Machine Learning , Analytics & Cyber Security the Next Level Threat Analytics

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Who am I – Manjunath N V

- Education
  - B.E. in Computer Science (Bangalore University)
  - Post Graduation in S.O.C (university of Edinburgh, Glasgow)
  - Post Graduation in Digital Network Communication(London Metropolitan university)
- Professional Experience
  - 15+ Years of Consulting and Training experience in Programming, Networking, testing & Security.
  - Hold 20+ Active Professional Certifications in SECURITY
  - Have Trained 3000+ People in Last 8 Years in IT Security
- WARNING – **MAD** about Security (can talk Hours on the Subject)

Topics Covered

- Theoretical Nature of
  - Definitions
  - Importance of these Technologies
  - Where to Find More resources
- Hands On Materials
  - Lab Setup
  - Basic Demonstration
- Guidance to Projects
  - Market Demand for Technologies
  - Project IDEAS

Motivation

- JOBS

  - Live online Openings

Final OUTPUT (DEMO)

- A working Docker IMAGE
  - With Python Library installed
  - Saved as LOCAL DOCKER IMAGE
  - Seems Very simple but need to understand MANY Concepts such as
    - Virtualisation
    - Containers
    - Devops

(WILL SHARE LOT OF self study LAB books for the MOTIVATED)

Definitions

- **Machine Learning (ML)**

Google’s definition - Machine learning is a type of artificial intelligence (AI) that provides computers with the ability to learn without being explicitly programmed. Machine learning focuses on the development of computer programs that can teach themselves to grow and change when exposed to new data.

Definitions (Contd.)

- **Data Analytics**

Data analysis is a process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, suggesting conclusions, and supporting decision-making.

Definitions (Contd.)

- **Cyber Security**

Cybersecurity is the body of technologies, processes and practices designed to protect networks, computers, programs and data from attack, damage or unauthorized access. In a computing context, **security** includes both **cybersecurity**and physical **security**.

Definitions (Finally.)

- **ML + Data Analytics + Cyber Security**

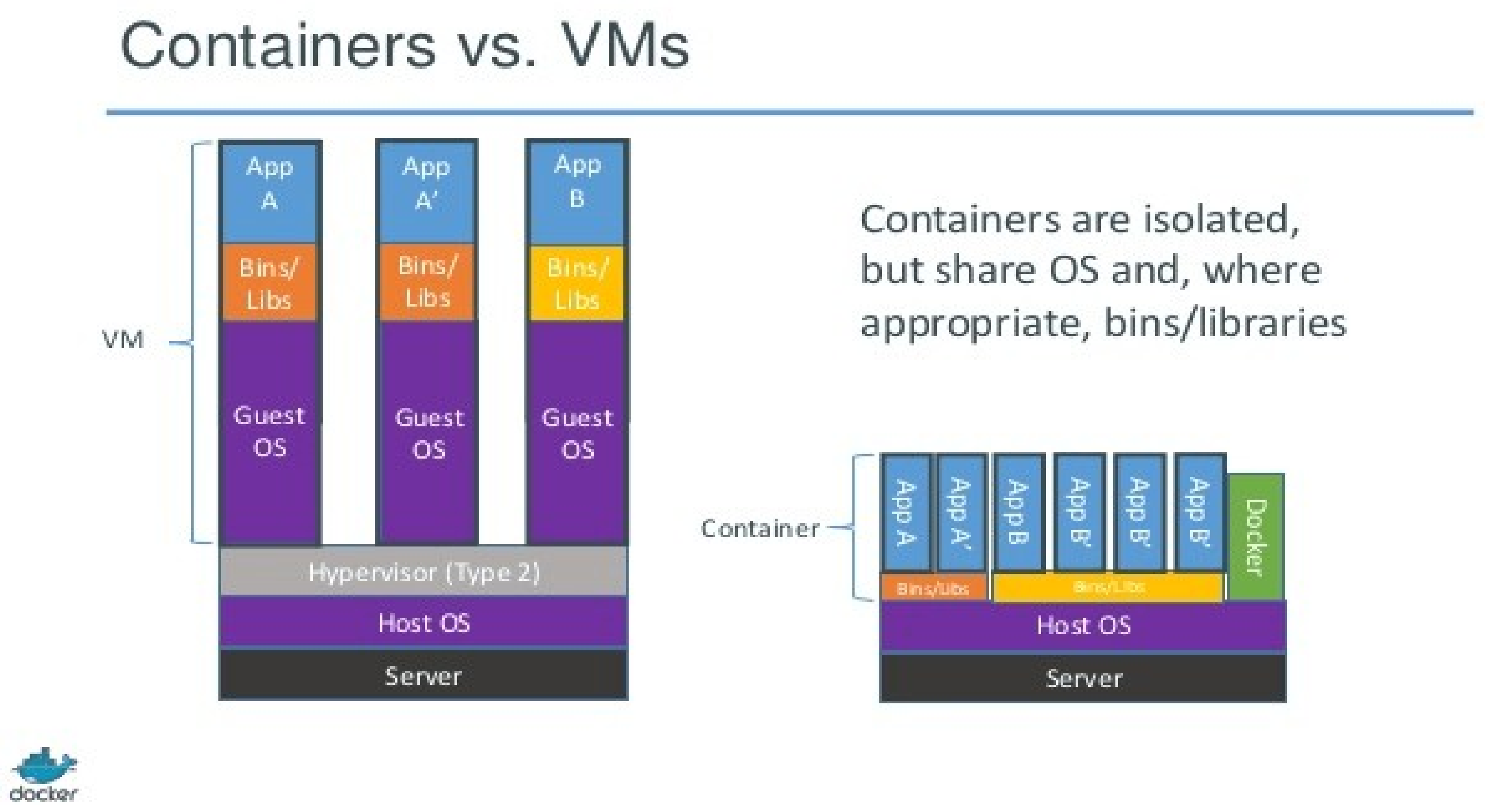
Machine learning has been quickly adopted in cybersecurity for its potential to automate the detection and prevention of attacks, particularly for next-generation antivirus (NGAV) products. ML models in NGAV have fundamental advantages compared to traditional AV, including the higher likelihood of identifying novel, zero-day attacks and targeted malware, an increased difficulty of evasion, and continued efficacy during prolonged offline periods

Implementation Technologies - 1

- Virtualisation
  - Type 1
    - ESXi,KVM

  - Type 2
    - Vmware Workstation,VirtualBOX
- Containers
  - DOCKER
  - LXC
  - KUBERNETES

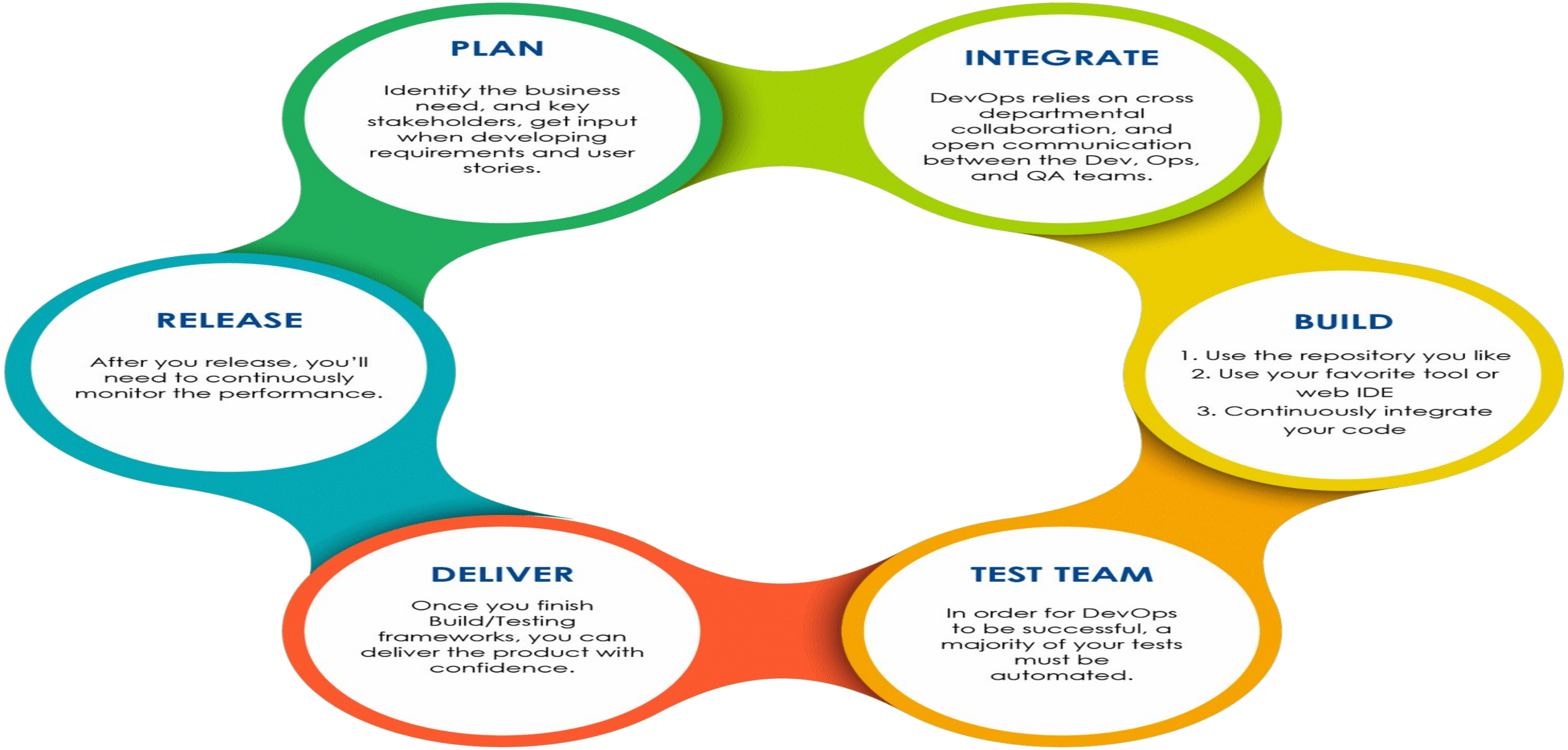
Implementation Technologies - 1



Containers vs. VMs

Containers are isolated, but share OS and, where appropriate, bins/libraries

Devops implementation



PLAN

Identify the business need, and key stakeholders, get input when developing requirements and user stories.

