

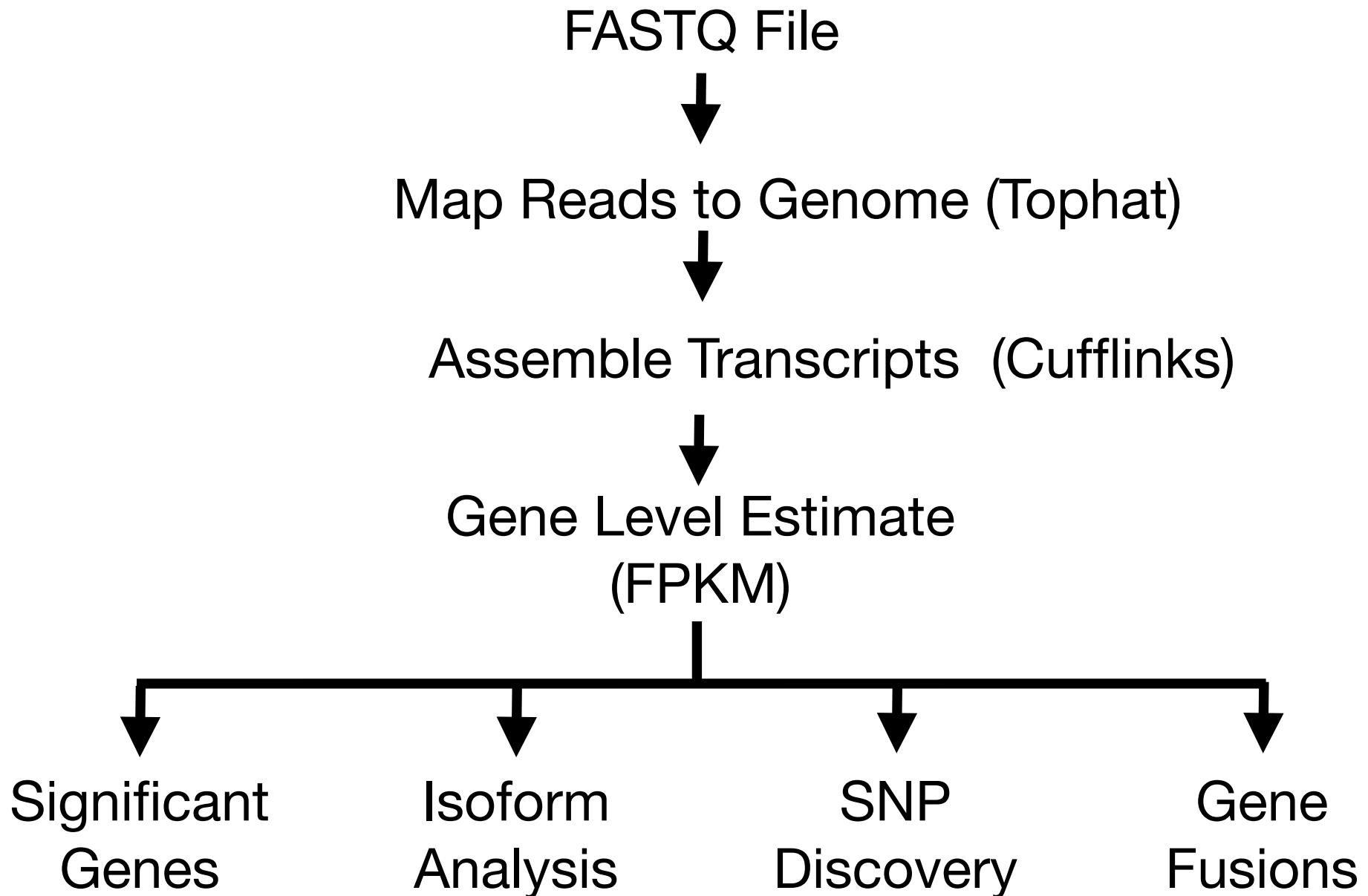
# Amazon EC2 and R

David Astling

University of Colorado School of Medicine

[David.Astling@ucdenver.edu](mailto:David.Astling@ucdenver.edu)

# RNASeq Pipeline



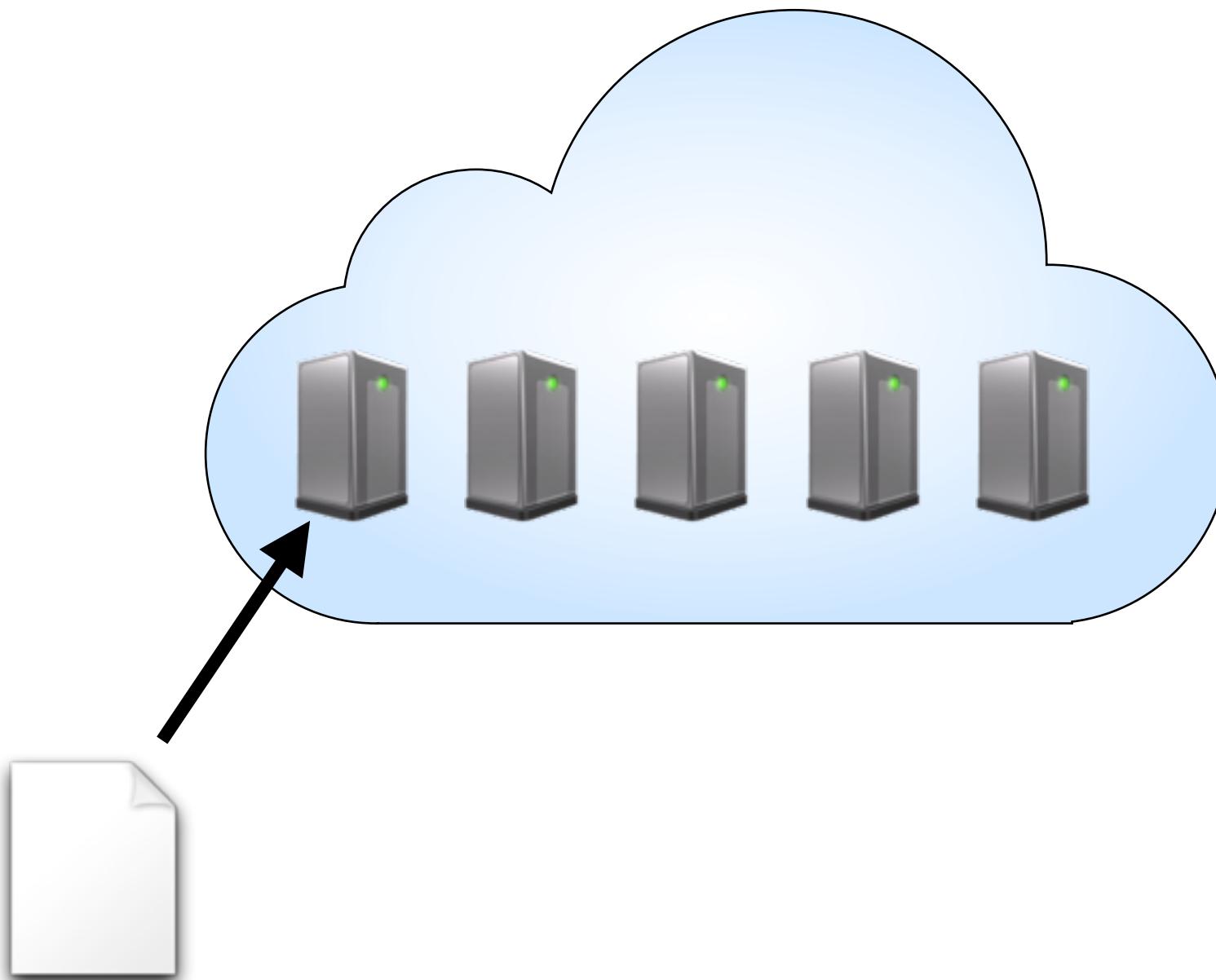
# Pipeline development

- Run sequencing simulation to determine optimal coverage for typical experiments
  - Vary number of reads, read length, paired-end
  - Run through Tophat/Cufflinks
  - Determine optimal coverage
- 
- Want to generate 100 files x 5 replicates
  - 500 - 700 files with 18 billion sequence reads
  - ~ 1 TB total data

# Computing Resources

- Personal Laptop/Desktop
- Small server cluster at work  
(with limited access)

# Amazon Elastic Compute Cloud



# Outline

- Look before you leap
- Launching an Amazon EC2 instance
- Launching Multiple Instances for HPC Applications

Look Before You Leap

# More Data vs. Better Algorithms

Test Accuracy

Banko & Brill, 2001

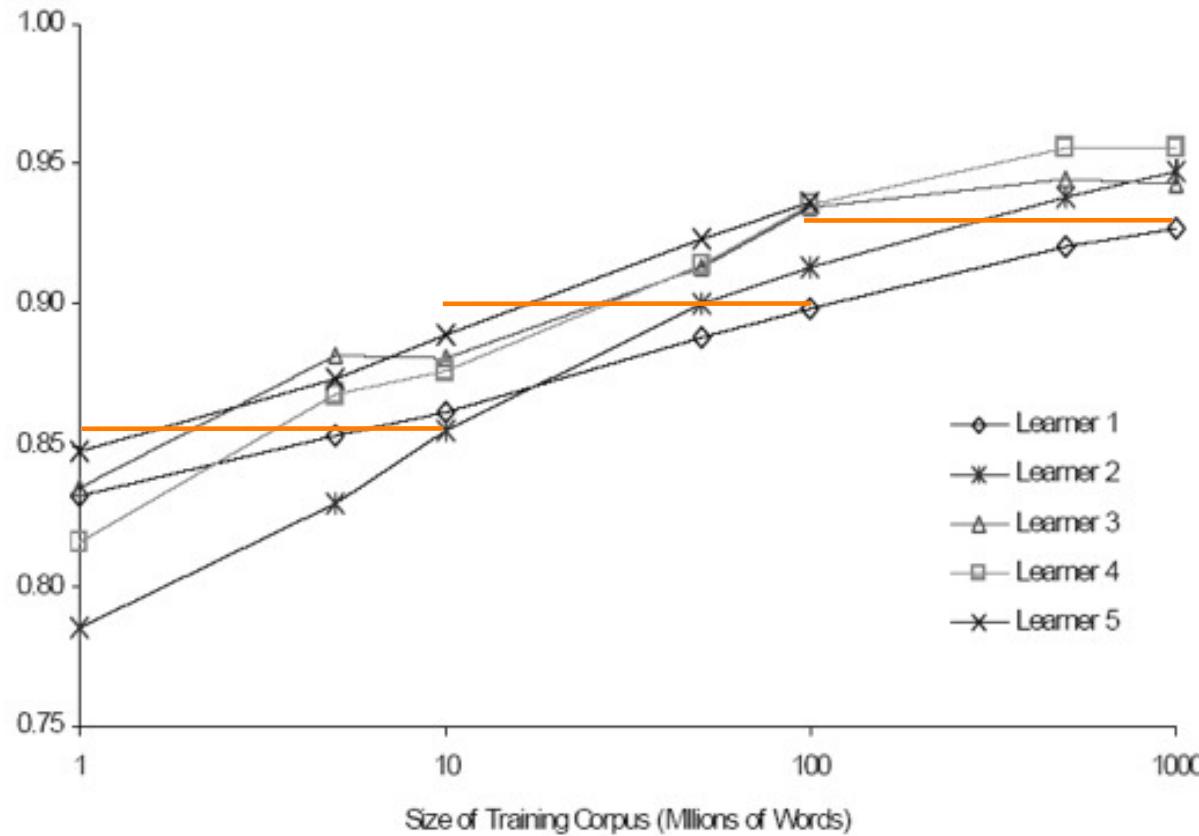


Figure 2. Learning Curves for Confusable Disambiguation

“The Unreasonable Effectiveness of Data”  
- Peter Norvig 2010

<http://www.youtube.com/watch?v=yvDCzhbjYWs>

# Thoughts on Big Data

- Sure, Big Data Is Great. But So Is Intuition.

