AWS GPU Instances

An NVIDIA GPU.

Depending on the size of your training set and the speed of your CPU, you might be able to train your neural network on your local CPU. Training could take anywhere from 15 minutes to several hours if you train for many epochs.

A faster alternative is to train on a GPU.

It's possible to purchase your own NVIDIA GPU, or you may have one built into your machine already.

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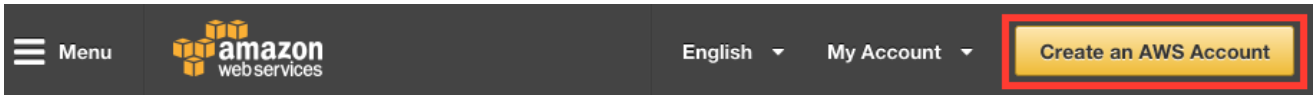
As part of this program, **we will provide you with up to $100 in AWS credits.** Instructions to access these credits are below.

1. Create an AWS Account

Visit **aws.amazon.com** and click on the "Create an AWS Account" button.



If you have an AWS account already, sign in.

If you do not have an AWS account, sign up.

When you sign up, you will need to provide a credit card. But don't worry, you won't be charged for anything yet.

Furthermore, when you sign up, you will also need to choose a support plan. You can choose the free Basic Support Plan.

Once you finish signing up, wait a few minutes to receive your AWS account confirmation email. Then return to **aws.amazon.com** and sign in.

2. View Your Limit

View your EC2 Service Limit report at: **https://console.aws.amazon.com/ec2/v2/home?#Limits**

Find your "Current Limit" for the g2.2xlarge instance type.

Note: Not every AWS region supports GPU instances. If the region you've chosen does not support GPU instances, but you would like to use a GPU instance, then change your AWS region.

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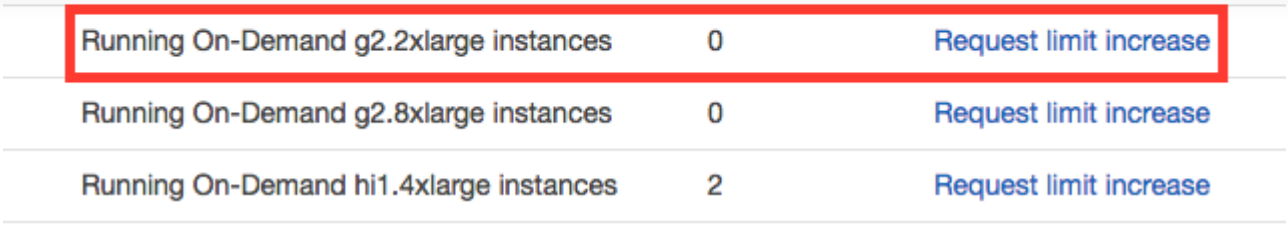


Amazon Web Services has a service called **Elastic Compute Cloud (EC2)**, which allows you to launch virtual servers (or "instances"), including instances with attached GPUs. The specific type of GPU instance you should launch for this tutorial is called "g2.2xlarge".

By default, however, AWS sets a limit of 0 on the number of g2.2xlarge instances a user can run, which effectively prevents you from launching this instance.

3. Submit a Limit Increase Request

From the EC2 Service Limits page, click on "Request limit increase" next to "g2.2xlarge".

You will not be charged for requesting a limit increase. You will only be charged once you actually launch an instance.

