon Web Services

Ariane Ducellier

University of Washington

ESS 490-590 Data science for Earth and planetary systems -
Spring 2021

First step: Create an AWS Educate account

Go to <https://aws.amazon.com/education/awseducate/>

Creating the account will give you access to AWS tutorials and some AWS credits.

Second step: Create an AWS account

Go to <https://aws.amazon.com/>. You will need to enter a credit card number.

Once your account is created, you should be able to redeem your AWS credits.

Most important points

- Do not forget to terminate your instances.
- Check your billing dashboard on a regular basis.
- The EC2 dashboard shows only instances and keys for the region you have currently selected. Other instances may be running in other regions.

Start working! Open the home page of your AWS account

The screenshot shows the AWS Management Console home page. At the top, there's a navigation bar with links for AWS, AWS Educate, GitHub - Ariane Ducellier, Gmail, Google, DevNet, Code, Courses, Science, and Washington. The main content area has a title "AWS Management Console" and a sidebar titled "AWS services". The sidebar lists various AWS services under categories like Compute, Customer Enablement, Machine Learning, AWS Cost Management, and more. A red box highlights the "Compute" section, specifically the "EC2" link. On the right side, there are promotional boxes for "Stay connected to your AWS resources on-the-go" (AWS Console Mobile App) and "Explore AWS" (AWS Backup). Below the sidebar, there's a "Feedback" link and language selection for English (US). The bottom of the screen shows the Mac OS X dock with icons for Mail, Finder, Calendar, and others, along with the Firefox browser icon.

Check the region where you are (here Oregon = us-west-2)

The screenshot shows the AWS EC2 Management console interface. At the top right, the region is set to "Oregon".

Resources

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

Instances (running)	0	Dedicated Hosts	0	Elastic IPs	0
Instances	0	Key pairs	4	Load balancers	0
Placement groups	0	Security groups	2	Snapshots	0
Volumes	0				

Launch instance

To get started, launch an Amazon EC2 instance, which is a virtual server in the cloud.

Service health

Region: US West (Oregon) Status: This service is operating normally

Zones

Zone name	Zone ID
us-west-2a	usw2-az2
us-west-2b	usw2-az1
us-west-2c	usw2-az3
us-west-2d	usw2-az4

Additional Information

- Enable Best Price-Performance with AWS Graviton2
- Get Up to 40% Better Price Performance
- Save up to 90% on EC2 with Spot Instances

You need to create a key pair to access EC2 instances

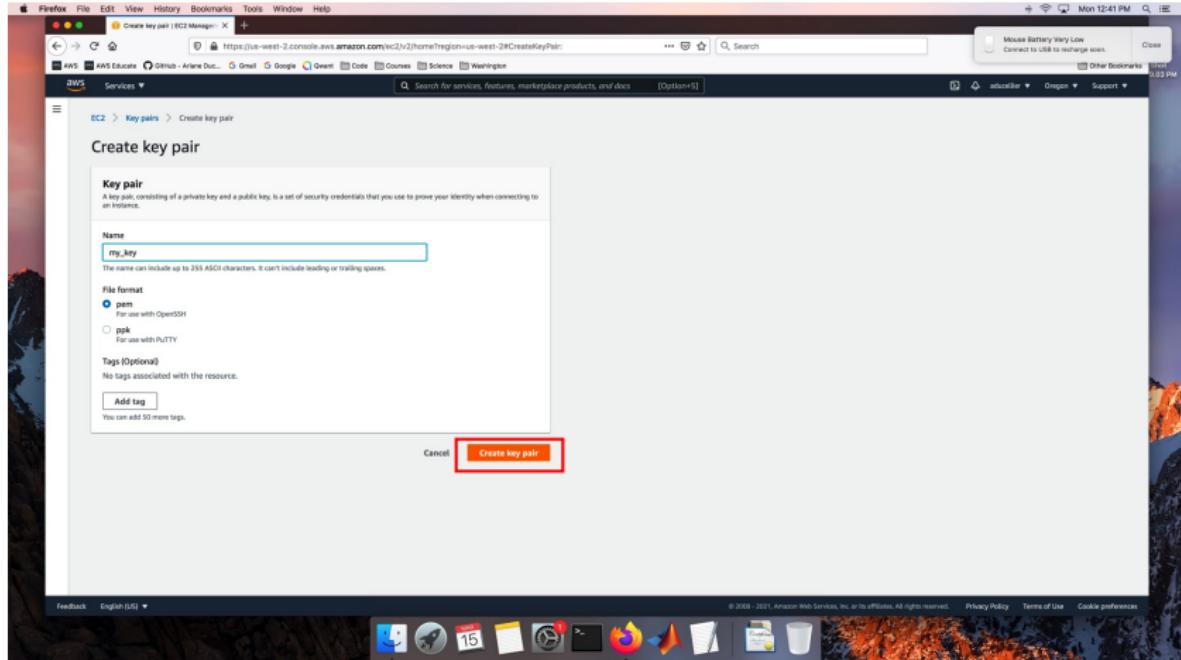
The screenshot shows the AWS EC2 Management console on a Mac OS X desktop. The left sidebar navigation includes 'EC2 Dashboard', 'Instances' (selected), 'Images', 'Elastic Block Store', 'Network & Security', and 'Additional Information'. The main content area displays 'Resources' for the US West (Oregon) Region. A table lists 'Instances (running)', 'Dedicated Hosts', 'Elastic IPs', 'Instances', 'Key pairs' (highlighted with a red box), 'Load balancers', 'Placement groups', 'Security groups', and 'Volumes'. Below the table is a note about Microsoft SQL Server Always On availability groups. To the right, sections for 'Account attributes' (VPC, Default VPC), 'Explore AWS' (Graviton2, Get Up to 40% Better Price Performance), and 'Additional Information' (Enable additional Zones) are visible. The bottom of the screen shows the Mac OS X dock with various application icons.

Click on *Create key pair* to start

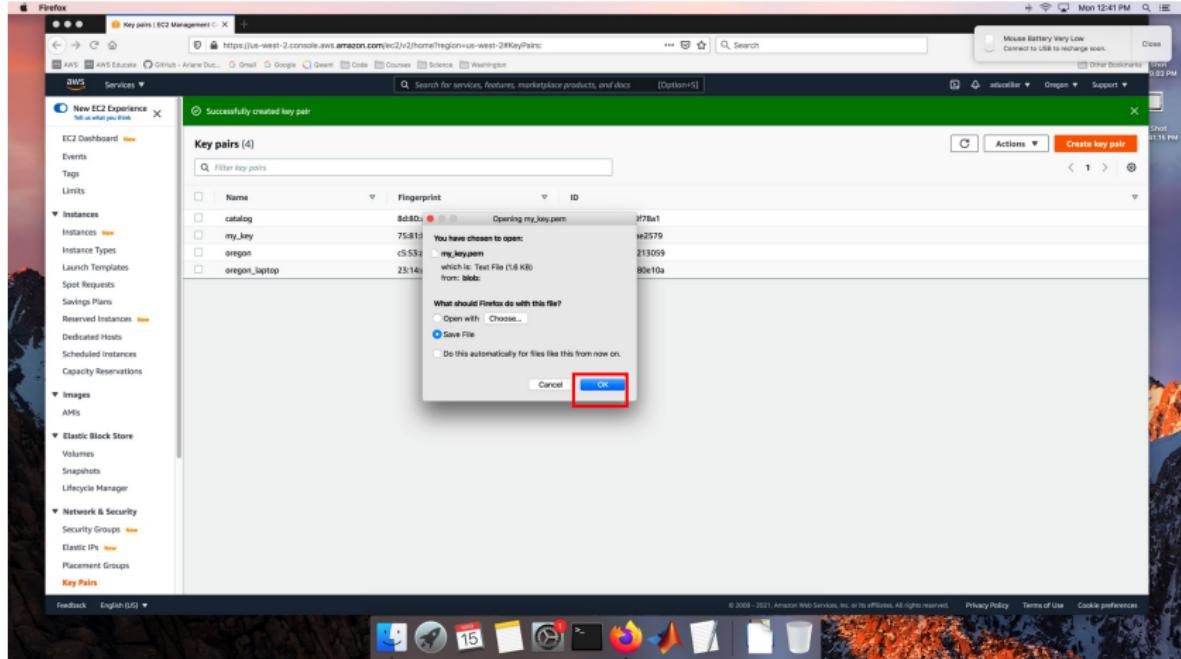
The screenshot shows the AWS EC2 Key Pairs Management interface. On the left, a sidebar lists various AWS services: New EC2 Experience, EC2 Dashboard, Events, Tags, Limits, Instances (selected), Instance Types, Launch Templates, Spot Requests, Savings Plans, Reserved Instances, Dedicated Hosts, Scheduled Instances, Capacity Reservations, Images, AMIs, Elastic Block Store, Volumes, Snapshots, Lifecycle Manager, Network & Security, Security Groups, Elastic IPs, Placement Groups, and Key Pairs (selected). The main content area is titled "Key pairs (3)". It displays a table with three rows, each representing a key pair: "catalog" (Fingerprint: 8d80...), "oregon" (Fingerprint: c5:53:0c:...), and "oregon_laptop" (Fingerprint: 23:14:...). A red box highlights the "Create key pair" button at the top right of the table header.