<http://www.nytimes.com/2012/12/30/technology/big-data-is-great-but-dont-forget-intuition.html>

- What statistics should do about big data:  
problem forward not solution backward

<http://simplystatistics.org/2013/05/29>

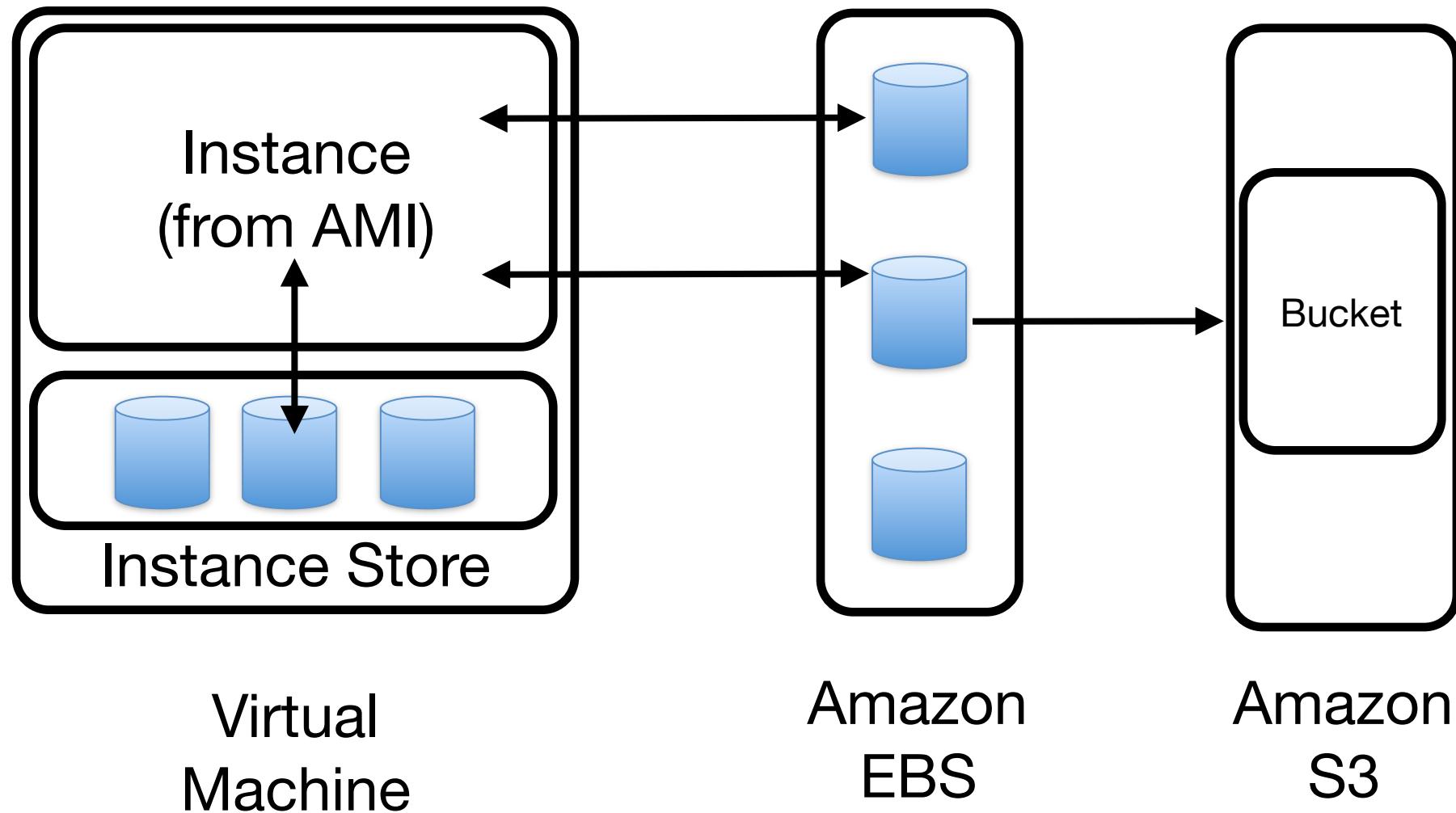
- Most data isn't “big”

<http://qz.com/81661/most-data-isnt-big-and-businesses-are-wasting-money-pretending-it-is/>

# Look before you leap

- Optimize code  
(e.g. use apply instead of for loop)
- Performance testing  
(I/O, Memory, or CPU bound)
- Work with subset of data
- Quality control testing using positive and negative controls

# Getting started with Amazon EC2



# EC2 Instances

Instance Type	vCPU	Memory (GiB)	Instance Storage (GB)	Network Performance
t1.micro	1	0.615	EBS only	Very Low
m1.small	1	1.7	1 x 160	Low
m1.medium	1	3.75	1 x 410	Moderate
m1.large	2	7.5	2 x 420	Moderate
m1.xlarge	4	15	4 x 420	High
m3.xlarge	4	15	EBS only	Moderate
m3.2xlarge	8	30	EBS only	High
c1.medium	2	1.7	1 x 350	Moderate
c1.xlarge	8	7	4 x 420	High
cc2.8xlarge	32	60.5	4 x 840	10 Gigabit
m2.xlarge	2	17.1	1 x 420	Moderate
m2.2xlarge	4	34.2	1 x 850	Moderate
m2.4xlarge	8	68.4	2 x 840	High
cr1.8xlarge	32	244	2 x 120 SSD	10 Gigabit
hi1.4xlarge	16	60.5	2 x 1,024 SSD	10 Gigabit

<http://aws.amazon.com/ec2/instance-types/>

\* as of  
6/18/2013 for  
US East

# EC2 Pricing (per hour)

Instance Type	On Demand Instance	Spot Instance	Reserved Instance (1 Year of Medium Use)	
t1.micro	\$0.020	\$0.003	\$54	\$0.007
m1.small	\$0.060	\$0.007	\$139	\$0.021
m1.medium	\$0.120	\$0.013	\$277	\$0.042
m1.large	\$0.240	\$0.026	\$554	\$0.084
m1.xlarge	\$0.480	\$0.052	\$1,108	\$0.168
m3.xlarge	\$0.500	\$0.0575	\$1,217	\$0.184
m3.2xlarge	\$1.000	\$0.115	\$2,434	\$0.368
c1.medium	\$0.145	\$0.018	\$370	\$0.054
c1.xlarge	\$0.580	\$0.070	\$1,480	\$0.216
cc2.8xlarge	\$1.300	\$0.270	\$4,146	\$0.540
m2.xlarge	\$0.410	\$0.035	\$651	\$0.103
m2.2xlarge	\$0.820	\$0.070	\$1,302	\$0.206
m2.4xlarge	\$1.640	\$0.140	\$2,604	\$0.412
cr1.8xlarge	\$3.500	\$0.343	\$5,958	\$0.930
hi1.4xlarge	\$3.100	\$0.208	\$5,973	\$0.909

\*\* For accurate pricing visit -->

<http://aws.amazon.com/ec2/pricing/>

\* as of  
6/18/2013 for  
US East

# EC2 Pricing

## Data Transfer IN To Amazon EC2 From

Internet	\$0.00 per GB
----------	---------------

## Data Transfer OUT From Amazon EC2 To Internet

First 1 GB / month	\$0.00 per GB
Up to 10 TB / month	\$0.12 per GB
Next 40 TB / month	\$0.09 per GB
Next 100 TB / month	\$0.07 per GB
Next 350 TB / month	\$0.05 per GB

## Amazon EBS Standard Volumes

\$0.10 per GB-month of provisioned storage

\$0.10 per 1 million I/O requests

## Amazon EBS Snapshots to Amazon S3

\$0.095 per GB-month of data stored

\*\* For accurate pricing visit -->

<http://aws.amazon.com/ec2/pricing/>

# Snail Mail is Sometimes Faster



Let's do it!

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## Amazon EC2 Details

- [EC2 Overview](#)
- [EC2 FAQs](#)
- [EC2 Pricing](#)
- [Amazon EC2 SLA](#)
- [EC2 Instance Types](#)
- [EC2 Instance Purchasing Options](#)
- [Reserved Instances](#)
- [Spot Instances](#)
- [Windows Instances](#)

## Amazon Elastic Compute Cloud (Amazon EC2)

Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale computing easier for developers.

Amazon EC2's simple web service interface allows you to obtain and configure capacity with minimal friction. It provides you with complete control of your computing resources and lets you run on Amazon's proven computing environment. Amazon EC2 reduces the time required to obtain and boot new server instances to minutes, allowing you to quickly scale capacity, both up and down, as your computing requirements change. Amazon EC2 changes the economics of computing by allowing you to pay only for capacity that you actually use. Amazon EC2 provides developers the tools to build failure resilient applications and isolate themselves from common failure scenarios.

### Get Started with AWS for Free

[Create Free Account »](#)

AWS Free Tier includes 750 hours of Linux or Windows Micro Instances each month for one year. To stay within the Free Tier, use only EC2 Micro instances.

[View AWS Free Tier Details »](#)

## Amazon EC2 Features

- [Elastic Block Store](#)
- [Amazon CloudWatch](#)
- [Auto Scaling](#)
- [Elastic Load Balancing](#)
- [High Performance Computing](#)
- [VM Import/Export](#)



Instagram can drive data to its computing systems on Amazon EC2 20 times as fast with solid-state drives.

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This page contains the following categories of information. Click to jump down:

- [↓ Amazon EC2 Functionality](#)
- [↓ Service Highlights](#)

- [↓ Pricing](#)
- [↓ Resources](#)



## Sign In or Create an AWS Account

You may sign in using your existing Amazon.com account or you can create a new account by selecting "I am a new user."

My e-mail address is:

- I am a new user.  
 I am a returning user  
and my password is:

[Sign in using our secure server](#)

[Forgot your password?](#)

[Has your e-mail address changed?](#)

Learn more about [AWS Identity and Access Management](#) and [AWS Multi-Factor Authentication](#), features that provide additional security for your AWS Account.

### About Amazon.com Sign In

Amazon Web Services uses information from your Amazon.com account to identify you and allow access to Amazon Web Services. Your use of this site is governed by our [Terms of Use](#) and [Privacy Policy](#) linked below.



Amazon Web Services Sign Up

## Contact Information

\* required fields

**Full Name\***:**Company Name:****Country\***:**Address Line 1\***:

Street address, P.O. box, company name, c/o

**Address Line 2:**

Apartment, suite, unit, building, floor, etc.

**City\***:**State, Province or Region\***:**ZIP or Postal Code\***:**Phone number\***:

## AWS Customer Agreement



Check here to indicate that you have read and agree to the terms of the  
Amazon Web Services Customer Agreement. [\[Link\]](#)

**Create Account and Continue**

[Amazon Web Services Sign Up](#)[CREATE ACCOUNT](#)[PAYMENT METHOD](#)[IDENTITY VERIFICATION](#)[CONFIRMATION](#)

## Activating your account...

We are in the process of activating your account so that you can begin using AWS.

We will notify you by e-mail at once the verification is complete. You will then be able to begin using all AWS Infrastructure Services. For most customers, this process only takes a couple of minutes (but can sometimes take a few hours if additional account verification is required). As part of the account activation process, a \$1 authorization will be placed on the payment method (normally, a Debit or Credit Card) to make sure your payment method is valid. **This authorization is not a charge**, but your bank may hold the authorized funds as unavailable until the authorization expires.

## Start Exploring Amazon Web Services

- [Products & Services](#)
- [Detailed Service Pricing](#)
- [Documentation](#)
- [FAQs](#)
- [Discussion Forums](#)

## Protect your account with AWS Multi-Factor Authentication (MFA)

AWS MFA is a feature that is available at no extra cost that greatly enhances your account's security. In addition to your username and password, AWS MFA requires a one-time code from your MFA device when signing in to AWS web properties.

[Activate MFA](#) [Learn more](#)

## Sign Up For AWS Support

AWS Support is a one-on-one, fast response support channel to help you build and run applications on AWS. With pay-by-the-month pricing and an unlimited number of support cases, you are not constrained by long-term support contracts or limited support privileges.