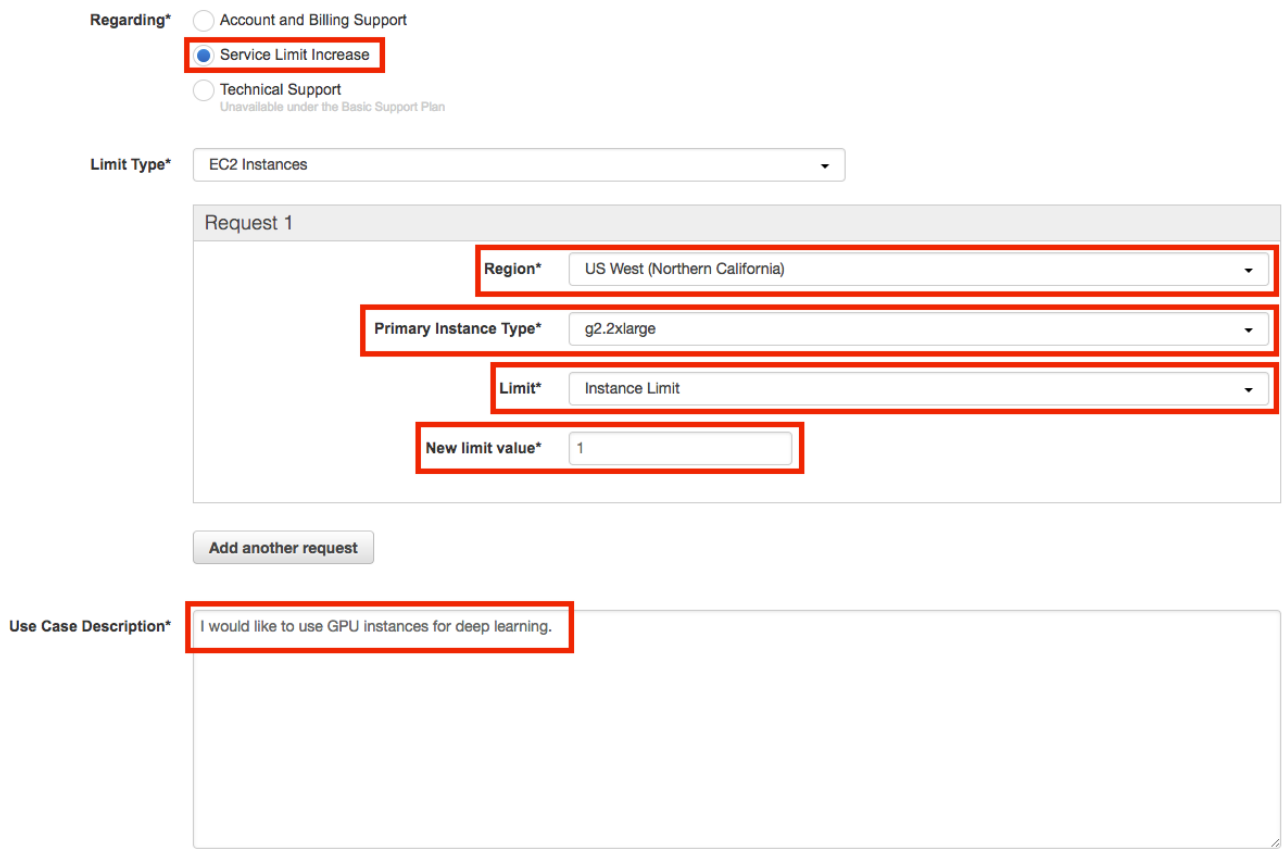
On the service request form, you will need to complete several fields.

For the "Region" field, select the region closest to you.

For the "New limit value", enter a value of 1 (or more, if you wish).

For the "Use Case Description", you can simply state: "I would like to use GPU instances for deep learning."

they approve the limit increase. To do so, launch one EC2 instance (of those for which you are already allowed an instance) in your region to initialize the account - you can immediately close the instance once it is shown as *Running* to avoid any charges.



4. Wait for Approval

You must wait until AWS approves your Limit Increase Request. AWS typically approves these requests within 48 hours.

5. AWS Credits

We provide all Self-Driving Car Engineer Nanodegree Program students with **$100 in AWS credits** for use on their work on program project(s).

To access your AWS credits, go to the 'Resources' tab on the left side of the classroom; there will be an 'AWS Credits' link to click on there. Click on the 'Go to AWS' button to request your credits. Fill in the data for this page. In your AWS account, your AWS Account ID can be found under 'My Account.'

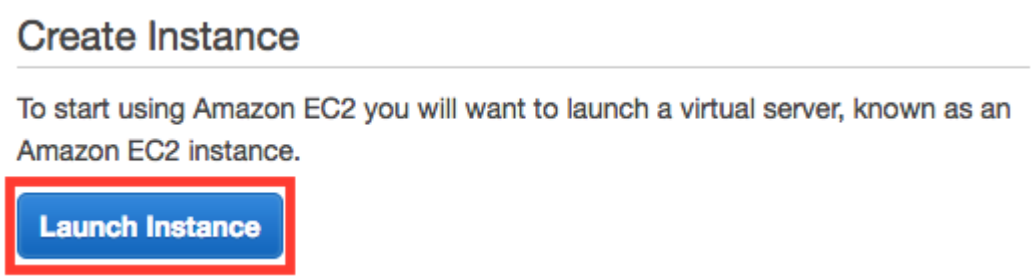
this email. Click on the link provided in the email to apply the credits to your account.

