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Data Science for Security Professionals - Day 1

Module 1: Introduction & Data Preparation with Pandas

Expectations

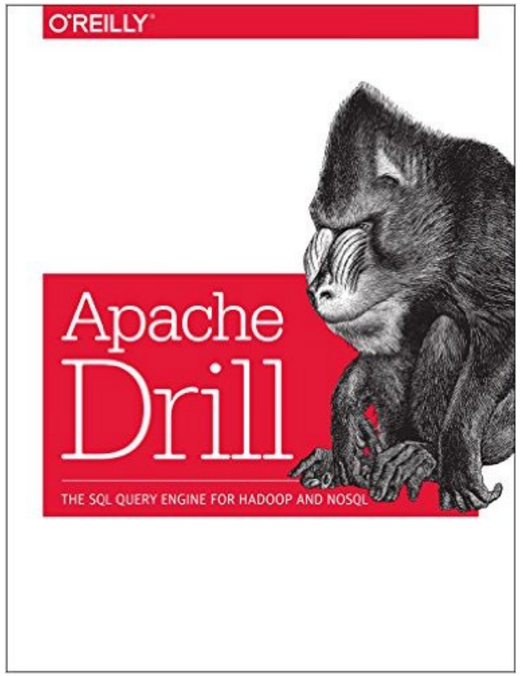
- Please participate and **ask questions.**
- Please follow along and **TRY OUT** the examples yourself during the class
- All the answers are in the slide decks or GitHub repository, but please try to complete the exercises **without looking at the answers**.
- Have fun!

Introduction

Who am I?

Charles Givre

- Senior Lead Data Scientist @ Booz Allen
- 5 Years @ CIA
- Working on Apache Drill Book
- Masters Degree in Middle Eastern Studies
- Undergraduate in Comp.Sci & Music



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What is Data Science?

Data Science is the art of **turning data into actions**. This is accomplished through the creation of data products, which provide actionable information without exposing decision makers to the underlying data or analytics

Booz Allen Hamilton, Field Guide to Data Science, Pg. 17

Extracting **useful information**

Extracting useful information **from data**

Answering questions

Answering **business questions**

Answering business questions **with data**

Answering business questions with data

- Know what you want to know

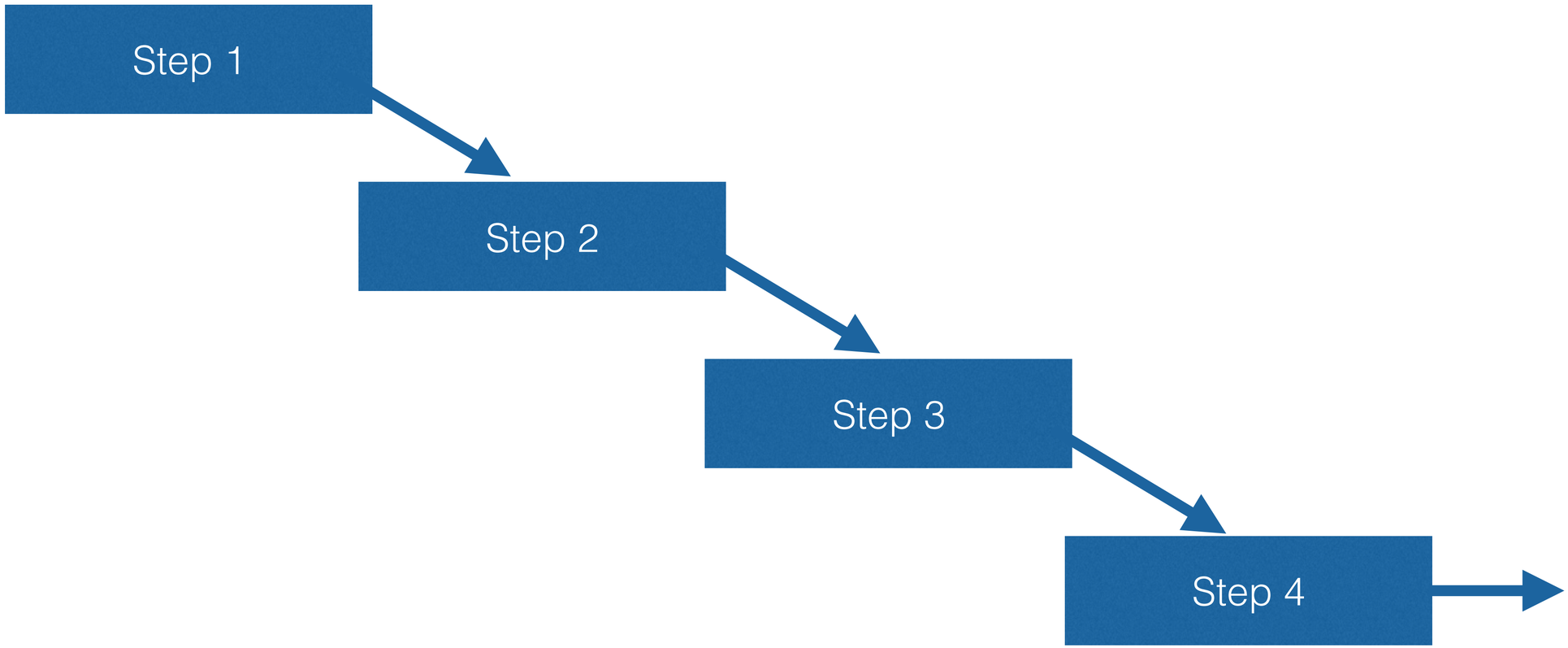
Answering business questions **with data**

