

Work with R on Amazon's Cloud

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Outline

- 1. Amazon's Web Services (AWS):
 - Elastic Compute Cloud (EC2)
 - Simple Storage Service (S3)
 - Elastic MapReduce
 - Amazon AWS console
 - Key Pairs
- 2. Basic instruments to work with remote server:
 - SSH
 - Putty
 - Xming
- 3. Amazon Machine Images (AMIs)
 - Launching
 - Running
 - Saving
- 4. Transferring R code and data to and from AWS
 - Execution
 - Important R packages

Need:

download and install free software:

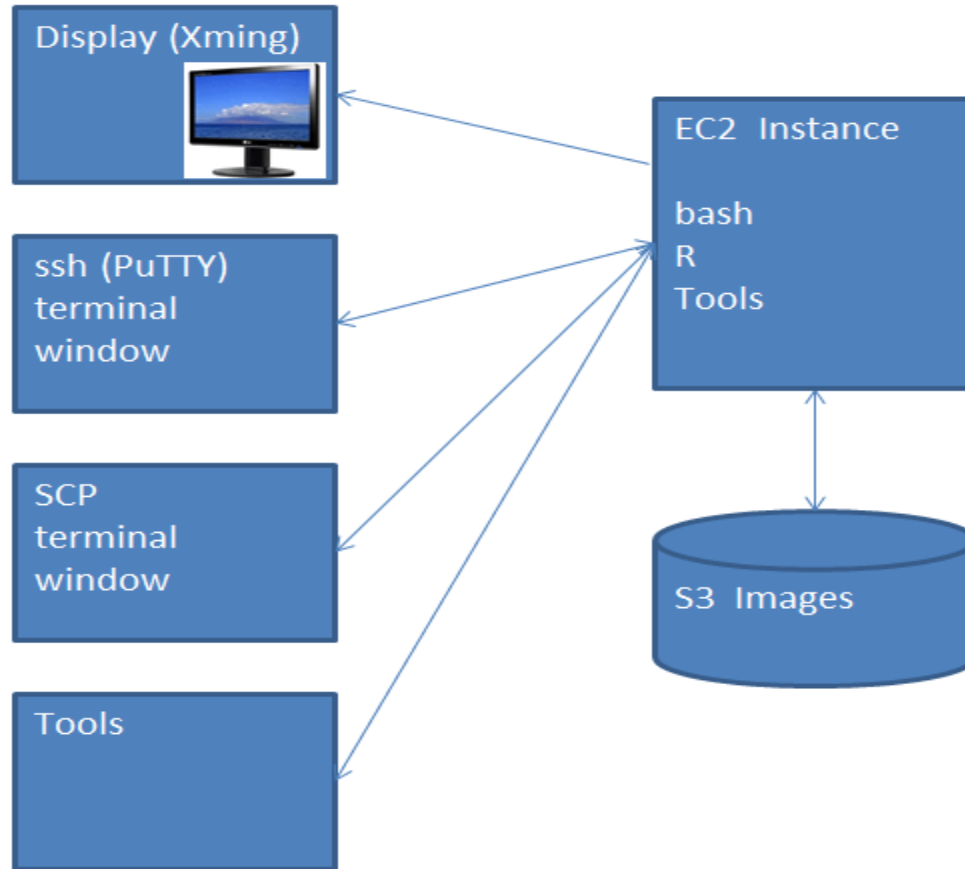
- 1) R - any version
- 2) Mozilla Firefox with plugins: ElasticFox (Mozilla Firefox extension for managing your Amazon EC2 account): <http://developer.amazonwebservices.com/connect/entry.jspa?externalID=609>, and Amazon S3 Firefox Organizer(S3Fox): <https://addons.mozilla.org/en-US/firefox/addon/3247/>.

Register for AWS EC2 and S3 account (<http://aws.amazon.com/>), get and keep handy your:

Account Number
Access Key ID
Secret Access Key
509 Certificate, and
Amazon EC2 API Tools

MS Windows users :

1. Any IDE for R, e.g. Tinn-R (www.sciviews.org/Tinn-R/), Download: <http://sourceforge.net/projects/tinn-r/>
2. Xming (www.straightrunning.com/XmingNotes/) , Download: <http://sourceforge.net/projects/xming/>
3. WinSCP, link and download: <http://winscp.net/eng/index.php>
4. PuTTY www.chiark.greenend.org.uk/~sgtatham/putty/
5. PuTTYgen: www.chiark.greenend.org.uk/~sgtatham/putty/download.html



Why AWS?

- **Simple and convenient to use.** An AMI contains your applications, libraries, data and all associated configuration settings. You simply access it. You don't need to configure it. This applies not only to applications like R, but also can include any third-party data that you require.
- **Available on-demand** over the Internet whenever you need them. You can configure the AMIs yourself without involving the service provider. You don't need to order any hardware and set it up.
- **Elastic access** - you can rapidly provision and access the additional resources you need. Again, no human intervention from the service provider is required. This type of elastic capacity can be used to handle surge requirements when you might need many machines for a short time in order to complete a computation.
- **Pay per use.** The cost of 1 AMI for 100 hours and 100 AMI for 1 hour is the same. With pay per use pricing, which is sometimes called utility pricing, you simply pay for the resources that you use.

Amazon's Web Services (AWS): www.aws.amazon.com

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. AmazonEC2 provides developers the tools to build failure resilient applications and isolate themselves from common failure scenarios.

Prices

Standard On-Demand Instances	Linux/UNIX Usage	Windows Usage
Small (Default)	\$0.085 per hour	\$0.12 per hour
Large	\$0.34 per hour	\$0.48 per hour
Extra Large	\$0.68 per hour	\$0.96 per hour
High-Memory On-Demand Instances		
Extra Large	\$0.50 per hour	\$0.62 per hour
Double Extra Large	\$1.20 per hour	\$1.44 per hour
Quadruple Extra Large	\$2.40 per hour	\$2.88 per hour
High-CPU On-Demand Instances		
Medium	\$0.17 per hour	\$0.29 per hour
Extra Large	\$0.68 per hour	\$1.16 per hour

Amazon Elastic MapReduce

Amazon Elastic MapReduce is a web service that enables businesses, researchers, data analysts, and developers to easily and cost-effectively process vast amounts of data. It utilizes a hosted Hadoop framework running on the web-scale infrastructure of Amazon Elastic Compute Cloud (Amazon EC2) and Amazon Simple Storage Service (Amazon S3).