[Sign Up Now](#) [Learn more](#)

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## Amazon Elastic Compute Cloud (Amazon EC2)

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AWS Management Console Home

https://console.aws.amazon.com/console/home?#

David Astling Global Help

## Amazon Web Services

Compute & Networking

- Direct Connect** Dedicated Network Connection to AWS
- EC2** Virtual Servers in the Cloud
- Elastic MapReduce** Managed Hadoop Framework
- Route 53** Scalable Domain Name System
- VPC** Isolated Cloud Resources

Storage & Content Delivery

- CloudFront** Global Content Delivery Network
- Glacier** Archive Storage in the Cloud
- S3** Scalable Storage in the Cloud
- Storage Gateway** Integrates On-Premises IT Environments with Cloud Storage

Database

- DynamoDB** Predictable and Scalable NoSQL Data Store
- ElastiCache** In-Memory Cache
- RDS** Managed Relational Database Service
- Redshift** NEW Managed Petabyte-Scale Data Warehouse Service

Deployment & Management

- CloudFormation** Templated AWS Resource Creation
- CloudWatch** Resource and Application Monitoring
- Data Pipeline** Orchestration for Data-Driven Workflows
- Elastic Beanstalk** AWS Application Container
- IAM** Secure AWS Access Control
- OpsWorks** NEW DevOps Application Management Service

App Services

- CloudSearch** Managed Search Service
- Elastic Transcoder** NEW Easy-to-use Scalable Media Transcoding
- SES** Email Sending Service
- SNS** Push Notification Service
- SQS** Message Queue Service
- SWF** Workflow Service for Coordinating Application Components

Additional Resources

**Getting Started**  
See our documentation to get started and learn more about how to use our services.

**Trusted Advisor**  
Best practice recommendations to save money, improve fault tolerance, increase performance, and close security gaps.

**Service Health**

All services operating normally.

Service Health Dashboard

Set Start Page

Console Home

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

Feedback

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Services

Edit

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Oregon

Help

## EC2 Dashboard

Events

Tags

## INSTANCES

Instances

Spot Requests

Reserved Instances

## IMAGES

AMIs

Bundle Tasks

## ELASTIC BLOCK STORE

Volumes

Snapshots

## NETWORK &amp; SECURITY

Security Groups

Elastic IPs

Placement Groups

Load Balancers

Key Pairs

Network Interfaces

## Resources

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

0 Running Instances

0 Volumes

0 Key Pairs

0 Placement Groups

0 Elastic IPs

0 Snapshots

0 Load Balancers

1 Security Group

Optimize your resources' cost, performance  
and security with AWS Trusted Advisor

## Account Attributes

Supported Platforms

EC2-VPC

Default VPC

vpc-

## Additional Information

[Getting Started Guide](#)[Documentation](#)[All EC2 Resources](#)[Forums](#)[Pricing](#)[Report an Issue](#)

## Create Instance

To start using Amazon EC2 you will want to launch a virtual server, known as an Amazon EC2 instance.

[Launch Instance](#)

Note: Your instances will launch in the US West (Oregon) region

## Service Health

## Service Status:

US West (Oregon):  
This service is operating normally

## Availability Zone Status:

us-west-2a:  
Availability zone is operating normally

us-west-2b:

## Scheduled Events

## US West (Oregon):

No events

## Popular AMIs on AWS Marketplace

[Debian GNU/Linux](#)

Provided by Debian

Rating

Free Software, pay only for AWS usage  
[View all Operating Systems](#)[Couchbase Server - Community Edition](#)

Provided by Couchbase

Rating



## EC2 Dashboard

## Create a New Instance

Cancel

Select an option below:

## Launch with the Classic Wizard

 **Classic Wizard**

Launch an On-Demand or Spot instance using the classic wizard with fine-grained control over how it is launched.

 **Quick Launch Wizard**

Launch an On-Demand instance using an editable, default configuration so that you can get started in the cloud as quickly as possible.

 **AWS Marketplace**

AWS Marketplace is an online store where you can find and buy software that runs on AWS. Launch with 1-Click and pay by the hour.

Request Instances Wizard

Choose an Amazon Machine Image (AMI) from one of the tabbed lists below by clicking its Select button.

**Quick Start** **My AMIs** **Community AMIs**

<b>Basic 32-bit Amazon Linux AMI 2011.02.1 Beta (AMI Id: ami-0c1f4eef)</b> Amazon Linux AMI Base 2011.02.1, EBS boot, 32-bit architecture with Amazon EC2 AMI Tools. Root Device Size: 8 GB	<input type="button" value="Select"/>
<b>Basic 64-bit Amazon Linux AMI 2011.02.1 Beta (AMI Id: ami-0a1f4eef)</b> Amazon Linux AMI Base 2011.02.1, EBS boot, 64-bit architecture with Amazon EC2 AMI Tools. Root Device Size: 8 GB	<input type="button" value="Select"/>
<b>Red Hat Enterprise Linux 6.1 32-bit (AMI Id: ami-0cb64265)</b> Red Hat Enterprise Linux version 6.1, EBS-boot, 32-bit architecture. Root Device Size: 7 GB	<input type="button" value="Select"/>
<b>Red Hat Enterprise Linux 6.1 64-bit (AMI Id: ami-0e937937)</b> Red Hat Enterprise Linux version 6.1, EBS-boot, 64-bit architecture. Root Device Size: 6 GB	<input type="button" value="Select"/>
<b>SUSE Linux Enterprise Server 11 64-bit (AMI Id: ami-e4a357d)</b> SUSE Linux Enterprise Server 11 Service Pack 1 basic install, EBS boot, 64-bit architecture with Amazon EC2 AMI Tools preinstalled; Apache 2.2, MySQL 5.0, PHP 5.3, Ruby 1.8.7, and Rails 2.3. Root Device Size: 15.6 GB	<input type="button" value="Select"/>

Free tier eligible if used with a micro instance. See [AWS Free Tier](#) for complete details and terms.

**Continue** [Submit Feedback](#) [Getting Started Guide](#)



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## Request Instances Wizard

Cancel



INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Choose an Amazon Machine Image (AMI) from one of the tabbed lists below by clicking its **Select** button.

**Quick Start****My AMIs****Community AMIs****AWS Marketplace**

### Amazon Linux AMI 2013.03.1

The Amazon Linux AMI is an EBS-backed, PV-GRUB image. It includes Linux 3.4, AWS tools, and repository access to multiple versions of MySQL, PostgreSQL, Python, Ruby, and Tomcat.

Root Device Size: 8 GB

 64 bit  32 bit**Select** 

### Red Hat Enterprise Linux 6.4

Red Hat Enterprise Linux version 6.4, EBS-boot.

Root Device Size: 7 GB

 64 bit  32 bit**Select** 

### SUSE Linux Enterprise Server 11

SUSE Linux Enterprise Server 11 Service Pack 2 basic install, EBS boot with Amazon EC2 AMI Tools preinstalled; Apache 2.2, MySQL 5.0, PHP 5.3, and Ruby 1.8.7

Root Device Size: 10 GB

 64 bit  32 bit**Select** 

### Ubuntu Server 12.04.2 LTS

Ubuntu Server 12.04.2 LTS, with support available from Canonical (<http://www.ubuntu.com/cloud/services>).

Root Device Size: 8 GB

 64 bit  32 bit**Select** 

### Ubuntu Server 13.04

Ubuntu Server 13.04 with support available from Canonical



Free tier eligible if used with a micro instance. See [AWS free tier](#) for complete details and terms.



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Cancel



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Choose an Amazon Machine Image (AMI) from one of the tabbed lists below by clicking its **Select** button.

**Quick Start****My AMIs**

Community AMIs

AWS Marketplace

Viewing:

Owned By Me

Search

&lt; &lt; &gt; &gt;

You do not own any Images.

Use the select box above to view Images owned by Amazon and others.



Free tier eligible if used with a micro instance. See [AWS free tier](#) for complete details and terms.



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## Request Instances Wizard

Cancel

CHOOSE AN AMI

INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Choose an Amazon Machine Image (AMI) from one of the tabbed lists below by clicking its **Select** button.

Quick Start

My AMIs

Community AMIs

AWS Marketplace

Viewing: All Images

Search

1 to 50 of 7439 Items



AMI ID	Root Device	Manifest	Platform	
ami-00028830	instance store	wowzamediaserveruswest2/3.5.2.01-x86_64.manifest	Other Linux	<input type="button" value="Select"/>
ami-00088030	ebs	aws-marketplace/jumpbox-amis/cacti-1.7.7-ebsroot.manifest	Other Linux	<input type="button" value="Select"/>
ami-000f8130	instance store	bitnami-cloud-us-west-2/lampstack/bitnami-lampstack.manifest	Ubuntu	<input type="button" value="Select"/>
ami-00129e30	ebs	979382823631/bitnami-ezpublish-2012.5-0-linux-ubuntu.manifest	Ubuntu	<input type="button" value="Select"/>
ami-00199530	ebs	071989450653/Porticor Cloud Security v1.10 20120625.manifest	Other Linux	<input type="button" value="Select"/>
ami-001a9130	ebs	aws-marketplace/turnkey-piwik-12.0-squeeze-x86.manifest	Other Linux	<input type="button" value="Select"/>
ami-0021ab30	instance store	bitnami-cloud-us-west-2/lampstack/bitnami-lampstack.manifest	Ubuntu	<input type="button" value="Select"/>
ami-0022a930	ebs	150678950558/silkscreen-crahen.manifest	Other Linux	<input type="button" value="Select"/>
ami-0027ae30	ebs	411009282317/RightImage_RHEL_5.8_x64_v5.8.8.3.manifest	Red Hat	<input type="button" value="Select"/>
ami-0028a730	ebs	979382823631/bitnami-trac-1.0beta1-0-dev-linux-ubuntu.manifest	Ubuntu	<input type="button" value="Select"/>
ami-002ca430	instance store	bitnami-cloud-us-west-2/nodejs/bitnami-nodejs-0.8.1.manifest	Ubuntu	<input type="button" value="Select"/>

★ Free tier eligible if used with a micro instance. See [AWS free tier](#) for complete details and terms.



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## Request Instances Wizard

Cancel



INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Choose an Amazon Machine Image (AMI) from one of the tabbed lists below by clicking its **Select** button.

[Quick Start](#)[My AMIs](#)[Community AMIs](#)[AWS Marketplace](#)

Find and buy software from well known sellers

[GO](#)

(Results will launch in a new browser tab or window)

► Or visit Your Software in AWS Marketplace to see the Marketplace products you are subscribed to



Free tier eligible if used with a micro instance. See [AWS free tier](#) for complete details and terms.



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Root Device Size: 8 GB

 64 bit  32 bit**Select** **Red Hat Enterprise Linux 6.4**

Red Hat Enterprise Linux version 6.4, EBS-boot.

Root Device Size: 7 GB

 64 bit  32 bit**Select** **SUSE Linux Enterprise Server 11**

SUSE Linux Enterprise Server 11 Service Pack 2 basic install, EBS boot with Amazon EC2 AMI Tools preinstalled; Apache 2.2, MySQL 5.0, PHP 5.3, and Ruby 1.8.7

Root Device Size: 10 GB

 64 bit  32 bit**Select** **Ubuntu Server 12.04.2 LTS**

Ubuntu Server 12.04.2 LTS, with support available from Canonical (<http://www.ubuntu.com/cloud/services>).

Root Device Size: 8 GB

 64 bit  32 bit**Select** **Ubuntu Server 13.04**

Ubuntu Server 13.04 with support available from Canonical



Free tier eligible if used with a micro instance. See [AWS free tier](#) for complete details and terms.



## Request Instances Wizard

Cancel

CHOOSE AN AMI

INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Provide the details for your instance(s). You may also decide whether you want to launch your instances as "on-demand" or "spot" instances.

**Number of Instances:**

1

**Instance Type:**

T1 Micro (t1.micro, 613 MiB)

**Launch as an EBS-Optimized instance (additional charges apply):** Not supported for this instance type**Launch Instances**

EC2 Instances let you pay for compute capacity by the hour with no long term commitments. This transforms what are commonly large fixed costs into much smaller variable costs.

**Launch into:** EC2-Classic     EC2-VPC**Availability Zone:**

No Preference

**Request Spot Instances**[Back](#)[Continue](#)



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## Request Instances Wizard

Cancel

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INSTANCE DETAILS

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REVIEW

Provide the details for your instance(s). You may also decide whether you want to launch your instances as "on-demand" or "spot" instances.