Name	Fingerprint	ID
catalog	8d80:a2:b0:2b:8rec:56:2d:ab:2f:1a:7...	key-065c70c2e5ef778a1
oregon	c5:53:0c:c5:35:32:c8:d8:37:f0:96:05:ad...	key-0477ed512753213059
oregon_laptop	23:14:e2:d6:13:a1:ab:2d:57:0b:5c:47:2...	key-04895d4179680e10a

Fill in the form and click on *Create key pair*



Download the file on your machine



Your new key pair appears on the list of available key pairs

The screenshot shows a Firefox browser window displaying the AWS EC2 Management console at <https://us-west-2.console.aws.amazon.com/ec2/v2/home?region=us-west-2#KeyPairs>. The title bar indicates it's a "Key pairs | EC2 Management" page. The left sidebar shows the "Instances" section with "my_key" highlighted by a red box. The main content area displays a table titled "Key pairs (4)".

Name	Fingerprint	ID
catalog	8d80a2b02b8ec562dab2f1a7...	key-063c70c3a5e0f78a1
my_key	75:81:bfe672d2a27fdbb1bd2a82...	key-0ae1e12a860aae2579
oregon	c553a0c53532xb0837fd9605ad...	key-0477ed51275213059
oregon_laptop	23:14:d2:dc13a1ab2d370b5c472...	key-04895d4179680e10a

Move key pair to .ssh for instance

```
> cd Downloads  
> mv my_key.pem ~/.ssh
```

Now let us launch a new EC2 instance!

The screenshot shows the AWS EC2 Management console interface. On the left, there's a sidebar with navigation links for EC2 Dashboard, Instances, Images, Elastic Block Store, Network & Security, and more. The main content area has several sections:

- Resources**: A summary of Amazon EC2 resources in the US West (Oregon) Region.

Instances (running)	Dedicated Hosts	Elastic IPs
0	0	0

Instances	Key pairs	Load balancers
0	4	0

Placement groups	Security groups	Snapshots
0	2	0

Volumes
0
- Launch instance**: A section to start a new EC2 instance. It includes a red box around the "Launch instance" button.
- Service health**: Shows the region as "US West (Oregon)" and the status as "This service is operating normally".
- Zones**: A table listing availability zones and their zone IDs:

Zone name	Zone ID
us-west-2a	usw2-az2
us-west-2b	usw2-az1
us-west-2c	usw2-az3
us-west-2d	usw2-az4
- Explore AWS**: Promotional sections for Graviton2, T4g instances, and EC2 Spot Instances.

You first need to choose an Amazon Machine Image (AMI)

The screenshot shows a Firefox browser window displaying the AWS Launch Instance Wizard. The URL in the address bar is <https://us-west-2.console.aws.amazon.com/v2/home?region=us-west-2&LaunchInstanceWizard>. The page title is "Launch instance wizard (EC2) - AWS".

The navigation bar at the top includes: File, Edit, View, History, Bookmarks, Tools, Window, Help.

The search bar contains: Search for services, features, marketplace products, and docs [Option+G].

The AWS navigation bar shows: AWS Services ▾ AWS Educate GitHub - Ariane Ducellier Gmail Google Drive Code Courses Science Washington.

The main content area has tabs: 1. Choose AMI, 2. Choose Instance Type, 3. Configure Instance, 4. Add Storage, 5. Add Tags, 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 application) 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.

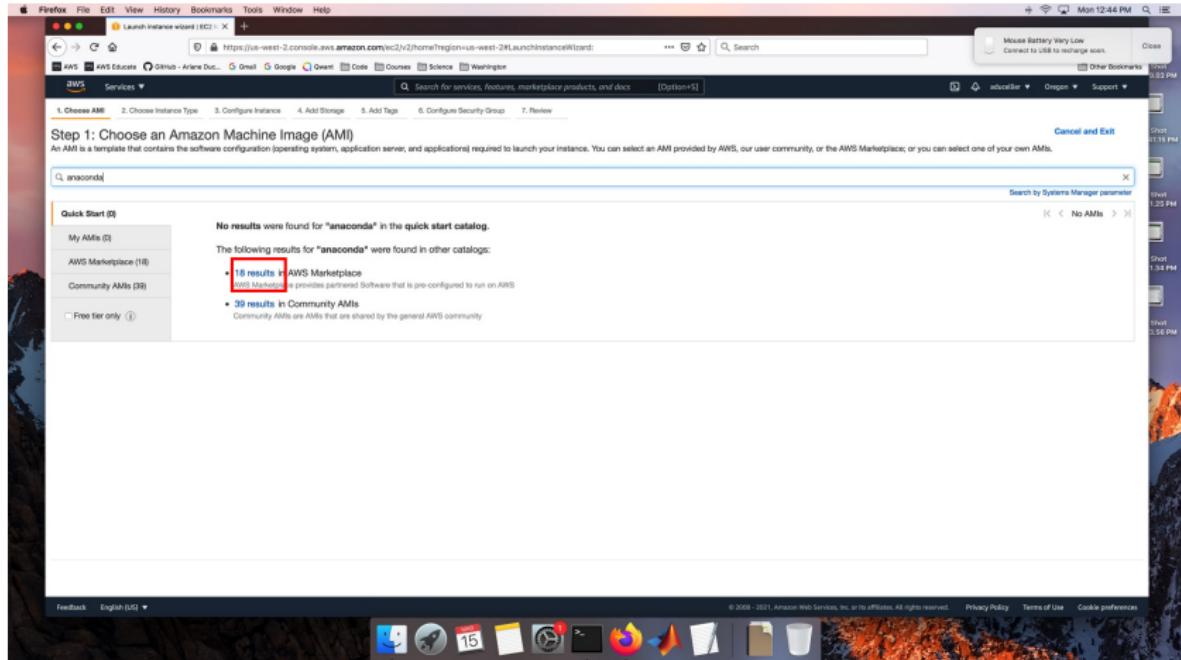
A search bar at the top right says "Search by Systems Manager parameter".

The results list includes:

- Amazon Linux 2 AMI (HVM, SSD Volume Type)** - ami-00f94089d04c0cfa (64-bit x86) / ami-01bcadcc02161d4ea (64-bit Arm)
Amazon Linux 2 comes with five years support. It provides Linux kernel 4.14 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is approaching end-of-life on December 31, 2020 and has been removed from this wizard.
Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
Select 64-bit (x86) 64-bit (Arm)
- macOS Big Sur 11.2.1** - ami-08288bd53de177400
The macOS Big Sur AMI is an EBS-backed, AWS-supported image. This AMI includes the AWS Command Line Interface, Command Line Tools for Xcode, Amazon SSM Agent, and Homebrew. The AWS Homebrew Tap includes the latest versions of multiple AWS packages included in the AMI.
Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
Select 64-bit (Mac)
- macOS Catalina 10.15.7** - ami-01465445794a143d
The macOS Catalina AMI is an EBS-backed, AWS-supported image. This AMI includes the AWS Command Line Interface, Command Line Tools for Xcode, Amazon SSM Agent, and Homebrew. The AWS Homebrew Tap includes the latest versions of multiple AWS packages included in the AMI.
Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
Select 64-bit (Mac)
- macOS Mojave 10.14.6** - ami-060c8c07d7e42fb04f
The macOS Mojave AMI is an EBS-backed, AWS-supported image. This AMI includes the AWS Command Line Interface, Command Line Tools for Xcode, Amazon SSM Agent, and Homebrew. The AWS Homebrew Tap includes the latest versions of multiple AWS packages included in the AMI.
Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
Select 64-bit (Mac)
- Red Hat Enterprise Linux 8 (HVM, SSD Volume Type)** - ami-01e78c5619cde6bb4 (64-bit x86) / ami-03ef21db8a2525ca9 (64-bit Arm)
Red Hat Enterprise Linux version 8 (HVM, EBS General Purpose (SSD) Volume Type)
Select 64-bit (x86) 64-bit (Arm)

At the bottom, there are links for Feedback, English (US), Privacy Policy, Terms of Use, and Cookie preferences. The status bar shows: © 2008 - 2021, Amazon Web Services, Inc. or its Affiliates. All rights reserved. Mon 12:43 PM.

