

Distributed Computing, Grids and Clouds

Julian Bunn, 2015

# INTRODUCTION TO CLOUD COMPUTING

# Distributed Computing

- ⦿ Run an application on one or more computers connected in a network
- ⦿ Computers are autonomous and possibly heterogeneous
- ⦿ Target problem is subdivided into separate tasks
- ⦿ Computers communicate via messages
- ⦿ cf Parallel Computing (tightly coupled Distributed Computing)

# Grid Computing

- ⦿ “Distributed Computing with Authentication” – certificates etc.
- ⦿ Supported by e.g. Globus “toolkit”
- ⦿ No central control
- ⦿ “Virtual Organizations”
- ⦿ Typically used in research and academic communities
- ⦿ A bit long in the tooth and hard to use

# Cloud Computing

- ⦿ “Cloud” is a metaphor for the network
- ⦿ Physical Infrastructure abstracted away
- ⦿ Resources accessed as “Services”
- ⦿ Resources are shared transparently – “Virtualised”
- ⦿ Inherently scalable
- ⦿ Guarantees of service
- ⦿ Mainly commercial (Amazon, Google ...) and Pay As You Go
- ⦿ Simple to use

# Cloud Services

- “Software as a Service” (SaaS) e.g. Gmail, Google Apps (**App = Application**)
- “Platform as a Service” (PaaS) e.g. Google App Engine, MS SQL Services
- “Infrastructure as a Service” (IaaS) e.g. Amazon EC2
  
- **SaaS** – user just uses the service
- **PaaS** – service appears as potentially infinitely large computer running unknown OS
- **IaaS** – Service hardware abstracted away

# 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 [cloud computing](#) easier for developers.”

You can try Amazon EC2 for free (750 hours of “t2.micro” instances per month for a year).

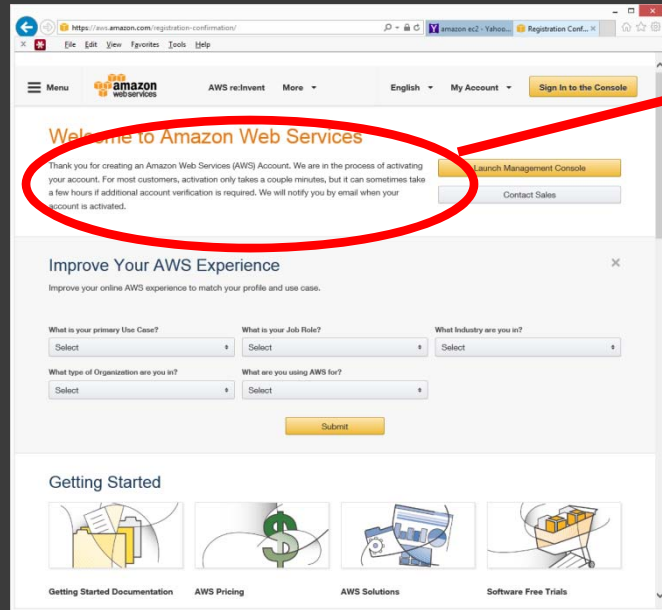
# SETTING UP FOR EC2

## ⦿ Create an account

- Go to <http://aws.amazon.com/ec2/>
- Click “Try AWS for Free”
- Create a new user using your email address
- You will need to enter a credit card number (I used a gift card with a few \$ on it)
- Amazon will call your ‘phone and ask you to enter the on-screen PIN
- Sign up for the basic free support plan