Number of Instances:

1

Instance Type:

T1 Micro (t1.micro, 613 MiB)

Launch as an EBS-Optimized Instance (optional):

 Launch Instances

EC2 Instances let you pay for commonly large fixed costs.

Launch into:

 Request Spot Instances

Type	CPU Units	CPU Cores	Memory
T1 Micro (t1.micro) ★ Free tier eligible	Up to 2 ECUs	1 Core	613 MiB
M1 Small (m1.small)	1 ECU	1 Core	1.7 GiB
M1 Medium (m1.medium)	2 ECUs	1 Core	3.7 GiB
M1 Large (m1.large)	4 ECUs	2 Cores	7.5 GiB
M1 Extra Large (m1.xlarge)	8 ECUs	4 Cores	15 GiB
M3 Extra Large (m3.xlarge)	13 ECUs	4 Cores	15 GiB
M3 Double Extra Large (m3.2xlarge)	26 ECUs	8 Cores	30 GiB
M2 High-Memory Extra Large (m2.xlarge)	6.5 ECUs	2 Cores	17.1 GiB
M2 High-Memory Double Extra Large (m2.2xlarge)	13 ECUs	4 Cores	34.2 GiB
M2 High-Memory Quadruple Extra Large (m2.4xlarge)	26 ECUs	8 Cores	68.4 GiB
C1 High-CPU Medium (c1.medium)	5 ECUs	2 Cores	1.7 GiB
C1 High-CPU Extra Large (c1.xlarge)	20 ECUs	8 Cores	7 GiB
High I/O Quadruple Extra Large (hi1.4xlarge)	35 ECUs	16 Cores	60.5 GiB
High Storage Eight Extra Large (hs1.8xlarge)	35 ECUs	16 Cores	117 GiB

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## Request Instances Wizard

Cancel

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INSTANCE DETAILS

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REVIEW

**Number of Instances:** 1**Availability Zone:** No Preference

### Advanced Instance Options

Here you can choose a specific kernel or RAM disk to use with your instances. You can also choose to enable CloudWatch Detailed Monitoring or enter data that will be available from your instances once they launch.

**Kernel ID:****RAM Disk ID:****Monitoring:** Enable CloudWatch detailed monitoring for this instance  
(additional charges will apply)**User Data:**

(Use shift+enter to insert a newline)

 base64 encoded**Termination Protection:** Prevention against accidental termination.**Shutdown Behavior:****IAM Role:**[Back](#)[Continue](#)



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## Request Instances Wizard

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REVIEW

**Number of Instances:** 1**Availability Zone:** No Preference

### Storage Device Configuration

Your instance will be launched with the following storage device settings. Edit these settings to add EBS volumes, instance store volumes, or edit the settings of the root volume.

Type	Device	Snapshot ID	Size	Volume Type	IOPS	Delete on Termination
Root	/dev/sda1	snap-	8	standard		true

**0 EBS Volumes**[« Back](#)[Continue](#)



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## Request Instances Wizard

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REVIEW

Add tags to your instance to simplify the administration of your EC2 infrastructure. A form of metadata, tags consist of a case-sensitive key/value pair, are stored in the cloud and are private to your account. You can create user-friendly names that help you organize, search, and browse your resources. For example, you could define a tag with key = Name and value = Webserver. You can add up to 10 unique keys to each instance along with an optional value for each key. For more information, go to [Tagging Your Amazon EC2 Resources](#) in the *EC2 User Guide*.

Key (127 characters maximum)	Value (255 characters maximum)	Remove
Name		X
		X

[Add another Tag.](#) (Maximum of 10)[Back](#)[Continue](#)



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## Request Instances Wizard

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REVIEW

Public/private key pairs allow you to securely connect to your instance after it launches. For Windows Server instances, a Key Pair is required to set and deliver a secure encrypted password. For Linux server instances, a key pair allows you to SSH into your instance. To create a key pair, enter a name and click **Create & Download Your Key Pair**. You will be prompted to save the private key to your computer. Note: You only need to generate a key pair once - not each time you want to deploy an Amazon EC2 instance.

 Choose from your existing Key Pairs Create a new Key Pair

1. Enter a name for your key pair\*:  (e.g., jdoekey)

2. Click to create your key pair\*:

**Create & Download your Key Pair**

 Save this file in a place that you will remember. You can use this key pair to launch other instances in the future or visit the Key Pairs page to create or manage existing ones.

 Proceed without a Key Pair[Back](#)[Continue](#)

# example\_keypair.pem

```
-----BEGIN RSA PRIVATE KEY-----  
9q0d4md52izXfu27xbAnb3uAz5SBSIauqZo2C9L2c3JM2lUcj3kz6j8ErjjSg+hKv9kPcdPNqqYb  
fRNzaMU1xlVCILm0F9ctEbwehXRE1FBwjLMIQ0AE9y0Um9/pmvU840MmR/C5Btgaf3dfHShWf041  
sbnJr/wqUsdFvdPx870EIDp6ifp5/GC7CXFLimVb0D+gHGe/B1Ge+qG5LXKsrjQjA9tbdeAzD0bN  
7JvYbXiWRR9wnEUne5Kzj/zVY/B07Z2f++HLotQQSpajfDwOuDYsw+tYRoQvLgRiDC74glg3GJu0  
vMa1FPGB48Fu8iR6fxwHBeCzK2xiLNECgJAhB1PDii4Wc1ECA4kaj6KC+/AXbJeLS98i18ATZKM  
0+FKznpuH7JIomPFyDVQiAHRdLh292V+sqP914aqI+G8IweajYntwfYv+ie7U7nqqUhypTYixWbo  
q1oy/x0G1EEmJopfTFsuwix4nXJ4PGHn4xBBzEQ+H0EpUMdYkAA/szT9na0zxKJQzdbkf0YVCjEt  
Wpw6axU1rja0K55ULg3ju6DKM/uz+lg9vAvdPKpubX9LwwBiAIYn0gYxBnIB4CfqhmqrgAWoRoH  
bqU8KovKw+rwBYl6dsldwwvEk0oX8Lg67t920RXOC0cXgCnCkgz6PUDWkbxf8f9AKWK21+u8Shua  
rH4Z+j5V58SyZxoYKHLzV0+LgeScwBPrjyVn9icTAx5kWvJQot4VBSe3a0aFk/QUWMwecnz70ZCL  
fZ6V08uj9QCpAGxD6NsvzmyLLhSjgyylHm6+zBX35WzdcH44507lgG0DbSxb3q6i3Sc3vsYpFjPg  
I0z4LuzeC3Bs8rw9qcKh4cpjhBQyc/S1g6+vbkII90Ejh6eBZhfkd1s7eCWwrl8650Jp+6Wpc  
BMYRAj0ll6fOPzDLjhAeSWr5G/FuN1p1E0Wib63HfsvxKU9DkLkdHdnL4B3lA8Eor/dZ8iYbiTx2  
xasv2SVHcYLCEnG8X811LXi yMEQ25lm+XUU+FTXfhdx3XaRq0Q+KHUMpxM77Bbj6omubDR96rDmCw  
1x156haFqfwHgDgWddyJj4wEB58G7kSj2U4Y+swVRfejrNlmgd4z/dz80yvNVWS1+egbclVI7oL+  
R5TuMZYQoFbHuyPlExDUaESGqP0GZwMjtyGc1ji/j/9AJBzONJj3nH/Mf+l1Y1iPnk/87qM+h1LEJ  
Jol0p+aR3HggYPQNdc+D+aVm7rEbCh5THVHGUUxz7h787kfUKLcTcblqac21iE7Qy7XA09A0LJFF  
OwiUMpfr1A2jFEG5mHFQToRprEmy7D6j3Qbyn1b9DgVPdV+4kMTKaX2K1NasUJc+0VaUc1xFt8/+  
ErN1mLTcQBRDcn7mf1uZ7CMd+4ChigGJrQKDQClhxds6ZgLdd89W2lhGZ+YoB3tYmaUAm4kIJpDF  
ILPcU4tnUk8X9Z2akEjC9o4Q8s/9xvGFmna4tZKxmQQu b1qlDb5rLTi5aLxcKz/mROFtB6GkYs9G  
U+yU7KttKQGKFA sFMxpGbfacjJqGvy0z/U+IkPUzpc3ioFt1QD9kzWnbJx0YkyIShzdT6i4  
-----END RSA PRIVATE KEY-----
```

note: this is not a real key pair



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## Request Instances Wizard

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INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Security groups determine whether a network port is open or blocked on your instances. You may use an existing security group, or we can help you create a new security group to allow access to your instances using the suggested ports below. Add additional ports now or update your security group anytime using the Security Groups page.

Choose one or more of your existing Security Groups

Create a new Security Group

**Group Name**

quick-start-1

**Group Description**

quick-start-1

**Inbound Rules**Create a  
new rule:

Custom TCP rule

Port range:

(e.g., 80 or 49152-65535)

Source:

0.0.0.0/0

(e.g., 192.168.2.0/24, sg-47ad482e, or  
1234567890/default)

Add Rule

TCP		
Port (Service)	Source	Action
22 (SSH)	0.0.0.0/0	Delete

[Back](#)[Continue](#)

## Request Instances Wizard

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CONFIGURE FIREWALL

REVIEW

Security groups determine whether a network port is open or blocked on your instances. You may use an existing security group, or we can help you create a new security group to allow access to your instances using the suggested ports below. Add additional ports now or update your security group anytime using the Security Groups page.

 Choose one or more of your existing security groups Create a new security group

Custom TCP rule

Custom UDP rule

Custom ICMP rule

All TCP

All UDP

All ICMP

SSH

SMTP

DNS

HTTP

POP3

IMAP

LDAP

HTTPS

SMTPS

IMAPS

POP3S

MS SQL

MYSQL

RDP

Create a new rule:

Source:

## Choose one or more of your existing security groups

TCP		
Port (Service)	Source	Action
22 (SSH)	0.0.0.0/0	Delete

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REVIEW

Security groups determine whether a network port is open or blocked on your instances. You may use an existing security group, or we can help you create a new security group to allow access to your instances using the suggested ports below. Add additional ports now or update your security group anytime using the Security Groups page.

Choose one or more of your existing Security Groups

Create a new Security Group

**Group Name**

quick-start-1

**Group Description**

quick-start-1

**Inbound Rules**Create a  
new rule:

Custom TCP rule

Port range:

(e.g., 80 or 49152-65535)

Source:

0.0.0.0/0

(e.g., 192.168.2.0/24, sg-47ad482e, or  
1234567890/default)

Add Rule

TCP		
Port (Service)	Source	Action
22 (SSH)	0.0.0.0/0	Delete

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## Request Instances Wizard

Cancel

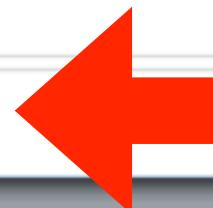
CHOOSE AN AMI

INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Please review the information below, then click **Launch**.**AMI:** Amazon Linux AMI ID ami-05355a6c (x86\_64)**Name:** Amazon Linux AMI 2013.03.1**Description:** The Amazon Linux AMI is an EBS-backed, PV-GRUB image. It includes Linux 3.4, AWS tools, and repository access to multiple versions of MySQL, PostgreSQL, Python, Ruby, and Tomcat.[Edit AMI](#)**Number of Instances:** 1**Availability Zone:** No Preference**Instance Type:** T1 Micro (t1.micro)**Instance Class:** On Demand[Edit Instance Details](#)**EBS-Optimized:** No**Monitoring:** Disabled**Termination Protection:** Disabled**Tenancy:** Default**Kernel ID:** Use Default**Shutdown Behavior:** Stop**RAM Disk ID:** Use Default**Network Interfaces:****Secondary IP Addresses:****User Data:****IAM Role:**[Edit Advanced Details](#)[Back](#)[Launch](#) 

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Instances

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EC2 Dashboard Events Tags

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NETWORK & SECURITY Security Groups Elastic IPs Placement Groups Load Balancers Key Pairs Network Interfaces

Launch Instance Actions Viewing: All Instances All Instance Types Search 1 to 1 of 1 Instances

Name	Instance	AMI ID	Root Device	Type	State	Status Checks	Alarm Status
empty	i- [REDACTED]	ami-05355a6c	ebs	t1.micro	running	initializing...	none

1 EC2 Instance selected.

EC2 Instance: i- [REDACTED] .compute-1.amazonaws.com

Description Status Checks Monitoring Tags

AMI: amzn-ami-pv-2013.03.1.x86\_64-ebs (ami-05355a6c)

Zone: us-east-1c

Alarm Status: none

Security Groups: quick-start-1. view rules

Feedback

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# Log into the instance from a terminal

```
$ ssh -i example_keypair.pem \  
ec2-user@ec2-blah.compute1.amazonaws.com
```

For default Amazon AMI:

```
ec2-user@ec2-blah.compute1.amazonaws.com
```

For Ubuntu AMI:

```
ubuntu@ec2-blah.compute1.amazonaws.com
```

```
[astling@laptop ~]$ ssh -i example_keypair.pem \
ec2-user@ec2-blah.compute1.amazonaws.com
```

WARNING: UNPROTECTED PRIVATE KEY FILE!