We want one with Anaconda installed



We choose the one with Anaconda and Python 3

The screenshot shows the AWS Launch Instance Wizard interface. The user has selected the 'Anaconda with Python 3' AMI from the list. This AMI is highlighted with a red box. To the right of the list, there is a search bar labeled 'Search by Systems Manager parameter' and a 'Select' button, which is also highlighted with a red box. The interface includes a sidebar with categories like 'Quick Start (0)', 'My AMIs (0)', 'AWS Marketplace (18)', 'Community AMIs (39)', 'Categories', 'Architecture', and 'Operating System'. At the bottom, there is a toolbar with various icons and links to 'Privacy Policy', 'Terms of Use', and 'Cookie preferences'.

Check the cost of each type of instance before choosing one

The screenshot shows a Firefox browser window displaying the AWS Launch Instance wizard. The URL is <https://us-west-2.console.aws.amazon.com/ec2/v2/home?region=us-west-2#LaunchInstanceWizard>. The page title is "Launch Instance wizard (EC2) | AWS Services". The search bar contains "Search for services, features, marketplace products, and docs". The main content area is titled "Step 1: Choose an Amazon Machine Image (AMI)". It shows the "Anaconda with Python 3" AMI selected. The "Pricing Details" section shows hourly fees for various EC2 instance types. A red box highlights the "Continue" button at the bottom right of the pricing table.

Anaconda with Python 3

Anaconda is the most popular python data science distribution. Anaconda includes all the libraries you need to build, highly optimized, and tested together to ensure compatibility. Use the conda package manager to easily install 1000+ data science packages along with managing your packages, dependencies, ...

[More Info](#)

[View Additional Details in AWS Marketplace](#)

Product Details

By [Anaconda, Inc.](#)
Customer Rating  (1)
Latest Version Anaconda3 2020.11 202011119
Base Operating System Linux, Unix, Amazon Linux 2018.03
Delivery Method 64-bit (x86) Amazon Machine Image (AMI)
Licenses Agreement [End User License Agreement](#)
On Marketplace Since 4/29/18

Highlights

- Over 200 open source data science packages, including numpy, scipy, pandas, matplotlib, scikit-learn, jupyter

Instance Type	Software	EC2	Total
c2.nano	\$0.00	\$0.006	\$0.006/hr
c2.micro	\$0.00	\$0.018	\$0.018/hr
c2.small	\$0.00	\$0.023	\$0.023/hr
c2.medium	\$0.00	\$0.046	\$0.046/hr
c2.large	\$0.00	\$0.093	\$0.093/hr
c2.xlarge	\$0.00	\$0.186	\$0.186/hr
c2.2xlarge	\$0.00	\$0.371	\$0.371/hr
c3.nano	\$0.00	\$0.005	\$0.005/hr
c3.micro	\$0.00	\$0.011	\$0.011/hr
c3.small	\$0.00	\$0.021	\$0.021/hr
c3.medium	\$0.00	\$0.042	\$0.042/hr
c3.large	\$0.00	\$0.083	\$0.083/hr
c3.xlarge	\$0.00	\$0.166	\$0.166/hr
c3.2xlarge	\$0.00	\$0.333	\$0.333/hr
c3.large	\$0.00	\$0.105	\$0.105/hr
c3.xlarge	\$0.00	\$0.21	\$0.21/hr
c3.2xlarge	\$0.00	\$0.42	\$0.42/hr

[Cancel](#) [Continue](#)

Select the type of instance you want: We choose t3.small

The screenshot shows a Firefox browser window on a Mac OS X desktop. The URL in the address bar is <https://us-west-2.console.aws.amazon.com/v2/home?region=us-west-2&LaunchInstanceWizard>. The AWS logo is visible in the top left of the browser window. The main content area displays the 'Step 2: Choose an Instance Type' page of the Launch Instance Wizard. The heading says, '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.' Below this, there is a table comparing various instance families and types based on vCPUs, memory, instance storage, EBS-optimized availability, network performance, and IPv6 support. The 't3.small' row is highlighted with a red box around its checkbox, indicating it is selected. Other rows include t2.nano, t2.micro, t2.small, t2.medium, t2.large, t2.xlarge, t3.nano, t3.micro, and t3.large. The table has columns for Family, Type, vCPUs, Memory (GiB), Instance Storage (GiB), EBS-Optimized Available, Network Performance, and IPv6 Support. At the bottom of the table, there are buttons for 'Cancel', 'Previous', 'Review and Launch', and 'Next: Configure Instance Details'. The status bar at the bottom of the screen shows various application icons and the date/time.

Family	Type	vCPUs	Memory (GiB)	Instance Storage (GiB)	EBS-Optimized Available	Network Performance	IPv6 Support
t2	t2.nano	1	0.5	EBS only	-	Low to Moderate	Yes
t2	t2.micro	1	1	EBS only	-	Low to Moderate	Yes
t2	t2.small	1	2	EBS only	-	Low to Moderate	Yes
t2	t2.medium	2	4	EBS only	-	Low to Moderate	Yes
t2	t2.large	2	8	EBS only	-	Low to Moderate	Yes
t2	t2.xlarge	4	16	EBS only	-	Moderate	Yes
t2	t2.2xlarge	8	32	EBS only	-	Moderate	Yes
t3	t3.nano	2	0.5	EBS only	Yes	Up to 5 Gigabit	Yes
t3	t3.micro	2	1	EBS only	Yes	Up to 5 Gigabit	Yes
t3	t3.small	2	2	EBS only	Yes	Up to 5 Gigabit	Yes
t3	t3.medium	2	4	EBS only	Yes	Up to 5 Gigabit	Yes
t3	t3.large	2	8	EBS only	Yes	Up to 5 Gigabit	Yes

Configure the instance (you can leave it as it is)

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 Launch into Auto Scaling Group:

Purchasing option: Request Spot Instances

Network: vpc-dab7fd12 (default) Create new VPC

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

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

Placement group: Add instance to placement group

Capacity Reservation: Open

Domain join directory: No directory Create new directory

IAM role: None Create new IAM role

CPU options: Specify CPU options

Shutdown behavior: Stop

Stop - Hibernate behavior: Enable hibernation as an additional stop behavior

Enable termination protection: Protect against accidental termination

Monitoring: Enable CloudWatch detailed monitoring
Additional charges apply.

EBS-optimized instance: Launch as EBS-optimized instance

Tenancy: Shared - Run a shared hardware instance
Additional charges will apply for dedicated tenancy.

Cancel Previous Review and Launch Next: Add Storage

Choose the storage (you can leave it as it is)

The screenshot shows a Firefox browser window displaying the AWS Launch Instance Wizard (Step 4: Add Storage). The URL in the address bar is <https://us-west-2.console.aws.amazon.com/v2/home?region=us-west-2&LaunchInstanceWizard>. The page title is "Launch instance wizard (EC2)".