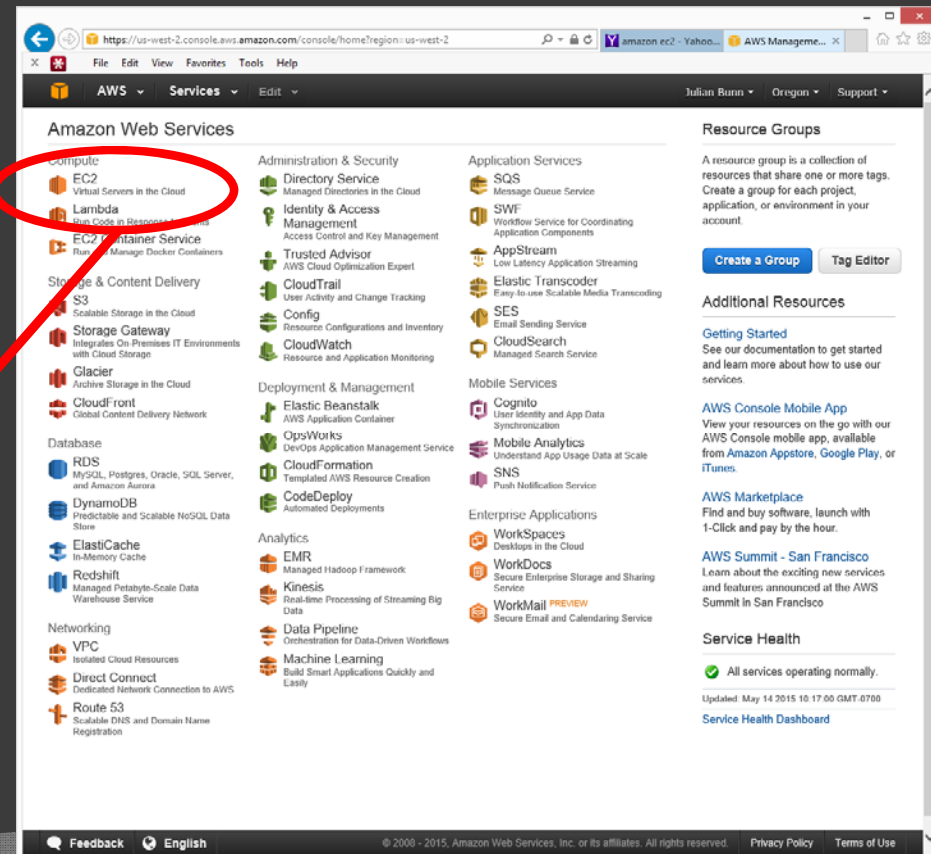


# Use the Management Console



(There is sometimes a delay before you can use the Management Console.)

Select the "EC2" service





# Launch an EC2 Instance

The screenshot displays the AWS Management Console interface for the US West (Oregon) region. The left-hand navigation pane lists various services, with 'INSTANCES' expanded. The 'Launch Instance' button is highlighted with a red circle. The main content area shows the 'Resources' section, indicating that the user is using Amazon EC2 resources in the US West (Oregon) region. It lists 0 Running Instances, 0 Elastic IPs, 0 Volumes, 0 Snapshots, 0 Key Pairs, 0 Load Balancers, 0 Placement Groups, and 1 Security Groups. Below this, the 'Create Instance' section provides instructions on how to start using Amazon EC2 and includes a 'Launch Instance' button. The 'Service Health' section shows that the US West (Oregon) service is operating normally across all availability zones. The right-hand sidebar contains 'Account Attributes', 'Additional Information', and 'AWS Marketplace' sections.

**Resources**

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

- 0 Running Instances
- 0 Elastic IPs
- 0 Volumes
- 0 Snapshots
- 0 Key Pairs
- 0 Load Balancers
- 0 Placement Groups
- 1 Security Groups

**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: Availability zone is operating normally
- us-west-2c: Availability zone is operating normally

[Service Health Dashboard](#)

**Scheduled Events**

**US West (Oregon):**

- No events

**Account Attributes**

**Supported Platforms**

- VPC
- Default VPC
- vpc-a560e2c0

**Additional Information**

- [Getting Started Guide](#)
- [Documentation](#)
- [All EC2 Resources](#)
- [Forums](#)
- [Pricing](#)
- [Contact Us](#)

**AWS Marketplace**

Find **free software trial** products in the AWS Marketplace from the [EC2 Launch Wizard](#).