6. Launch an Instance

Once AWS approves your Limit Increase Request, you can start the process of launching your instance.

Visit the EC2 Management Console: **https://console.aws.amazon.com/ec2/v2/home**

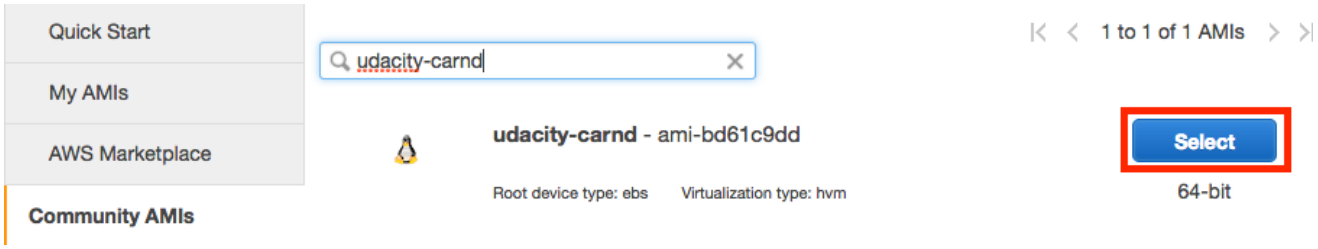
Click on the “Launch Instance” button.



Before launching an instance, you must first choose an AMI (Amazon Machine Image) which defines the operating system for your instance, as well as any configurations and pre-installed software.

We’ve created an AMI for you!

Search for the “udacity-carnd” AMI.



Click on the “Select” button.

7. Select the Instance Type

You must next choose an instance type, which is the hardware on which the AMI will run.

Filter the instance list to only show “GPU instances”:

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Currently selected: t2.micro (Variable ECUs, 1 vCPUs, 2.5 GHz,

	Family	Type	vCPUs
☐	GPU instances	g2.2xlarge	8
☐	GPU instances	g2.8xlarge	32

Select the g2.2xlarge instance type:

Filter by: GPU instances | Current generation | Show/Hide Columns

Currently selected: t2.micro (Variable ECUs, 1 vCPUs, 2.5 GHz, Intel Xeon Family, 1 GiB memory, EBS only)

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available
☐	GPU instances	g2.2xlarge	8	15	1 x 60 (SSD)	Yes
☐	GPU instances	g2.8xlarge	32	60	2 x 120 (SSD)	-

There is an optional request called a **Spot Instance** that you can select as an option, which can save you up to 90% on the rate of a regular GPU instance. An important thing to note is that Spot Instances **can be terminated at any time**, so be careful in using this type of instance - the normal instance request method will not be terminated until you tell AWS to do so. You will want to code your network outside of AWS and just utilize the instance for training (although to conserve on costs, this is good practice with a regular instance as well). See below for how to select this instance option.

1. Choose AMI | 2. Choose Instance Type | 3. Configure Instance | 4. Add Stora

Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instan

Number of instances 1

Purchasing option ☑ Request Spot instances

Finally, click on the “Review and Launch” button:

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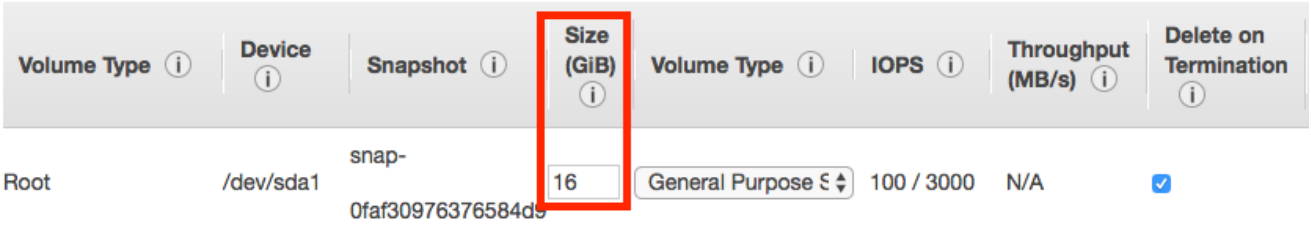
Increase the storage size to 16 GB (or more, if necessary):



Click on the “Review and Launch” button again.