INTEGRATE

DevOps relies on cross departmental collaboration, and open communication between the Dev, Ops, and QA teams.

BUILD

1. Use the repository you like
2. Use your favorite tool or web IDE
3. Continuously integrate your code

TEST TEAM

In order for DevOps to be successful, a majority of your tests must be automated.

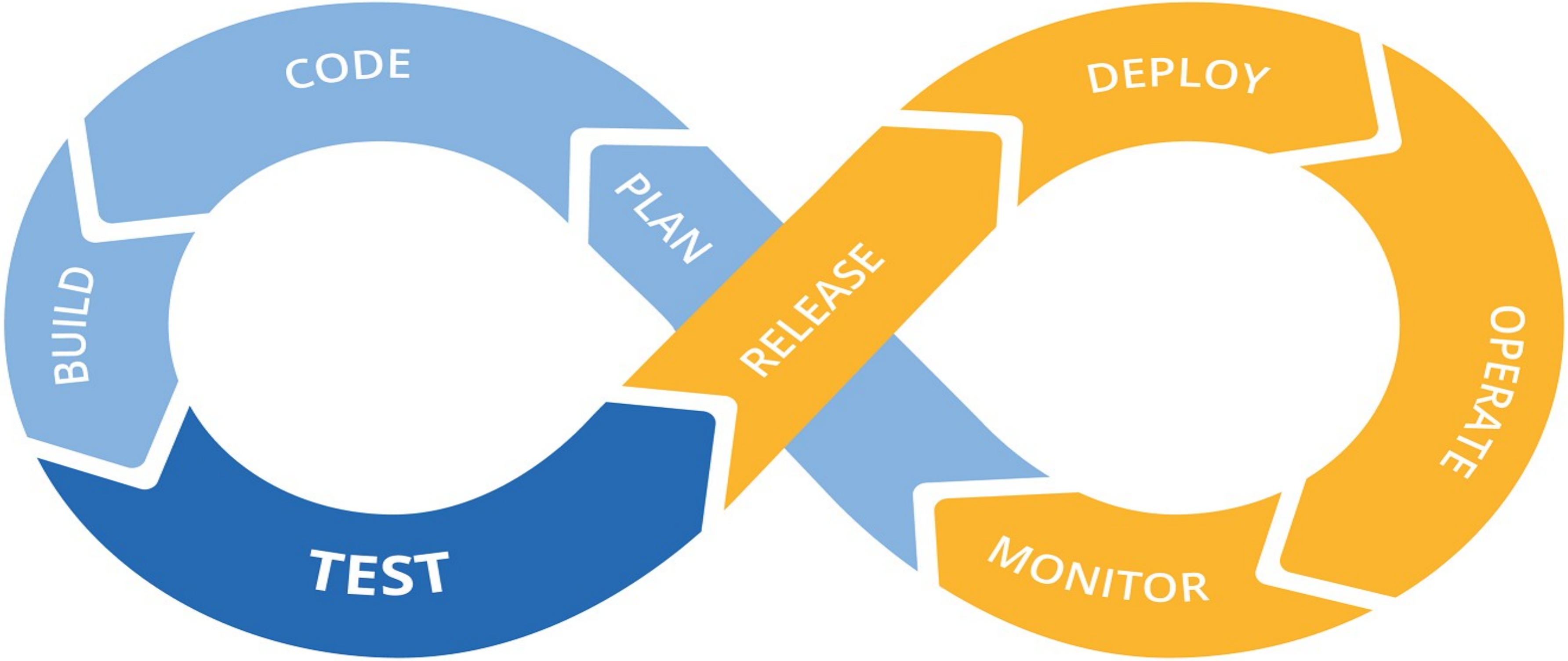
DELIVER

Once you finish Build/Testing frameworks, you can deliver the product with confidence.

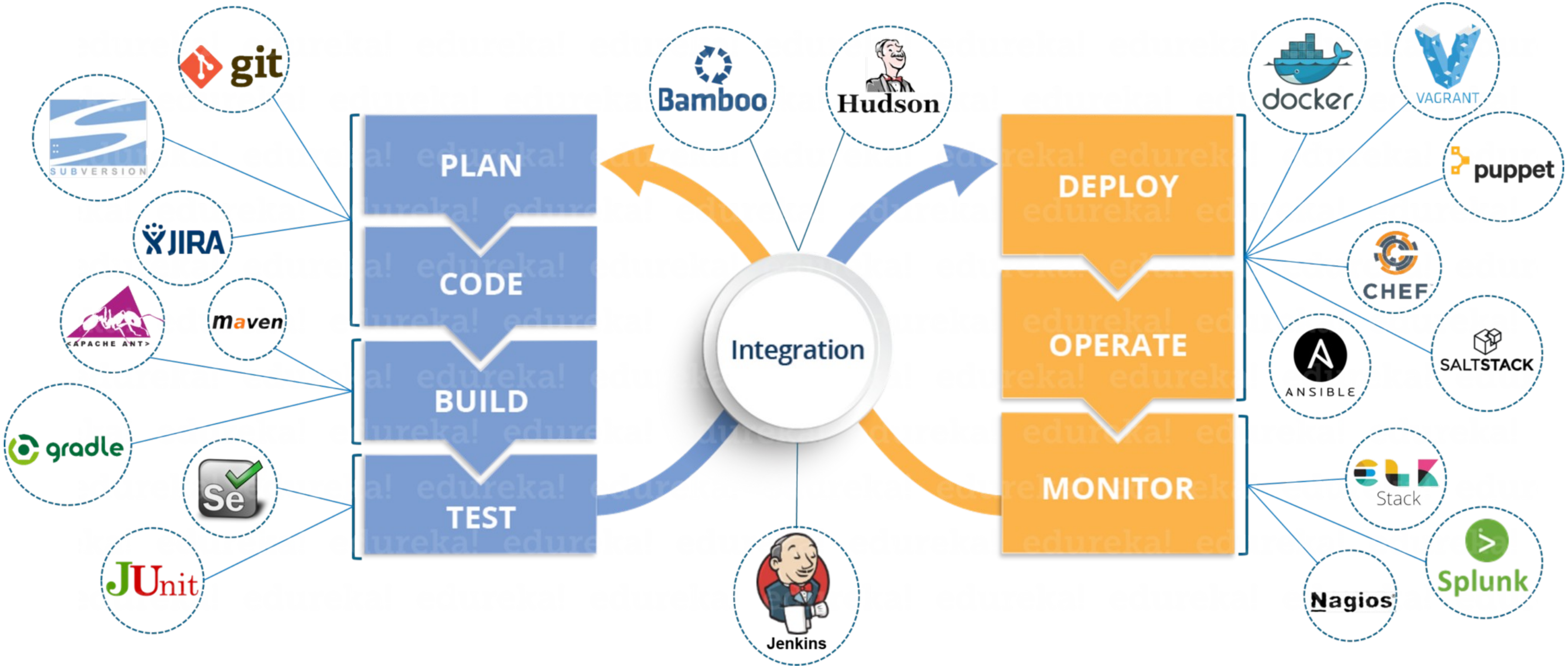
RELEASE

After you release, you'll need to continuously monitor the performance.

DEVOPS LIFECYCLE



DEVOPS – Technology Mapping



What is Docker? (the Silver Bullet)

- Docker is a ‘container technology’
  - Linux-specific
    - can’t run Mac OSX, Windows *in* docker containers
    - But *can* run docker containers *on* Mac OSX & Windows
  - Shrink-wrap your software, run it on any Linux platform

- *Not* a virtual machine
  - Similar to virtual machines, but more lightweight
    - Smaller, faster to start, easier to maintain and manage
    - Lighter on system resources => vastly more scalable
  - VM-thinking will lead to poor results, avoid it!

why use Docker?

- Portability:
    - No need to rebuild your application for a new platform!
        - Build a container once, run it anywhere
            - Cori/Edison/Genepool/…
            - AWS/GCP/…
        - Stable s/w versions across all platforms, no runtime glitches
    - Think of it as ‘modules-to-go’
        - Instead of ‘module load PQR’ you ‘docker pull PQR’
        - No waiting for modules to be built/deployed for you!