Or try these popular AMIs:

- [Vyatta Virtual Router/Firewall/VPN](#)
- Provided by Vyatta, Inc.
- Rating ★★★★★
- Pay by the hour for software and AWS usage
- [View all Networking](#)
- [Alert Logic Threat Manager for AWS](#)
- Provided by Alert Logic, Inc.
- Rating ★★★★★
- Pay by the hour for software and AWS usage
- [View all Security Software](#)
- [TIBCO Spotfire Analytics Platform \(Hourly\)](#)
- Provided by TIBCO Software, Inc.
- Rating ★★★★★
- Pay by the hour for software and AWS usage

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# Choose the Machine Image type

Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

**Quick Start**

- My AMIs
- AWS Marketplace
- Community AMIs
- ☒ Free tier only ⓘ

**Amazon Linux AMI 2015.03 (HVM), SSD Volume Type - ami-e7527ed7**

The Amazon Linux AMI is an EBS-backed, AWS-supported image. The default image includes AWS command line tools, Python, Ruby, Perl, and Java. The repositories include Docker, PHP, MySQL, PostgreSQL, and other packages.

64-bit

**Red Hat Enterprise Linux 7.1 (HVM), SSD Volume Type - ami-4dbf9e7d**

Red Hat Enterprise Linux version 7.1 (HVM), EBS General Purpose (SSD) Volume Type

64-bit

**SUSE Linux Enterprise Server 12 (HVM), SSD Volume Type - ami-d7450be7**

SUSE Linux Enterprise Server 12 (HVM), EBS General Purpose (SSD) Volume Type. Public Cloud, Advanced Systems Management, Web and Scripting, and Legacy modules enabled.

**Ubuntu Server 14.04 LTS (HVM), SSD Volume Type - ami-5189a661**

Ubuntu Server 14.04 LTS (HVM), EBS General Purpose (SSD) Volume Type. Support available from Canonical (<http://www.ubuntu.com/cloud/services>).

**Microsoft Windows Server 2012 R2 Base - ami-8fd3f9bf**

Microsoft Windows 2012 R2 Standard edition with 64-bit architecture. [English]

**Are you launching a database instance? Try Amazon RDS.**

Amazon Relational Database Service (RDS) makes it easy to set up, operate, and scale a relational database of your choice (MySQL, PostgreSQL, Oracle, SQL Server) in the cloud. It provides cost-efficient and resizable capacity while managing time-consuming database management tasks, freeing you up to focus on your applications and business. [Learn more.](#)

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# Choose the Instance type

t2.micro

Step 2: Choose an Instance Type

Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instances are virtual servers that can run applications. They have varying combinations of CPU, memory, storage, and networking capacity, and give you the flexibility to choose the appropriate mix of resources for your applications. [Learn more](#) about instance types and how they can meet your computing needs.

Filter by: All instance types Current generation [Show/Hide Columns](#)

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

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
<input checked="" type="checkbox"/>	General purpose	t2.micro Free tier eligible	1	1	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.small	1	2	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.medium	2	4	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	m3.medium	1	3.75	1 x 4 (SSD)	-	Moderate
<input type="checkbox"/>	General purpose	m3.large	2	7.5	1 x 32 (SSD)	-	Moderate
<input type="checkbox"/>	General purpose	m3.xlarge	4	15	2 x 40 (SSD)	Yes	High
<input type="checkbox"/>	General purpose	m3.2xlarge	8	30	2 x 80 (SSD)	Yes	High
<input type="checkbox"/>	Compute optimized	c4.large	2	3.75	EBS only	Yes	Moderate
<input type="checkbox"/>	Compute optimized	c4.xlarge	4	7.5	EBS only	Yes	High
<input type="checkbox"/>	Compute optimized	c4.2xlarge	8	15	EBS only	Yes	High
<input type="checkbox"/>	Compute optimized	c4.4xlarge	16	30	EBS only	Yes	High
<input type="checkbox"/>	Compute optimized	c4.8xlarge	36	60	EBS only	Yes	High

[Cancel](#) [Previous](#) [Review and Launch](#) [Next: Configure Instance Details](#)