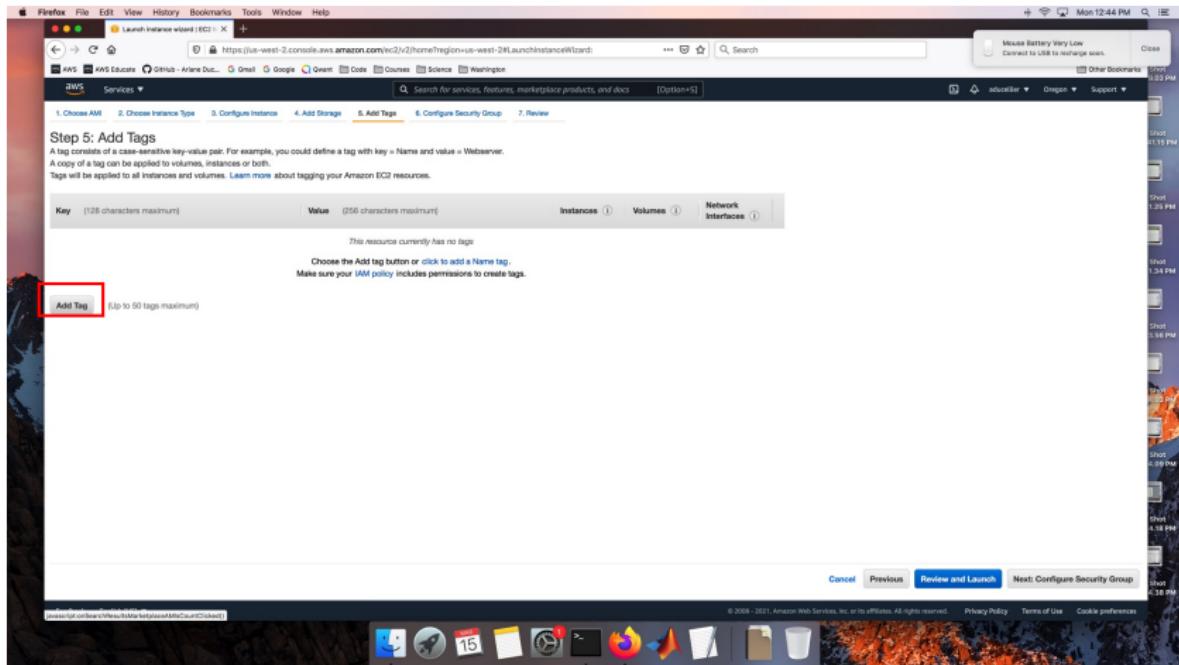
The main content area is titled "Step 4: Add Storage". It displays a table with one row of data:

Volume Type	Device	Snapshot	Size (GB)	Volume Type	IOPS	Throughput (MB/s)	Delete on Termination	Encryption
Root	/dev/xvda	snap-0df2520b694fb1fa3	8	General Purpose SSD (gp2)	100 / 3000	N/A	<input checked="" type="checkbox"/>	Not Encrypted

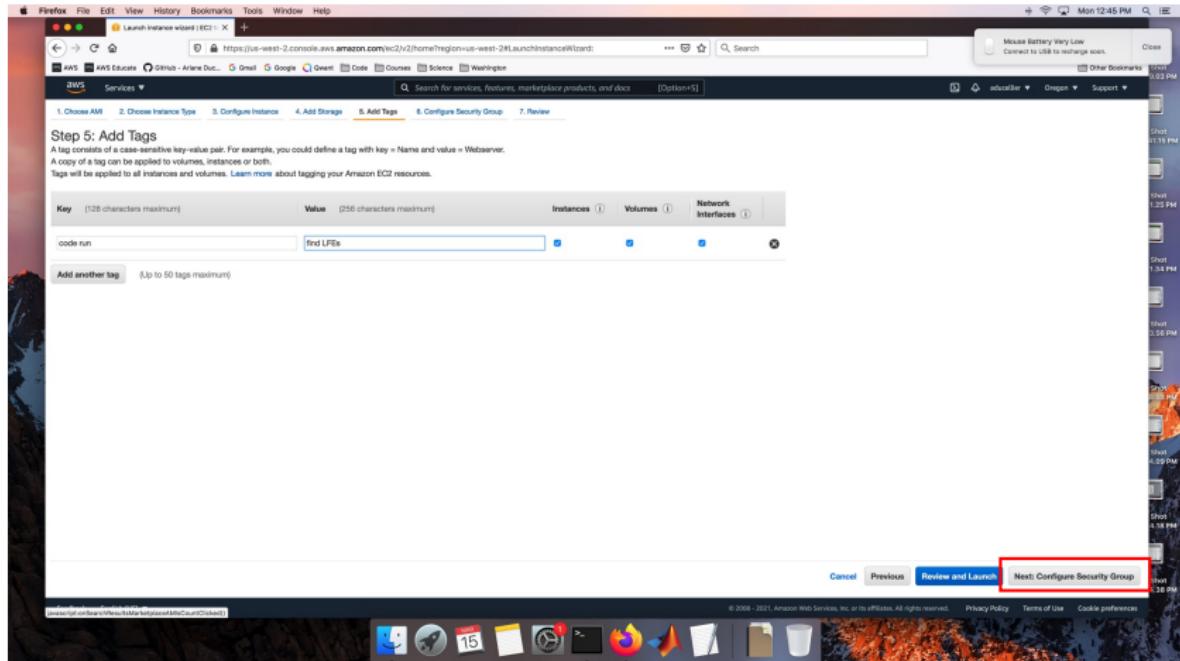
Below the table, there is a button labeled "Add New Volume". A callout box highlights a note: "Free tier eligible customers can get up to 30 GB of EBS General Purpose (SSD) or Magnetic storage. [Learn more](#) about free usage tier eligibility and usage restrictions."

At the bottom right of the page, there are navigation buttons: "Cancel", "Previous", "Review and Launch", and "Next: Add Tags". The "Review and Launch" button is highlighted with a red box.

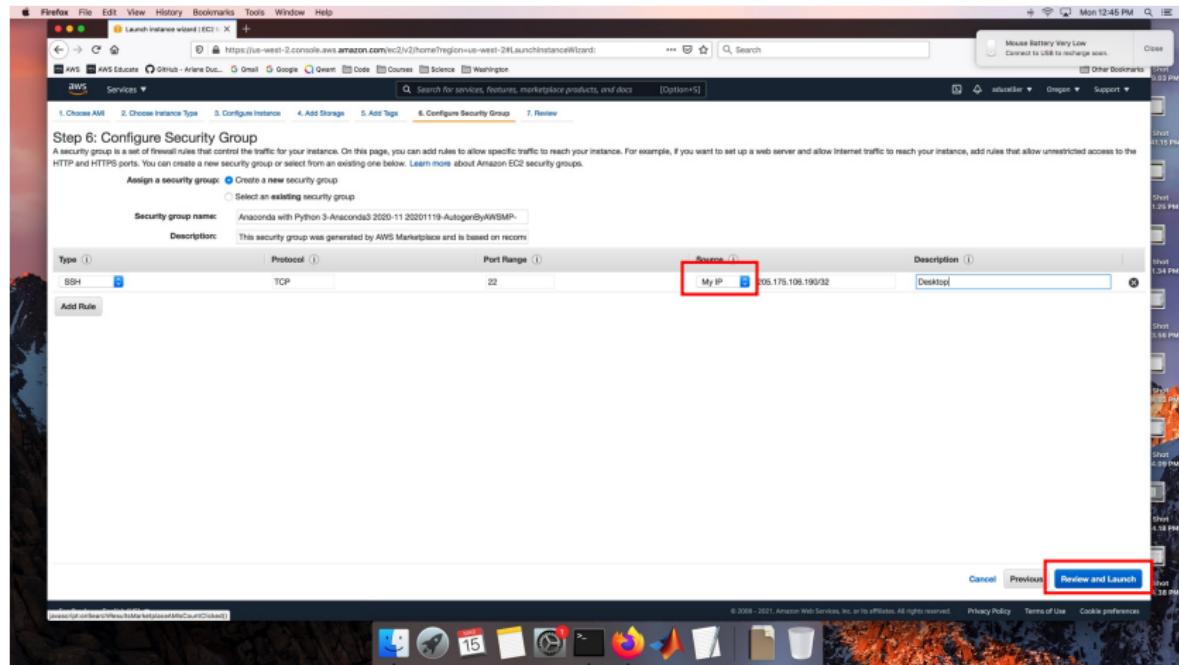
Add tags to remember what jobs you will be running on your EC2 instance



I want to run the Python script *find_all_LFEs_parallel.py*



Choose a security group (you can use the same for several instances)