- Know what you want to know
- Have the **technical skills** to get it

Analyst ⟷ Developer

Analyst + Developer

What Data Science is Not



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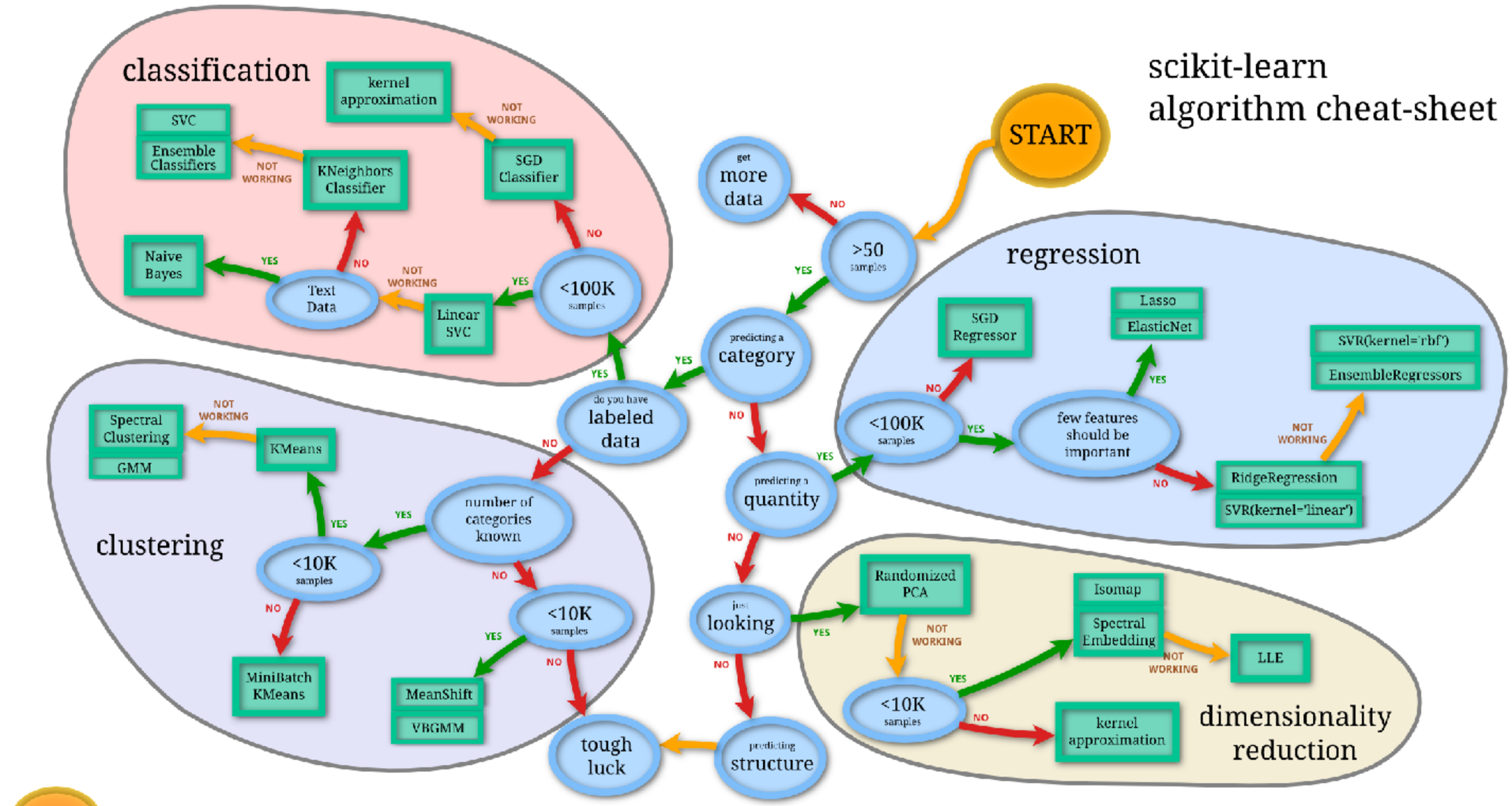
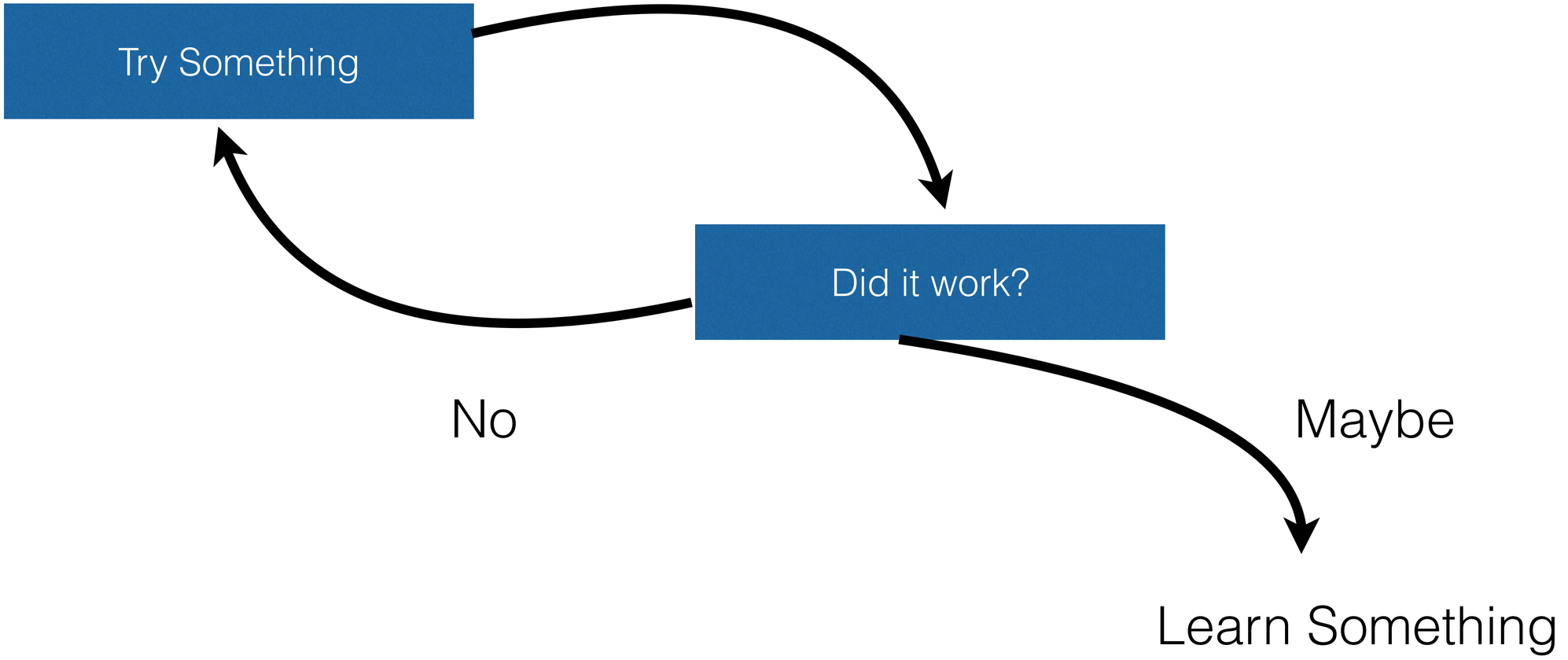
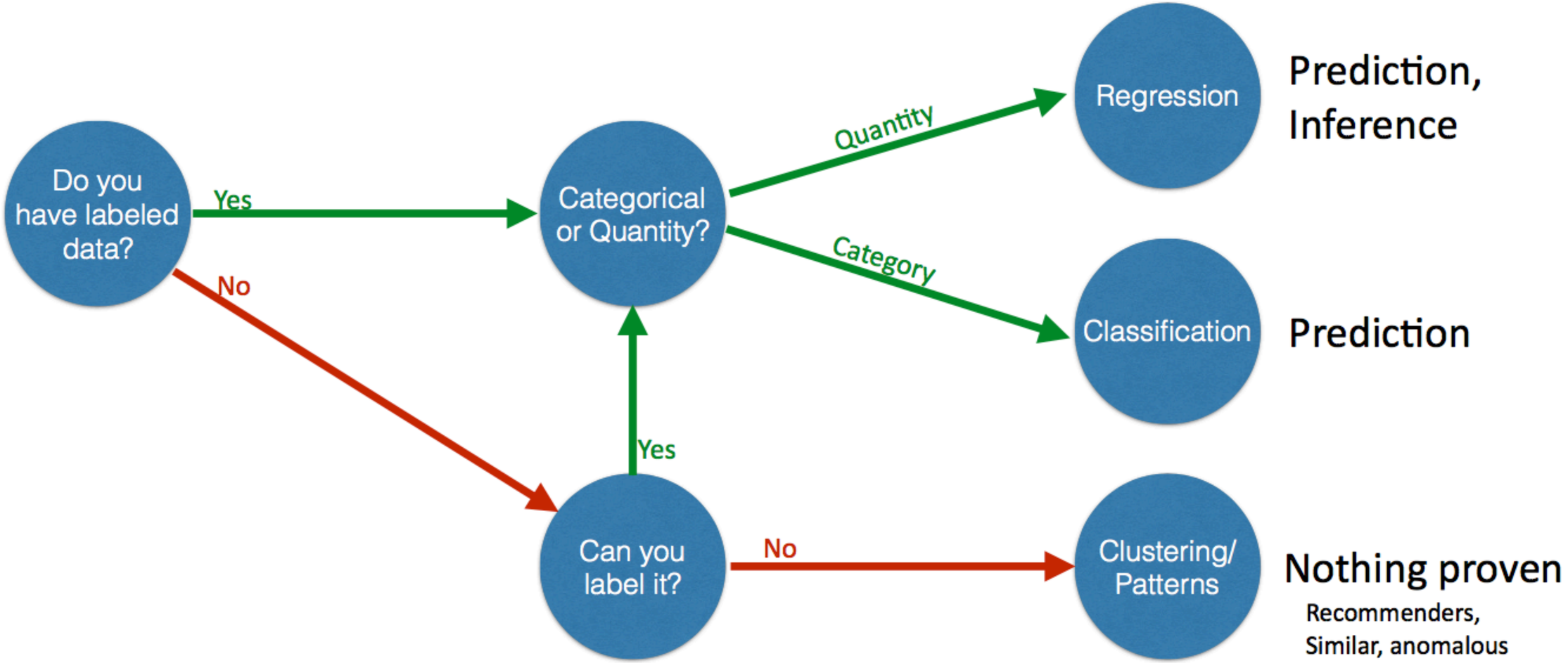
What Data Science is Not