Using Amazon Elastic MapReduce, you can instantly provision as much or as little capacity as you like to perform data-intensive tasks for applications such as web indexing, data mining, log file analysis, machine learning, financial analysis, scientific simulation, and bioinformatics research. Amazon Elastic MapReduce lets you focus on crunching or analyzing your data without having to worry about time-consuming set-up, management or tuning of Hadoop clusters or the compute capacity upon which they sit.

Amazon Simple Storage Service (Amazon S3)

Amazon S3 is storage for the Internet. It is designed to make web-scale computing easier for developers.

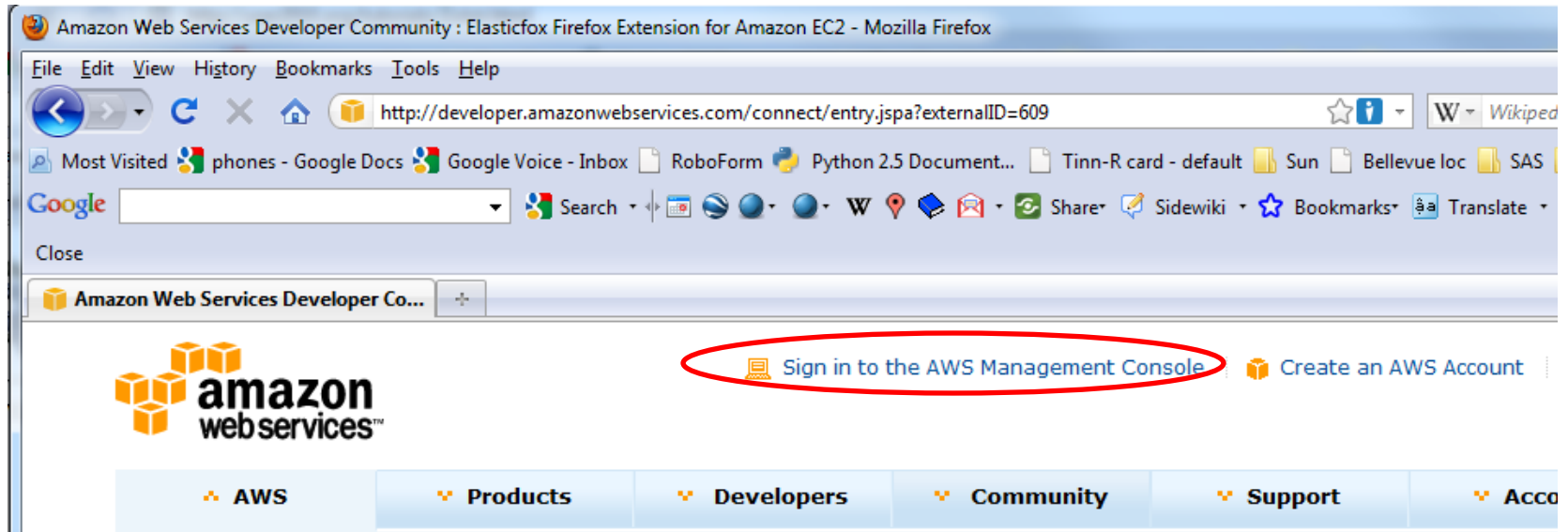
Amazon S3 provides a simple web services interface that can be used to store and retrieve any amount of data, at any time, from anywhere on the web. It gives any developer access to the same highly scalable, reliable, secure, fast, inexpensive infrastructure that Amazon uses to run its own global network of web sites. The service aims to maximize benefits of scale and to pass those benefits on to developers.

Amazon S3, prices

Storage (Designed for 99.999999999% Durability)		Reduced Redundancy Storage (Designed for 99.99% Durability)		Data Transfer*		Requests	
Tier	Pricing	Tier	Pricing	Tier	Pricing	Type	Pricing
First 50 TB / Month of Storage Used	\$0.150 per GB	First 50 TB / Month of Storage Used	\$0.100 per GB	All Data Transfer In	Free until June 30th, 2010**	PUT, COPY, POST, or LIST	\$0.01 per 1,000 Requests
Next 50 TB / Month of Storage Used	\$0.140 per GB	Next 50 TB / Month of Storage Used	\$0.093 per GB	First 1 GB / month data transfer out	\$0.000 per GB	GET and All Other Requests***	\$0.01 per 10,000 Requests
Next 400 TB / Month of Storage Used	\$0.130 per GB	Next 400 TB / Month of Storage Used	\$0.087 per GB	Up to 10 TB / month data transfer out	\$0.150 per GB		
Next 500 TB / Month of Storage Used	\$0.105 per GB	Next 500 TB / Month of Storage Used	\$0.070 per GB	Next 40 TB / month data transfer out	\$0.110 per GB		
Next 4000 TB / Month of Storage Used	\$0.080 per GB	Next 4000 TB / Month of Storage Used	\$0.053 per GB	Next 100 TB / month data transfer out	\$0.090 per GB		
Storage Used / Month Over 5000 TB	\$0.055 per GB	Storage Used / Month Over 5000 TB	\$0.037 per GB	Greater than 150 TB / month data transfer out	\$0.080 per GB		

Setting up.

2) Firefox



Setting up. Get Security Credentials



Sign in to the AWS Management Console | Create an AWS Account | English

- AWS
- Products
- Developers
- Community
- Support
- Account**

- Account
- Account Activity
- Usage Reports
- Security Credentials**
- Personal Information
- Payment Method
- Consolidated Billing
- AWS Management Console
- DevPay

Security Credentials

Welcome, Alex | Sign Out

Account Number 51

Access to applications and services within AWS cloud is secure and protected in multiple ways. Accessing those applications and services requires the use of special credentials that are associated with your account. There are three types of credentials currently offered by AWS. If you know which security credentials you need, simply select one of the links below:

- ↓ **Access Credentials:** Your Access Keys, X.509 Certificates, and Key Pairs
- ↓ **Sign-In Credentials:** Your E-mail Address, Password, and AWS Multi-Factor Authentication Device
- ↓ **Account Identifiers:** Your AWS Account ID and Canonical User ID

If you are not sure which security credentials you should use, the link below will help you identify the credentials you need for the task you want to accomplish:

[Find out which AWS Security Credentials you need](#)

Access Credentials

There are three types of access credentials used to authenticate your requests to AWS services: (a) access keys, (b) X.509 certificates, and (c) key pairs. Each access credential type is explained below.