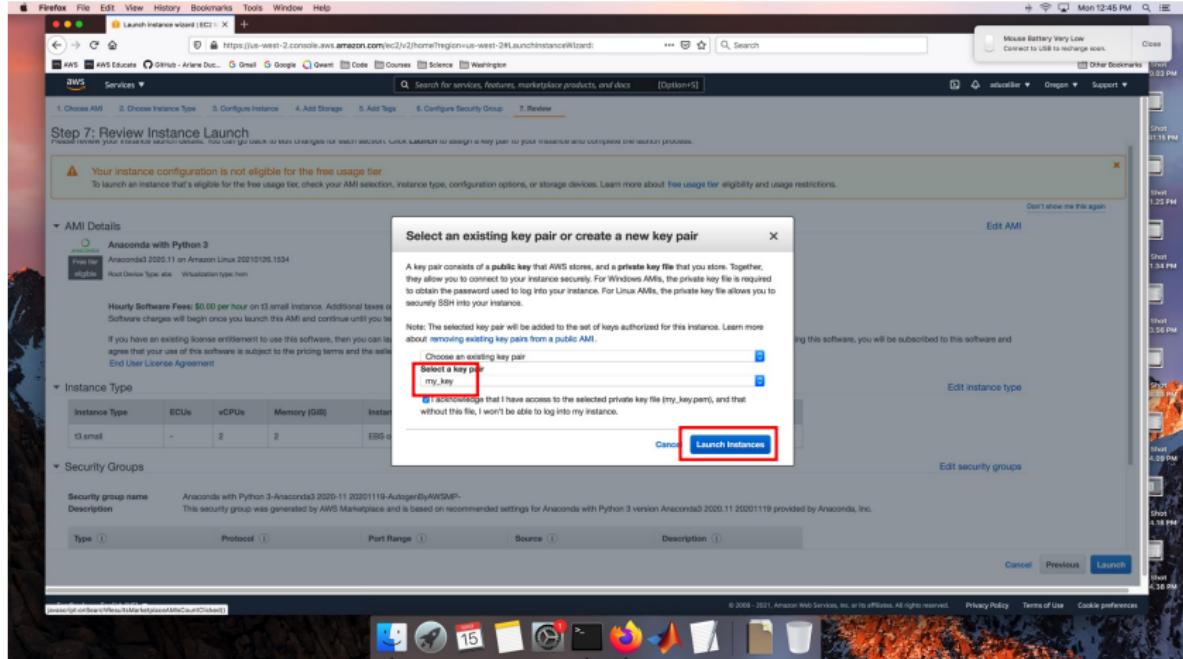
Review your options before launching

The screenshot shows the AWS Launch Instance Wizard Step 7: Review Instance Launch. The configuration details are as follows:

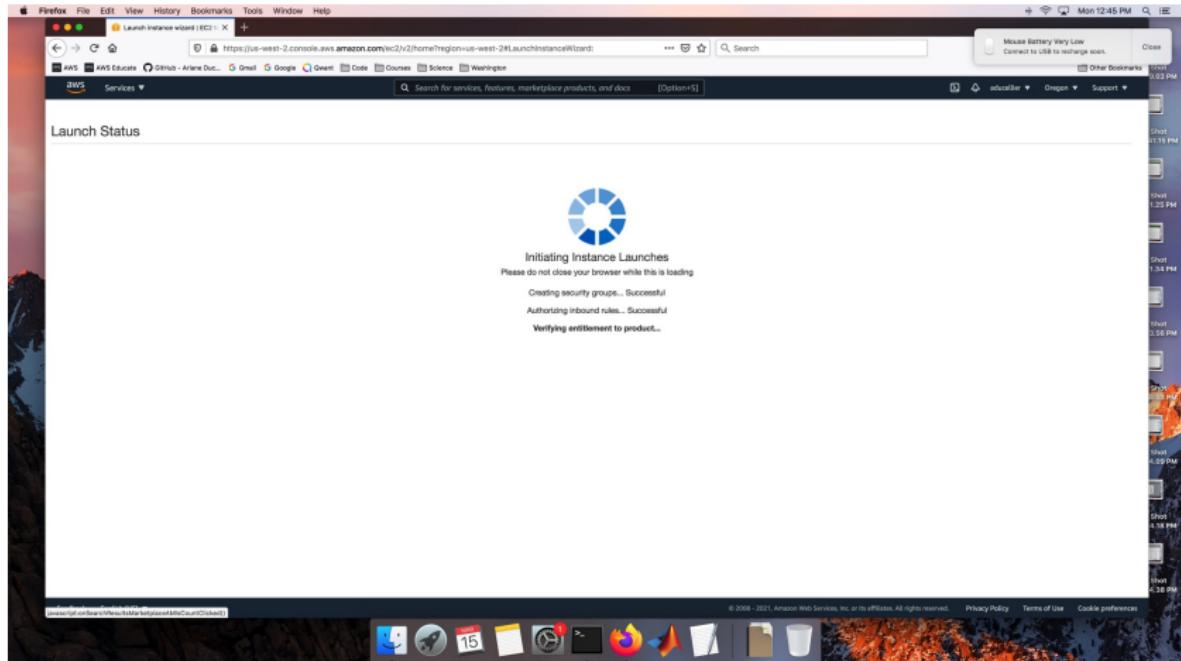
- AMI Details:** Anaconda with Python 3 (Free tier eligible). It's a Free tier instance running on Amazon Linux 20210102.1534.
- Hourly Software Fees:** \$0.00 per hour on t3.small instance. Additional taxes or fees may apply. Software charges will begin once you launch this AMI and continue until you terminate the instance.
- Instance Type:** t3.small (ECUs: 1, vCPUs: 2, Memory: 2 GiB, EBS only, EBS-Optimized Available, Network Performance: Up to 5 Gigabit).
- Security Groups:** Security group name: Anaconda with Python 3-Anaconda3 2020-11-20201119-AutogerByAWSMP-. Description: This security group was generated by AWS Marketplace and is based on recommended settings for Anaconda with Python 3 version Anaconda3 2020.11 20201119 provided by Anaconda, Inc.

At the bottom right, there is a red box around the "Launch" button.

Choose a key pair: the one you have downloaded earlier



Your EC2 instance is launching



Go back to the list of instances

The screenshot shows a Firefox browser window with the AWS Launch Instance wizard (EC2) open. The URL is <https://us-west-2.console.aws.amazon.com/ec2/v2/home?region=us-west-2#LaunchInstanceWizard>. The page displays the "Launch Status" section with a green success message: "Your instances are now launching. The following instance launches have been initiated: i-0fdd208ec0ba02fc1" and a link to "View launch log". Below this, there's a reminder to "Get notified of estimated charges" with a note about creating billing alerts. The "How to connect to your instances" section includes links to "View Instances" (which is highlighted with a red box), "Getting started with your software" (with links to "View Usage Instructions" and "Open Your Software on AWS Marketplace"), and a list of helpful resources like "How to connect to your Linux instance" and "Amazon EC2 User Guide". At the bottom, there's a note about launching instances and links to "Create status check alarms", "Create and attach additional EBS volumes", and "Manage security groups". The browser toolbar at the bottom includes icons for various applications like Finder, Mail, Calendar, and the Dock.

Your new EC2 instance is here

The screenshot shows the AWS EC2 Management console interface. On the left, a sidebar navigation menu includes sections for EC2 Dashboard, Events, Tags, Instances (with sub-options like Instance Types, Launch Templates, Spot Requests, Savings Plans, Reserved Instances, Dedicated Hosts, Scheduled Instances, Capacity Reservations), Images, AMIs, Elastic Block Store (Volumes, Snapshots, Lifecycle Manager), Network & Security (Security Groups, Elastic IP, Placement Groups, Key Pairs), and Feedback. The main content area displays the 'Instances' page, which lists one instance: i-04ddb08ec8ba226c1. This instance is shown as 'Running' with an 'Initializing' status check. The instance details page is open, showing information such as Public IPv4 address (34.220.203.122), Private IPv4 addresses (172.31.11.54), Public IPv4 DNS (ec2-54-220-203-122.us-west-2.compute.amazonaws.com), Private IPv4 DNS (ip-172-31-11-54.us-west-2.compute.internal), VPC ID (vpc-6ab71d12), and Subnet ID (subnet-122b5d48). The browser's toolbar at the bottom includes icons for Home, Back, Forward, Stop, Refresh, and Search.

