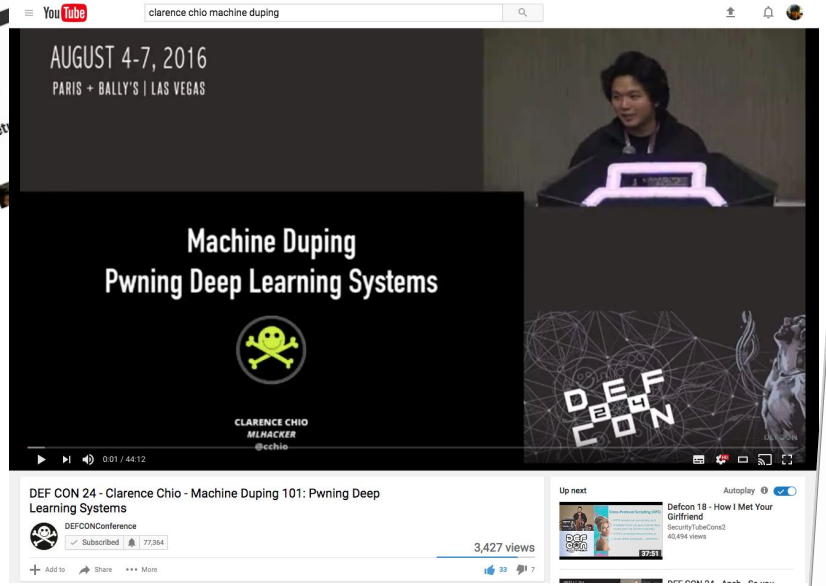
Practical Machine Learning in Infosec

Making & Breaking Machine Learning Systems

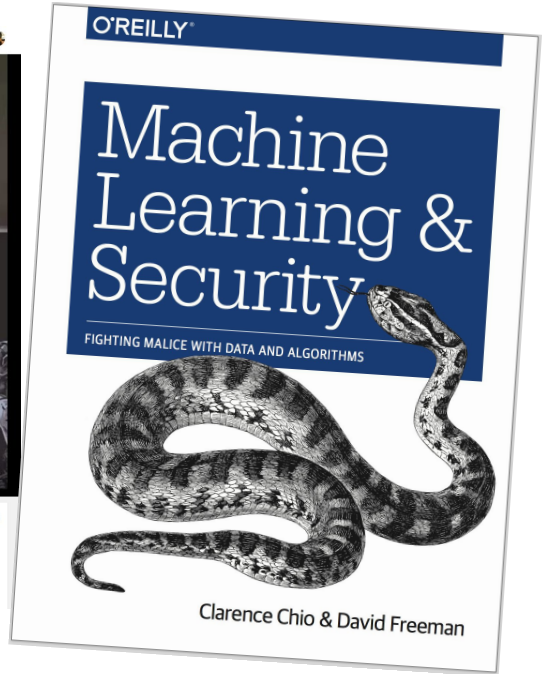
(for infosec)

clarence chio (@cchio)

https://www.meetup.com/Data-Mining-for-Cyber-Security/



https://www.youtube.com/watch?v=JAGDpJFFM2A



who are we?

anto joseph (@antojosep007)