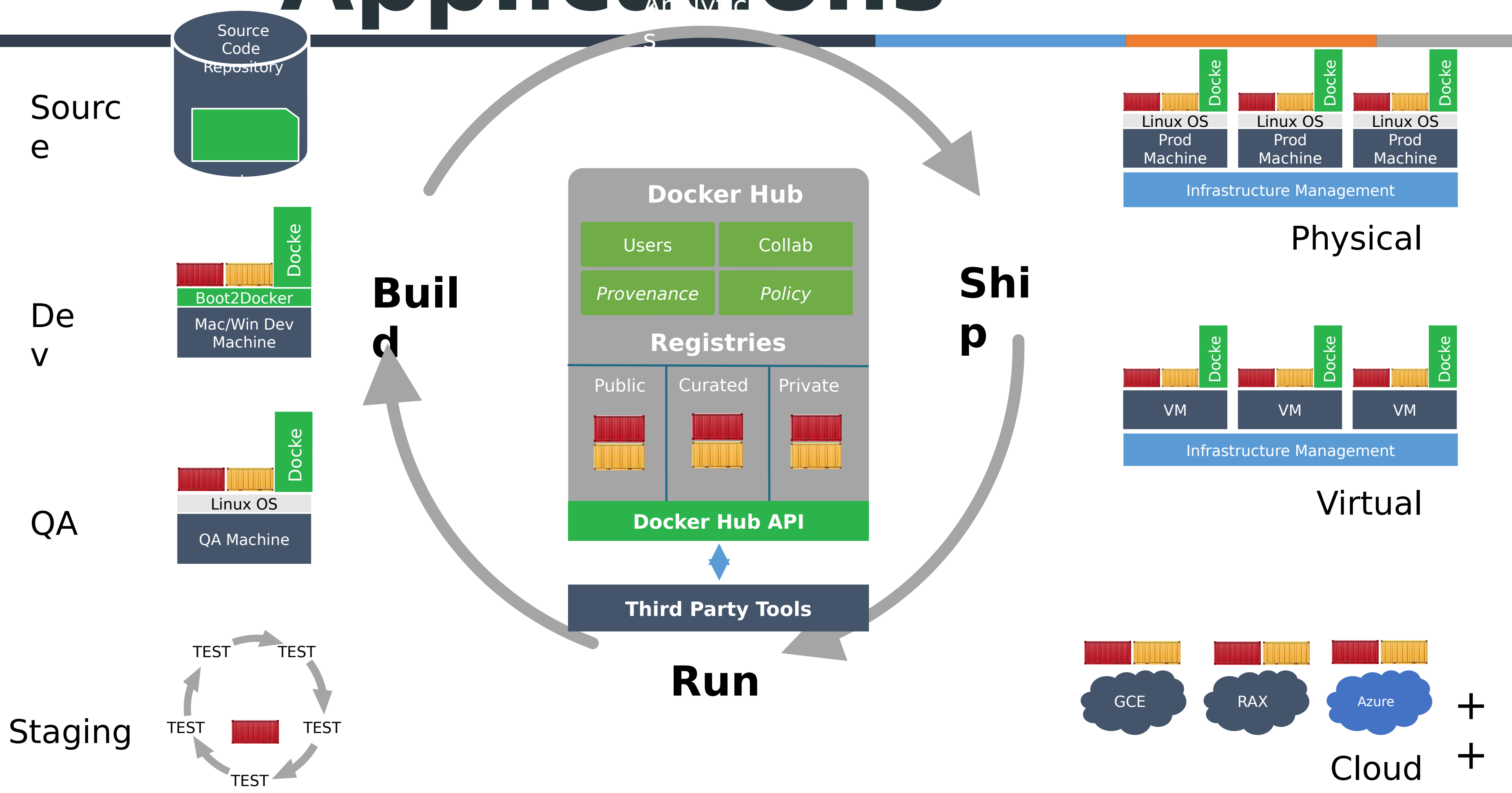
- Reproducibility:
    - Because your s/w is stable, your pipeline is reproducible
        - Run the exact same binaries again 10 years from now □ □

What can you do with it?

- Computational workloads
  - Use applications without having to install them
  - Run your applications anywhere; clouds
  - **Reproducible pipelines** – today’s focus

- Services
  - Web portals/gateways (**R/Shiny**, Apache, Jupyter…)
  - Persistent workflow manager interfaces (Fireworks…)
  - Continuous build systems (**Gitlab**…)
  - For prototyping or for production running (databases etc)
  - All those things you run in the background on the login nodes today!

Docker Hub: Build, Ship, Run Applications



Analytics

Source

Source Code Repository

Dev

Docke

Boot2Docker

Mac/Win Dev Machine

QA

Docke

Linux OS

QA Machine

Staging

TEST

TEST

TEST

TEST

TEST

Build

Docker Hub

Users

Collab

Provenance

Policy

Registries

Public

Curated

Private

Docker Hub API

Third Party Tools

Run

Ship

Docke

Linux OS

Prod Machine

Docke

Linux OS

Prod Machine

Docke

Linux OS

Prod Machine

Infrastructure Management

Physical

Docke

VM

Docke

VM

Docke

VM

Infrastructure Management

Virtual

GCE

RAX

Azure

Cloud

+

+

DockerHub provides a centralized resource for container image discovery, distribution and change management, user and team collaboration, and workflow automation

Building a container: the Dockerfile

- A recipe for building a container
- Start with a base image, add software layer by layer
  - Choosing the base image has a big effect on how large your container will be: go small (‘alpine’ or ‘busybox’)!
- Add metadata describing the container
  - Always a good idea
- Set the command to run when starting the container, map network ports, set environment variables
  - Not strictly needed for batch applications, useful for services (web apps, databases…)

Dockerfile

```
FROM debian:jessie

# LABEL lets you specify metadata, visible with 'docker inspect'
LABEL Maintainer="Tony Wildish, wildish@lbl.gov" Version=1.0

# I can set environment variables
ENV PATH /usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin

# Commands to prepare the container
ENV DEBIAN_FRONTEND=noninteractive
RUN apt-get update -y
RUN apt-get install --assume-yes apt-utils
RUN apt-get install -y python
RUN apt-get install -y python-pip
RUN apt-get clean all
RUN pip install bottle

# Add local files
ADD hello.py /tmp/

# open a port
EXPOSE 5000

# specify the default command to run
```

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# open a port
EXPOSE 5000

# specify the default command to run
CMD ["python", "/tmp/hello.py“]
```

Name+version

Contact info

Heavy lifting, install base tools before our code

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```

Name+version

‘heavy’ base image: 123 MB

Contact info

Heavy lifting, install base tools before our code

Blind update – to what???
Container != VM

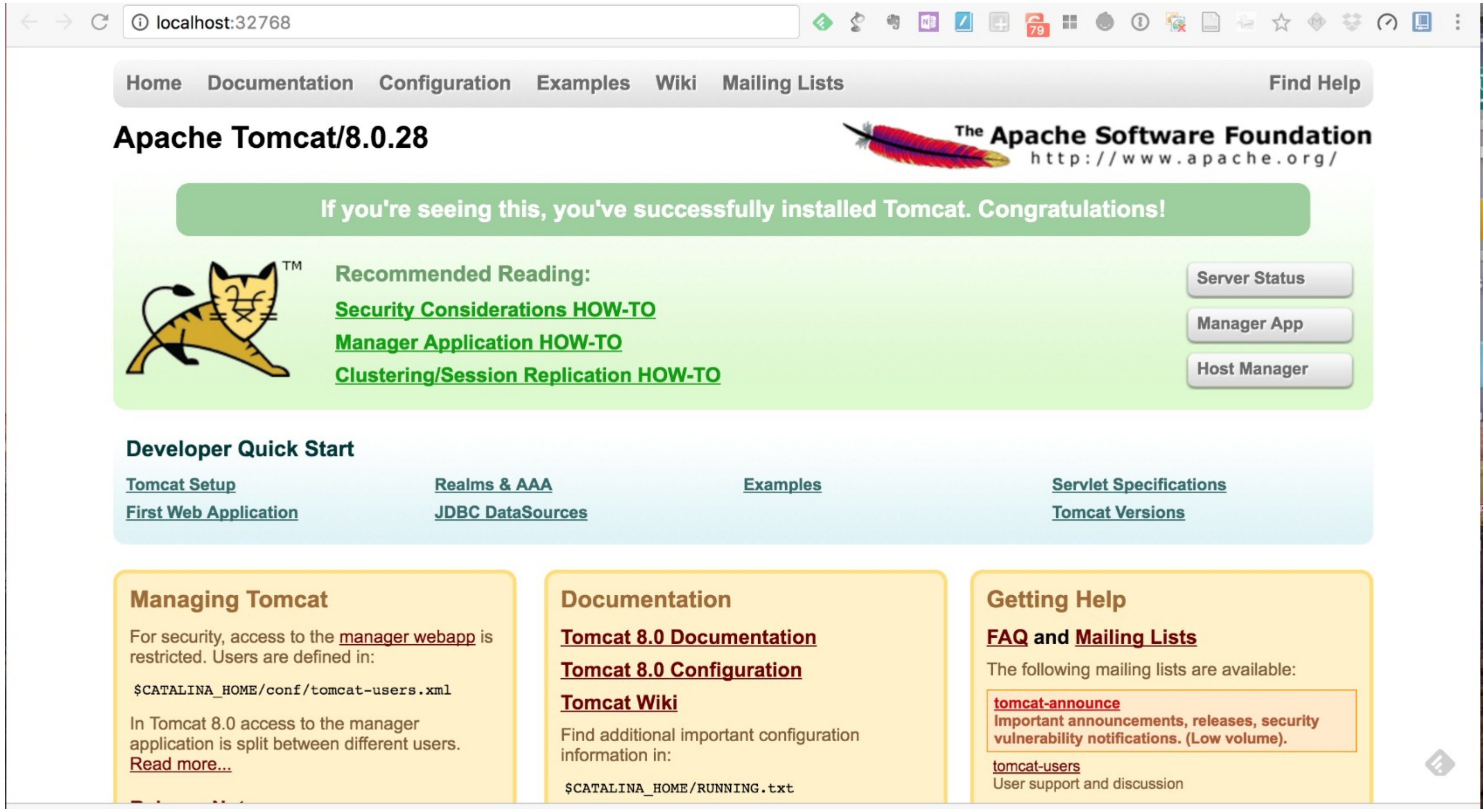
Lots of RUN commands means lots of layers, not ideal for the cache

Final image size: 360 MB

Four Examples of What You Can Do with Docker in Instructional Settings

Apache Tomcat

Apache Tomcat is a Java-based Web server. It is important in this context because it forms the basis for a number of key platforms, including DSpace, Fedora, and Islandora



localhost:32768

Home Documentation Configuration Examples Wiki Mailing Lists Find Help

Apache Tomcat/8.0.28

The Apache Software Foundation
http://www.apache.org/

If you're seeing this, you've successfully installed Tomcat. Congratulations!

Recommended Reading:
Security Considerations HOW-TO
Manager Application HOW-TO
Clustering/Session Replication HOW-TO

Server Status
Manager App
Host Manager

Developer Quick Start

Tomcat Setup
First Web Application
Realms & AAA
JDBC DataSources
Examples
Servlet Specifications
Tomcat Versions

Managing Tomcat

For security, access to the manager webapp is restricted. Users are defined in:

```
$CATALINA_HOME/conf/tomcat-users.xml
```

In Tomcat 8.0 access to the manager application is split between different users. Read more...

Documentation

Tomcat 8.0 Documentation
Tomcat 8.0 Configuration
Tomcat Wiki

Find additional important configuration information in:

```
$CATALINA_HOME/RUNNING.txt
```

Getting Help

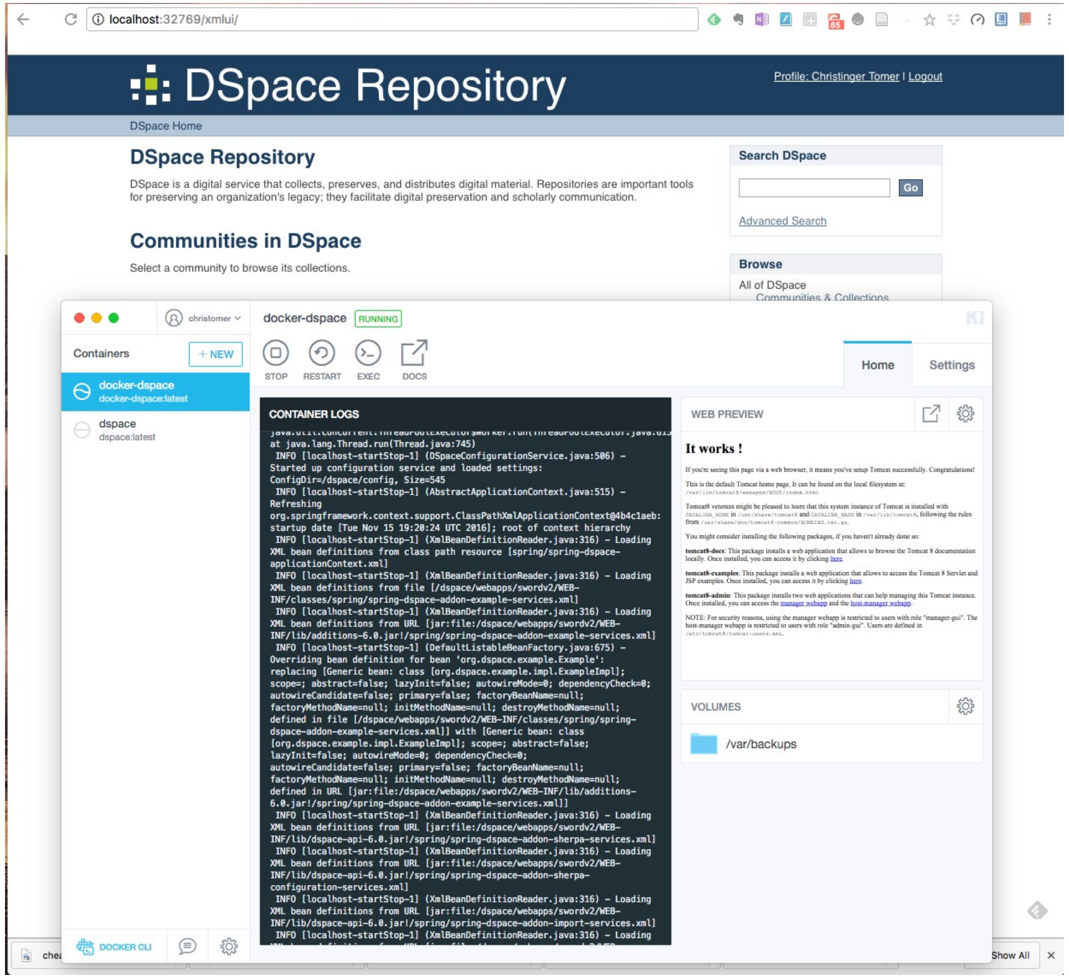
FAQ and Mailing Lists

The following mailing lists are available:

tomcat-announce
Important announcements, releases, security vulnerability notifications. (Low volume).

tomcat-users
User support and discussion

DSpace



DSpace Repository

DSpace is a digital service that collects, preserves, and distributes digital material. Repositories are important tools for preserving an organization's legacy; they facilitate digital preservation and scholarly communication.

Communities in DSpace

Select a community to browse its collections.