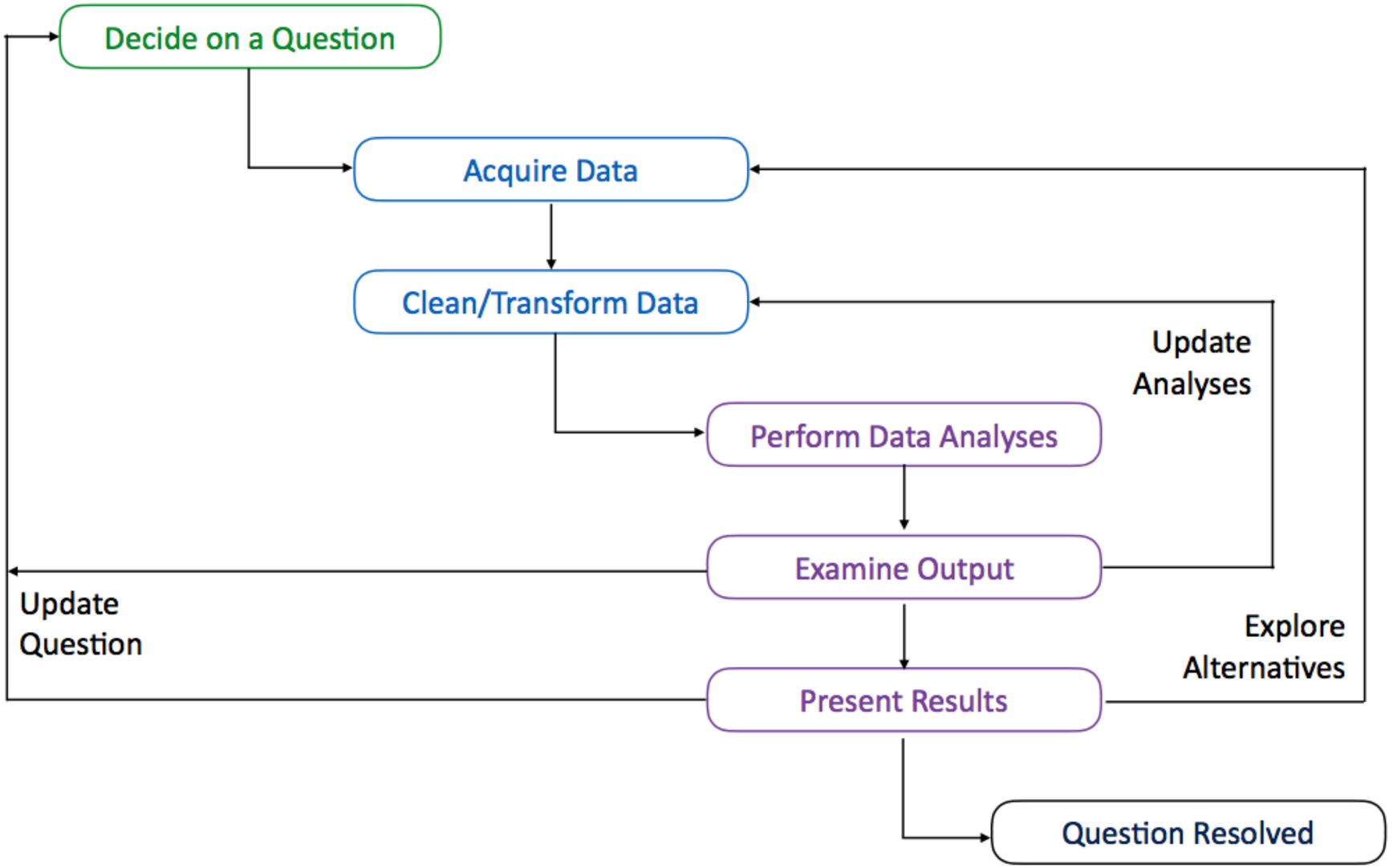
What Data Science is



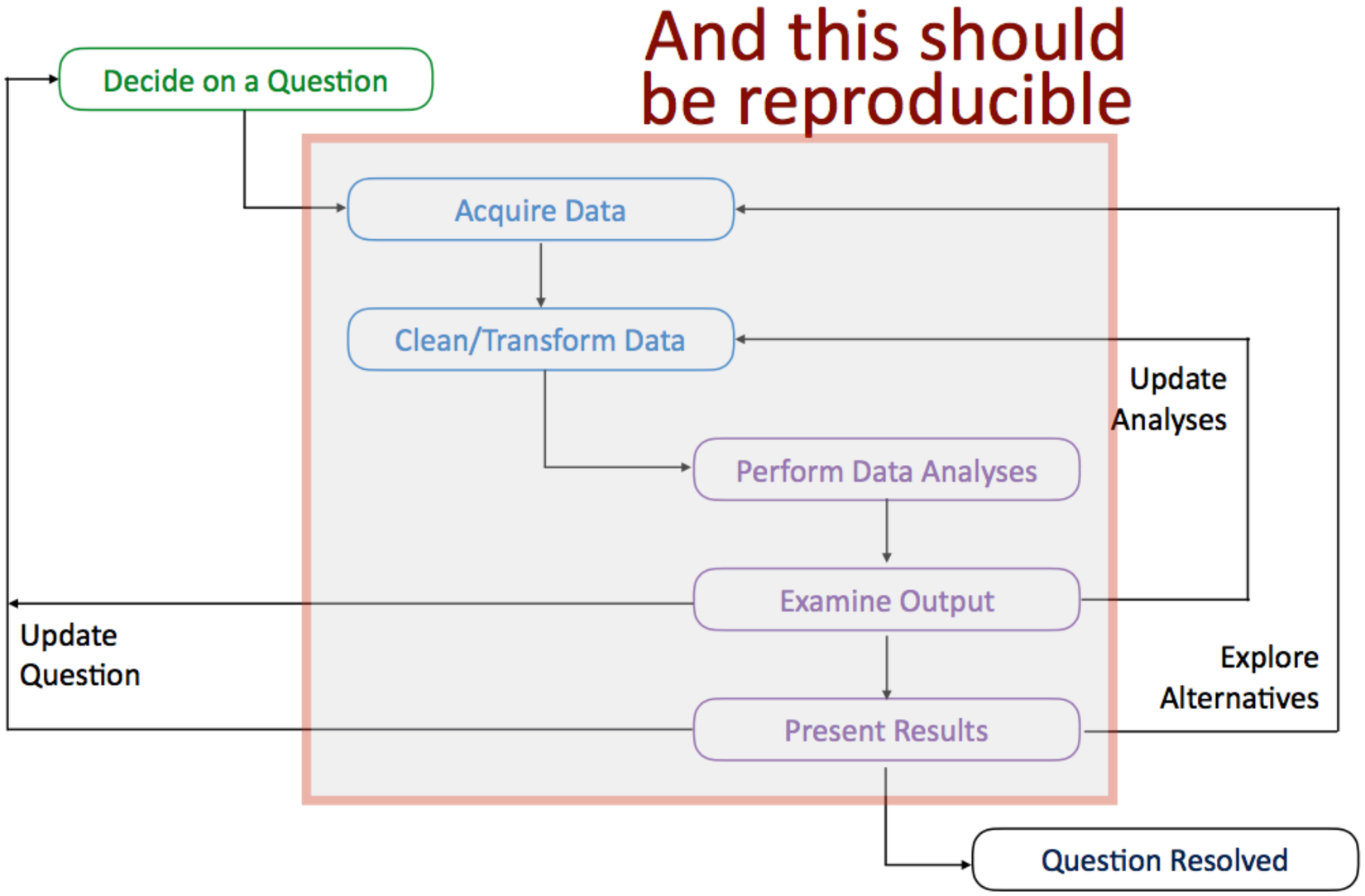
What Data Science might be..



Research Process



Research Process



"The term "data scientist" will subside and may well sound dated five years from now. **The skills will become more commonplace and commoditized. When that happens, the real boom will begin**, because the technology will become widely adopted and thus more useful. … **Instead, we need self-service tools that empower smart and tenacious business people to perform Big Data analysis themselves.**