Permissions 0644 for 'example\_keypair.pem' are too open.

It is recommended that your private key files are NOT accessible by others.

This private key will be ignored.

bad permissions: ignore key: example\_keypair.pem

Permission denied (publickey).

[astling@laptop ~]\$

```
[astling@laptop ~]$ ssh -i example_keypair.pem \
ec2-user@ec2-blah.compute1.amazonaws.com

@         WARNING: UNPROTECTED PRIVATE KEY FILE!          @
@Permissions 0644 for 'example_keypair.pem' are too open.
It is recommended that your private key files are NOT accessible by
others.
This private key will be ignored.
bad permissions: ignore key: example_keypair.pem
Permission denied (publickey).
[astling@laptop ~]$ chmod 400 example_keypair.pem
[astling@laptop ~]$
```

```
[astling@laptop ~]$ ssh -i example_keypair.pem \
ec2user@ec2-blah.compute1.amazonaws.com
```

```
__|__|_)  
_|( / Amazon Linux AMI  
___|\___|___|
```

```
https://aws.amazon.com/amazon-linux-ami/2013.03-release-notes/  
There are 1 security update(s) out of 3 total update(s) available  
Run "sudo yum update" to apply all updates.
```

```
[ec2-user@domU-blah ~]$
```

# Success!!

# Package Managers

- **yum** - Yellowdog Updater Modified  
(Red Hat, Fedora, CentOS)
- **apt-get** - Advanced Packaging Tool  
(Ubuntu, Debian)

# For Amazon/Red Hat

```
[ec2-user@domU-blah ~]$ sudo yum update  
[ec2-user@domU-blah ~]$ sudo yum install R  
[ec2-user@domU-blah ~]$ sudo yum install svn mercurial gcc-c++  
[other packages...]
```

```
[ec2-user@domU-blah ~]$ R  
R version 2.15.2 (2012-10-26) -- "Trick or Treat"  
Copyright (C) 2012 The R Foundation for Statistical Computing  
ISBN 3-900051-07-0  
Platform: x86_64-redhat-linux-gnu (64-bit)
```

```
R is free software and comes with ABSOLUTELY NO WARRANTY.  
You are welcome to redistribute it under certain conditions.  
Type 'license()' or 'licence()' for distribution details.
```

Natural language support but running in an English locale

```
R is a collaborative project with many contributors.  
Type 'contributors()' for more information and  
'citation()' on how to cite R or R packages in publications.
```

```
Type 'demo()' for some demos, 'help()' for on-line help, or  
'help.start()' for an HTML browser interface to help.  
Type 'q()' to quit R.
```

>

# For Ubuntu

```
$ sudo apt-get update  
  
$ sudo apt-get upgrade  
  
$ sudo apt-get install build-essential  
  
$ sudo apt-get install r-base  
  
$ sudo apt-get install r-cran-cluster  
r-cran-lattice r-cran-mass r-cran-mgcv  
r-cran-nlme r-cran-nnet r-cran-survival  
r-cran-rodbc
```

# Upload Code/Data

```
[astling@laptop ~]$ scp -r -i example_keypair.pem \
path/to/stuff \
ec2-user@ec2-blah.amazonaws.com:path/to/folder
```

# Mount Ephemeral Storage

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#startWizards=true

amazon EC2

Services Edit David Astling N. Virginia Help

Request Instances Wizard

CHOOSE AN AMI INSTANCE DETAILS CREATE KEY PAIR CONFIGURE FIREWALL REVIEW

Provide the details for your instance(s). You may also decide whether you want to launch your instances as "on-demand" or "spot" instances.

Number of Instances: 1 Instance Type: M1 Large (m1.large, 7.5 GiB)

Launch as an EBS-Optimized instance (additional charges apply):

**Launch Instances**

EC2 Instances let you pay for compute capacity by the hour with no long term commitments. This transforms what are commonly large fixed costs into much smaller variable costs.

Launch into:  EC2-Classic  EC2-VPC

Availability Zone: No Preference

**Request Spot Instances**

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Loading "https://console.aws.amazon.com/ec2/home?region=us-east-1#startWizards=true", completed 23 of 25 items

The screenshot shows the 'Request Instances Wizard' dialog box on the AWS EC2 Management Console. The 'INSTANCE DETAILS' tab is selected. The user has specified 1 instance of type 'M1 Large (m1.large, 7.5 GiB)'. There is an unchecked checkbox for launching as an EBS-optimized instance. The 'Launch into:' section shows 'EC2-Classic' selected. The 'Availability Zone:' dropdown is set to 'No Preference'. Below this, there is a section for 'Request Spot Instances'. At the bottom, there are 'Back' and 'Continue' buttons. The status bar at the bottom of the browser window indicates it is loading the URL 'https://console.aws.amazon.com/ec2/home?region=us-east-1#startWizards=true'.

includes 2x 420 GB instance storage



## Request Instances Wizard

Cancel

CHOOSE AN AMI

INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

**Number of Instances:** 1**Availability Zone:** No Preference**Storage Device Configuration**

Your instance will be launched with the following storage device settings. Edit these settings to add EBS volumes, instance store volumes, or edit the settings of the root volume.

Type	Device	Snapshot ID	Size	Volume Type	IOPS	Delete on Termination
Root	/dev/sda1	snap-	8	standard		true

**0 EBS Volumes    0 Ephemerals**

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## Request Instances Wizard

Cancel

CHOOSE AN AMI

INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

**Number of Instances:** 1**Availability Zone:** No Preference

### Storage Device Configuration

Your instance will be launched with the following storage device settings. Edit these settings to add EBS volumes, instance store volumes, or edit the settings of the root volume.

 Root Volume EBS Volumes Instance Store Volumes

Optionally, edit the root volume of your instance and then click Save.

Volume Size:  GiBVolume Type: IOPS: 

Device: /dev/sda1

Delete on Termination:  Save

Type	Device	Snapshot ID	Size	Volume Type	IOPS	Delete on Termination
Root	/dev/sda1	snap-	8	standard		true

**0 EBS Volumes    0 Ephemerals**[« Back](#)[Continue](#)

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#startWizards=true

amazon EC2

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Request Instances Wizard

CHOOSE AN AMI INSTANCE DETAILS CREATE KEY PAIR CONFIGURE FIREWALL REVIEW

Number of Instances: 1

Availability Zone: No Preference

Storage Device Configuration

Your instance will be launched with the following storage device settings. Edit these settings to add EBS volumes, instance store volumes, or edit the settings of the root volume.

Root Volume  EBS Volumes  Instance Store Volumes

Map an instance store volume to the specified device.

Instance Store: 0

Device: /dev/ sdb

Add

Type	Device	Snapshot ID	Size	Volume Type	IOPS	Delete on Termination
Root	/dev/sda1	snap-	8	standard		true

0 EBS Volumes 0 Ephemerals

Back Continue

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Type	Device	Snapshot ID	Size	Volume Type	IOPS	Delete on Termination
Root	/dev/sda1	snap-	8	standard		true



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## Request Instances Wizard

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REVIEW

**Number of Instances:** 1**Availability Zone:** No Preference

### Storage Device Configuration

Your instance will be launched with the following storage device settings. Edit these settings to add EBS volumes, instance store volumes, or edit the settings of the root volume.

 Root Volume EBS Volumes Instance Store Volumes

Map an instance store volume to the specified device.

Instance Store: Device: /dev/ 

Type	Device	Snapshot ID	Size	Volume Type	IOPS	Delete on Termination
Root	/dev/sda1	snap-	8	standard		true
Ephemeral	/dev/sdb	instance store volume: ephemeral0				
Ephemeral	/dev/sdc	instance store volume: ephemeral1				

**0 EBS Volumes    2 Ephemerals**[« Back](#)[Continue](#)

# Mounting the Instance Store

```
[ec2-user@ip-blah ~]$ df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/xvda1       7.9G  1.6G  6.3G  20% /
tmpfs           3.7G    0  3.7G   0% /dev/shm
/dev/xvdb       414G  199M  393G   1% /media/ephemeral0
[ec2-user@ip-blah ~]$
```

where is /media/ephemeral1 ??

# Mounting the Instance Store

```
[ec2-user@ip-blah ~]$ ls /dev
```

autofs	full	input	loop7	ppp	stderr	ttyS2	vcsa
block	fuse	kmsg	loop-control	psaux	stdin	ttyS3	vcsa1
btrfs-control	hvc0	log	mapper	ptmx	stdout	urandom	vcsa2
char	hvc1	loop0	mem	pts	tty	vcs	vcsa3
console	hvc2	loop1	net	random	tty0	vcs1	vcsa4
core	hvc3	loop2	network_latency	root	tty1	vcs2	vcsa5
cpu	hvc4	loop3	network_throughput	sdal	tty10	vcs3	vcsa6
cpu_dma_latency	hvc5	loop4	null	sdb	tty11	vcs4	vga_arbiter
disk	hvc6	loop5	oldmem	sdc	tty12	vcs5	vhost-net
fd	hvc7	loop6	port	shm	tty13	vcs6	xen

xvda1  
xvdb  
xvdc

zero

```
[ec2-user@ip-blah ~]$
```

# Mounting the Instance Store

```
$ sudo mkfs /dev/xvdc
$ sudo mkdir /media/ephemeral1
$ sudo mount -t ext4 /dev/xvdc /media/ephemeral1

$ sudo chown ec2-user /media/ephemeral0
$ sudo chown ec2-user /media/ephemeral1
```

# Mounting the Instance Store

```
[ec2-user@ip-blah ~]$ df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/xvda1       7.9G  1.6G  6.3G  20% /
tmpfs            3.7G    0  3.7G   0% /dev/shm
/dev/xvdb       414G  199M  393G   1% /media/ephemeral0
/dev/xvdc       414G   71M  393G   1% /media/ephemeral1
[ec2-user@ip-blah ~]$
```

# Automated Mounting

```
[ec2-user@ip-blah ~]$ sudo vim /etc/fstab
#
#          /           ext4    defaults,noatime      1   1
tmpfs     /dev/shm     tmpfs   defaults            0   0
devpts    /dev/pts     devpts  gid=5,mode=620       0   0
sysfs    /sys          sysfs   defaults            0   0
proc      /proc         proc    defaults            0   0
/dev/sdb  /media/ephemeral0 auto    defaults,comment=cloudconfig  0   2
/dev/sdc  /media/ephemeral1 auto    defaults,comment=cloudconfig  0   2

[ec2-user@ip-blah ~]$
```

Caution: if instance storage fails to mount (e.g. not configured correctly), you may not be able to boot and ssh into the instance

# Add EBS Storage

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Instances

amazon EC2

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Launch Instance Actions Viewing: All Instances All Instance Types Search 1 to 2 of 2 Instances

Name	Instance	AMI ID	Root Device	Type	State	Status Checks	Alarm Status
<input type="checkbox"/> empty		i- [REDACTED]	ami-05355a6c	ebs	m1.large	<span style="color: red;">●</span> terminated	none
<input checked="" type="checkbox"/> empty		i- [REDACTED]	ami-05355a6c	ebs	m1.large	<span style="color: green;">●</span> running	<span style="color: green;">✓</span> 2/2 checks p