```
at java.lang.Thread.run(Thread.java:745)
 INFO [localhost-startStop-1] (DSpaceConfigurationService.java:506) -
Started up configuration service and loaded settings:
ConfigDir=/dspace/config, Size=545
 INFO [localhost-startStop-1] (AbstractApplicationContext.java:515) -
Refreshing
org.springframework.context.support.ClassPathXmlApplicationContext@4b4c1aeb:
startup date [Tue Nov 15 19:20:24 UTC 2016]; root of context hierarchy
 INFO [localhost-startStop-1] (XmlBeanDefinitionReader.java:316) - Loading
XML bean definitions from class path resource [spring/spring-dspace-
applicationContext.xml]
 INFO [localhost-startStop-1] (XmlBeanDefinitionReader.java:316) - Loading
XML bean definitions from file [/dspace/webapps/swordv2/WEB-
INF/classes/spring/spring-dspace-addon-example-services.xml]
 INFO [localhost-startStop-1] (XmlBeanDefinitionReader.java:316) - Loading
XML bean definitions from URL [jar:file:/dspace/webapps/swordv2/WEB-
INF/lib/additions-6.0.jar!/spring/spring-dspace-addon-example-services.xml]
 INFO [localhost-startStop-1] (DefaultListableBeanFactory.java:675) -
Overriding bean definition for bean 'org.dspace.example.Example':
replacing [Generic bean: class [org.dspace.example.impl.ExampleImpl];
scope=; abstract=false; lazyInit=false; autowireMode=0; dependencyCheck=0;
autowireCandidate=false; primary=false; factoryBeanName=null;
factoryMethodName=null; initMethodName=null; destroyMethodName=null;
defined in file [/dspace/webapps/swordv2/WEB-INF/classes/spring/spring-
dspace-addon-example-services.xml]] with [Generic bean: class
[org.dspace.example.impl.ExampleImpl]; scope=; abstract=false;
lazyInit=false; autowireMode=0; dependencyCheck=0;
autowireCandidate=false; primary=false; factoryBeanName=null;
factoryMethodName=null; initMethodName=null; destroyMethodName=null;
defined in URL [jar:file:/dspace/webapps/swordv2/WEB-INF/lib/additions-
6.0.jar!/spring/spring-dspace-addon-example-services.xml]]
 INFO [localhost-startStop-1] (XmlBeanDefinitionReader.java:316) - Loading
XML bean definitions from URL [jar:file:/dspace/webapps/swordv2/WEB-
INF/lib/dspace-api-6.0.jar!/spring/spring-dspace-addon-sherpa-services.xml]
 INFO [localhost-startStop-1] (XmlBeanDefinitionReader.java:316) - Loading
XML bean definitions from URL [jar:file:/dspace/webapps/swordv2/WEB-
INF/lib/dspace-api-6.0.jar!/spring/spring-dspace-addon-sherpa-
configuration-services.xml]
 INFO [localhost-startStop-1] (XmlBeanDefinitionReader.java:316) - Loading
XML bean definitions from URL [jar:file:/dspace/webapps/swordv2/WEB-
INF/lib/dspace-api-6.0.jar!/spring/spring-dspace-addon-import-services.xml]
 INFO [localhost-startStop-1] (XmlBeanDefinitionReader.java:316) - Loading
```

It works !

If you're seeing this page via a web browser, it means you've setup Tomcat successfully. Congratulations!

This is the default Tomcat home page. It can be found on the local filesystem at: /var/lib/tomcat8/webapps/ROOT/index.html

Tomcat8 veterans might be pleased to learn that this system instance of Tomcat is installed with CATALINA_HOME in /usr/share/tomcat8 and CATALINA_BASE in /var/lib/tomcat8, following the rules from /usr/share/doc/tomcat8-common/RUNNING.txt.gz.

You might consider installing the following packages, if you haven't already done so:

tomcat8-docs: This package installs a web application that allows to browse the Tomcat 8 documentation locally. Once installed, you can access it by clicking here.

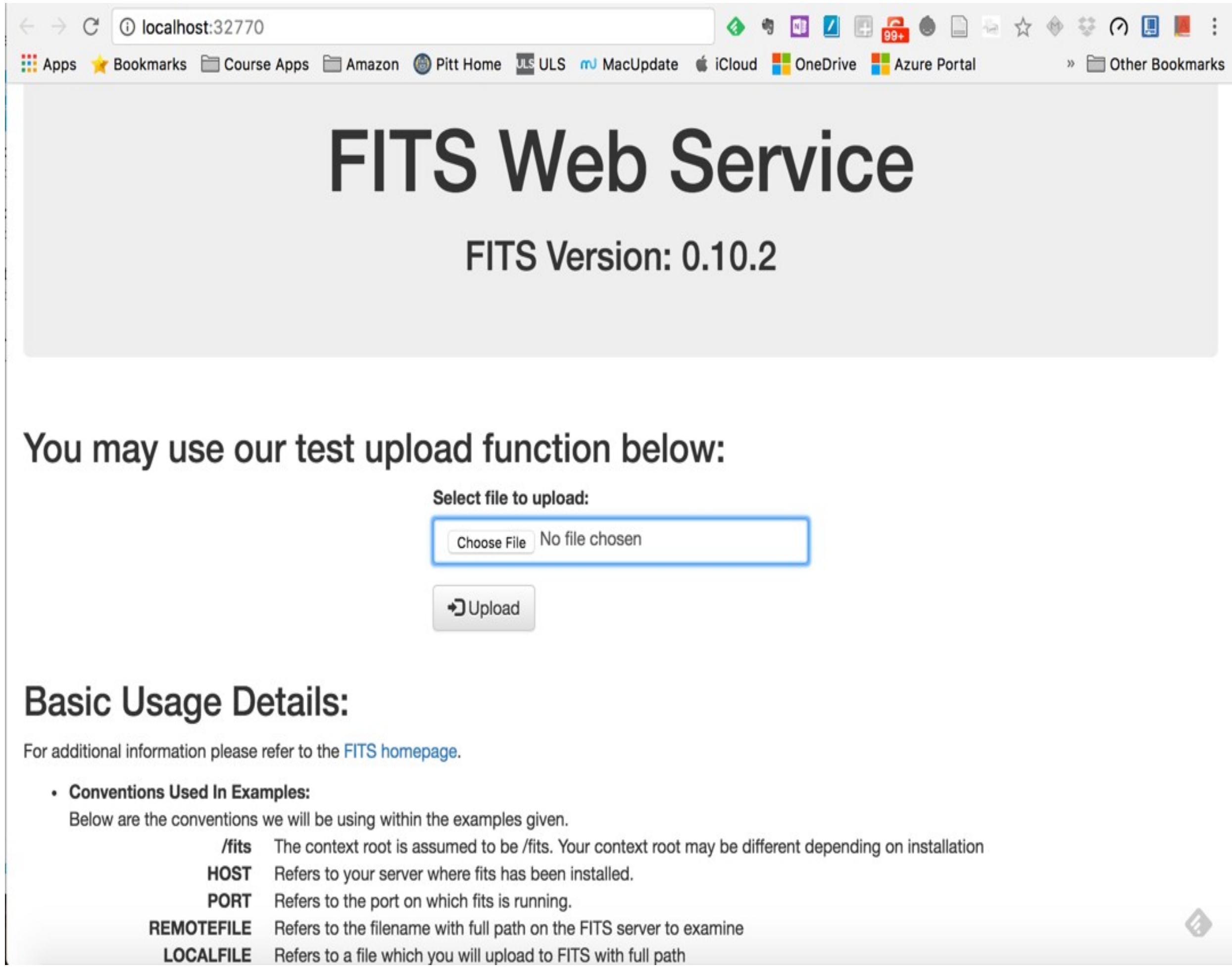
tomcat8-examples: This package installs a web application that allows to access the Tomcat 8 Servlet and JSP examples. Once installed, you can access it by clicking here.

tomcat8-admin: This package installs two web applications that can help managing this Tomcat instance. Once installed, you can access the manager webapp and the host-manager webapp.

NOTE: For security reasons, using the manager webapp is restricted to users with role "manager-gui". The host-manager webapp is restricted to users with role "admin-gui". Users are defined in /etc/tomcat8/tomcat-users.xml.

DSpace is an open source repository software package typically used for creating open access repositories for scholarly and/or published digital content. Its design is focused on the long-term storage, access and preservation of digital content.

File Information Tool Set (FITS)



FITS Web Service

FITS Version: 0.10.2

You may use our test upload function below:

Select file to upload:

Choose File No file chosen

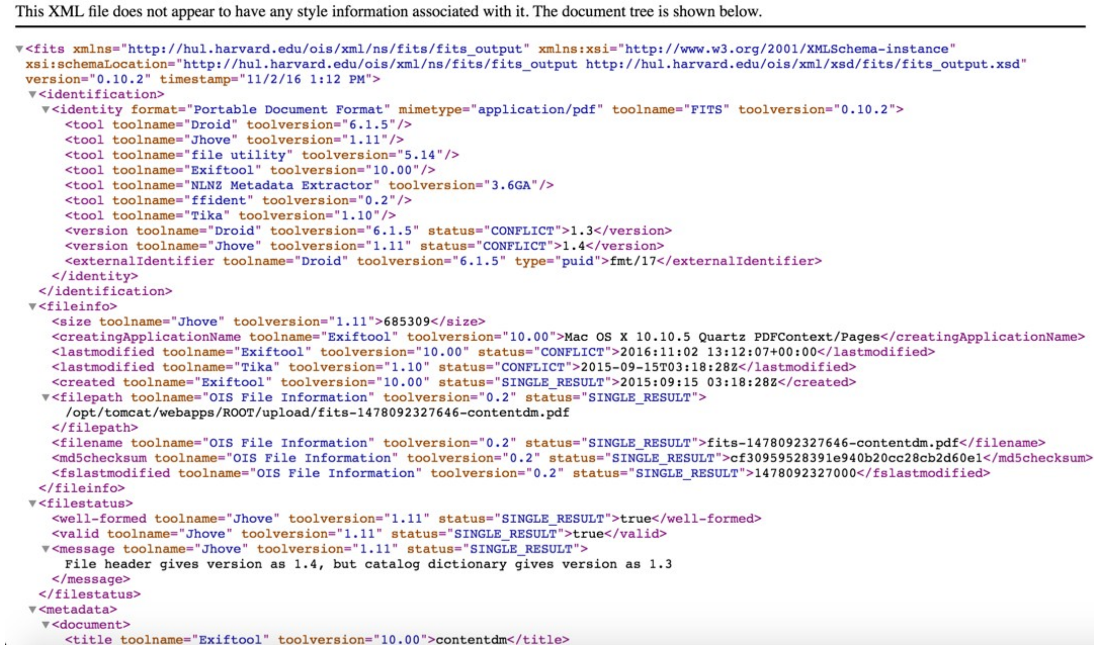
Upload

Basic Usage Details:

For additional information please refer to the FITS homepage.

- **Conventions Used In Examples:**
  Below are the conventions we will be using within the examples given.

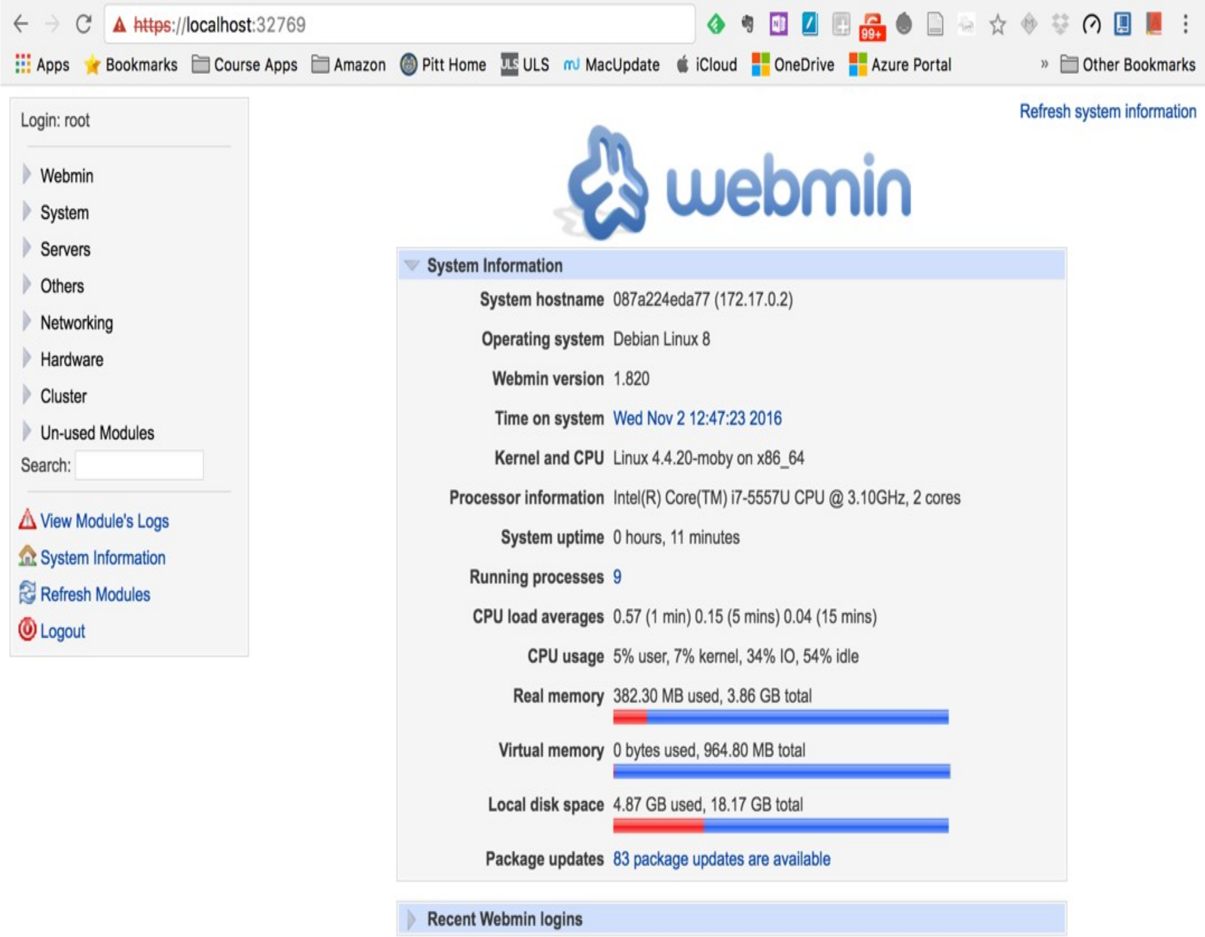
/fits	The context root is assumed to be /fits. Your context root may be different depending on installation
HOST	Refers to your server where fits has been installed.
PORT	Refers to the port on which fits is running.
REMOTEFILE	Refers to the filename with full path on the FITS server to examine
LOCALFILE	Refers to a file which you will upload to FITS with full path



This XML file does not appear to have any style information associated with it. The document tree is shown below.