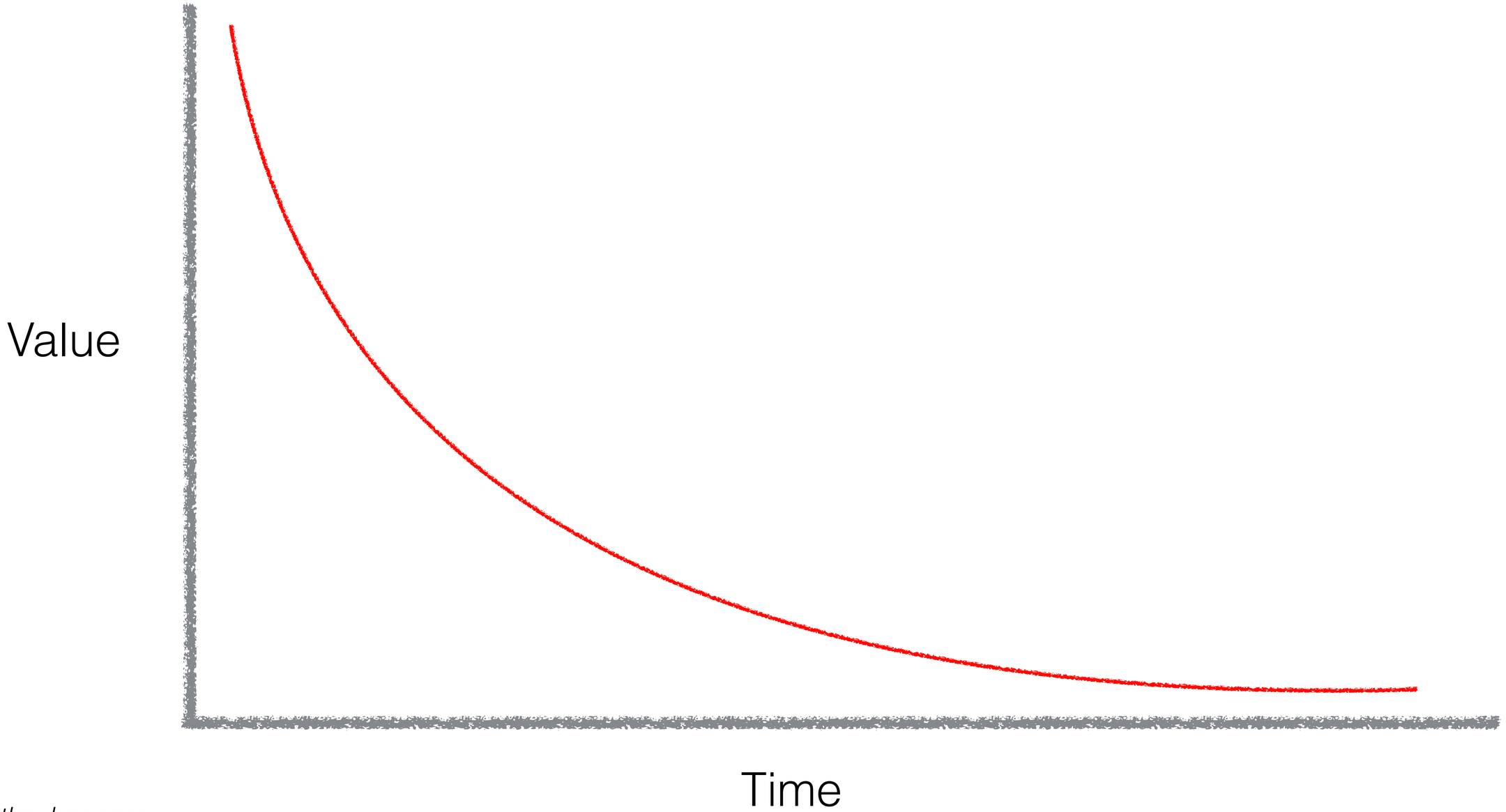
–Andrew Brust, "Data scientists don't scale", http://www.zdnet.com/article/data-scientists-dont-scale/