Access Keys | X.509 Certificates | Key Pairs

Use access keys to make secure REST or Query protocol requests to any AWS service API. We create one for you when your account is created — see your access key below.

Your Access Keys

Created	Access Key ID	Secret Access Key	Status
August 24, 2009	AKIAI44QH8D8EXAMPLE	Show	Active (Make Inactive)

[Create a new Access Key](#)

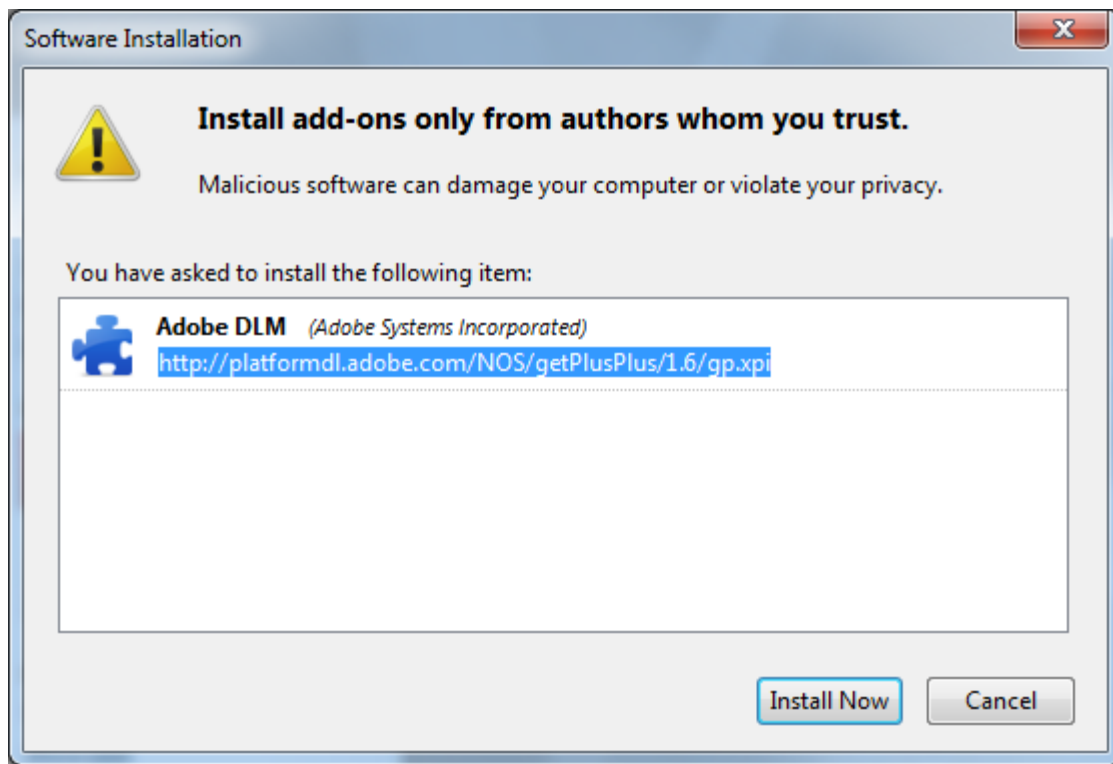
Keep credentials:

Account Number 517 [redacted] 3

Access Key ID: A [redacted] Q

Secret Access Key: ISlu7O [redacted] 4p

Canonical User Id: cd25 [redacted] abb|



Security Credentials

Welcome, Alex [redacted]ski | [Sign Out](#)
Account Number [redacted]

Access to applications and services within AWS cloud is secure and protected in multiple ways. Accessing those applications and services requires the use of special credentials that are associated with your account. There are three types of credentials currently offered by AWS. If you know which security credentials you need, simply select one of the links below:

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- ↓ [Sign-In Credentials](#): Your E-mail Address, Password, and AWS Multi-Factor Authentication Device
- ↓ [Account Identifiers](#): Your AWS Account ID and Canonical User ID

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Access Credentials

There are three types of access credentials used to authenticate your requests to AWS services: (a) access keys, (b) X.509 certificates, and (c) key pairs. Each access credential type is explained below.

[Access Keys](#) |
 [X.509 Certificates](#) |
 [Key Pairs](#)

Use X.509 certificates to make secure SOAP protocol requests to AWS service APIs.

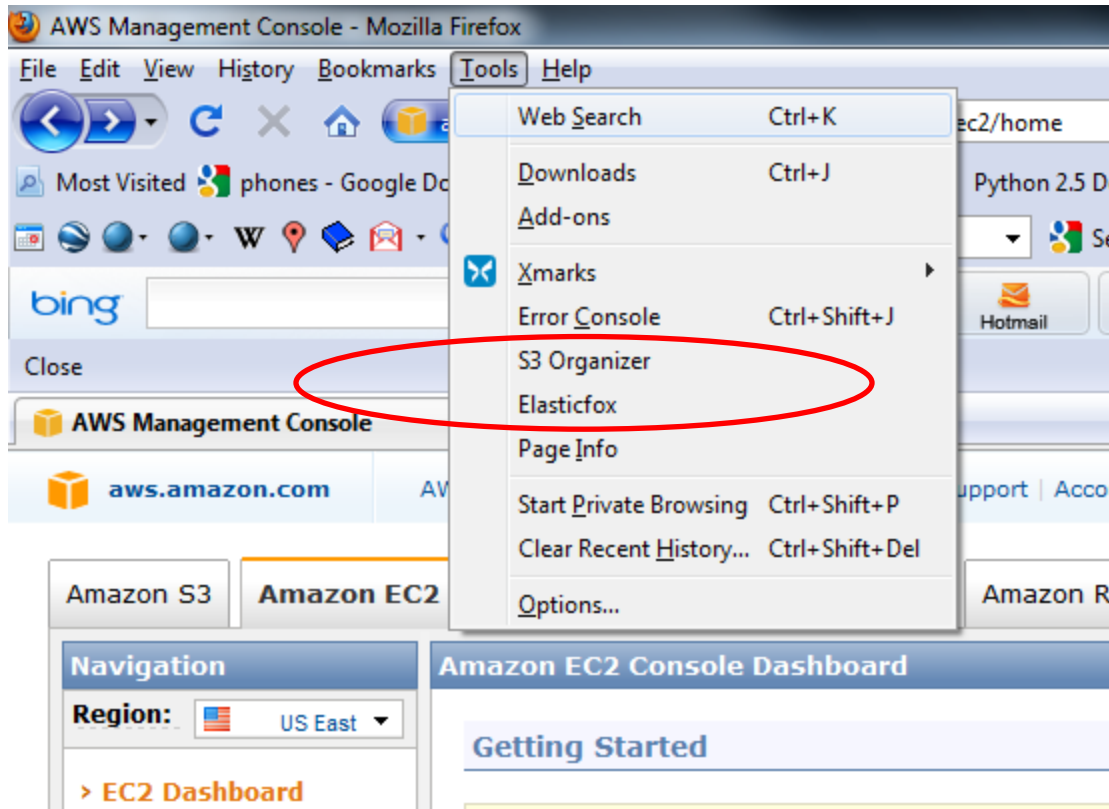
Exceptions: Amazon S3 and Amazon Mechanical Turk instead require your [Access Keys](#) for SOAP requests.