1 EC2 Instance selected.

EC2 Instance: i- [REDACTED] .compute-1.amazonaws.com

Description Status Checks Monitoring Tags

AMI: amzn-ami-pv-2013.03.1.x86\_64-ebs (ami-05355a6c) Alarm Status: none

Zone: us-east-1d Security Groups: quick-start-1. view rules

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EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Volumes

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EC2 Dashboard Events Tags

Create Volume Actions Viewing: All Volumes Search 1 to 1 of 1 Items

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0 Volumes selected Select a volume above

Feedback

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	Name	Volume ID	Capacity	Volume Type	Snapshot	Created	Zone	State
<input type="checkbox"/>	empty	vol-8b2ee2d1	8 GiB	standard	snap-	2013-06-17T23:11:43	us-east-1d	in-use

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Volumes

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Create Volume Actions Viewing: All Volumes Search 1 to 1 of 1 Items

Name	Volume ID	Capacity	Volume Type	Snapshot	Created	Zone	State
empty	vol-8b2ee2d1	8 GiB	standard	snap-	2013-06-17T23:11:43	us-east-1d	in-use

Create Volume

Volume Type: Please Select

Size: 1 GiB (Min: 1 GiB, Max: 1TiB)

IOPS: (Max: 4000 IOPS)

Availability Zone: us-east-1b

Snapshot: --- No Snapshot ---

Cancel Yes, Create

0 Volumes

Select a volume above

Feedback

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Volumes

amazon EC2

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Create Volume Actions Viewing: All Volumes Search 1 to 1 of 1 Items

Name	Volume ID	Capacity	Volume Type	Snapshot	Created	Zone	State
empty	vol-8b2ee2d1	8 GiB	standard	snap-	2013-06-17T23:11:43	us-east-1d	in-use

**Create Volume**

Volume Type: Standard

Size: 100 GiB (Min: 1 GiB, Max: 1TiB)

IOPS: (Max: 4000 IOPS)

Availability Zone: us-east-1b

Snapshot: No Snapshot

Cancel Yes, Create

0 Volumes Select a volume above

Feedback

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The screenshot shows the AWS EC2 Management Console interface. On the left, there's a sidebar with various service links like EC2 Dashboard, Instances, Images, and Network & Security. The 'VOLUMES' link under 'ELASTIC BLOCK STORE' is currently selected. In the main content area, a table lists existing volumes, including one named 'empty' with a volume ID of 'vol-8b2ee2d1'. A red arrow points to this row. Below the table, a modal dialog box titled 'Create Volume' is open. It contains fields for 'Volume Type' (set to 'Standard'), 'Size' (set to '100 GiB'), 'IOPS' (set to 'Max: 4000 IOPS'), 'Availability Zone' (set to 'us-east-1b'), and a 'Snapshot' dropdown menu which has a red arrow pointing to it. The 'Snapshot' dropdown shows the option 'No Snapshot'. At the bottom of the modal are 'Cancel' and 'Yes, Create' buttons. A red arrow also points to the 'in-use' status of the 'empty' volume in the table.

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Volumes

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Create Volume Actions Viewing: All Volumes Search 1 to 2 of 2 Items

	Name	Volume ID	Capacity	Volume Type	Snapshot	Created	Zone	State
<input type="checkbox"/>	empty	vol-8b2ee2d1	8 GiB	standard	snap-	2013-06-17T23:11:43	us-east-1d	<span style="color: green;">in-use</span>
<input checked="" type="checkbox"/>	empty	vol-b467abee	100 GiB	standard	-	2013-06-17T23:45:44	us-east-1d	<span style="color: blue;">available</span>

1 Volume selected

Volume: vol-b467abee

Details Status Checks Monitoring Tags

Volume ID:	vol-b467abee	Alarm Status:	none
Capacity:	100 GiB	Snapshot:	
Created:	2013-06-17 17:45 MDT	Zone:	us-east-1d

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EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Volumes

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Create Volume Actions Viewing: All Volumes

- Delete Volume
- Attach Volume**
- Detach Volume
- Force Detach
- Create Snapshot
- Change Auto-Enable IO Setting

1 to 2 of 2 Items

Type	Snapshot	Created	Zone	State
Standard	snap-00000000	2013-06-17T23:11:43	us-east-1d	in-use
Standard	--	2013-06-17T23:45:44	us-east-1d	available

1 Volume selected

Volume: vol-b467abee

Details Status Checks Monitoring Tags

Volume ID:	vol-b467abee	Alarm Status:	none
Capacity:	100 GiB	Snapshot:	
Created:	2013-06-17 17:45 MDT	Zone:	us-east-1d

Feedback

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Volumes

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Create Volume Actions Viewing: All Volumes Search 1 to 2 of 2 Items

	Name	Volume ID	Capacity	Volume Type	Snapshot	Created	Zone	State
<input type="checkbox"/>	empty	vol-8b2ee2d1	8 GiB	standard	snap-	2013-06-17T23:11:43	us-east-1d	<span style="color: green;">in-use</span>
<input checked="" type="checkbox"/>	empty	vol-b467abee	100 GiB	standard	-	2013-06-17T23:45:44	us-east-1d	<span style="color: blue;">available</span>

**Attach Volume**

Volume: vol-b467abee in us-east-1d

Instances: i- (running) in us-east-1d

Device: /dev/sdf

Linux Devices: /dev/sdf through /dev/sdp  
Note: Newer linux kernels may rename your devices to /dev/xvdf through /dev/xvdः internally, even when the device name entered here (and shown in the details) is /dev/sdf through /dev/sdp.

1 Volume

Cancel Yes, Attach

**Volume: vol-b467abee**

Details Status Checks Monitoring Tags

Volume ID: vol-b467abee Alarm Status: none

Capacity: 100 GiB Snapshot:

Created: 2013-06-17 17:45 MDT Zone: us-east-1d

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EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Volumes

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Create Volume Actions Viewing: All Volumes Search 1 to 2 of 2 Items

	Name	Volume ID	Capacity	Volume Type	Snapshot	Created	Zone	State
<input type="checkbox"/>	empty	vol-8b2ee2d1	8 GiB	standard	snap-	2013-06-17T23:11:43	us-east-1d	<span>in-use</span>
<input checked="" type="checkbox"/>	empty	vol-b467abee	100 GiB	standard	-	2013-06-17T23:45:44	us-east-1d	<span>in-use</span>

1 Volume selected

Volume: vol-b467abee

Details Status Checks Monitoring Tags

Volume ID:	vol-b467abee	Alarm Status:	none
Capacity:	100 GiB	Snapshot:	
Created:	2013-06-17 17:45 MDT	Zone:	us-east-1d

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# Mounting the EBS Volume

```
$ sudo mkfs /dev/xvdf
$ sudo mkdir -p /Volumes/things_n_stuff
$ sudo mount -t ext4 /dev/xvdf /Volumes/things_n_stuff

$ sudo chown ec2-user /Volumes/things_n_stuff
```

# Mounting the EBS Volume

```
[ec2-user@ip-blah ~]$ df -h
Filesystem      Size   Used  Avail Use% Mounted on
/dev/xvda1      7.9G  1.6G  6.3G  20% /
tmpfs           3.7G     0  3.7G  0% /dev/shm
/dev/xvdb      414G  199M  393G  1% /media/ephemeral0
/dev/xvdc      414G   71M  393G  1% /media/ephemeral1
/dev/xvdf      99G   60M   94G  1% /Volumes/things_n_stuff
[ec2-user@ip-blah ~]$
```

# Creating an AMI

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Volumes

amazon EC2

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Create Volume Actions Viewing: All Volumes

Delete Volume Attach Volume Detach Volume Force Detach Create Snapshot Change Auto-Enable IO Setting

1 to 2 of 2 Items

Name	Type	Snapshot	Created	Zone	State
empty	Standard	snapshot-f270dca8	2013-06-17T23:11:43	us-east-1d	in-use
empty	Standard	--	2013-06-17T23:45:44	us-east-1d	in-use

1 Volume selected

Volume: vol-8b2ee2d1

Details Status Checks Monitoring Tags

Volume ID:	vol-8b2ee2d1	Alarm Status:	none
Capacity:	8 GiB	Snapshot:	snap-f270dca8
Created:	2013-06-17 17:11 MDT	Zone:	us-east-1d

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EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Volumes

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Create Volume Actions Viewing: All Volumes Search 1 to 2 of 2 Items

Name	Volume ID	Capacity	Volume Type	Snapshot	Created	Zone	State
<input checked="" type="checkbox"/> empty	vol-8b2ee2d1	8 GiB	standard	snap-f270dca8	2013-06-17T23:11:43	us-east-1d	<span style="color: green;">in-use</span>
<input type="checkbox"/> empty	vol-b467abee	100 GiB	standard	--	2013-06-17T23:45:44	us-east-1d	<span style="color: green;">in-use</span>

Create Snapshot

Volume: vol-8b2ee2d1

Name: example\_ami

Description: Example AMI

Cancel Yes, Create

1 Volume selected

Volume: vol-8b2ee2d1

Details Status Checks Monitoring Tags

Volume ID:	vol-8b2ee2d1	Alarm Status:	none
Capacity:	8 GiB	Snapshot:	snap-f270dca8
Created:	2013-06-17 17:11 MDT	Zone:	us-east-1d

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EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Snapshots

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Create Snapshot Delete Permissions Create Volume Create Image Copy

Viewing: Owned By Me Search 1 to 1 of 1 Items

Name	Snapshot ID	Capacity	Description	Status	Started
example_ami	snap-3f387c61	8 GiB	Example AMI	completed	2013-06-17 17:58 M

1 Elastic Block Store Volume Snapshot selected

Elastic Block Store Volume Snapshot: snap-3f387c61

Description Tags

Snapshot ID: snap-3f387c61

Status: pending Progress:

Volume: vol-8b2ee2d1 Capacity: 8 GiB

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The screenshot shows the AWS EC2 Management Console interface. The left sidebar contains navigation links for EC2 Dashboard, Events, Tags, INSTANCES, IMAGES, ELASTIC BLOCK STORE, and NETWORK & SECURITY. Under the ELASTIC BLOCK STORE section, 'Snapshots' is highlighted with a red arrow. In the main content area, the 'Snapshots' tab is selected, showing a single item named 'example\_ami'. A red arrow points to the 'Create Image' button in the top right of the snapshot details panel. The bottom of the screen includes standard AWS footer links for Privacy Policy and Terms of Use.

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Snapshots

amazon EC2

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EC2 Dashboard Events Tags

Create Snapshot Delete Permissions Create Volume Create Image Copy

Cancel Items > > |

**Create Image from EBS Snapshot**

This will create and register a new Amazon Machine Image using the selected snapshot as the root device.

Name: Example AMI Description:

Architecture: x86\_64 Root Device Name: /dev/sda1

Kernel ID: Use Default Ramdisk ID: Use Default

**Block Device Mapping:**

Root Volume  EBS Volumes  Instance Store Volumes

Map an instance store volume to the specified device.