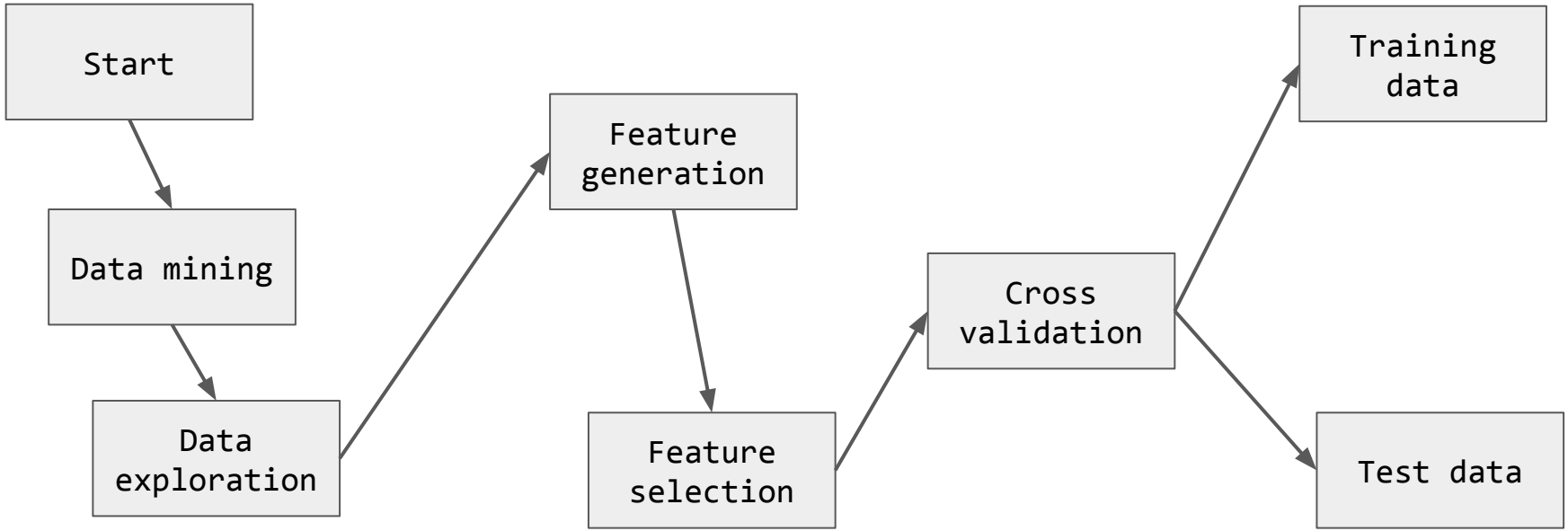
Agenda

- Intro to the development environment
- Spam classifiers
- Anomaly detection
- Classifying malware
- Security of machine learning

(supervised)

Machine learning from 10,000ft

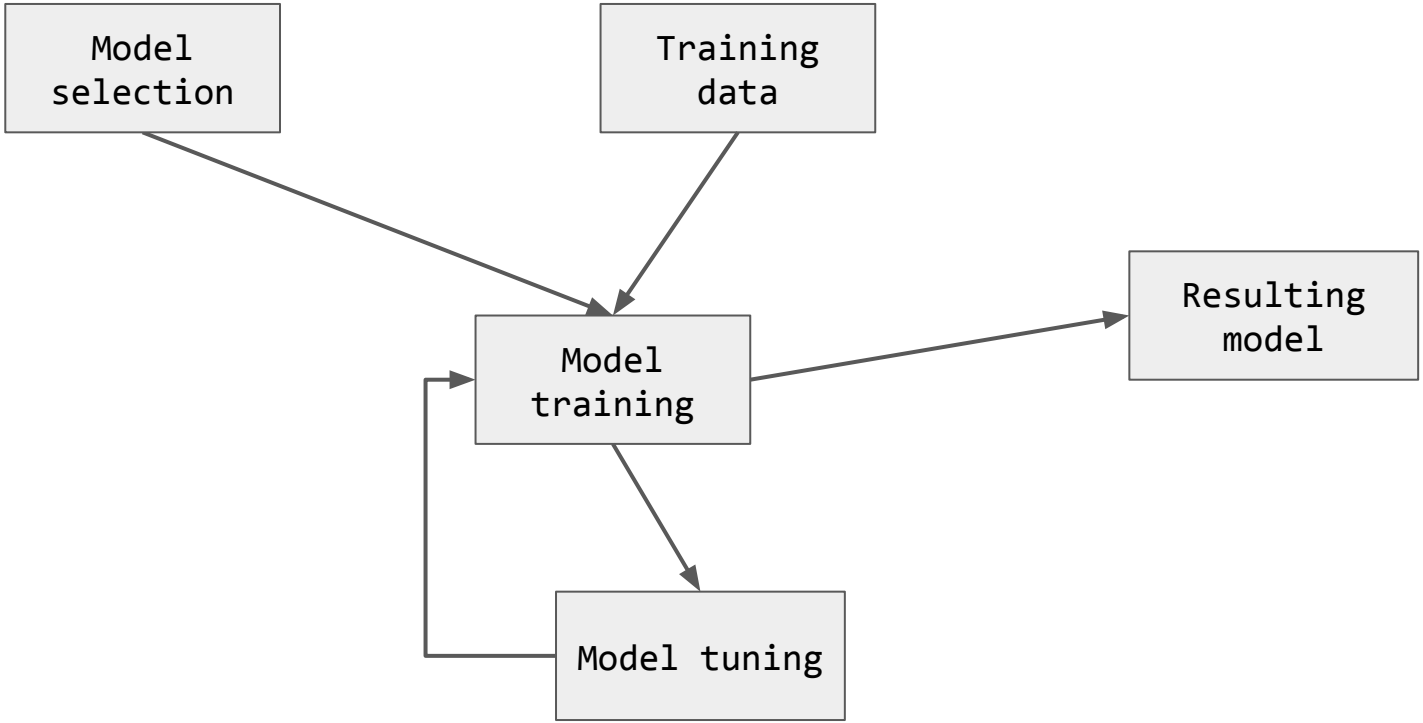
data engineering phase



(supervised)