Created	X.509 Certificate	Status
August 24, 2009	cert-UK [redacted]JJ.pem (Download)	Active (Make Inactive)

[Create a new Certificate](#) |
 [Upload Your Own Certificate](#)

Setting up.

3) Firefox Plugins



Set security group (in AWS Mgm.Cons)

The screenshot displays the AWS Management Console interface. The browser tab is labeled "AWS Management Console". The navigation pane on the left shows "Amazon EC2" selected. The main content area shows the "Security Groups" page for the "US East" region. A table lists three security groups: "zgroup" (description: "az group ssh,rdp"), "webserver" (description: "undefined"), and "default" (description: "default group"). The "default" group is selected. Below the table, the "Allowed Connections" for the selected group are shown in a table:

Connection Method	Protocol	From Port	To Port	Source (IP or group)	Actions
All	icmp	-1	-1	default group	Remove
All	tcp	0	65535	default group	Remove
All	udp	0	65535	default group	Remove
SSH	tcp	22	22	67.171.52.10/32	Remove
HTTP	tcp	80	80	67.171.52.10/32	Remove

Set security group (In Elasticfox FF plugin)

The screenshot shows the Elasticfox AWS Management Console interface. The browser tabs include 'Inbox (11048) - alex.z...', 'AWS Management C...', 'Amazon Web Services', 'S3Fox Organizer', and 'Elasticfox'. The 'Elasticfox' tab is highlighted with a red box. The navigation bar shows 'Regions', 'Credentials' (alexzotol), 'Account IDs', and 'Tools'. The main navigation tabs include 'Instances', 'Images', 'Key Pairs', 'Security Groups', 'Elastic IP', 'Volumes and Snapshots', 'Bundle Tasks', 'Reserved Instances', 'Virtual Private Clouds', 'VPN Connections', and 'Availability Z'. The 'Security Groups' tab is highlighted with a red box.

Under 'Your Groups', there is a table with the following data:

Owner	Name	Description
51	default	default group
51	webserver	undefined
51	zgroup	az group ssh,rdp

Under 'Group Permissions', there is a table with the following data:

Protocol	From Port/ICMP Type	To Port/ICMP Code	Source User:Group	Source CIDR
icmp	-1	-1	517	
tcp	0	65535	517	
udp	0	65535	517	
tcp	22	22		67.171.52.10/32
tcp	80	80		67.171.52.10/32

Choose AMI - Launch Instance (in AWS Mgm.Cons)

The screenshot shows the AWS Management Console interface. The browser tab is labeled "AWS Management Console". The navigation pane on the left shows "Amazon EC2" and "AMIs" circled in red. The main content area displays "Amazon Machine Images" with a table of AMIs. The "Viewing" dropdown is set to "Public Images", and the "Launch Instance" context menu is open over the "ami-b7ca2ade" AMI.

AMI ID	Source
<input checked="" type="checkbox"/> ami-b7ca2ade	alexz

- Launch Instance
- Request Spot Instance
- Edit Permissions
- De-register AMI

Choose AMI - Launch Instance (In Elasticfox FF plugin)

The screenshot shows the AWS Management Console interface with the Elasticfox plugin active. The 'Elasticfox' tab is highlighted in a red box. The 'Images' tab is also highlighted in a red box. The search filter 'alexz' is entered in the search bar and highlighted in a red box. A table of AMIs is displayed, with the first row selected. A context menu is open over the first row, and the 'Launch instance(s) of this AMI' option is highlighted in a red box.

ID	Manifest	State	Owner	Visibility	Architecture	Platform	Root Device
ami-b7ca...	alexzolot/az_img.manifest.xml	available	5...	public	i386	Linux	...
ami-288c...	alexzolot/az_img.manifest.xml	available	5...	private	i386	Linux	...

Choose AMI - Launch Instance (in AWS Mgm.Cons)

The screenshot shows the AWS Management Console interface. The browser tabs include 'AWS Management Console', 'S3Fox Organizer', and 'Elasticfox'. The main navigation pane on the left shows 'Amazon EC2' selected, with 'Launch' and 'Spot Request' buttons highlighted. The 'AMI ID' dropdown is set to 'ami-b7ca2ade'. The 'Request Instances Wizard' is open, showing the 'CHOOSE AN AMI' step. The 'Choose from your existing Key Pairs' option is selected, and the dropdown menu shows 'az613' as the chosen key pair.

Choose AMI - Launch Instance (in AWS Mgm.Cons)

The screenshot shows the AWS Management Console interface. The browser tabs include 'AWS Management Console', 'S3Fox Organizer', and 'Elasticfox'. The URL bar shows 'aws.amazon.com'. The navigation menu includes 'Amazon S3', 'Amazon EC2', 'Amazon Elastic MapReduce', 'Amazon CloudFront', and 'Amazon RDS'. The 'Amazon EC2' tab is selected. The 'My Instances' section is visible, showing a table of instances. The table has columns for Instance, AMI ID, Root Device Type, Type, and Status. One instance is listed with ID 'i-af8947c5', AMI ID 'ami-b7ca2ade', Root Device Type 'instance-store', Type 'm1.small', and Status 'pending'. The 'pending' status is highlighted with a red box. The 'Instances' link in the navigation menu is also highlighted with a red box.

Instance	AMI ID	Root Device Type	Type	Status
i-af8947c5	ami-b7ca2ade	instance-store	m1.small	pending

Choose AMI - Launch Instance (in AWS Mgm.Cons)

The screenshot shows the AWS Management Console interface. The browser tabs include 'AWS Management Console', 'S3Fox Organizer', and 'Elasticfox'. The URL is 'aws.amazon.com'. The navigation menu is open, showing 'Amazon EC2' selected. The 'My Instances' section is visible, showing a table of instances. The 'Instances' link in the navigation menu is highlighted. The table shows one instance with a 'pending' status, which is also highlighted.