```
▼<fits xmlns="http://hul.harvard.edu/ois/xml/ns/fits/fits_output" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://hul.harvard.edu/ois/xml/ns/fits/fits_output http://hul.harvard.edu/ois/xml/xsd/fits/fits_output.xsd"
 version="0.10.2" timestamp="11/2/16 1:12 PM">
  ▼<identification>
    ▼<identity format="Portable Document Format" mimetype="application/pdf" toolname="FITS" toolversion="0.10.2">
       <tool toolname="Droid" toolversion="6.1.5"/>
       <tool toolname="Jhove" toolversion="1.11"/>
       <tool toolname="file utility" toolversion="5.14"/>
       <tool toolname="Exiftool" toolversion="10.00"/>
       <tool toolname="NLNZ Metadata Extractor" toolversion="3.6GA"/>
       <tool toolname="ffident" toolversion="0.2"/>
       <tool toolname="Tika" toolversion="1.10"/>
       <version toolname="Droid" toolversion="6.1.5" status="CONFLICT">1.3</version>
       <version toolname="Jhove" toolversion="1.11" status="CONFLICT">1.4</version>
       <externalIdentifier toolname="Droid" toolversion="6.1.5" type="puid">fmt/17</externalIdentifier>
     </identity>
   </identification>
  ▼<fileinfo>
     <size toolname="Jhove" toolversion="1.11">685309</size>
     <creatingApplicationName toolname="Exiftool" toolversion="10.00">Mac OS X 10.10.5 Quartz PDFContext/Pages</creatingApplicationName>
     <lastmodified toolname="Exiftool" toolversion="10.00" status="CONFLICT">2016:11:02 13:12:07+00:00</lastmodified>
     <lastmodified toolname="Tika" toolversion="1.10" status="CONFLICT">2015-09-15T03:18:28Z</lastmodified>
     <created toolname="Exiftool" toolversion="10.00" status="SINGLE_RESULT">2015:09:15 03:18:28Z</created>
    ▼<filepath toolname="OIS File Information" toolversion="0.2" status="SINGLE_RESULT">
       /opt/tomcat/webapps/ROOT/upload/fits-1478092327646-contentdm.pdf
     </filepath>
     <filename toolname="OIS File Information" toolversion="0.2" status="SINGLE_RESULT">fits-1478092327646-contentdm.pdf</filename>
     <md5checksum toolname="OIS File Information" toolversion="0.2" status="SINGLE_RESULT">cf30959528391e940b20cc28cb2d60e1</md5checksum>
     <fslastmodified toolname="OIS File Information" toolversion="0.2" status="SINGLE_RESULT">1478092327000</fslastmodified>
   </fileinfo>
  ▼<filestatus>
     <well-formed toolname="Jhove" toolversion="1.11" status="SINGLE_RESULT">true</well-formed>
     <valid toolname="Jhove" toolversion="1.11" status="SINGLE_RESULT">true</valid>
    ▼<message toolname="Jhove" toolversion="1.11" status="SINGLE_RESULT">
       File header gives version as 1.4, but catalog dictionary gives version as 1.3
     </message>
   </filestatus>
  ▼<metadata>
    ▼<document>
       <title toolname="Exiftool" toolversion="10.00">contentdm</title>
```

Webmin



System hostname	087a224eda77 (172.17.0.2)
Operating system	Debian Linux 8
Webmin version	1.820
Time on system	Wed Nov 2 12:47:23 2016
Kernel and CPU	Linux 4.4.20-moby on x86_64
Processor information	Intel(R) Core(TM) i7-5557U CPU @ 3.10GHz, 2 cores
System uptime	0 hours, 11 minutes
Running processes	9
CPU load averages	0.57 (1 min) 0.15 (5 mins) 0.04 (15 mins)
CPU usage	5% user, 7% kernel, 34% IO, 54% idle
Real memory	382.30 MB used, 3.86 GB total
Virtual memory	0 bytes used, 964.80 MB total
Local disk space	4.87 GB used, 18.17 GB total
Package updates	83 package updates are available