Instance Store: 2 Device:/dev/ sdd

Add

Type	Device	Snapshot ID	Size	Volume Type	IOPS	Delete on Termination
Root	/dev/sda1	snap-3f387c61	8	standard		true
Ephemeral	/dev/sdb	Instance store volume: ephemeral0				
Ephemeral	/dev/sdc	Instance store volume: ephemeral1				

0 EBS Volumes 2 Ephemerals

Cancel Yes, Create

Volume: vol-8b2ee2d1 Capacity: 8 GiB

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**Request Instances Wizard**

Cancel

**CHOOSE AN AMI**

INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Choose an Amazon Machine Image (AMI) from one of the tabbed lists below by clicking its **Select** button.[Quick Start](#)[My AMIs](#)[Community AMIs](#)[AWS Marketplace](#)

Viewing:

Owned By Me



Search



1 to 1 of 1 Items



AMI ID

Root Device

Name

Platform



ami-4502732c

ebs

/Example AMI



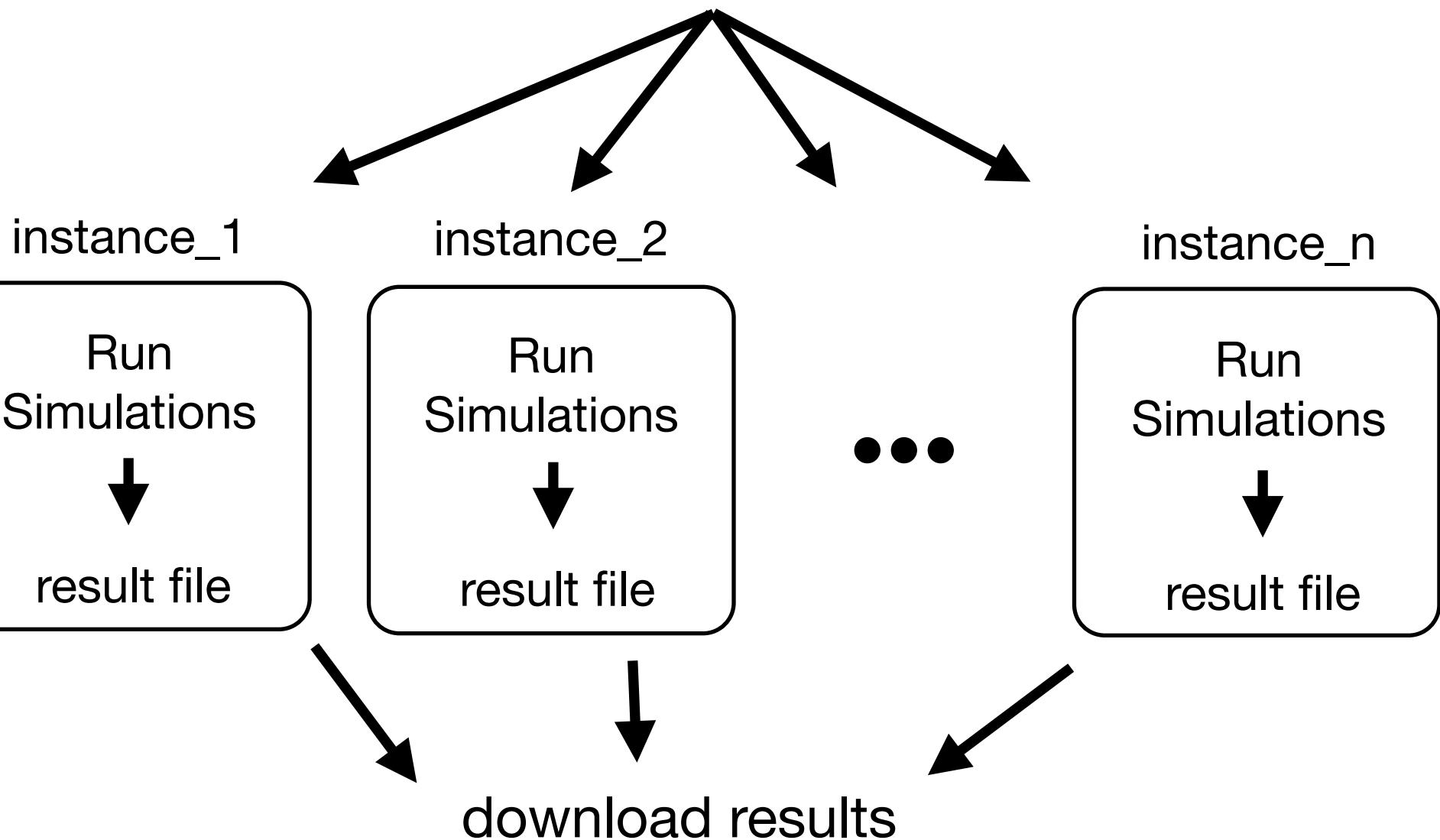
Other Linux

[Select](#) Free tier eligible if used with a micro instance. See [AWS free tier](#) for complete details and terms.

# Launching Multiple Instances for HPC Applications

# For Independent Processes

launch instances from custom AMI



# For HPC Applications

## 1. Building a Cluster in 10 min

<http://www.youtube.com/embed/YfCgK1bmCjw>

## 2. MIT StarCluster

<http://star.mit.edu/cluster/>

## 3. MPI Cluster Setup

<http://glennklockwood.blogspot.com/2013/04/quick-mpi-cluster-setup-on-amazon-ec2.html>

### Request Instances Wizard

CHOOSE AN AMI    INSTANCE DETAILS    CREATE KEY PAIR    CONFIGURE FIREWALL    REVIEW

Choose an Amazon Machine Image (AMI) from one of the tabbed lists below by clicking its **Select** button.

**Quick Start**    My AMIs    Community AMIs    AWS Marketplace

**Ubuntu Server 13.04**  
ubuntu • Ubuntu Server version 13.04, with support available from Canonical (<http://www.ubuntu.com/cloud/services>).  
Root Device Size: 8 GB     64 bit  32 bit

**Cluster Compute Amazon Linux AMI 2013.03.1**  
amazon web services The Amazon Linux AMI is an EBS-backed, HVM image. It includes Linux 3.4, AWS tools, and repository access to multiple versions of MySQL, PostgreSQL, Python, Ruby, and Tomcat.  
Root Device Size: 8 GB     64 bit  32 bit

**Red Hat Enterprise Linux 6.4 for Cluster Instances**  
redhat Red Hat Enterprise Linux version 6.4 is an EBS-backed, HVM image for use with Amazon EC2 Cluster Instances.  
Root Device Size: 7 GB     64 bit  32 bit

**Cluster Instances HVM SUSE Linux Enterprise 11**  
SUSE Linux Enterprise SUSE Linux Enterprise Server 11 Service Pack 2, 64-bit architecture, and HVM based virtualization for use with Amazon EC2 Cluster Compute and Cluster GPU Instances. Nvidia driver installs automatically during startup.  
Root Device Size: 10 GB     64 bit  32 bit

**Ubuntu Server 12.04.2 LTS for HVM Instances**

★ Free tier eligible if used with a micro instance. See [AWS free tier](#) for complete details and terms.

Cancel



Instances &gt; &gt;

EC2 Dashboard  
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NETWORK SECURITY Elastic Network Load Balancer Key Pairs Networks

### Request Instances Wizard

CHOOSE AN AMI    INSTANCE DETAILS    CREATE KEY PAIR    CONFIGURE FIREWALL    REVIEW

Provide the details for your instance(s). You may also decide whether you want to launch your instances as "on-demand" or "spot" instances.

**Number of Instances:** 1    **Instance Type:** CC1 Cluster Compute (cc1.4xlarge, 23 GiB)

**Launch as an EBS-Optimized Instance (optional):**

**Launch Instances**  
EC2 Instances let you purchase commonly large fixed capacity instances.

**Request Spot Instances**  
Request spot instances at lower prices than on-demand instances.

Type	CPU Units	CPU Cores	Memory
M3 Extra Large (m3.xlarge)	13 ECUs	4 Cores	15 GiB
M3 Double Extra Large (m3.2xlarge)	26 ECUs	8 Cores	30 GiB
<b>CC1 Cluster Compute (cc1.4xlarge)</b>	<b>33.5 ECUs</b>	<b>8 Cores</b>	<b>23 GiB</b>
CC2 Cluster Compute (cc2.8xlarge)	88 ECUs	16 Cores	60.5 GiB
CR1 High Memory Cluster Compute (cr1.8xlarge)	88 ECUs	16 Cores	244 GiB
CG1 Cluster GPU (cg1.4xlarge)	33.5 ECUs	8 Cores	22 GiB
High I/O Quadruple Extra Large (hi1.4xlarge)	35 ECUs	16 Cores	60.5 GiB
High Storage Eight Extra Large (hs1.8xlarge)	35 ECUs	16 Cores	117 GiB

**Launch into:**

**Default VPC**  
Launch instances into the default VPC.

**Custom VPC**  
Launch instances into a custom VPC.

**Continue** >

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## Request Instances Wizard

CHOOSE AN AMI INSTANCE DETAILS CREATE KEY PAIR CONFIGURE FIREWALL REVIEW

**Number of Instances:** 1 **Availability Zone:** No Preference

### Advanced Instance Options

Placement groups provide low latency, full bisection 10 Gbps bandwidth between instances within a placement group. You can choose to launch Cluster Compute Instances in a placement group by either providing a new name for one to be created or selecting one of your existing placement groups. You can also choose to enable CloudWatch Detailed Monitoring or enter data that will be available from your instances once they launch.

**Placement Group:** Create new placement group...

**Strategy:** Cluster

**Monitoring:**  Enable CloudWatch detailed monitoring for this instance  
(additional charges will apply)

**User Data:**   
(Use shift+enter to insert a newline)  
 base64 encoded  
 Prevention against accidental termination.

**Termination Protection:** **Shutdown Behavior:** Stop

**IAM Role:** None

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**Request Instances Wizard**

Cancel

CHOOSE AN AMI

INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Security groups determine whether a network port is open or blocked on your instances. You may use an existing security group, or we can help you create a new security group to allow access to your instances using the suggested ports below. Add additional ports now or update your security group anytime using the Security Groups page.

 Choose one or more of your existing Security Groups Create a new Security Group**Group Name**

HPC

**Group Description**

Security settings for HPC

**Inbound Rules**Create a  
new rule:

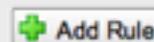
Custom TCP rule

Port range:

(e.g., 80 or 49152-65535)

Source:

0.0.0.0/0

(e.g., 192.168.2.0/24, sg-47ad482e, or  
1234567890/default) Add Rule[Back](#)[Continue](#)

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### Request Instances Wizard

CHOOSE AN AMI    INSTANCE DETAILS    CREATE KEY PAIR    **CONFIGURE FIREWALL**    REVIEW

Security groups determine whether a network port is open or blocked on your instances. You may use an existing security group, or we can help you create a new security group to allow access to your instances using the suggested ports below. Add additional ports now or update your security group anytime using the Security Groups page.

Choose one or more of your existing Security Groups  
 Create a new Security Group

**Group Name** HPC  
**Group Description** Security settings for HPC

**Inbound Rules**

Create a new rule: Custom TCP rule

Port range: (e.g., 80 or 49152-65535)

Source: 0.0.0.0/0 (e.g., 192.168.2.0/24, sg-47ad482e, or 1234567890/default)

**TCP**

Port (Service)	Source	Action
22 (SSH)	0.0.0.0/0	Delete

[Add Rule](#)

[Back](#) [Continue](#)

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## Request Instances Wizard

Cancel X

CHOOSE AN AMI

INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Security groups determine whether a network port is open or blocked on your instances. You may use an existing security group, or we can help you create a new security group to allow access to your instances using the suggested ports below. Add additional ports now or update your security group anytime using the Security Groups page.

 Choose one or more of your existing Security Groups Create a new Security Group**Group Name**

HPC

**Group Description**

Security settings for HPC

**Inbound Rules**Create a  
new rule:

- Custom TCP rule
- Custom UDP rule
- Custom ICMP rule

Port range:

All TCP

All UDP

All ICMP

SSH

SMTP

DNS

HTTP

POP3

IMAP

LDAP

HTTPS

SMTPS

IMAPS

POP3S

MS SQL

MySQL

RDP

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**TCP**

Port (Service)	Source	Action
22 (SSH)	0.0.0.0/0	Delete

Continue ➞

Services

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Help

**Request Instances Wizard**

Cancel



CHOOSE AN AMI

INSTANCE DETAILS

CREATE KEY PAIR

CONFIGURE FIREWALL

REVIEW

Security groups determine whether a network port is open or blocked on your instances. You may use an existing security group, or we can help you create a new security group to allow access to your instances using the suggested ports below. Add additional ports now or update your security group anytime using the Security Groups page.