Instance	AMI ID	Root Device Type	Type	Status
i-af8947c5	ami-b7ca2ade	instance-store	m1.small	pending

Choose AMI - Launch Instance (in AWS Mgm.Cons) wait/refresh till Status= "running", then connect

The screenshot shows the AWS Management Console interface. At the top, the browser tabs include 'AWS Management Console', 'S3Fox Organizer', and 'Elasticfox'. The console header shows 'aws.amazon.com' and navigation links for 'AWS', 'Products', 'Developers', 'Community', 'Support', and 'Account'. The main navigation pane on the left includes 'Amazon S3', 'Amazon EC2' (highlighted with a red box), 'Amazon Elastic MapReduce', 'Amazon CloudFront', and 'Amazon RDS'. The 'My Instances' section is active, showing a table of instances. The table has columns for Instance, AMI ID, Root Device Type, Type, Status, Lifecycle, Public DNS, Security Groups, and Key Pair Name. One instance is listed with AMI ID 'ami-b7ca2ade', Type 'm1.small', and Status 'running' (highlighted with a red box). A dropdown menu is open for the 'Connect' button (also highlighted with a red box), showing options under 'Instance Management' (Connect, Get System Log, Create Image (EBS AMI), Launch More Like This, Disassociate IP Address), 'Instance Lifecycle' (Terminate, Reboot), and 'CloudWatch Monitoring' (Enable CloudWatch, Disable CloudWatch). The status bar at the bottom indicates '1 EC2 Instance selected'.

Instance	AMI ID	Root Device Type	Type	Status	Lifecycle	Public DNS	Security Groups	Key Pair Name
<input checked="" type="checkbox"/> i-af8947c5	ami-b7ca2ade	instance-store	m1.small	running	normal	ec2-75-101-169-153.compute-	defa	

Choose AMI - Launch Instance (in AWS Mgm.Cons)
wait/refresh till Status= "running", then connect

The screenshot shows the AWS Management Console interface. The browser tab is titled "AWS Management Console". The navigation pane on the left has "Amazon EC2" selected, and "Instances" is highlighted in the sub-menu. The main content area shows "My Instances" with a table of instances. One instance is listed with ID "i-af8947c5", AMI ID "ami-b7ca2ade", and status "running". Below the table, the instance details are shown, including "Public DNS" which is circled in red.

Instance	AMI ID	Root Device Type	Type	Status
<input checked="" type="checkbox"/> i-af8947c5	ami-b7ca2ade	instance-store	m1.small	running

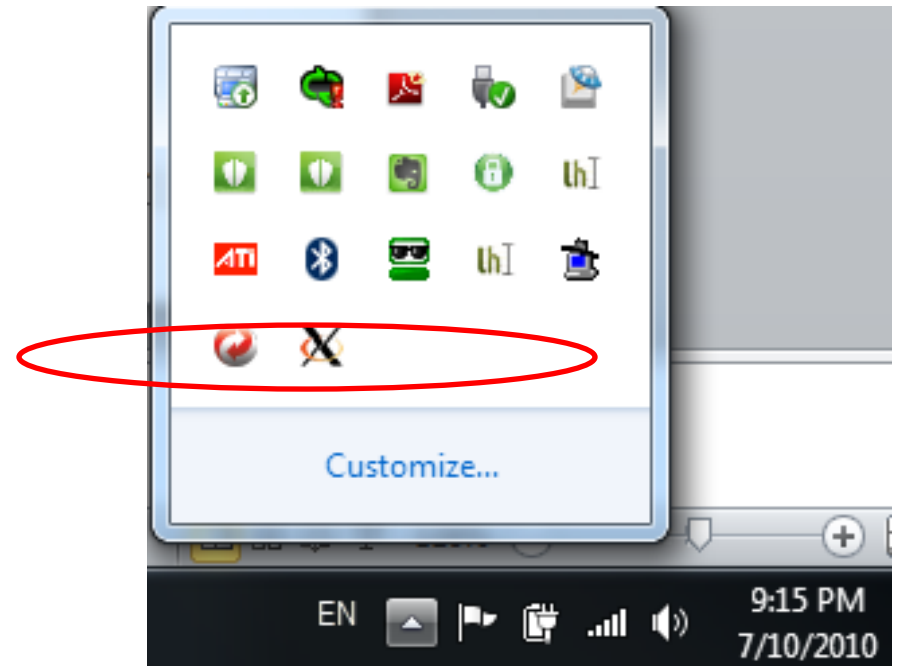
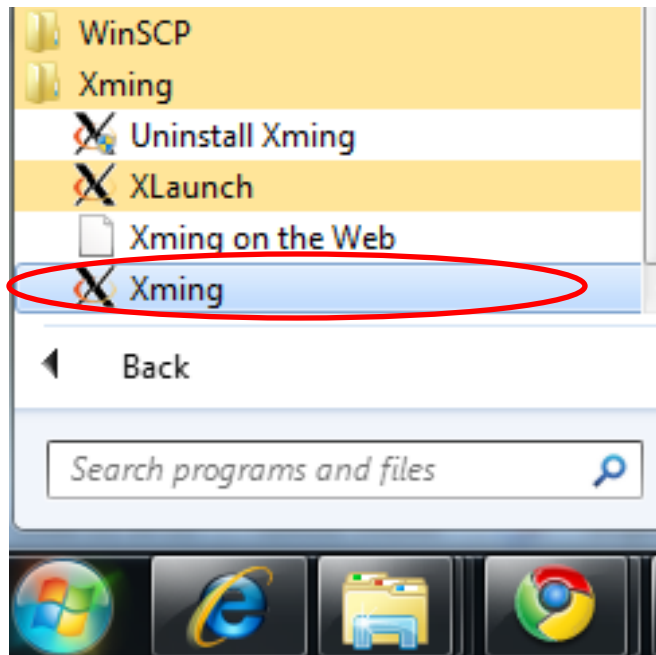
AMI ID:	ami-b7ca2ade
Security Groups:	default
Status:	running
Reservation:	r-ec931d87
Platform:	-
Kernel ID:	aki-a71cf9ce
AMI Launch Index:	0
Root Device:	-
Block Devices:	N/A - Instance Store
Lifecycle:	normal
Public DNS:	ec2-75-101-169-153.compute-1.amazonaws.com