You can modify the tags

The screenshot shows the AWS EC2 Management console in a Firefox browser window. The left sidebar is collapsed, showing navigation links like 'New EC2 Experience', 'EC2 Dashboard', 'Events', 'Tags', 'Limits', 'Instances' (selected), 'Instance Types', 'Launch Templates', 'Spot Requests', 'Savings Plans', 'Reserved Instances' (highlighted), 'Dedicated Hosts', 'Scheduled Instances', 'Capacity Reservations', 'Images', 'AMIs', 'Elastic Block Store', 'Volumes', 'Snapshots', 'Lifecycle Manager', 'Network & Security', 'Security Groups', 'Elastic IPs', 'Placement Groups', and 'Key Pairs'. The main content area displays the 'Instances (1/1)' page with a single instance listed:

Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IPv4 ...	Elastic IP
-	i-04ddb08ecfba226c1	Running	t3.small	Initializing	No alarms	us-west-2c	ec2-34-220-205-122.us...	34.220.205.122	-

Below the table, a modal window is open for the instance 'i-04ddb08ecfba226c1'. The 'Tags' tab is selected, highlighted with a red box. The 'Tags' section contains a search bar and a table with one entry:

Key	Value
code run	find LFEs

At the bottom of the modal, there are buttons for 'Manage tags', 'Create', and 'Delete'.

Your can modify the security group

The screenshot shows the AWS EC2 Management console in a Firefox browser. The left sidebar navigation includes 'Instances' (selected), 'Security Groups' (selected), and 'Network & Security'. The main content area displays an 'Instances' table with one item: 'i-04dd08ec8ba226c1' (Running, t3.small, Initializing). Below the table, the 'Security' tab is selected in the 'Instance: i-04dd08ec8ba226c1' details panel. In the 'Security groups' section, the 'sg-0796bd3da313f21c3 (Anaconda with Python 3-Anaconda3 2020-11-20201119-AutogenByAWSMP-)' group is listed and highlighted with a red box. Under 'Inbound rules', a single rule is shown: 'Port range: 22, Protocol: TCP, Source: 205.175.106.190/32, Security group: Anaconda with Python 3-Anaconda3 2020-11 20201119-AutogenByAWSMP-'. The bottom of the screen shows the Mac OS Dock with various application icons.

Change the rules to connect to your instances

The screenshot shows the AWS EC2 Management Console in a Firefox browser window. The URL is <https://us-west-2.console.aws.amazon.com/ec2/home?region=us-west-2#SecurityGroup:securityGroupID=sg-07968db5a315f27c5>. The page displays the details of a security group named "sg-07968db5a315f27c5 - Anaconda with Python 3-Anaconda3 2020-11 20201119-AutogenByAWSMP-". The security group ID is sg-07968db5a315f27c5. It was created by "Anaconda with Python 3-Anaconda3 2020-11 20201119-AutogenByAWSMP-" on 2020-11-19. The owner is 836178295133. There is one inbound rule for port 22 (TCP) from source 205.175.106.190/32, labeled "Desktop". The "Edit inbound rules" button is highlighted with a red box. The left sidebar shows navigation links for EC2 Dashboard, Instances, Images, Elastic Block Store, Network & Security, and more.

Type	Protocol	Port range	Source	Description - optional
SSH	TCP	22	205.175.106.190/32	Desktop

Your IP may have changed since the last time you connected

The screenshot shows a Firefox browser window open to the AWS EC2 Management Console at <https://us-west-2.console.aws.amazon.com/ec2/v2/home?region=us-west-2#ModifyInboundSecurityGroupRules:security-group-id=sg-07960d85a315f27c5>. The page title is "Edit inbound rules". The URL bar also shows "Anaconda with Python 3-Anaconda3 2020-11 20201119-AutogenedbyAWSMP-".

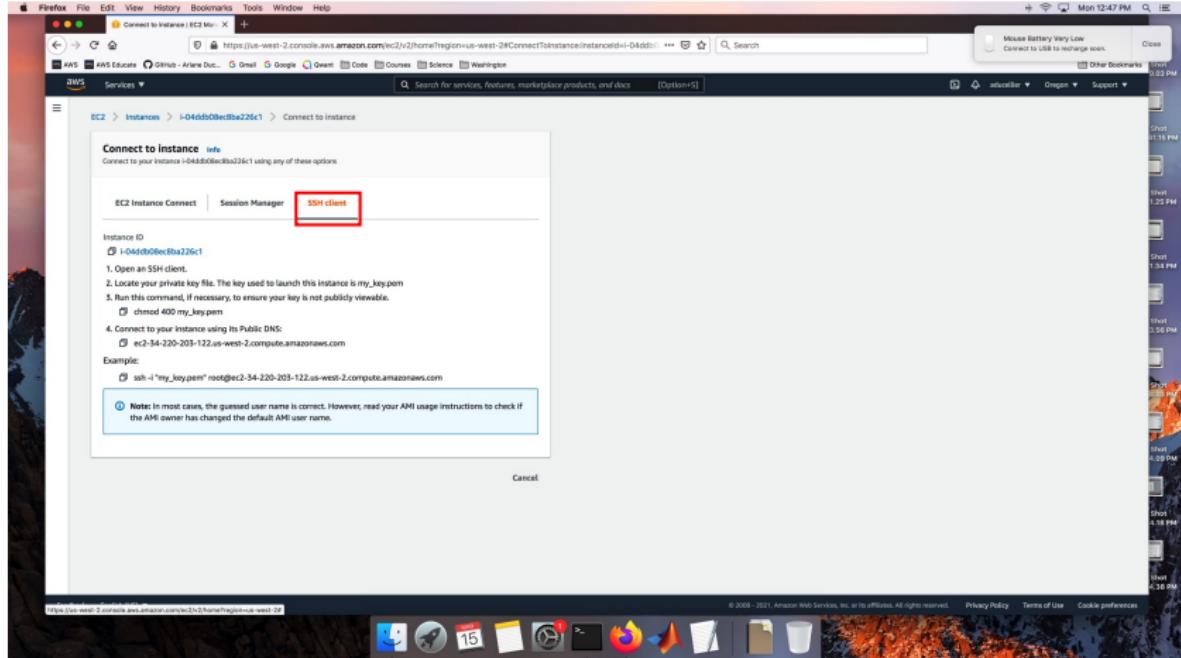
The main content area displays the "Inbound rules" section. A red box highlights the "Source" dropdown menu, which is set to "My IP". Below it, the IP address "205.175.106.190/32" is listed in a search bar. Another red box highlights the "Save rules" button at the bottom right of the form.

Below the form, a note states: "NOTE: Any edits made on existing rules will result in the edited rule being deleted and a new rule created with the new details. This will cause traffic that depends on that rule to be dropped for a very brief period of time until the new rule can be created."

A status message at the bottom left says: "You have not made any changes."

At the bottom right of the browser window, there is a vertical sidebar with several icons and a timestamp: "Mon 12:46 PM".

Follow the instructions to connect with SSH



Open an SSH terminal to connect to your instance

```
> cd ~/.ssh  
> ssh -i "my_key.pem" ec2-user@ec2-XXX-XXX-XXX-XXX.  
us-west-2.compute.amazonaws.com
```

Install git and clone your repository

```
> sudo yum install git  
> git clone "https://github.com/ArianeDucellier/  
catalog.git"
```

Create your Anaconda environment

```
> cd catalog  
> conda env create -f environment.yml  
> conda activate catalog
```

In my case, I just prepare some input files

```
> mkdir data/response  
> cd src  
> python get_responses.py
```

Use nohup to continue your computation after you disconnect

```
> nohup python find_all_LFEs_parallel.py &  
> ps -x -o pid,user,%mem,command  
> exit
```

Never forget to terminate your instances!!!