 Choose one or more of your existing Security Groups Create a new Security Group**Group Name**

HPC

**Group Description**

Security settings for HPC

**Inbound Rules**Create a  
new rule:

Custom TCP rule

Port range:

(e.g., 80 or 49152-65535)

Source:

0.0.0.0/0

(e.g., 192.168.2.0/24, sg-47ad482e, or  
1234567890/default)

Add Rule

TCP		
Port (Service)	Source	Action
22 (SSH)	0.0.0.0/0	<a href="#">Delete</a>
0 - 65535	HPC	<a href="#">Delete</a>

[« Back](#)[Continue](#)



## Request Instances Wizard

Cancel



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REVIEW

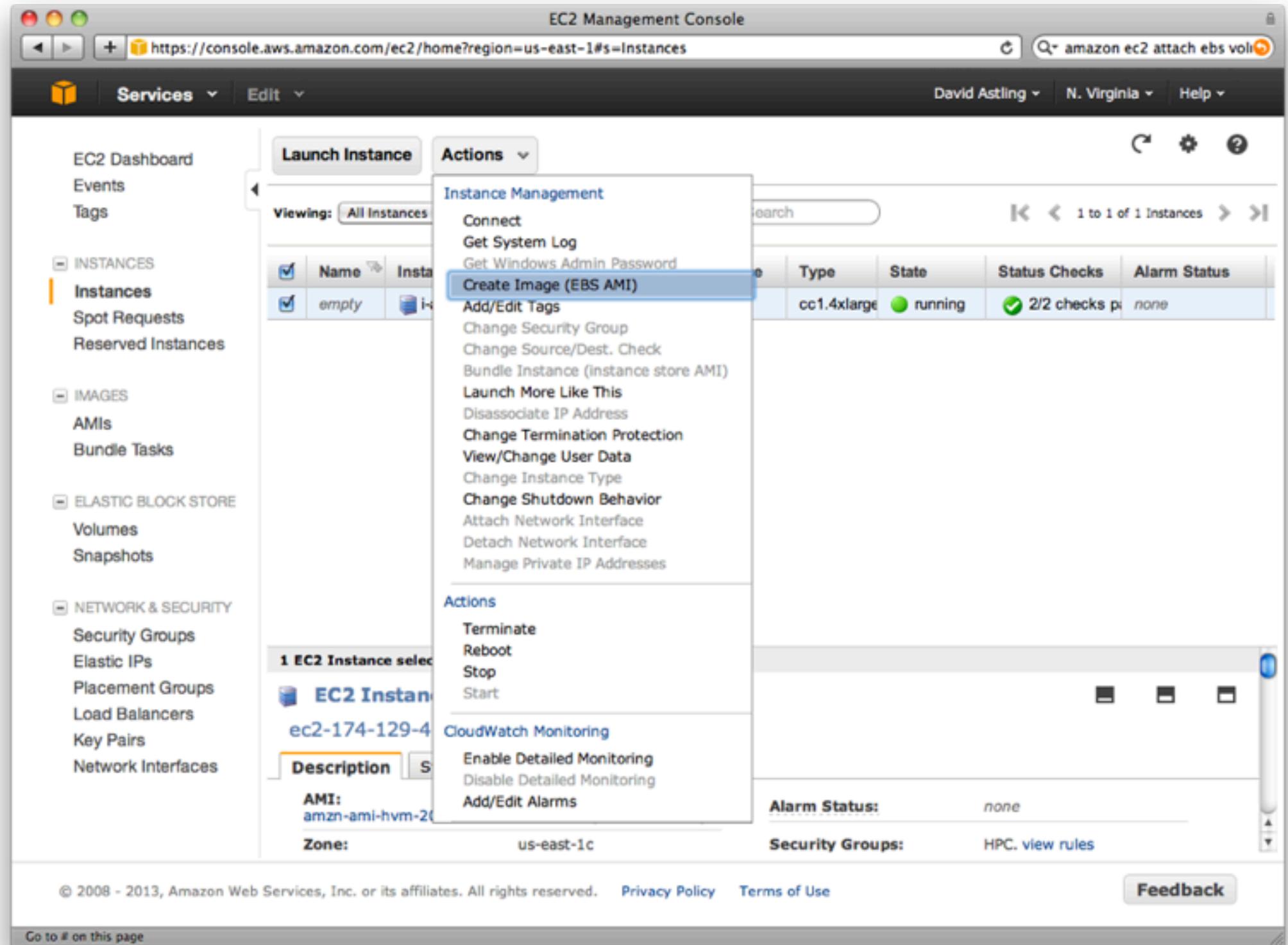
Please review the information below, then click Launch.

**AMI:** Amazon Linux AMI ID ami-a73758ce (x86\_64)**Name:** Cluster Compute Amazon Linux AMI 2013.03.1**Description:** The Amazon Linux AMI is an EBS-backed, HVM image. It includes Linux 3.4, AWS tools, and repository access to multiple versions of MySQL, PostgreSQL, Python, Ruby, and Tomcat.[Edit AMI](#)**Number of Instances:** 1**Availability Zone:** No Preference**Instance Type:** CC1 Cluster Compute (cc1.4xlarge)**Instance Class:** On Demand[Edit Instance Details](#)**EBS-Optimized:** No**Placement Group:** cluster**Strategy:** cluster**Monitoring:** Disabled**Termination Protection:** Disabled**Tenancy:** Default**Network Interfaces:****Secondary IP Addresses:****User Data:****IAM Role:**[Edit Advanced Details](#)[Back](#)[Launch](#)

# Configure User

```
$ sudo groupadd data
$ sudo useradd -s /bin/bash -m cluster -G data -p ""
$ su - cluster
$ cd ~
$ ssh-keygen -t dsa
$ cat ~/.ssh/id_dsa.pub >> ~/.ssh/authorized_keys
$ chmod 644 ~/.ssh/authorized_keys

$ R
> install.packages("doSNOW")
```



Services ▾

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EC2 Dashboard

Launch Instance

Actions ▾



## Create Image

Cancel

Instance ID: i-[REDACTED]

Image Name\*: HPC

Image Description: HPC Example

 No Reboot: Root Volume  EBS Volumes  Instance Store Volumes

Optionally, edit the root volume of your instance and then click Save.

Volume Size: 8  Volume Type: Standard Device:/dev/sda1 Delete on Termination: Save

Type	Device	Snapshot ID	Size	Volume Type	IOPS	Delete on Termination
Root	/dev/sda1		8	standard		true

## 0 EBS Volumes 0 Ephemerals

Total size of EBS volumes: 8 GB.

When you create an EBS image an EBS snapshot will also be created for each of the above volumes.

amzn-ami-hvm-2013.03.1.x86\_64-ebs (ami-a73758ce)

Zone:

us-east-1c

Security Groups:

HPC. view rules



## Request Instances Wizard

Cancel



CHOOSE AN AMI

INSTANCE DETAILS

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CONFIGURE FIREWALL

REVIEW

Provide the details for your instance(s). You may also decide whether you want to launch your instances as "on-demand" or "spot" instances.

**Number of Instances:**

3

**Instance Type:**

CC1 Cluster Compute (cc1.4xlarge, 23 GiB)

**Launch as an EBS-Optimized instance (additional charges apply):** Not supported for this instance type**① Launch Instances**

EC2 Instances let you pay for compute capacity by the hour with no long term commitments. This transforms what are commonly large fixed costs into much smaller variable costs.

**Launch into:** EC2-Classic EC2-VPC**Availability Zone:**

No Preference

**② Request Spot Instances**[« Back](#)[Continue](#)

Services Edit David Astling N. Virginia Help

## Request Instances Wizard

CHOOSE AN AMI INSTANCE DETAILS CREATE KEY PAIR CONFIGURE FIREWALL REVIEW

**Number of Instances:** 1      **Availability Zone:** No Preference

### Advanced Instance Options

Placement groups provide low latency, full bisection 10 Gbps bandwidth between instances within a placement group. You can choose to launch Cluster Compute Instances in a placement group by either providing a new name for one to be created or selecting one of your existing placement groups. You can also choose to enable CloudWatch Detailed Monitoring or enter data that will be available from your instances once they launch.

**Placement Group:** cluster

**Strategy:** Cluster

**Monitoring:**  Enable CloudWatch detailed monitoring for this instance  
(additional charges will apply)

**User Data:**   
(Use shift+enter to insert a newline)  
 base64 encoded  
 Prevention against accidental termination.

**Termination Protection:**

**IAM Role:**

**Shutdown Behavior:** Stop

[Continue](#)

Services

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**Request Instances Wizard**

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INSTANCE DETAILS

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REVIEW

Security groups determine whether a network port is open or blocked on your instances. You may use an existing security group, or we can help you create a new security group to allow access to your instances using the suggested ports below. Add additional ports now or update your security group anytime using the Security Groups page.

 Choose one or more of your existing Security Groups

- sg-[REDACTED] - HPC
- sg-[REDACTED] - default
- sg-[REDACTED] - quick-start-1

(Selected groups: sg-[REDACTED])

 Create a new Security Group

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Continue ➤

EC2 Management Console

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Instances

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Services Edit

EC2 Dashboard Events Tags

INSTANCES Instances Spot Requests Reserved Instances

IMAGES AMIs Bundle Tasks

ELASTIC BLOCK STORE Volumes Snapshots

NETWORK & SECURITY Security Groups Elastic IPs Placement Groups Load Balancers Key Pairs Network Interfaces

Launch Instance Actions Viewing: All Instances All Instance Types Search 1 to 4 of 4 Instances

Name	Instance	AMI ID	Root Device	Type	State	Status Checks	Alarm Status
<input checked="" type="checkbox"/> empty		ami-[REDACTED]	ebs	cc1.4xlarge	<span>running</span>	<span>2/2 checks passed</span>	none
<input checked="" type="checkbox"/> empty		ami-[REDACTED]	ebs	cc1.4xlarge	<span>running</span>	<span>2/2 checks passed</span>	none
<input checked="" type="checkbox"/> empty		ami-[REDACTED]	ebs	cc1.4xlarge	<span>running</span>	<span>2/2 checks passed</span>	none
<input type="checkbox"/> empty		ami-[REDACTED]	ebs	cc1.4xlarge	<span>running</span>	<span>2/2 checks passed</span>	none

3 EC2 Instances selected.

EC2 Instances: i-[REDACTED], i-[REDACTED], i-[REDACTED]

Description Status Checks Monitoring Tags

i-[REDACTED] : ec2-[REDACTED]	compute-1.amazonaws.com
i-[REDACTED] : ec2-[REDACTED]	.compute-1.amazonaws.com
i-[REDACTED] : ec2-[REDACTED]	.compute-1.amazonaws.com

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# Run Analysis

```
library(doSNOW)
servers <- c(rep("localhost", 5),
             rep("ec2-blah1.compute-1.amazonaws.com", 5),
             rep("ec2-blah2.compute-1.amazonaws.com", 5),
             rep("ec2-blah3.compute-1.amazonaws.com", 5))
cl <- makeCluster(servers)
registerDoSNOW(cl)
```

# Run Analysis

```
my.test <- function(n)
{
  for (i in 1:100000)
  {
    X <- matrix(rnorm(100), ncol = 10, nrow = 10)
    solve(X)
  }
}

times <- 100
system.time(for (i in 1:times) { my.test(i) })
system.time(x <- foreach(i = 1:times) %dopar% my.test(i))

stopCluster(cl)
```

# Run Analysis

```
> system.time(for (i in 1:times) { my.test(i) })
  user  system elapsed
1142.071   0.000 1142.021

> system.time(x <- foreach(i = 1:times) %dopar% my.test(i))
  user  system elapsed
 0.096   0.016  58.227

> stopCluster(cl)
```

# Run Analysis

Parallelizing for a single instance (or on your desktop):

```
> number.of.cores <- 5
> cl <- makeCluster(number.of.cores)
> registerDoSNOW(cl)
> system.time(x <- foreach(i = 1:times) %dopar% my.test(i))
  user  system elapsed
0.388   0.016 232.580
```

# Bonus Material

# Running RStudio on Amazon EC2

Follow instructions here:

[http://www.r-bloggers.com/instructions-for-installing-  
using-r-on-amazon-ec2/](http://www.r-bloggers.com/instructions-for-installing-using-r-on-amazon-ec2/)

... and then you can run R and access  
results through a web browser

# Getting Help

- Amazon EC2 Documentation  
<http://aws.amazon.com/documentation/ec2/>
- Getting Started Guide  
[http://docs.aws.amazon.com/AWSEC2/latest/UserGuide/EC2\\_GetStarted.html](http://docs.aws.amazon.com/AWSEC2/latest/UserGuide/EC2_GetStarted.html)
- More HPC Resources  
<http://aws.amazon.com/hpc-applications/>
- Manage/Configure Multiple Users  
<http://www.youtube.com/watch?v=XuRM4Id6uDY>

# Q & A

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