Choose AMI - Launch Instance (in AWS Mgm.Cons)
wait/refresh till Status= “running”, then connect

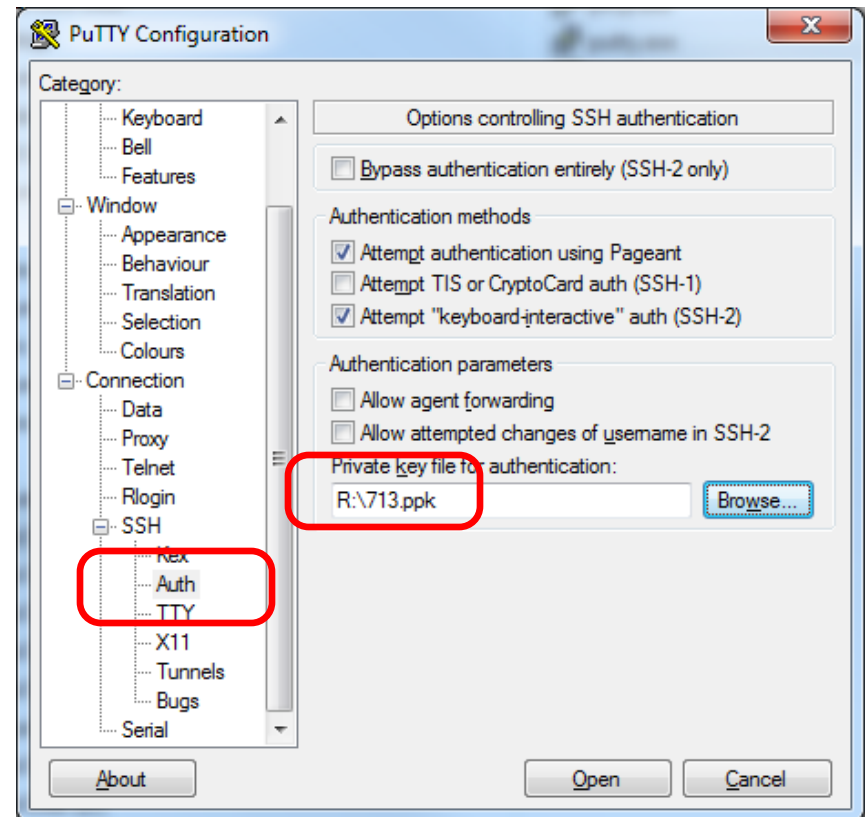
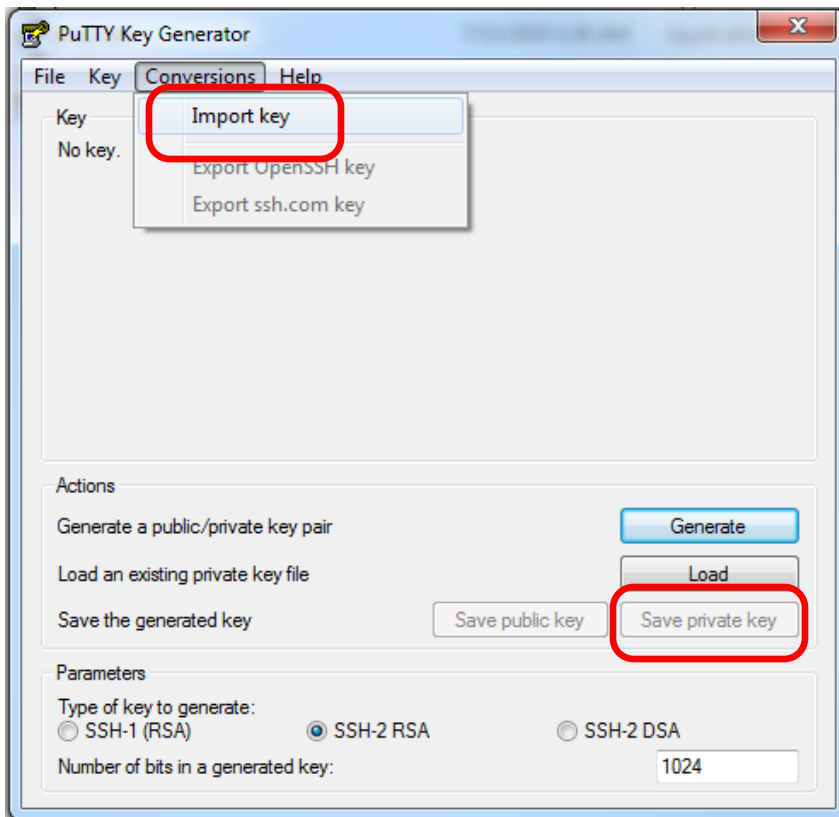
Public DNS: ec2-75-101-169-153.compute-1.amazonaws.com

Setting up.