Machine learning from 10,000ft

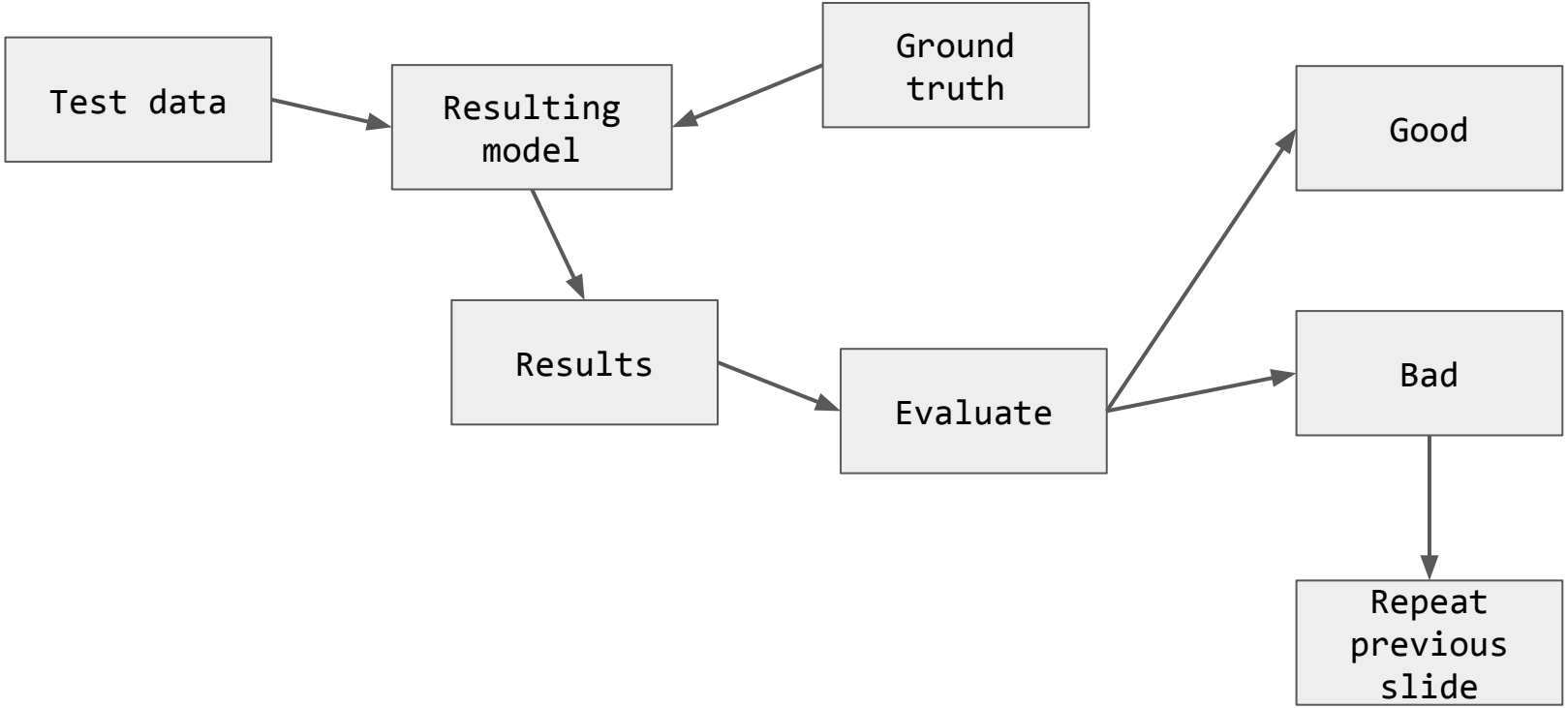
model training phase



(supervised)

Machine learning from 10,000ft

model validation phase



Python toolkits

- scikit-learn - Python library that implements a comprehensive range of machine learning algorithms

- TensorFlow - library for numerical computation using data flow graphs / deep learning

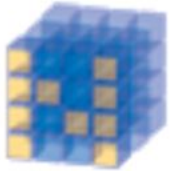
scikit-learn

- easy-to-use, general-purpose toolbox for machine learning in Python.
- supervised and unsupervised machine learning techniques.
- Utilities for common tasks such as model selection, feature extraction, and feature selection
- Built on NumPy, SciPy, and matplotlib
- Open source, commercially usable - BSD license

Tensorflow

- Open source
- By Google
- used for both research and production
- Used widely for deep learning/neural nets
  - But not restricted to just deep models
- Multiple GPU Support

Data science libs



NumPy

Base N-dimensional array package

SciPy library

Fundamental library for scientific computing

Matplotlib

Comprehensive 2D Plotting

IP[y]:
IPython

IPython

Enhanced Interactive Console

Sympy

Symbolic mathematics

pandas

Data structures & analysis

HANDS ON

classifying spam

The dataset: 2007 TREC Public Spam Corpus

http://plg.uwaterloo.ca/~gvcormac/treccorpus07/

MACHINE LEARNING 101

Types of machine learning use cases:

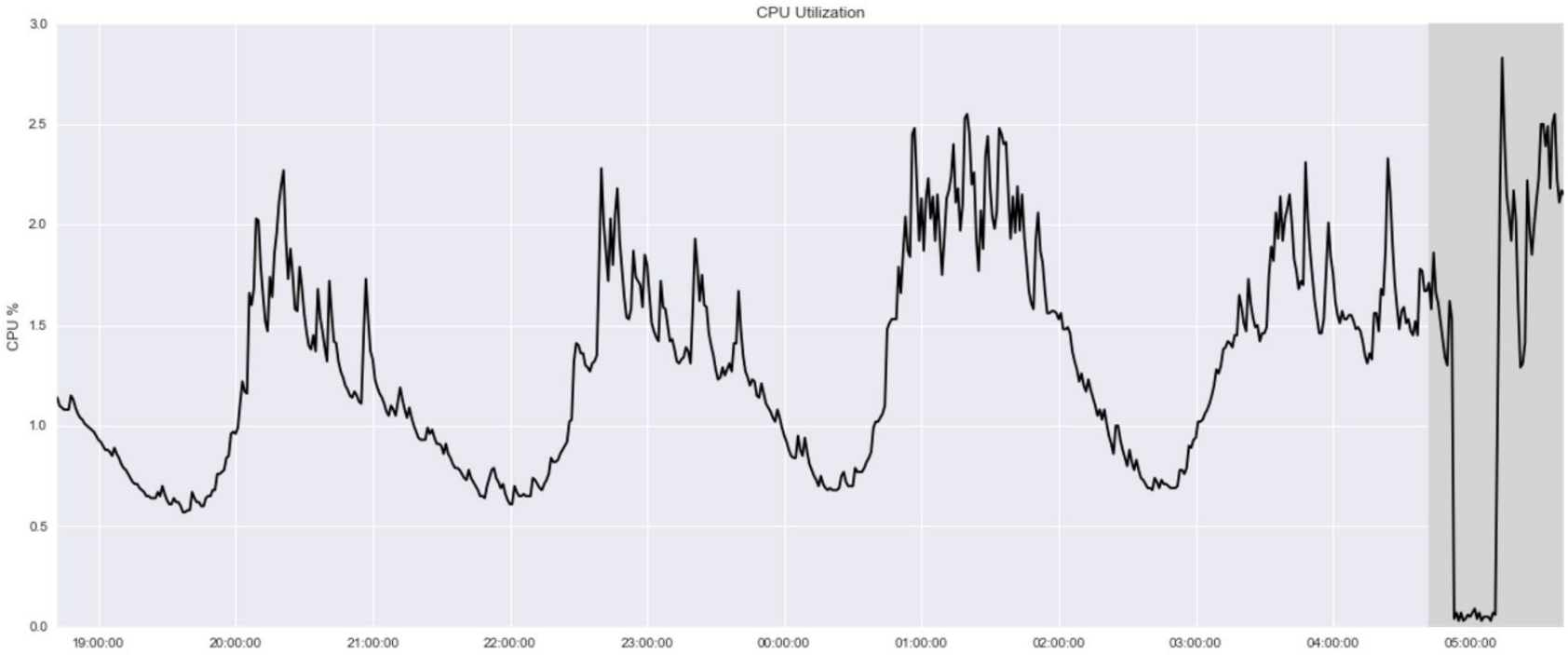
- Regression
- Classification — supervised / unsupervised
- Anomaly detection
- Recommendation
  won't cover here, but check out this talk

This covers **EVERYTHING**. (almost)

HANDS ON

Anomaly Detection

Anomaly detection



Anomaly detection

- Outliers vs. novelties
  - *novelties*: unobserved pattern in new observations not included in training data
- Simple statistics/forecasting methods
  - Exponential smoothing, Holt-Winters algorithm
- Machine learning methods
  - Elliptical envelope, density-based, clustering, SVM

Classification

Classification

labeled data - do you have it?

Classification

yes! lots!

supervised learning

no :(

unsupervised learning

only a little bit

(semi-supervised learning)