# Launch the Instance

[https://us-west-2.console.aws.amazon.com/ec2/v2/home?region=us-west-2#LaunchInstanceWizard:](#)

File Edit View Favorites Tools Help

AWS Services Edit

Julian Bunn Oregon Support

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

## Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

**⚠ Improve your instances' security. Your security group, launch-wizard-1, is open to the world.**

Your instances may be accessible from any IP address. We recommend that you update your security group rules to allow access from known IP addresses only. You can also open additional ports in your security group to facilitate access to the application or service you're running, e.g., HTTP (80) for web servers. [Edit security groups](#)

▶ AMI Details [Edit AMI](#)

▼ Instance Type [Edit instance type](#)

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
t2.micro	Variable	1	1	EBS only	-	Low to Moderate

▼ Security Groups [Edit security groups](#)

Security group name: launch-wizard-1  
Description: launch-wizard-1 created 2015-05-14T10:35:22.904-07:00

Type ⓘ	Protocol ⓘ	Port Range ⓘ	Source ⓘ
SSH	TCP	22	0.0.0.0/0

▶ Instance Details [Edit instance details](#)

▶ Storage [Edit storage](#)

▶ Tags [Edit tags](#)

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

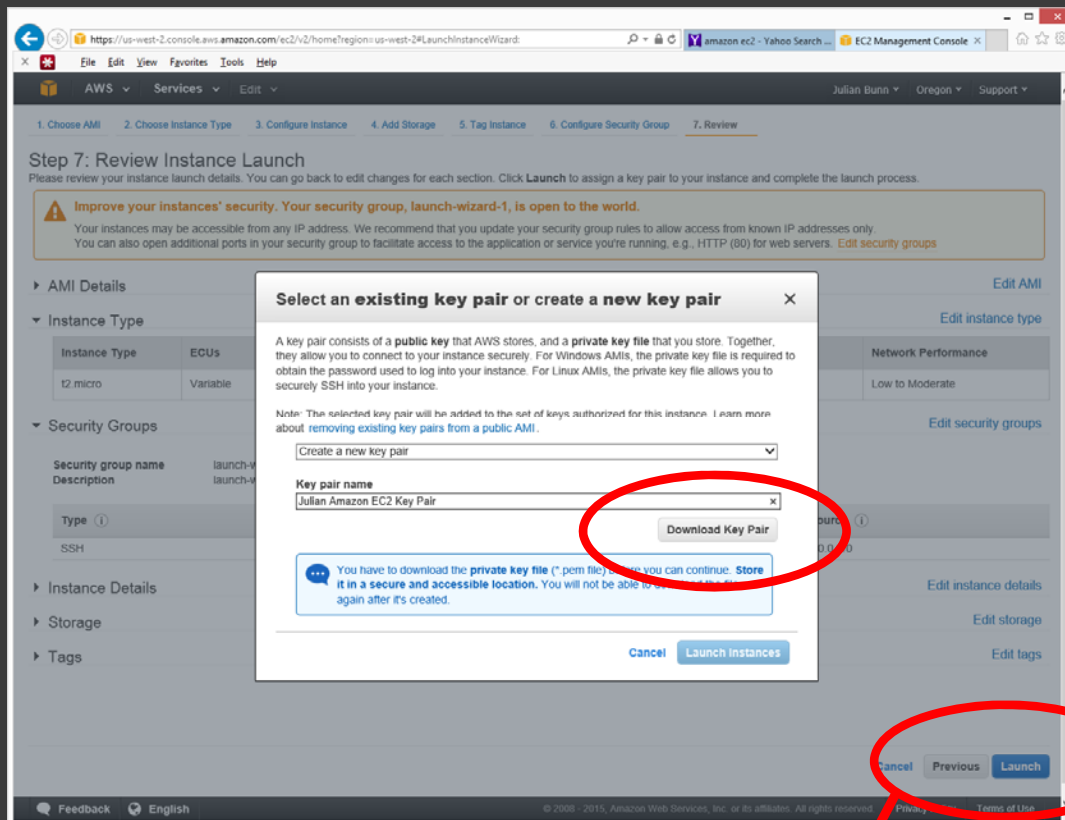
Feedback English

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# Create a Key Pair for access

You save the Key/Pair file (.pem) on your local machine.