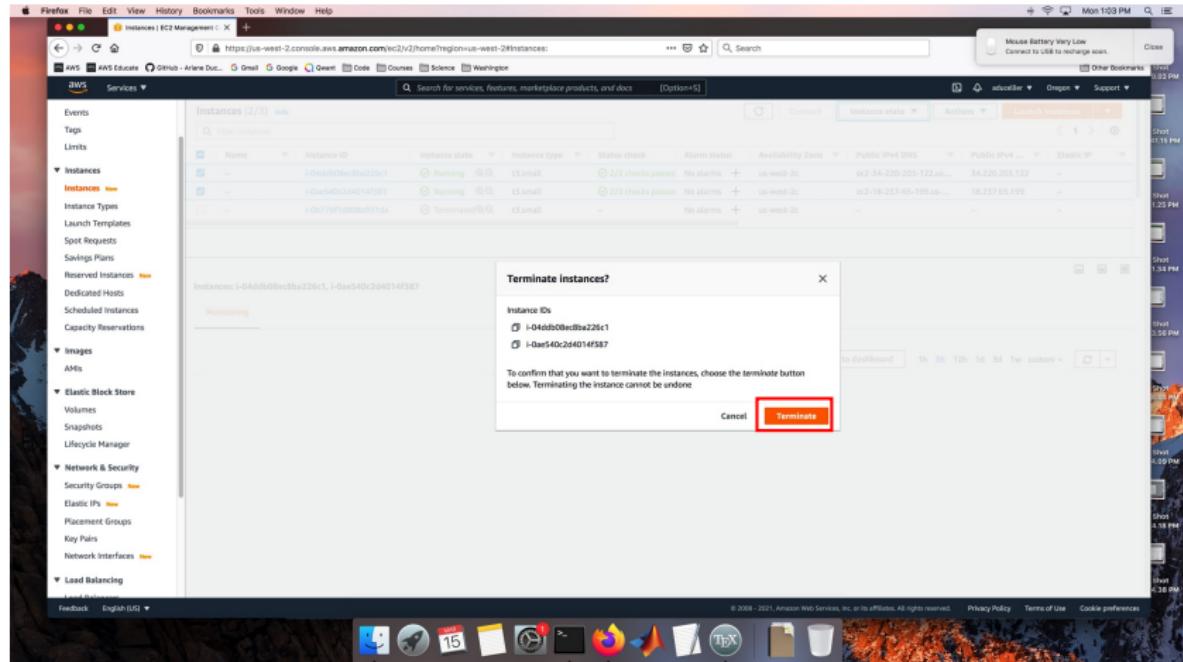
The screenshot shows the AWS EC2 Management console in a Firefox browser window. The left sidebar navigation includes: Instances (selected), Instances Types, Launch Templates, Spot Requests, Savings Plans, Reserved Instances, Dedicated Hosts, Scheduled Instances, Capacity Reservations, Images, AMIs, Elastic Block Store, Volumes, Snapshots, Lifecycle Manager, Network & Security, Security Groups, Elastic IPs, Placement Groups, Key Pairs, Network Interfaces, and Load Balancing.

The main content area displays the 'Instances (2/3) - Info' table. The table has columns: Name, Instance ID, Instance state, Instance type, Status check, Alarm status, Availability Zone, and Actions. Two instances are listed:

Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Actions
-	i-04dd80bec8ba226c1	Running	t3.small	2/2 checks passed	No alarms	us-west-2c	Stop instance Start instance Reboot instance Terminate instance
-	i-0ae5402d4014f587	Running	t3.small	2/2 checks passed	No alarms	us-west-2c	Public IPv4 ... Elastic IP ...
-	i-0b77bf1b086d031da	Terminated	t3.small	-	No alarms	us-west-2c	

A red box highlights the 'Terminate instance' link for the terminated instance. Below the table, a message says 'Instances: i-04dd80bec8ba226c1, i-0ae5402d4014f587'. A 'Monitoring' section is present with a 'Add to dashboard' button and a time range selector (1h, 5h, 12h, 1d, 3d, 1w, custom). The bottom of the screen shows the OS taskbar with various application icons.

Never forget to terminate your instances!!!



Check if your instance has been terminated

The screenshot shows the AWS EC2 Management Console interface. On the left, the navigation pane is open, showing various services like Events, Tags, Limits, Instances (selected), Instance Types, Launch Templates, Spot Requests, Savings Plans, Reserved Instances, Dedicated Hosts, Scheduled Instances, Capacity Reservations, Images, AMIs, Elastic Block Store, Volumes, Snapshots, Lifecycle Manager, Network & Security, Security Groups, Elastic IPs, Placement Groups, Key Pairs, Network Interfaces, and Load Balancing.

The main content area displays a table of instances. One instance, with the ID `i-0ae540c2d4014f387`, is highlighted with a red box around its status column. The status is listed as "Terminated" with a small icon. The instance type is t3.small, and the status check shows "2/2 checks passed" with "no alarms". The availability zone is us-west-2c.

A context menu is open over this instance, with the "Terminate instance" option highlighted. Below the table, a detailed view for the instance `i-0ae540c2d4014f387` is shown, including sections for Details, Security, Networking, Storage, Status checks, Monitoring, and Tags. The Details section is expanded, showing the Instance summary. The instance state is listed as "Running". Other details include Public IPv4 address (18.237.65.199), Private IPv4 addresses (172.31.6.254), Public IPv4 DNS (ec2-18-237-65-199.us-west-2.compute.amazonaws.com), Private IPv4 DNS (ip-172-51-6-254.us-west-2.compute.internal), VPC ID (vpc-6ab71d12), and Subnet ID (subnet-122b5d48).

Go to your billing dashboard

The screenshot shows a Firefox browser window displaying the AWS Billing Dashboard. The URL in the address bar is <https://us-west-2.console.aws.amazon.com/ec2/v2/home?region=us-west-2#/LaunchTemplates>. The browser interface includes a search bar, a tab for 'Launch templates | EC2 Metrics', and a status bar showing 'Mon 12:59 PM'.

The main content area is titled 'Launch templates (1) Info'. It lists one launch template:

Launch template ID	Launch template name	Default version	Latest version
i-05575f0d40d119d02	catalogAMI	1	1

On the right side of the dashboard, there is a sidebar with links: 'My Account' (836178293133), 'My Organization', 'My Service Quotas' (highlighted with a red box), 'My Billing Dashboard' (highlighted with a red box), and 'My Security Credentials'. Below these are 'Sign Out' and a 'Sign In' link.

The left sidebar of the browser shows the AWS navigation menu with sections like 'EC2 Dashboard', 'Instances', 'Launch Templates' (which is currently selected and highlighted in blue), 'Images', 'Elastic Block Store', 'Network & Security', and 'AWS Lambda'.

You can check how much you have been spending (do it often!)

The screenshot shows the AWS Billing & Cost Management Dashboard. The left sidebar has a 'Cost Management' section with links to Cost Explorer, Budgets, Budgets Reports, Savings Plans, Cost & Usage Reports, Cost Categories, and Cost allocation tags. Below that is a 'Billing' section with links to Bills, Payments, Credits, Purchase orders, Preferences, Billing preferences, Payment methods, Consolidated billing, and Tax settings.

The main content area has a 'Billing & Cost Management Dashboard' title. It features a 'Getting Started with AWS Billing & Cost Management' box with links to Manage your costs and usage using AWS Budgets, Visualize your cost drivers and usage trends via Cost Explorer, Dive deeper into your costs using the Cost and Usage Reports with Athena Integration, Learn more: Check out the AWS What's New webpage, and Do you have Reserved Instances (RI)? Access the RI Utilization & Coverage reports—and RI purchase recommendations—via Cost Explorer.

Below this is a 'Spend Summary' section showing a bar chart with the total spend for the last month, month-to-date, and forecast. The values are \$1.07 for Last Month (February 2021), \$0.54 for Month-to-Date (March 2021), and \$1.2 for Forecast (March 2021).

To the right is a 'Month-to-Date Spend by Service' section with a donut chart showing the proportion of costs spent on each service. The value is \$0.54. A table lists the services and their respective costs:

Service	Cost
CloudWatch	\$0.54
KMS	\$0.00
QueueService	\$0.00
S3	\$0.00
Other Services	\$0.00
Tax	\$0.00
Total	\$0.54

At the bottom, there are links for Feedback, English (US), Privacy Policy, Terms of Use, and Cookie preferences. The browser status bar shows 'Mozilla Firefox 90.0.2 (64-bit)' and the system tray shows battery level at 12:58 PM.