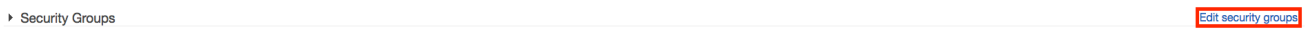
8. Configure the Security Group

Running and accessing a Jupyter notebook from AWS requires special configurations.

Most of these configurations are already set up on the `udacity-carnd` AMI. However, you must also configure the security group correctly when you launch the instance.

By default, AWS restricts access to most ports on an EC2 instance. In order to access the Jupyter notebook, you must configure the AWS Security Group to allow access to port 8888.

Click on "Edit security groups".

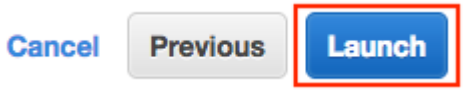


On the "Configure Security Group" page:

1. Select "Create a **new** security group"
2. Set the "Security group name" (i.e. "Jupyter")
3. Click "Add Rule"
4. Set a "Custom TCP Rule"
    1. Set the "Port Range" to "8888"
    2. Select "Anywhere" as the "Source"
5. Click "Review and Launch" (again)

9. Launch the Instance

Click on the “Launch” button to launch your GPU instance!



10. Proceed Without a Key Pair

Oops. Before you can launch, AWS will ask if you’d like to specify an authentication key pair.

Please note that some students may prefer to proceed with a keypair. In that case in the instruction in the Amazon resource below, may be helpful for generating a key, logging in, and launching Jupyter Notebook.

- **https://aws.amazon.com/blogs/ai/get-started-with-deep-learning-using-the-aws-deep-learning-ami/**

In this case the AMI has a pre-configured user account and password, so you can select “Proceed without a key pair” and click the “Launch Instances” button (for real this time!).

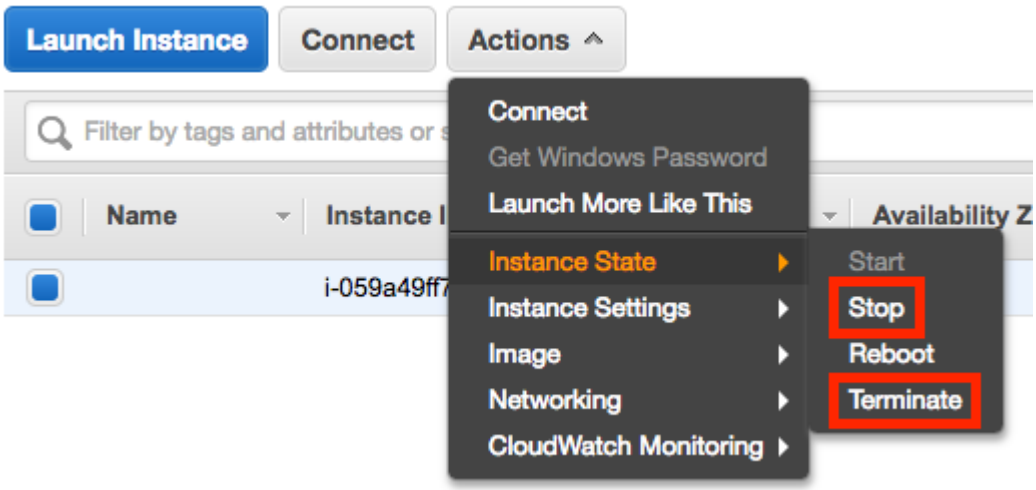
Next, click the “View Instances” button to go to the EC2 Management Console and watch your instance boot.

11. Be Careful!

From this point on, AWS will charge you for a running an EC2 instance. You can find the details on the **EC2 On-Demand Pricing page**.

remembering, and you'll wind up with a large bill!