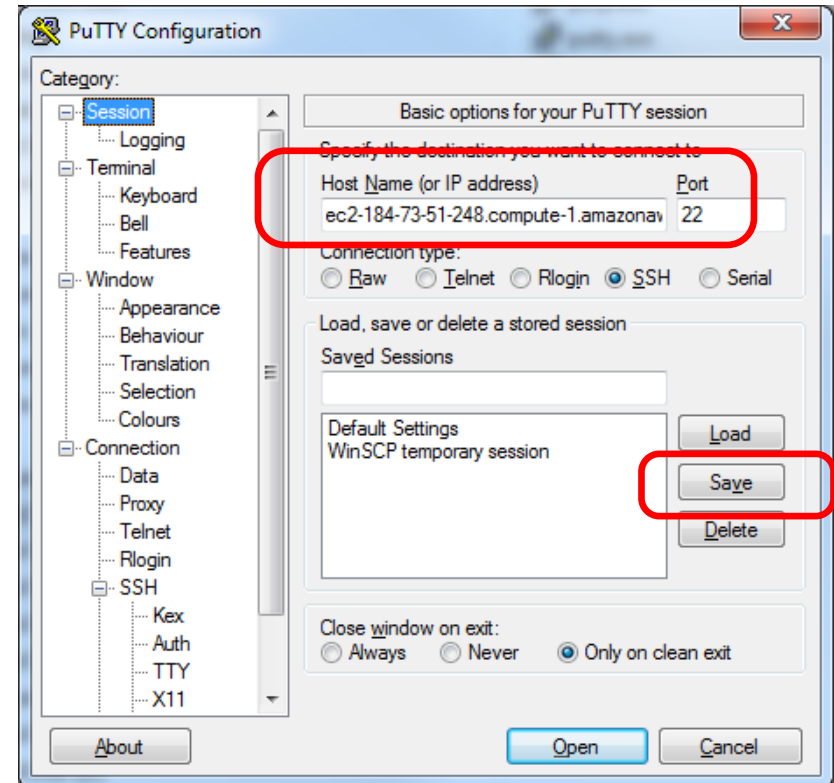
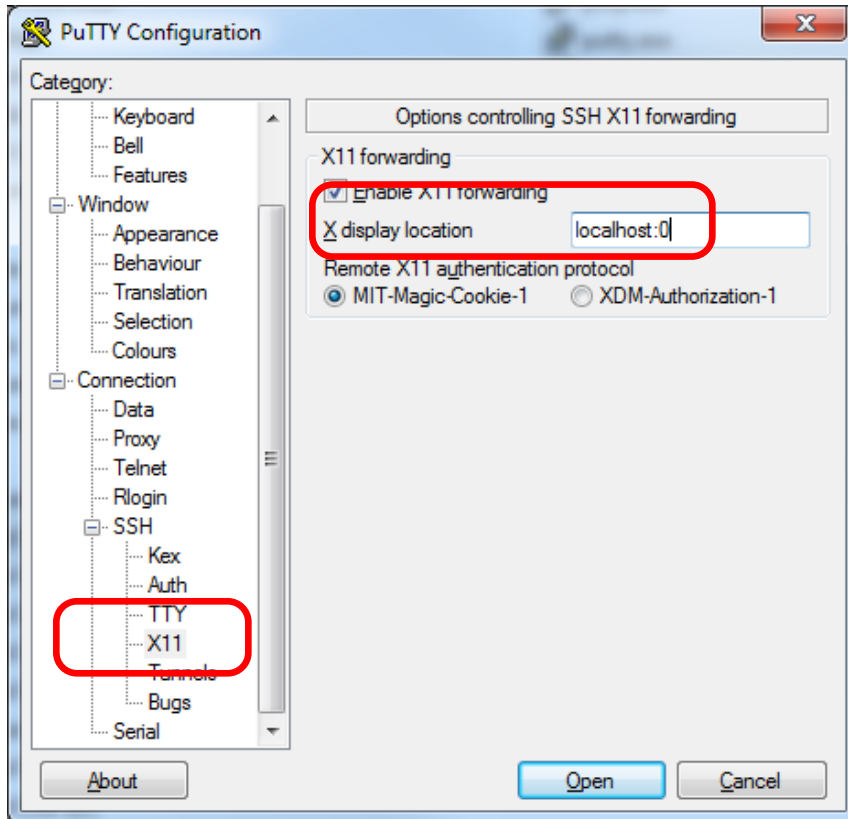
1) Xming



PuTTY 1.Convert .pem -> .ppk



PuTTY 2. Connection



Try R

```
# Example 1. (Xming)
```

```
plot(1:4)
```

```
plot(5:1)
```

```
x11()
```

```
plot(1:3)
```

Try R

WinSCP

Example 2. www – pdf()

```
setwd('/var/www/html')  
pdf('z.pdf')  
plot(1:4)  
plot(5:1)  
plot(1:3)  
dev.off()
```

Try R

WinSCP

Example 3. www – R2HTML()

```
install.packages("R2HTML", repos = "http://cran.stat.ucla.edu/")
library(R2HTML)
fout= HTMLInitFile(outdir = "/var/www/",
                  filename="z",
                  CSSFile="http://www.stat.ucl.ac.be/R2HTML/Pastel.css")
data(iris)
HTML(as.title("Fisher Iris dataset / Correlation 1"),file=fout)
HTML(cor(iris[,1:4]), file=fout)
HTML(as.title("Fisher Iris dataset / Correlation 2"),file=fout)
HTML.cormat(cor(iris[,1:4]), file=fout)
# File is generated, you can call the browser:
## Not run: browseURL(tmpfic)
```


R. Send data files from local PC to EC2 Instance and back.

WinSCP (pscp.exe)

Create your AMI

1. Download tools to the running Instance. Set Envir. Variables.
2. Upload private key and certificate to /mnt/c
3. Create bundle at S3.
4. Register AMI.

- **1. Getting the Command Line Tools**

- The command line tools: <http://s3.amazonaws.com/ec2-downloads/ec2-ami-tools.zip> These tools are written in Java and include shell scripts for both Windows 2000/XP and Linux/Unix/Mac OSX. The ZIP file is self-contained; no installation is required.
- 1b. Set Envir. Variables.
 - C:\> set EC2_HOME=<path-to-tools>
 - S:\51_AWS_cloud\ec2-api-tools-1.3-51254
 - C:\> set PATH=%PATH%;%EC2_HOME%\bin
 -
 - set JAVA_HOME=C:\Windows\System32
 - set EC2_HOME=S:\51_AWS_cloud\ec2-api-tools-1.3-51254
 - set PATH=%PATH%;%EC2_HOME%\bin
 -
 - C:\> set EC2_PRIVATE_KEY=c:\ec2\pk-HKZYKTAIG2ECMXYIBH3HXV4ZBZQ55CLO.pem
 - C:\>

To take a snap shot of the running server. While still on the server run the following command:
ec2-bundle-vol -d /mnt -k /mnt/pk-STRINGOFTHIRTYTWOLETTERSORDIGIT

Installation R using AMI w/o R.


1. Run Instance from AMI w/o R.
2. Install R from CRAN following instructions. – binary or from source

E.g. take debian xxx - see R-file

From source:

Win AMI

1 Security Group selected

 **Group Name:** webservers

Description: undefined

Allowed Connections:

Connection Method	Protocol	From Port ▲	To Port
SSH	tcp	22	22
SSH	tcp	22	22
RDP	tcp	3389	3389
HTTP	tcp	80	80

Win AMI

The image shows a Remote Desktop Connection window titled "Remote Desktop Connection" with the following details:

- Computer: 174-129-179-214.compute-1.amazonaws.com
- User name: IP-0AF85B66\Administrator
- Options: [v]
- Connect button

The desktop environment includes the following icons:

- Mozilla Firefox
- Google Chrome
- Opera
- Notepad++
- HeadTrax
- Cygwin
- R x64 2.11.1
- Microsoft Office Com...
- Microsoft IT VPN - Sho...
- NetBeans IDE 6.9