Time to Insight

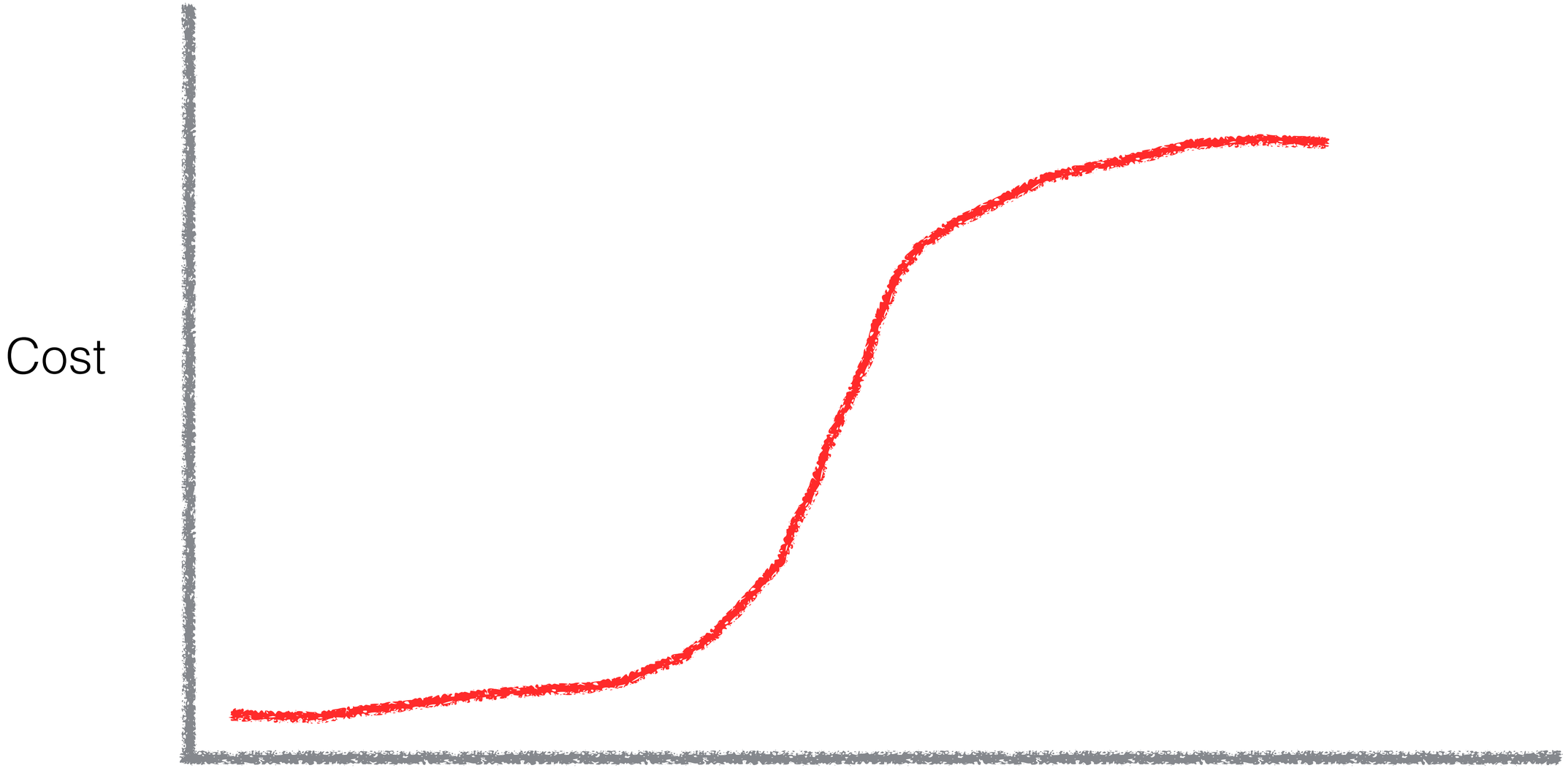
Time to Insight

Time = $$

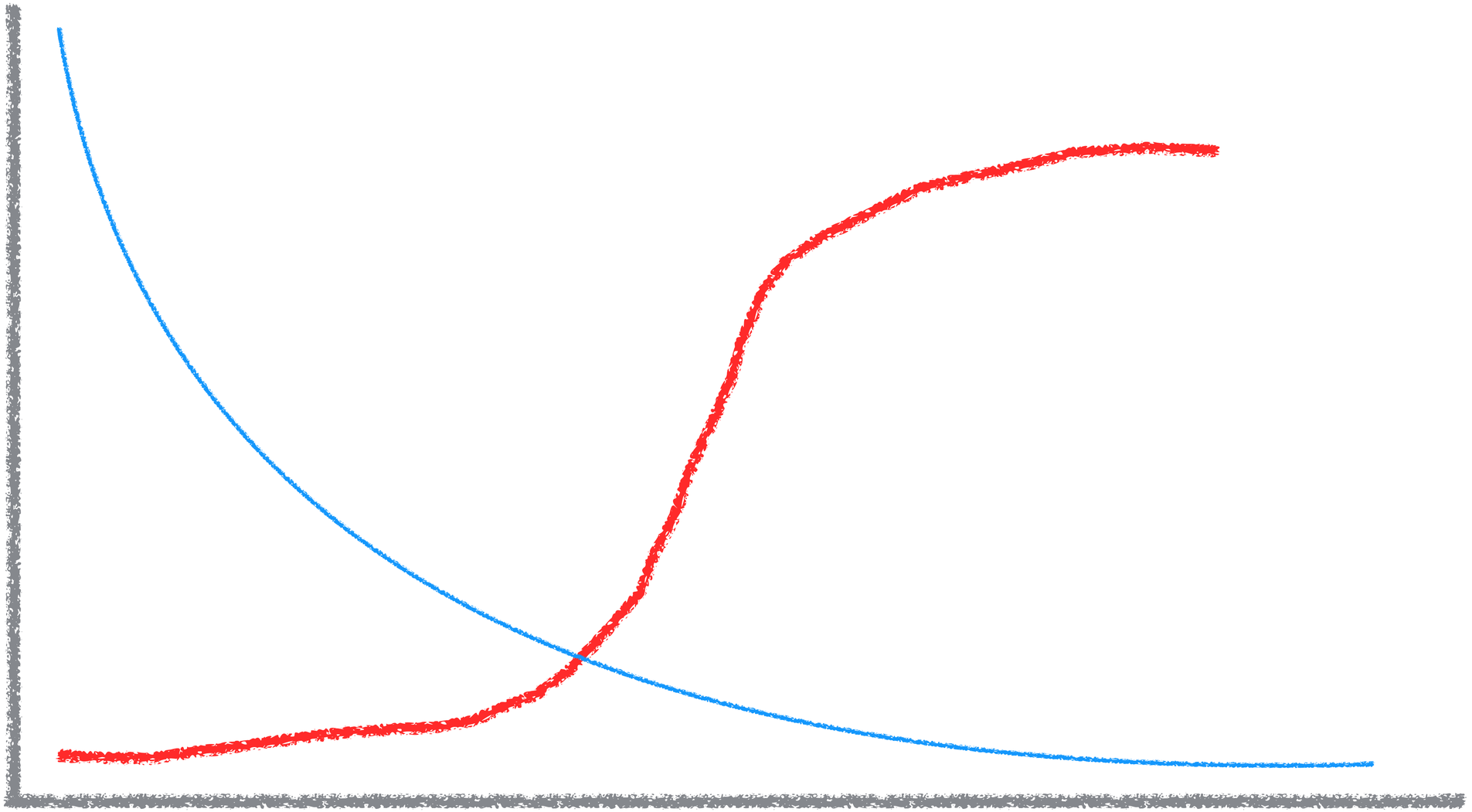
Value of Insights over Time



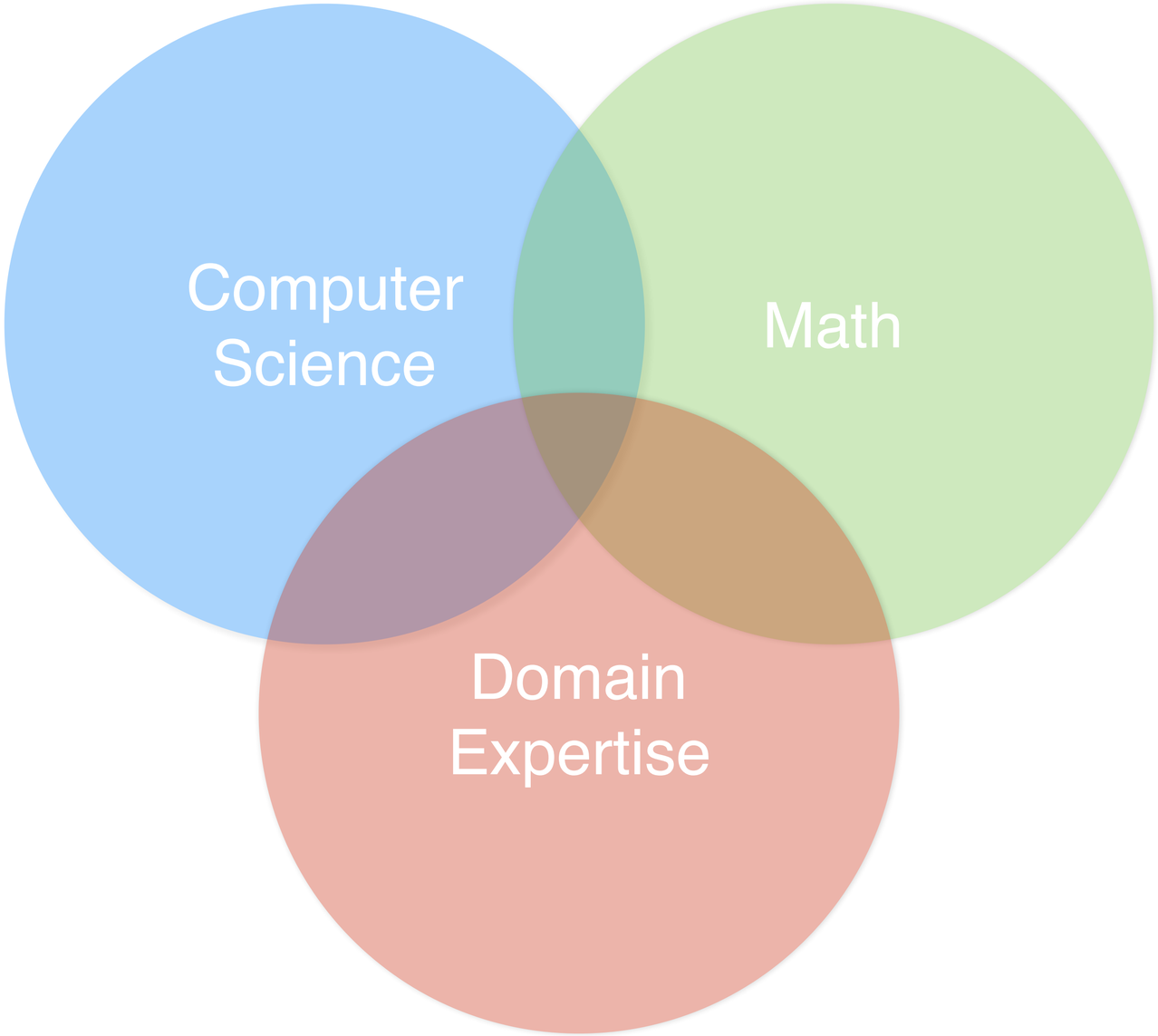
Cost of Insights over Time