It's a text file:



Once you have the Key Pair downloaded, launch your Instance

```
-----BEGIN RSA PRIVATE KEY-----
MIIEpAIBAAKCAQEA7tMKYNXAdjwFtultbRszAzXAFy6Hfk41nrcN0ZUXFDmoqkdsOZbJB0Rb
bm/qroEWS2LLGCMfEfnDNBplqIMJZ9EUQJ75XoMTYJoXykQZWZxNV6pdGxrULgdnUCbtCFdajgm/
gGuINchj/Mdu450YdgPnWMKSC9+bBMFMIX11mPWVvuGx+thH8jV90c2510WniCzNGafwzhtSX2uF
oaUJUZd3/VEKjZ6AnuQJ0TcSR6xGHdpxtbfomdeqoKwnAYr4Nn2H94JZUgNj+z2dy9onZusgKW
esQMMyMyW2ND+FiPI6bqO9VyaAHzuqgTORHdJeNbL/G93PFyHs6Zx4QIDAQABAOBADm9cL8odNGf
MiJNT+rgLhBxZL05H7g4kOHMirk37bJPZcUURxnh21pFk3PJDQDVyk9AAAdH49pY6JzoQL5hOI84D
uN7aEnX/BHM9mP9K8CLGwMs7XVnTYxig7aRIQvIVDS9Xx4+oQWYZ2SQGu/QazfLjly+FUPnR5kk
ZoezwI8kUYFogTAcS3rsVwqzVSVtfwgUJzeGnSKqAL+sVPSrZ2Xl/CKZhsHbvy/eGdYUybnclde
XMD1BLHymP/os9Xcq+RCYhatu3XFHZdvolZz33AjGiVXFuo+0nOMhE4To6iQ8sLF1ZpSk+E2n5V4
qilEqr8ZVbaSzAGCEi0grJ4+Q00CgYEA3FJScgt3RLRk+Bjqlk9Vsy72fPbX7CoaJOqG5HaY+kC
LHdfPsAOVXPrzChsIEaYKsmw/pfsh35h6UmE8JNBOD31i0FYnjG2RceA719smYGDJZC1w0EcQC
2AEByDyZsaDutRsjnKmAiyHc9fk5q44HUmXYOzDsCA19zP9Ne9cGyEax4qf/syTbRYH5MK5r1Dt
TOLclQn2hJIQHryM10p8r87ktVVD/qKRoYIF05iIRom2rq0vrRnPX8BONrYmji0SEt2TFN9Clgh
rUI+XnLWMD7JFLTrTmJeYtr94MwdHnvq68VLSl26STUMrjd9ajYWIHia0Okjhje7I29eBEwcC
gYAEoDXa7YkxatAyNukBArE85CvYQQ0B8lud6x0E/PoXI30ddCpGLastU70lweAUPB
GaADmRQTIIDH2xFarddPF/YU2MdojhHb/HyIBYyJElahWPY2Us8wxS7068wXQVqeD3DEtKI12/O
ikzdDgCn8q84luj0jeQQKBgQCliH8F4FgLSiqMJyt0MqBsTuCPPr5+TzFARdmlzEm8Hfuu
81xj+FRNsg6gZ/zJ0oIB4IYg3K3NN8R63XMefyL2jxGeBMqPExSamN27y4FVaX3ao3C7nQp8Wo
TZOZfjzlQe2gx1pWUwaoRgVTwhzsc4jnRpJomT4/QASFWkBgQDR0CM30mW6BjAHXEZbydTvcCZM
jxYZJIXKp0TniSK0Hqk3QD9iLdouYroG3QxpFv+p1bHaVz/N2xZZYZA9s9sYsv86W00NHIS0Xex
3UZ/wVynpoN58YoPmr2pAKQXqfYdLA4sY2x50iDlaA3aN73gHAcSr/O1ABms3CW5LIQ==
-----END RSA PRIVATE KEY-----
```