Go to Cost Explorer

The screenshot shows the AWS Billing & Cost Management Dashboard. On the left sidebar, under the 'Cost Management' section, the 'Cost Explorer' link is highlighted with a red box. The main content area displays a 'Billing & Cost Management Dashboard' with various sections like 'Getting Started with AWS Billing & Cost Management', 'Spend Summary', and a pie chart showing '\$0.54'. A bar chart below shows costs for 'Last Month (February 2021)', 'Month-to-Date (March 2021)', and a 'Forecast (March 2021)'. The 'Month-to-Date Spend by Service' section lists services and their costs.

Billing & Cost Management Dashboard

Getting Started with AWS Billing & Cost Management

- Manage your costs and usage using **AWS Budgets**
- Visualize your cost drivers and usage trends via **Cost Explorer**
- Dive deeper into your costs using the **Cost and Usage Reports** with Athena integration
- Learn more: Check out the [AWS What's New webpage](#)

Do you have Reserved Instances (RI)?
Access the RI Utilization & Coverage reports—and RI purchase recommendations—via [Cost Explorer](#).

Spend Summary

Welcome to the AWS Billing & Cost Management console. Your last month, month-to-date, and month-end forecasted costs appear below.

Current month-to-date balance for March 2021

\$0.54

Last Month (February 2021): \$1.07
Month-to-Date (March 2021): \$0.54
Forecast (March 2021): \$1.2

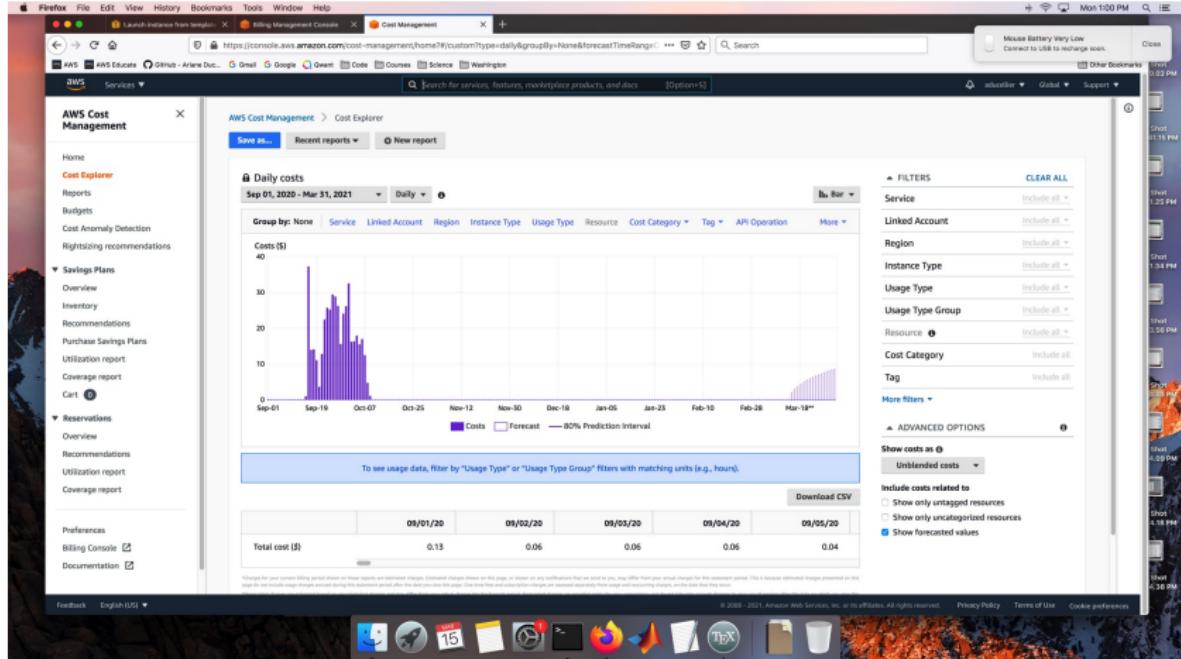
Month-to-Date Spend by Service

Service	Cost
CloudWatch	\$0.54
KMS	\$0.00
QueueService	\$0.00
S3	\$0.00
Other Services	\$0.00
Tax	\$0.00
Total	\$0.54

Look at the daily amounts you spent

The screenshot shows a Firefox browser window with the AWS Billing Management Console open. The URL is <https://console.aws.amazon.com/billing/home#/costexplorer>. The left sidebar has a tree view with nodes like Home, Cost Management, Cost Explorer (which is selected), Budgets, Budgets Reports, Savings Plans, Cost & Usage Reports, Cost Categories, Cost allocation tags, Bills, Payments, Credits, Purchase orders, Preferences, Billing preferences, Payment methods, Consolidated billing, and Tax settings. The main content area is titled "Cost Explorer" and shows "Preconfigured views". It lists three options: "Monthly spend by service view" (Shows the monthly spend over last three months, grouped by AWS services), "Monthly spend by linked account view" (Shows the monthly spend over last three months, grouped by Linked Accounts. This is only available for paying account in AWS Organizations), and "Daily spend view" (Shows the daily spend over last 60 days). A red box highlights the "Daily spend view" option. At the bottom of the browser window, there's a toolbar with various icons and a status bar showing "Mon 10 PM".

Look at the daily amounts you spent



Go to Budgets

Screenshot of the AWS Cost Management console showing the Daily costs report.

The sidebar navigation includes:

- AWS Cost Management
- Home
- Budgets** (highlighted)
- Cost Assembly Detection
- Rightsizing recommendations
- Savings Plans
- Overview
- Inventory
- Recommendations
- Purchase Savings Plans
- Utilization report
- Coverage report
- Cart (0)
- Reservations:
- Overview
- Recommendations
- Utilization report
- Coverage report
- Preferences
- Billing Console (2)
- Documentation (2)

The main content area displays the "Daily costs" report for the period Sep 01, 2020 - Mar 31, 2021. The chart shows actual costs (purple bars) and forecasts (blue line) over time. The chart title is "Daily costs". The Y-axis is "Costs (\$)" ranging from 0 to 40. The X-axis shows dates from Sep-01 to Mar-18**. A legend indicates "Costs" (purple bar), "Forecast" (blue line), and "80% Prediction Interval" (light blue shaded area). Below the chart, a note says "To see usage data, filter by "Usage Type" or "Usage Type Group" filters with matching units (e.g., hour)." A "Download CSV" button is available. The right sidebar contains filters for Service, Linked Account, Region, Usage Type, Usage Type Group, Resource, Cost Category, Tag, and More filters. Advanced options include Show costs as (Unblended costs selected), Include costs related to (unchecked), and Show forecasted values (checked). The URL in the address bar is <https://console.aws.amazon.com/billing/home#/budgets>.

You can create your own budgets

The screenshot shows the AWS Billing Management Console interface. On the left, there's a sidebar with various navigation links under 'AWS Services'. The main content area is titled 'AWS Budgets' and contains a message about new features. Below this is a table showing budget details for 'LFIs'. A red box highlights the 'Create budget' button at the top right of the table area.

Budget name	Type	Actions	Current	Budgeted	Forecasted	Current vs. budgeted	Forecasted vs. budgeted
LFIs	Cost	-	\$0.54	\$100.00	\$1.21	0.54%	1.21%

Some sources of funding

- Become a member of the Research Computing Club and apply for AWS credits through their Cloud Credit Program.
- Apply to the Integral Environmental Big Data Research Fund: For graduate students, deadline in February.
- Apply to an Azure compute grant if you want to use Azure instead of AWS, and your research focuses on Climate, Agriculture, Biodiversity, or Water.

- Azure 101: Getting Started with Azure:
<https://aka.ms/university-azure/GettingStartedAzure>
- Working with Data in Azure:
<https://aka.ms/university-azure/DataOnAzure>
- Machine Learning on Azure:
<https://aka.ms/university-azure/MachineLearning>
- Office Hours: April 9 at 10am PST, April 16 at 10am PST,
April 23 at 10am PST

Most important points

- Do not forget to terminate your instances.
- Check your billing dashboard on a regular basis.
- The EC2 dashboard shows only instances and keys for the region you have currently selected. Other instances may be running in other regions.

Happy computing!