The R GUI window is titled "RGui" and displays the following content:

R Console:

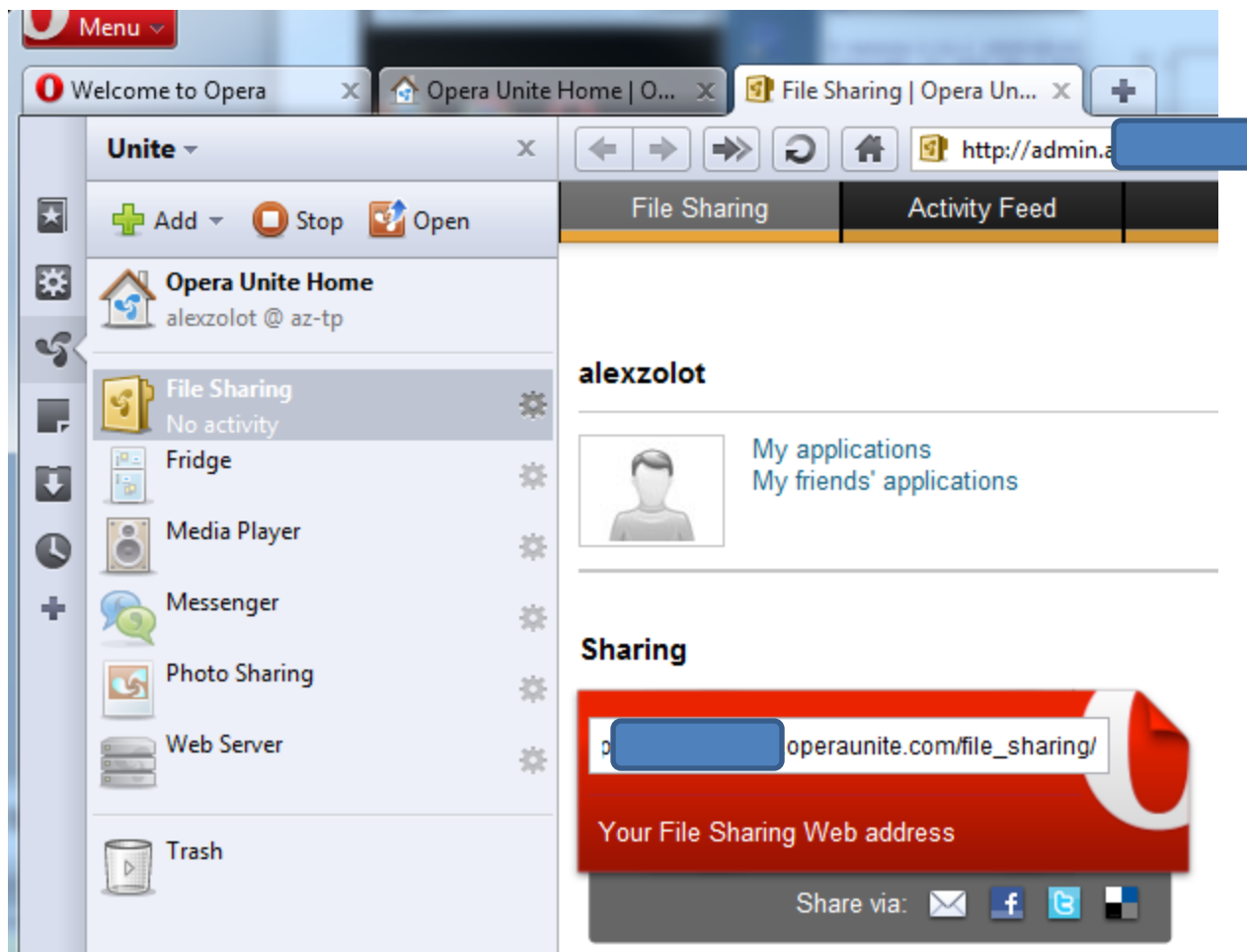
```
R version 2.11.1 (2010-05-31);  
Copyright (C) 2010 The R Founda...  
ISBN 3-900051-07-0  
  
R is free software and comes with...  
You are welcome to redistribute it...  
Type 'license()' or 'licence()' for...  
  
Natural language support by...  
  
R is a collaborative project with...  
Type 'contributors()' for more...  
'citation()' on how to cite R...  
  
Type 'demo()' for some demos.  ...  
'help.start()' for an HTML...  
Type 'q()' to quit R.  
  
> plot(sin,-9,9)  
> |
```

R Graphics: Device 2 (ACTIVE)

The plot shows a sine wave with the following characteristics:

- Y-axis: sin(x), ranging from -1.0 to 1.0.
- X-axis: x, ranging from -9 to 9.
- Labels: -5, 0 on the x-axis.

Win AMI. WinSCP -> Opera Unite



References

Work with R on Amazon's Cloud. <http://user2010.org/tutorials/Zolot.html>

1. Robert Grossman, Running R on Amazon's EC2 <http://rgrossman.com/2009/05/17/running-r-on-amazons-ec2>
2. Amazon Web Services (AWS) www.aws.amazon.com.
3. A quick overview of PuTTY and SSH for AWS Newbies <http://clouddb.info/2009/05/17/a-quick-overview-of-putty-and-ssh-for-aws-newbies>
4. Using Xming for X11 applications on an EC2 machine <http://www.full360.com/content/using-xming-x11-applications-ec2-machine>
5. Command Line Tools [Amazon EC2 Resource Center](http://aws.amazon.com/ec2/using-command-line-tools/)
6. [Deploying a Web Server on Amazon EC2](http://www.ondemandbeat.com/2009/04/30/deploying-a-web-server-on-amazon-ec2/) www.ondemandbeat.com/2009/04/30/deploying-a-web-server-on-amazon-ec2/
7. [SAVING A CUSTOMISED LINUX AMAZON INSTANCE \(EC2 AND S3\)](http://robrohan.com/2009/01/30/saving-a-customised-linux-amazon-instance-ec2-and-s3/) <http://robrohan.com/2009/01/30/saving-a-customised-linux-amazon-instance-ec2-and-s3/>
8. How to Run Windows & IIS in the Cloud on Amazon EC2 (in 15 mins) <http://blogs.iis.net/bills/archive/2009/01/13/how-to-run-windows-amp-iis-in-the-cloud-on-amazon-ec2-in-15-mins.aspx>
9. www.robertsosinski.com/2008/01/26/starting-amazon-ec2-with-mac-os-x