Webmin is a Web-based system configuration tool for Unix-like systems, although recent versions can also be installed and run on Windows. Using any Web browser that supports tables and forms (and Java for the `File Manager` module), Webmin enables a user to administer a Linux or Unix system, e.g., setup user accounts, Apache, DNS, file sharing, etc., through a graphical user interface.

An Overview of Machine Learning

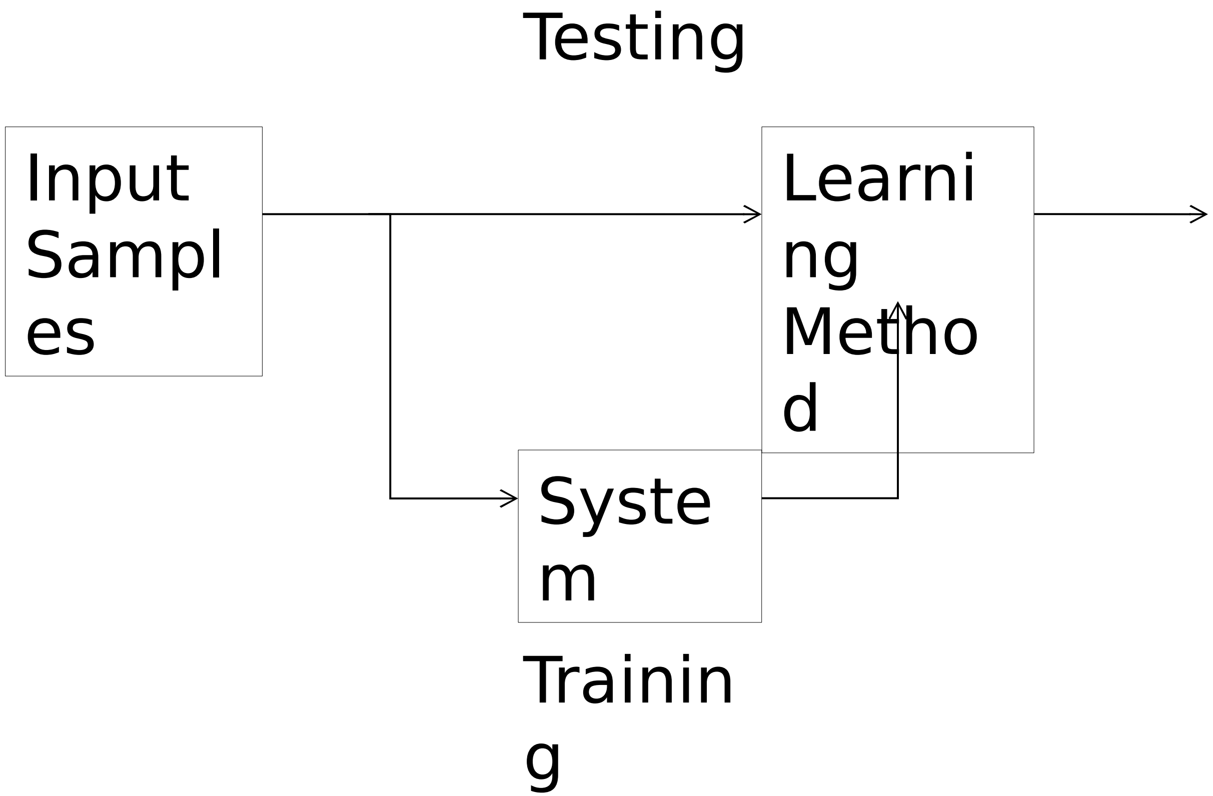
- What is machine learning?
- Learning system model
- Training and testing
- Performance
- Algorithms
- Machine learning structure
- Learning techniques
- Applications

What is machine learning?

- A branch of **artificial intelligence**, concerned with the design and development of algorithms that allow computers to evolve behaviors based on empirical data.

- As intelligence requires knowledge, it is necessary for the computers to acquire knowledge.

Learning system model



Testing

Input Samples

Learning Method

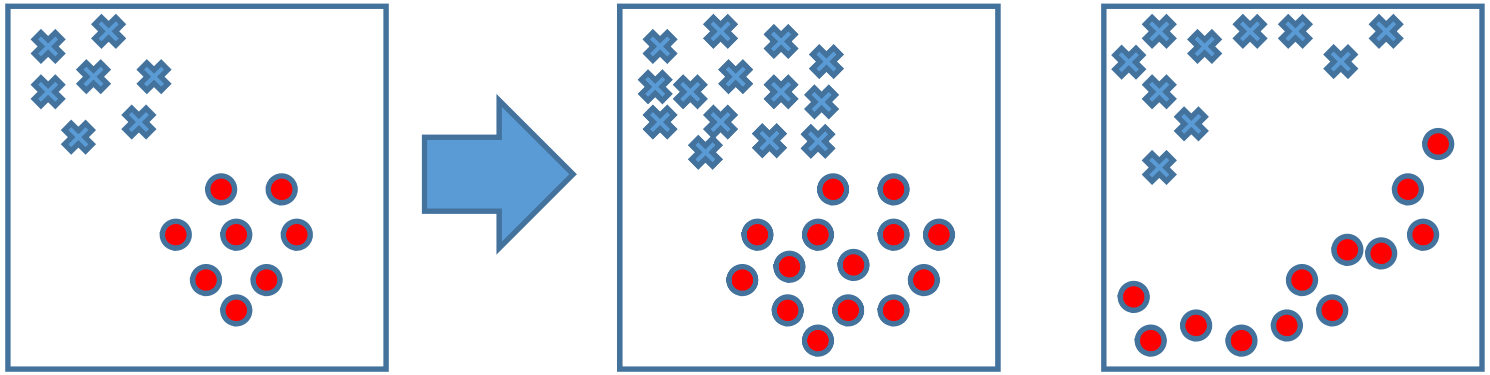
System

Training

Training and testing

- Training is the process of making the system able to learn.

- No free lunch rule:
  - Training set and testing set come from the same distribution
  - Need to make some assumptions or bias



Performance

- There are several factors affecting the performance:
  - **Types of training** provided
  - The form and extent of any initial **background knowledge**
  - The **type of feedback** provided
  - The **learning algorithms** used

- Two important factors:
  - Modeling
  - Optimization

Algorithms

- The success of machine learning system also depends on the algorithms.

- The algorithms control the search to find and build the knowledge structures.

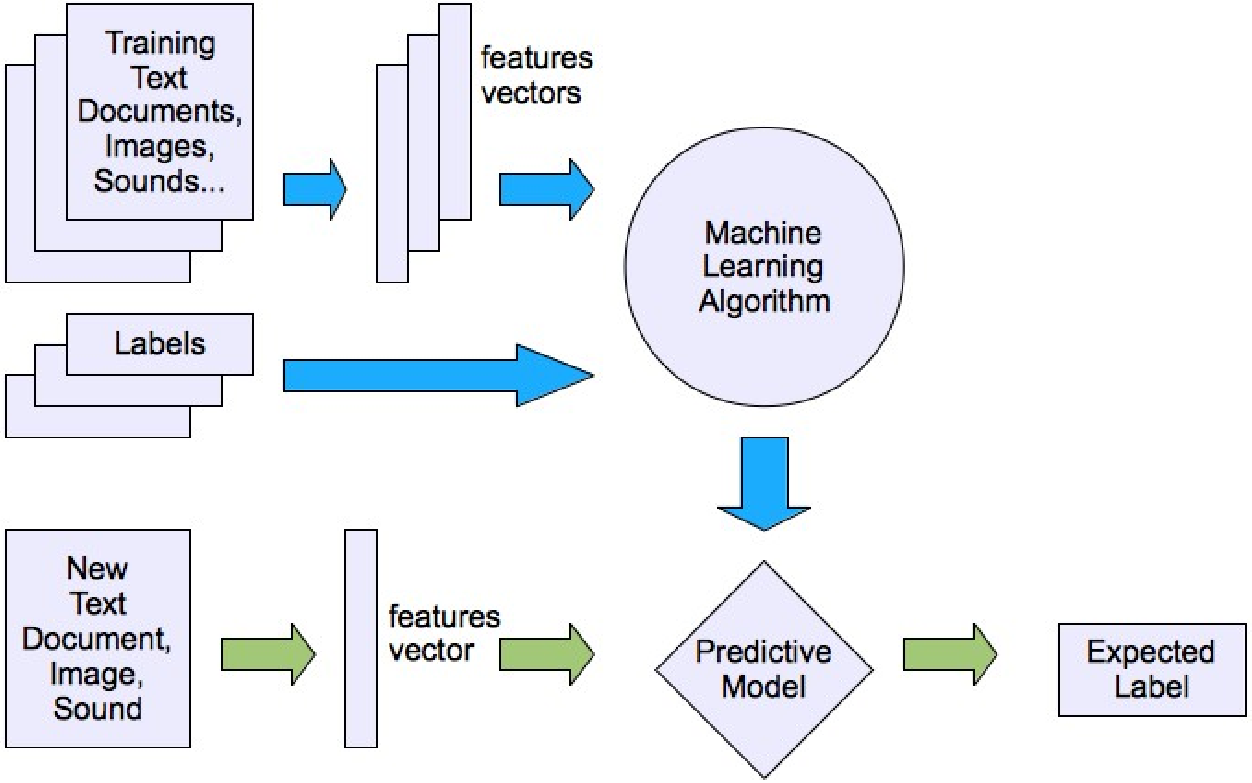
- The learning algorithms should extract useful information from training examples.

Algorithms

- **Supervised learning**
  - Prediction
  - Classification (discrete labels), Regression (real values)
- **Unsupervised learning**
  - Clustering
  - Probability distribution estimation
  - Finding association (in features)
  - Dimension reduction
- **Semi-supervised learning**
- **Reinforcement learning**
  - Decision making (robot, chess machine)

Machine learning structure

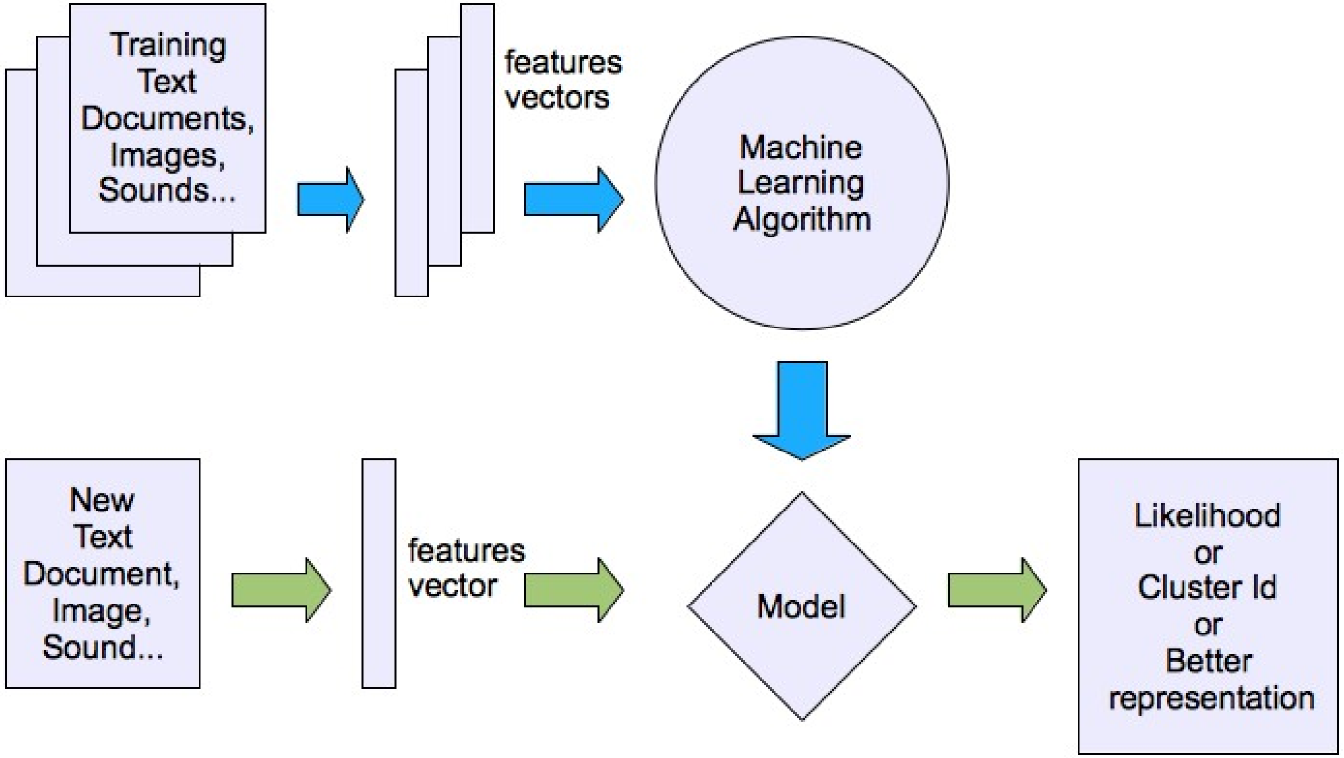
- Supervised learning



Training Text Documents, Images, Sounds...
features vectors
Labels
Machine Learning Algorithm
New Text Document, Image, Sound
features vector
Predictive Model
Expected Label

Machine learning structure

- Unsupervised learning


Training Text Documents, Images, Sounds...
features vectors
Machine Learning Algorithm
New Text Document, Image, Sound...
features vector
Model
Likelihood or Cluster Id or Better representation

Some Examples

- SPAM detection
  - Distinguish between SPAM and legitimate email
  - % of emails correctly classified
  - Hand-labeled emails
- Detecting catalog duplicates
  - Distinguish between duplicate and non-duplicate catalog entries
  - False positive/negative rate based on business criteria
  - *H*and-labeled duplicates and non-duplicates
- Go learner
  - *P*laying Go
  - % of games won in tournament
  - Practice games against itself

Programming Language - Why python?

- So many tools
  - Preprocessing, analysis, statistics, machine learning, natural language processing, network analysis, visualization, scalability
- Community support
- “Easy” language to learn
- Both a scripting and production-ready language

External libraries

A very complete list can be found at PyPi the Python Package Index:

https://pypi.python.org/pypi

To install, use pip, which comes with Python:

```
pip install package
```

or download, unzip, and run the installer directly from the directory:

```
python setup.py install
```

If you have Python 2 and Python 3 installed, use pip3 (though not with Anaconda) or make sure the right version is first in your PATH.

Pandas

- Data analysis and modeling
- Similar to R and Excel, Keep everything in Python
- Easy-to-use data structures
  - DataFrame
- Data wrangling tools
  - Merging, pivoting, etc
- Use for preprocessing
  - File I/0, cleaning, manipulation, etc
- Combinable with other modules
  - NumPy, SciPy, statsmodel, matplotlib

Scikit-learn

- Machine learning module
- Open-source
- Built-in datasets
- Good resources for learning
- Very comprehensive of machine learning algorithms
- Preprocessing tools
- Methods for testing the accuracy of your model

nltk

- Natural Language ToolKit
- Access to over 50 corpora
  - Corpus: body of text
- NLP tools
  - Stemming, tokenizing, etc
- Resources for learning
  - Lemmatizing, tokenization, tagging, parse trees
  - Classification
  - Chunking
  - Sentence structure

Beautiful Soup

https://www.crummy.com/software/BeautifulSoup/

Web analysis.

Need other packages to actually download pages like the library `requests`.

http://docs.python-requests.org/en/master/

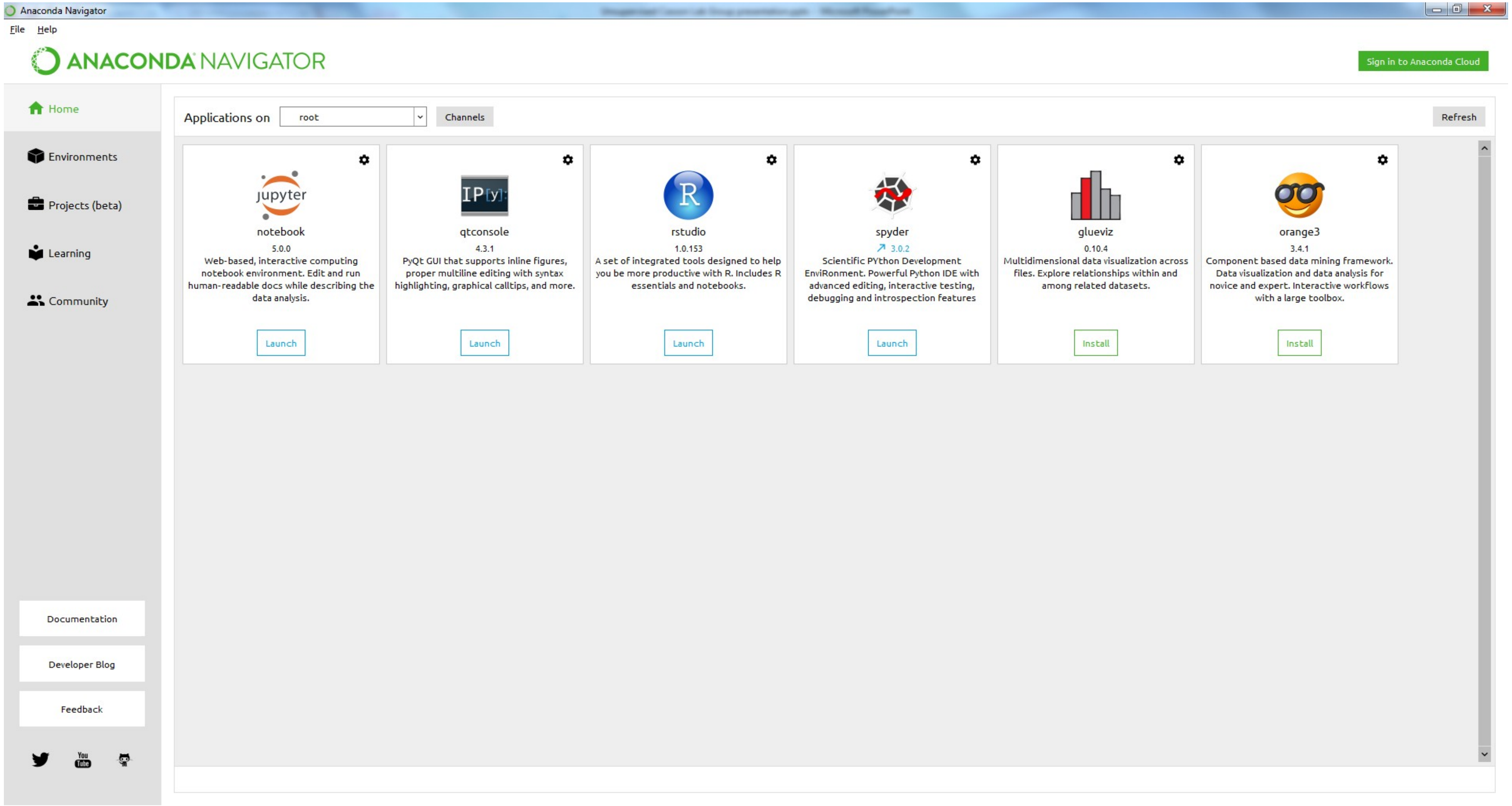
BeautifulSoup navigates the Document Object Model:

http://www.w3schools.com/

Not a library, but a nice intro to web programming with Python.

https://wiki.python.org/moin/WebProgramming

Anaconda Navigator



notebook
5.0.0
Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the data analysis.
Launch

qtconsole
4.3.1
PyQt GUI that supports inline figures, proper multiline editing with syntax highlighting, graphical calltips, and more.
Launch

rstudio
1.0.153
A set of integrated tools designed to help you be more productive with R. Includes R essentials and notebooks.
Launch

spyder
↗ 3.0.2
Scientific PYthon Development EnviRonment. Powerful Python IDE with advanced editing, interactive testing, debugging and introspection features
Launch

glueviz
0.10.4
Multidimensional data visualization across files. Explore relationships within and among related datasets.
Install

orange3
3.4.1
Component based data mining framework. Data visualization and data analysis for novice and expert. Interactive workflows with a large toolbox.
Install

Important Resources

https://www.tutorialspoint.com/linux_admin/linux_admin_tutorial.pdf

Linux Basic tutorial

https://www.tutorialspoint.com/docker/docker_tutorial.pdf

Docker Basic tutorial

http://www.tutorialspoint.com/python3/python3_tutorial.pdf

Python 3 Basic tutorial

https://www.tutorialspoint.com/python_pandas/python_pandas_tutorial.pdf

Pandas Basic tutorial

Important Resources

https://www.tutorialspoint.com/scipy/scipy_tutorial.pdf

Scipy tutorial

https
://www.tutorialspoint.com/big_data_analytics/big_data_analytics_tutorial.pdf

Data Analytics tutorial

https://www.tutorialspoint.com/web_analytics/web_analytics_tutorial.pdf

Web Analytics tutorial

https://archive.ics.uci.edu/ml/index.php

Machine Learning Data Sets

Finally – the Most Important Link

https://github.com/wtsxDev/Machine-Learning-for-Cyber-Security

Most Useful or Most Useless Link (Today most Useful)

https://www.packtpub.com/packt/offers/free-learning

A very Specific flow

https://github.com/martinwicke/tensorflow-tutorial

Questions

Is everyone Still Awake???????