AWS charges primarily for running instances, so most of the charges will cease once you stop the instance. However, there are smaller storage charges that continue to accrue until you "terminate" (i.e. delete) the instance.

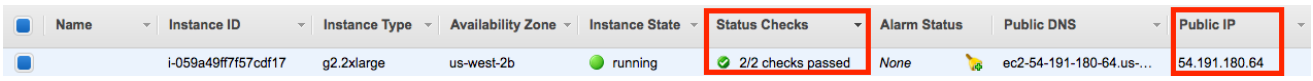


There is no way to limit AWS to only a certain budget and have it auto-shutdown when it hits that threshold. However, you can set **AWS Billing Alarms**.

12. Log In

After launch, your instance may take a few minutes to initialize.

Once you see "2/2 checks passed" on the EC2 Management Console, your instance is ready for you to log in.



Note the "Public IP" address (in the format of "X.X.X.X") on the EC2 Dashboard.

From a terminal, SSH to that address as user "carnd":

```
ssh carnd@X.X.X.X
```

Authenticate with the password: carnd

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Windows. Other options include **tera-term** and **putty**.

If login issues regarding setting up a private key are encountered:

- make sure step 9 has been followed
- try switching clients, many students have been successful with git-bash and putty

13. Launch a Jupyter Notebook

Congratulations! You now have a GPU-enabled server on which to train your neural networks.

Make sure everything is working properly by verifying that the instance can run the **LeNet-5 lab solution**.

On the EC2 instance:

1. Clone the LeNet Lab repo: `git clone https://github.com/udacity/CarND-LeNet-Lab.git`
2. Enter the repo directory: `cd CarND-LeNet-Lab`
3. Activate the new environment: `source activate carnd-term1`
4. Run the notebook: `jupyter notebook LeNet-Lab-Solution.ipynb`

Alternative Instructions

The instruction for launching and connecting to Jupyter Notebook may not work for all users. If these instruction do not work for you, please try this (differences start at step 3):

1. Clone the LeNet Lab repo: `git clone https://github.com/udacity/CarND-LeNet-Lab.git`
2. Enter the repo directory: `cd CarND-LeNet-Lab`
3. Activate the new environment: `source activate carnd-term1`
4. Start Jupyter: `jupyter notebook --ip=0.0.0.0 --no-browser`
5. Look at the output in the window, and find the line that looks like the following: `Copy/paste this URL into your browser when you connect for the first time to login with a token: http://0.0.0.0:8888/?token=3156e...`
6. Copy and paste the complete URL into the address bar of a web browser (Firefox, Safari, Chrome, etc). Before navigating to the URL, replace `0.0.0.0` in the URL with

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notebook and happy coding.

13. Run the Jupyter Notebook

From your local machine:

1. Access the Jupyter notebook index from your web browser by visiting: `X.X.X.X:8888` (where X.X.X.X is the IP address of your EC2 instance)
2. Click on the "LeNet-Lab-Solution.ipynb" link to launch the LeNet Lab Solution notebook
3. Run each cell in the notebook

It took me 7.5 minutes to train LeNet-5 for ten epochs on my local CPU, but only 1 minute on an AWS GPU instance!

Troubleshooting

Missing Modules

Some students have reported missing dependencies. These include tdqm and libgtk

- **tdqm** To install, execute `conda install -c anaconda tqdm`
- **libgtk** The command `import cv2` may result in the following error. `ImportError: libgtk-x11-2.0.so.0: cannot open shared object file: No such file or directory` . To address make sure you are switched into the correct environment and try `source activate carnd-term;conda install opencv` . If that is unsuccessful please try `apt-get update;apt-get install libgtk2.0-0` (may need to call as sudo) More information can be found **here**.

Importing Tensorflow

Some students have reported errors when importing Tensorflow. If this occurs, first double-check you have activated the anaconda environment, and then please try `pip install tensorflow-gpu==0.12.1` .

Nvidia CUDA/driver issues

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commands to remove the installed Nvidia driver and install version 367.57:

1. `sudo apt-get remove nvidia-*`
2. `wget http://us.download.nvidia.com/XFree86/Linux-x86_64/367.57/NVIDIA-Linux-x86_64-367.57.run`
3. `sudo bash ./NVIDIA-Linux-x86_64-367.57.run --dkms`