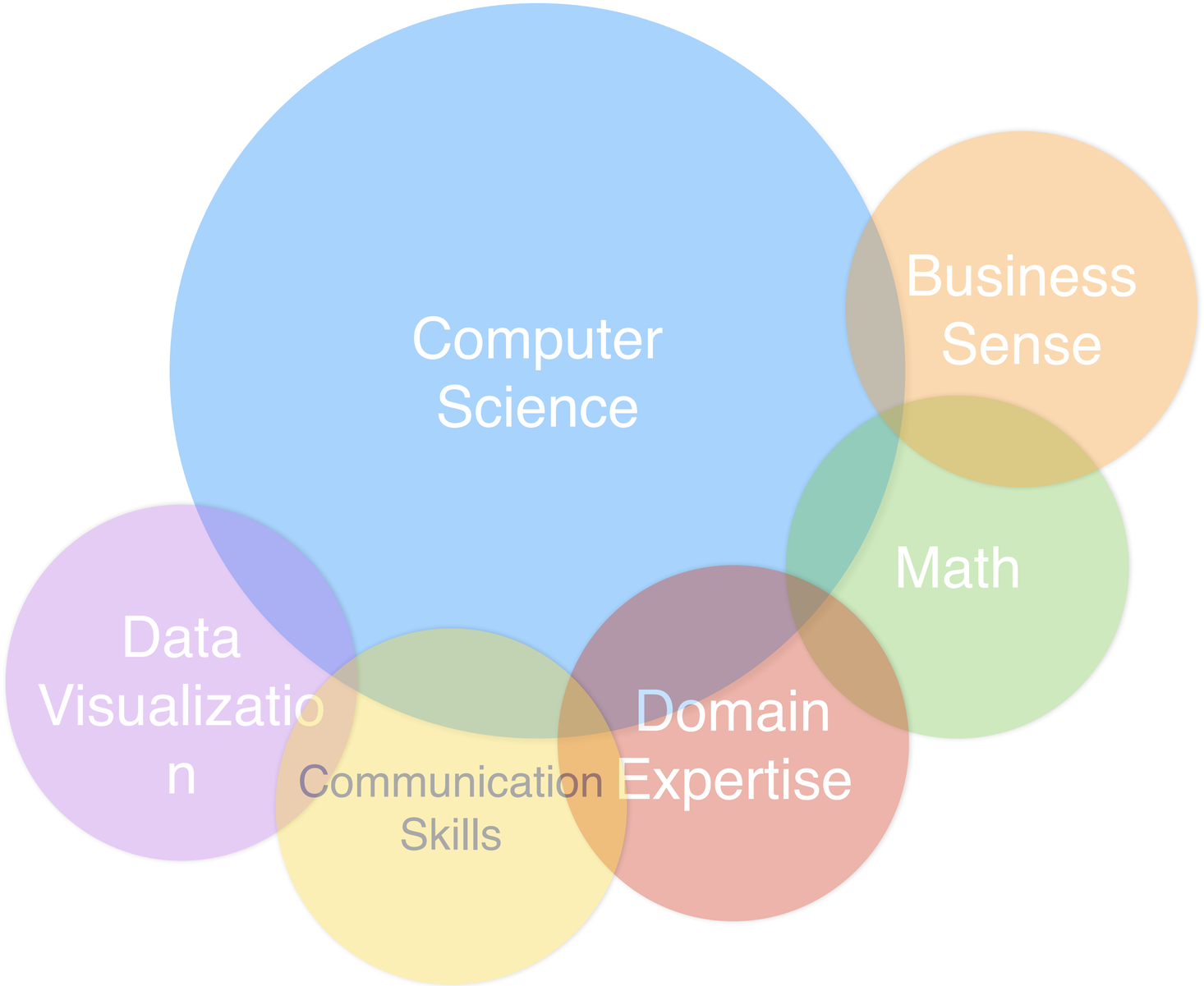


Cost of Insights over Time



What skills does a data scientist need?


Computer
Science
Math
Domain
Expertise


Computer Science
Business Sense
Math
Data Visualization
Communication Skills
Domain Expertise