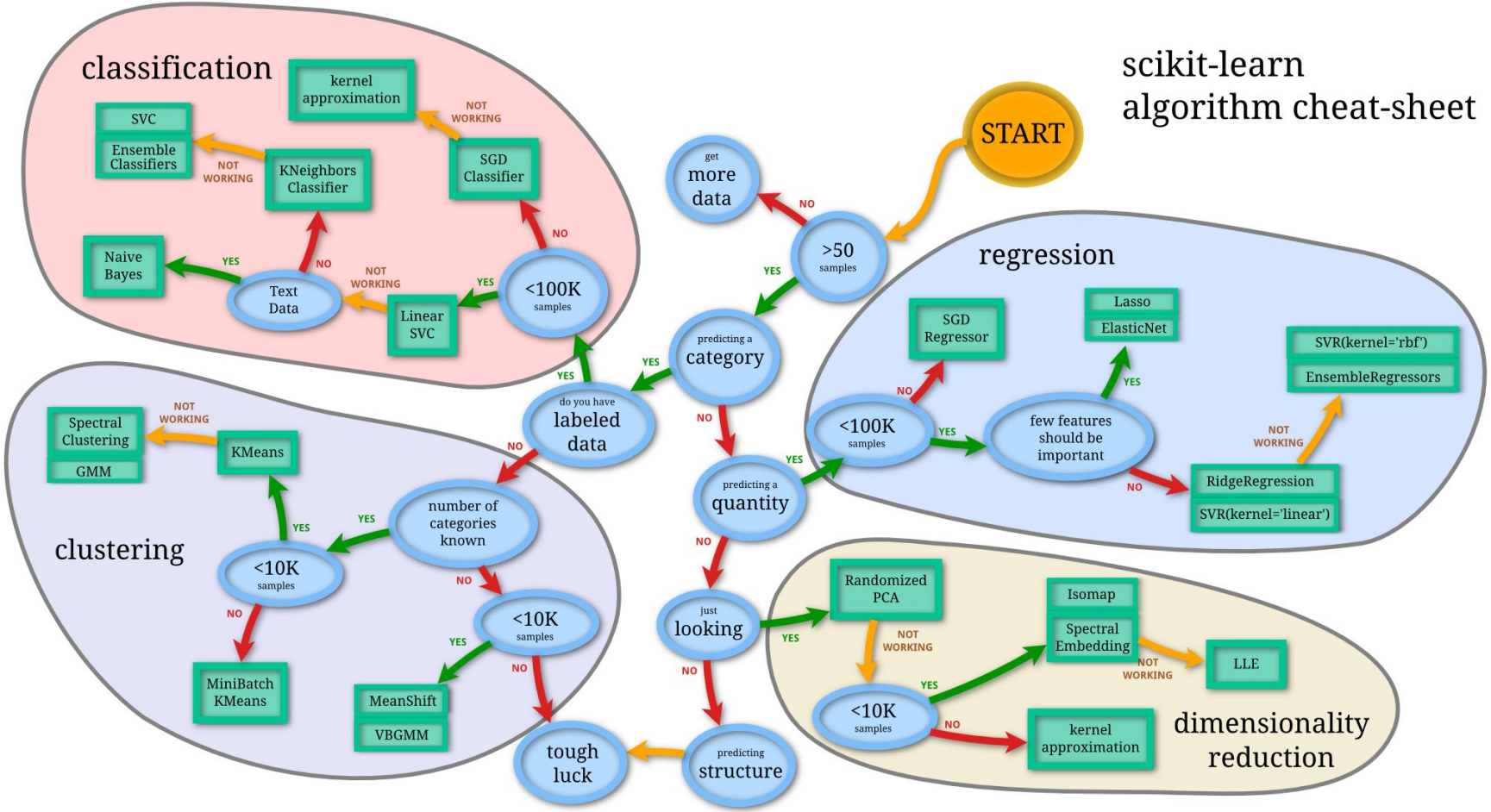
Supervised classification

- **Many different algorithms!**
- e.g.
  - Logistic regression (it's called regression but is *not* regression)
  - Naive Bayes
  - K-nearest neighbors
  - Support Vector Machines
  - Decision Trees

Unsupervised classification

- Mainly refers to **clustering**
- Four types:
  - **Centroid**: K-Means
  - **Distribution**: Gaussian mixture models
  - **Density**: DBSCAN
  - **Connectivity**: Hierarchical clustering

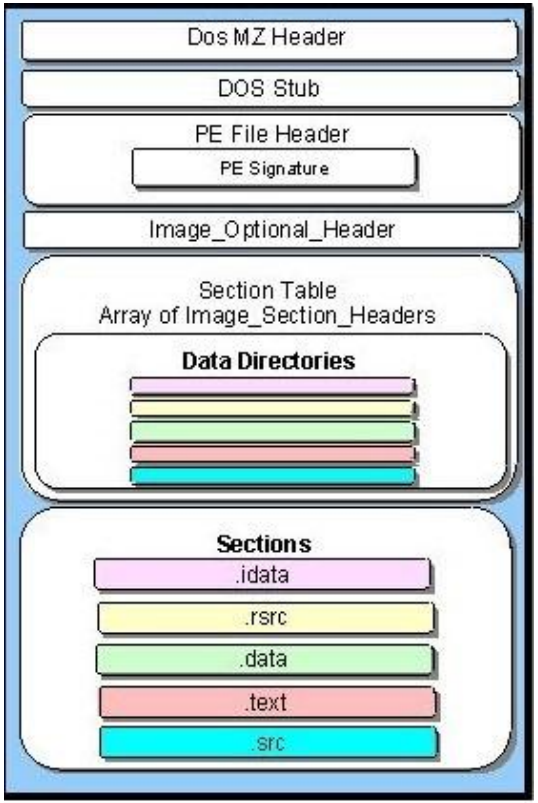
scikit-learn algorithm cheat-sheet



HANDS ON

classifying malware

Portable executable (PE)



pefile dump

----------Parsing Warnings----------

Suspicious NumberOfRvaAndSizes in the Optional Header. Normal values are never larger than 0x10, the value is: 0xdfffddde

Error parsing section 2. SizeOfRawData is larger than file.