# Check Launch and View Instances

**Launch Status**

✓ **Your instances are now launching**  
The following instance launches have been initiated: [i-88b2007f](#) [Hide launch log](#)

Creating security groups	Successful (sg-57bca032)
Authorizing inbound rules	Successful
Initiating launches	Successful
Launch initiation complete	

**Get notified of estimated charges**  
Create billing alerts to get an email notification when estimated charges on your AWS bill exceed an amount you define (for example, if you exceed the free usage tier).

**How to connect to your instances**  
Your instances are launching, and it may take a few minutes until they are in the **running** state, when they will be ready for you to use. Usage hours on your new instances will start immediately and continue to accrue until you stop or terminate your instances.  
Click **View Instances** to monitor your instances' status. Once your instances are in the **running** state, you can **connect** to them from the instances screen. [Find out](#) how to connect to your instances.

▼ **Here are some helpful resources to get you started**

- [How to connect to your Linux instance](#)
- [Learn about AWS Free Usage Tier](#)
- [Amazon EC2: User Guide](#)
- [Amazon EC2: Discussion Forum](#)

While your instances are launching you can also

- [Create status check alarms](#) to be notified when these instances fail status checks. (Additional charges may apply)
- [Create and attach additional EBS volumes](#) (Additional charges may apply)
- [Manage security groups](#)

[View Instances](#)

**Instances**

Launch Instance Connect Actions

Filter by tags and attributes or search by keyword

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS	Public IP	Key Name	Monitoring	Launch Time
	i-88b2007f	t2.micro	us-west-2b	running	2/2 checks...	None	ec2-52-10-130-99.us-w...	52.10.130.99	Julian Amazon...	disabled	May 14, 2015 at 10:45:23 A...



# ssh to your Instance

- Look for the public IP/DNS of your Instance

Status Checks		Monitoring	Tags
Instance ID	i-88b2007f		
Instance state	running		
Instance type	t2.micro		
		Public DNS	ec2-52-10-130-99.us-west-2.compute.amazonaws.com
		Public IP	52.10.130.99
		Elastic IP	-

- From a command prompt on your local machine, ssh to your Instance:

```
C:\Users\Julian>ssh -i JulianAmazonEC2KeyPair.pem ec2-user@52.10.130.99
```

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

```
https://aws.amazon.com/amazon-linux-ami/2015.03-release-notes/  
11 package(s) needed for security, out of 36 available  
Run "sudo yum update" to apply all updates.  
[ec2-user@ip-172-31-27-10 ~]$
```

# Using your Instance - Example

```
[ec2-user@ip-172-31-27-10 ~]$ cat > test.py  
print 'Hello World!'  
[ec2-user@ip-172-31-27-10 ~]$ python test.py  
Hello World!
```

# Google App Engine

- Run your Web Applications on Google's Infrastructure
- **Idea**: upload your Web App, and it's ready to serve users
- App can be written in Java, JavaScript, Ruby, Python
- Persistent storage, automatic scaling and load balancing, authentication
- Task Queues (work outside Web requests)
- Resources used measured in GBytes and CPU Hours

# App Engine Datastore

- Distributed storage with a Query Engine and Transactions
- Unlike traditional relational database
- Objects (“entities”) have kind and properties
- Queries return entities of a kind sorted by values of properties
- No schema

# App Engine Services and Tasks

- ◉ URL Fetch
- ◉ Mail
- ◉ Memcache (in-memory key/value pairs)
- ◉ Image manipulation
- ◉ (Others you create in code)
- ◉ Tasks
  - Cron-like
  - Asynchronous to Web requests

# Alternatives?

- ⦿ “AppScale” – from UC Santa Barbara
- ⦿ Open Source implementation of App Engine
- ⦿ Executes in Eucalyptus (IaaS and compatible with e.g. Amazon EC2)
- ⦿ Could be deployed in a private cloud