----------DOS_HEADER----------

[IMAGE_DOS_HEADER]
e_magic: 0x5A4D
e_cblp: 0x50
e_cp: 0x2

----------NT_HEADERS----------

[IMAGE_NT_HEADERS]
Signature: 0x4550

----------FILE_HEADER----------

[IMAGE_FILE_HEADER]
Machine: 0x14C
NumberOfSections: 0x4
TimeDateStamp: 0x851C3163 [INVALID TIME]
PointerToSymbolTable: 0x74726144
NumberOfSymbols: 0x455068
SizeOfOptionalHeader: 0xE0
Characteristics: 0x818F

----------OPTIONAL_HEADER----------

[IMAGE_OPTIONAL_HEADER]
Magic: 0x10B
MajorLinkerVersion: 0x2
MinorLinkerVersion: 0x19
SizeOfCode: 0x200
SizeOfInitializedData: 0x45400
SizeOfUninitializedData: 0x0
AddressOfEntryPoint: 0x2000
BaseOfCode: 0x1000
BaseOfData: 0x2000
ImageBase: 0xDE0000
SectionAlignment: 0x1000
FileAlignment: 0x1000
MajorOperatingSystemVersion: 0x1
MinorOperatingSystemVersion: 0x0

----------PE Sections----------

[IMAGE_SECTION_HEADER]
Name: CODE
Misc: 0x1000
Misc_PhysicalAddress: 0x1000
Misc_VirtualSize: 0x1000
VirtualAddress: 0x1000
SizeOfRawData: 0x1000
PointerToRawData: 0x1000
PointerToRelocations: 0x0
PointerToLinenumbers: 0x0
NumberOfRelocations: 0x0
NumberOfLinenumbers: 0x0
Characteristics: 0xE0000020
Flags: MEM_WRITE, CNT_CODE, MEM_EXECUTE, MEM_READ
Entropy: 0.061089 (Min=0.0, Max=8.0)

[IMAGE_SECTION_HEADER]
Name: DATA
Misc: 0x45000
Misc_PhysicalAddress: 0x45000
Misc_VirtualSize: 0x45000
VirtualAddress: 0x2000
SizeOfRawData: 0x45000
PointerToRawData: 0x2000
PointerToRelocations: 0x0
PointerToLinenumbers: 0x0
NumberOfRelocations: 0x0
NumberOfLinenumbers: 0x0
Characteristics: 0xC0000040
Flags: MEM_WRITE, CNT_INITIALIZED_DATA, MEM_READ
Entropy: 7.980693 (Min=0.0, Max=8.0)

[IMAGE_SECTION_HEADER]
Name: NicolasB
Misc: 0x1000
Misc_PhysicalAddress: 0x1000
Misc_VirtualSize: 0x1000
VirtualAddress: 0x47000
SizeOfRawData: 0xEFEFADFF
PointerToRawData: 0x47000
PointerToRelocations: 0x0
PointerToLinenumbers: 0x0
...

PE feature vector

Name|md5|Machine|SizeOfOptionalHeader|Characteristics|MajorLinkerVersion|MinorLinkerVersion|SizeOfCode|SizeOfInitializedData|SizeOfUninitializedData|AddressOfEntryPoint|BaseOfCode|BaseOfData|ImageBase|SectionAlignment|FileAlignment|MajorOperatingSystemVersion|MinorOperatingSystemVersion|MajorImageVersion|MinorImageVersion|MajorSubsystemVersion|MinorSubsystemVersion|SizeOfImage|SizeOfHeaders|CheckSum|Subsystem|DllCharacteristics|SizeOfStackReserve|SizeOfStackCommit|SizeOfHeapReserve|SizeOfHeapCommit|LoaderFlags|NumberOfRvaAndSizes|SectionsNb|SectionsMeanEntropy|SectionsMinEntropy|SectionsMaxEntropy|SectionsMeanRawsize|SectionsMinRawsize|SectionMaxRawsize|SectionsMeanVirtualsize|SectionsMinVirtualsize|SectionMaxVirtualsize|ImportsNbDLL|ImportsNb|ImportsNbOrdinal|ExportNb|ResourcesNb|ResourcesMeanEntropy|ResourcesMinEntropy|ResourcesMaxEntropy|ResourcesMeanSize|ResourcesMinSize|ResourcesMaxSize|LoadConfigurationSize|VersionInformationSize|**legitimate**

legitimate:

memtest.exe|631ea355665f28d4707448e442fbf5b8|332|224|258|9|0|361984|115712|0|6135|4096|372736|4194304|4096|512|0|0|0|0|1|0|1036288|1024|485887|16|1024|1048576|4096|1048576|4096|0|16|8|5.7668065537|3.60742957555|7.22105072892|59712.0|1024|325120|126875.875|896|551848|0|0|0|0|4|3.26282271103|2.56884382364|3.53793936419|8797.0|216|18032|0|16|1

malware:

VirusShare_76c2574c22b44f69e3ed519d36bd8dff|76c2574c22b44f69e3ed519d36bd8dff|332|224|258|10|0|28672|445952|16896|14819|4096|32768|4194304|4096|512|5|0|6|0|5|0|3977216|1024|680384|2|34112|1048576|4096|1048576|4096|0|16|6|2.65064184009|0.0|6.49788465186|30634.6666667|0|139264|661773.333333|3978|3362816|8|172|1|0|21|3.42072662405|1.86523352037|7.9688495098|6558.42857143|180|67624|0|0|0

SURPRISE CHALLENGE

l33tdawg
@l33tdawg

Following

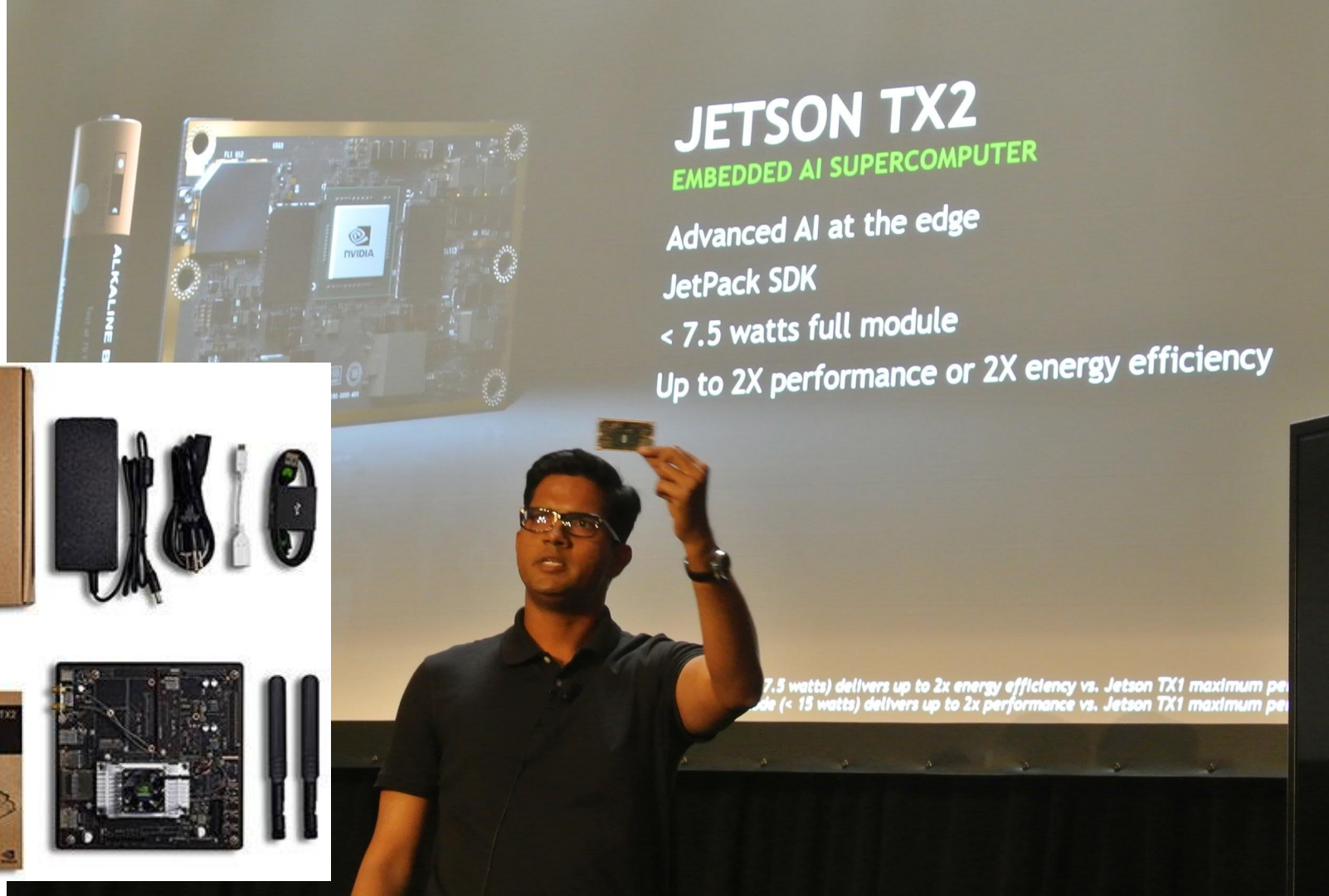
NVIDIA Jetson TX2 is the supercomputer that's going to build the next great idea flip.it/l-UTBH <--- gotta get one!

NVIDIA Jetson TX2 is the supercomputer that's going to build the next great i...

NVIDIA's Jetson TX2 is more than a worthy successor to the original. It's a new way to do things.Artificial Intelligence and machines that can learn are how the things...

flip.it


JETSON
TX2
NVIDIA JETSON TX2
NVIDIA JETSON TX2


JETSON TX2
EMBEDDED AI SUPERCOMPUTER
Advanced AI at the edge
JetPack SDK
< 7.5 watts full module
Up to 2X performance or 2X energy efficiency
NVIDIA
ALKALINE

CHALLENGE

a. **NETWORK CHALLENGE:** Capture packets on conference network and do some packet classification with machine learning (i.e. attack/non-attack, type of packet)

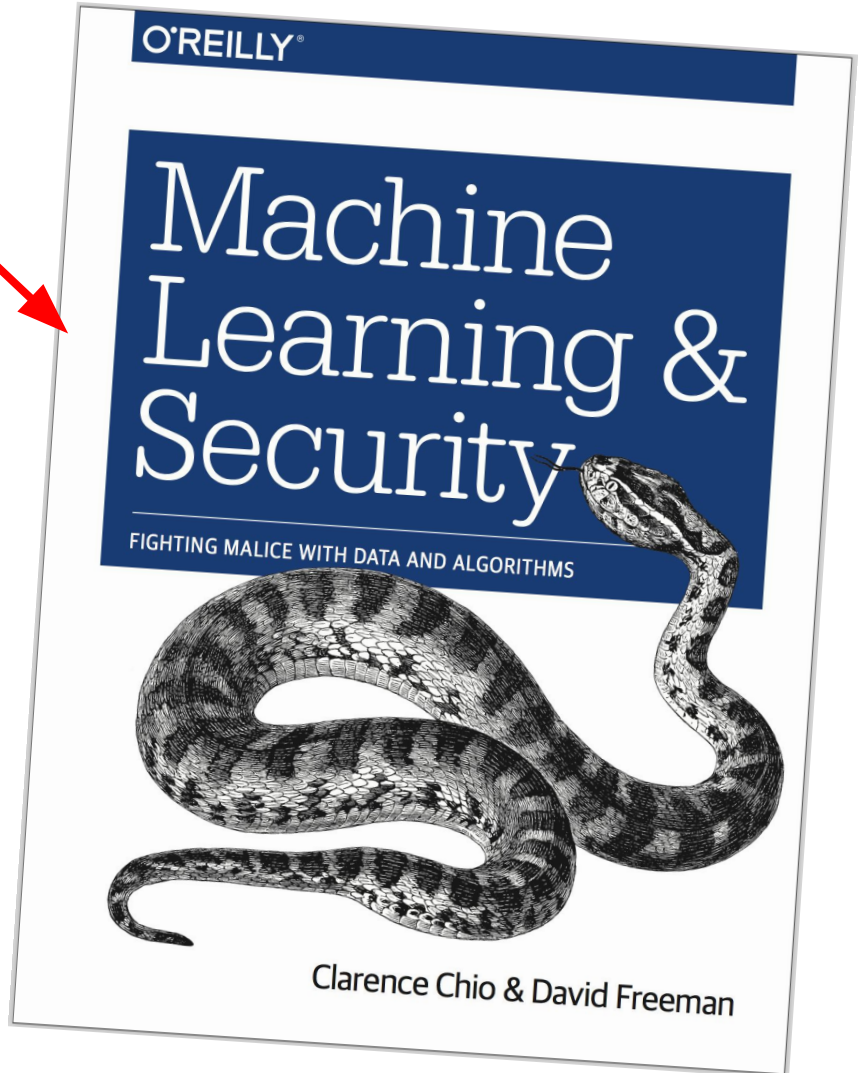
b. **MALWARE CHALLENGE:** Find malware binaries online (or get from us) and do some binary classification (i.e. malware/non-malware, type of malware)

GET CREATIVE!

- Final adjudication based on a 50-50 mix of how interesting the submission is, and how well it works.
- Can work in teams (but only 1 prize)
- **Show-and-tell style presentation tomorrow (friday) lunchtime at the main expo booth.**

signup for updates!

mlsec@cs.stanford.edu



Thank you!

@cchio

cchio@cs.stanford.edu

@antojosep007

antojoseph007@gmail.com