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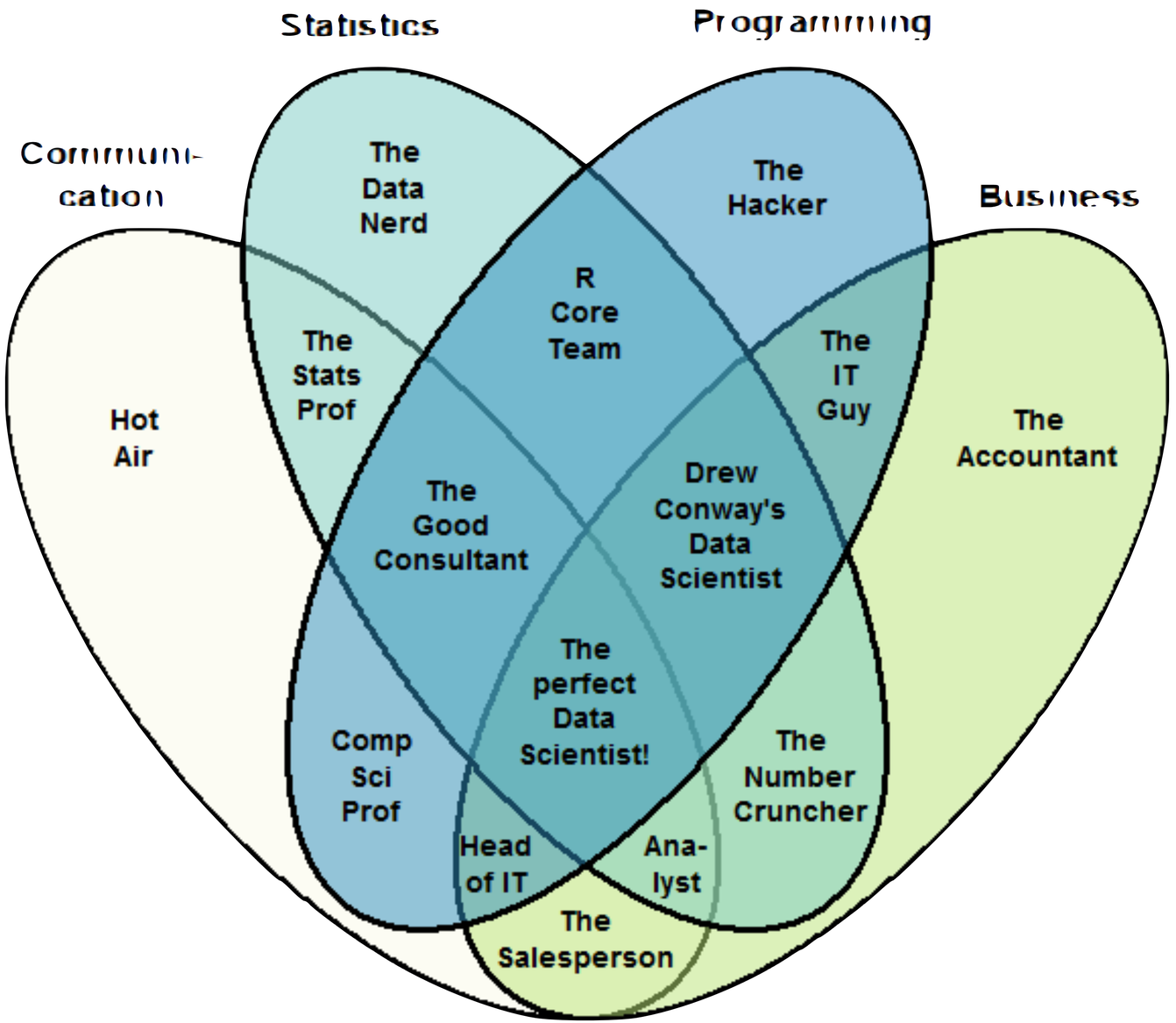
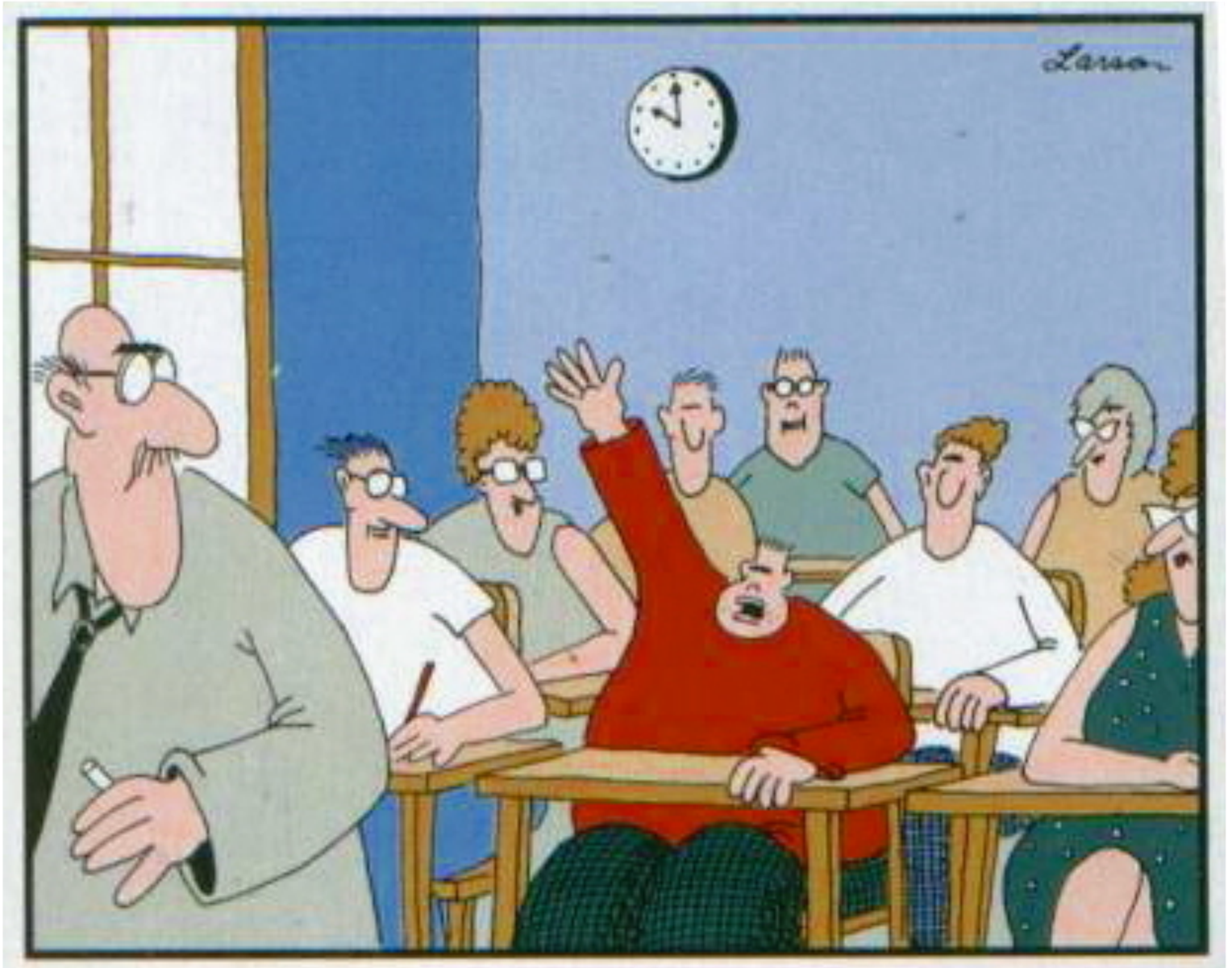
The Data Scientist Venn Diagram



Data Scientists spend 50-90% of their time being…

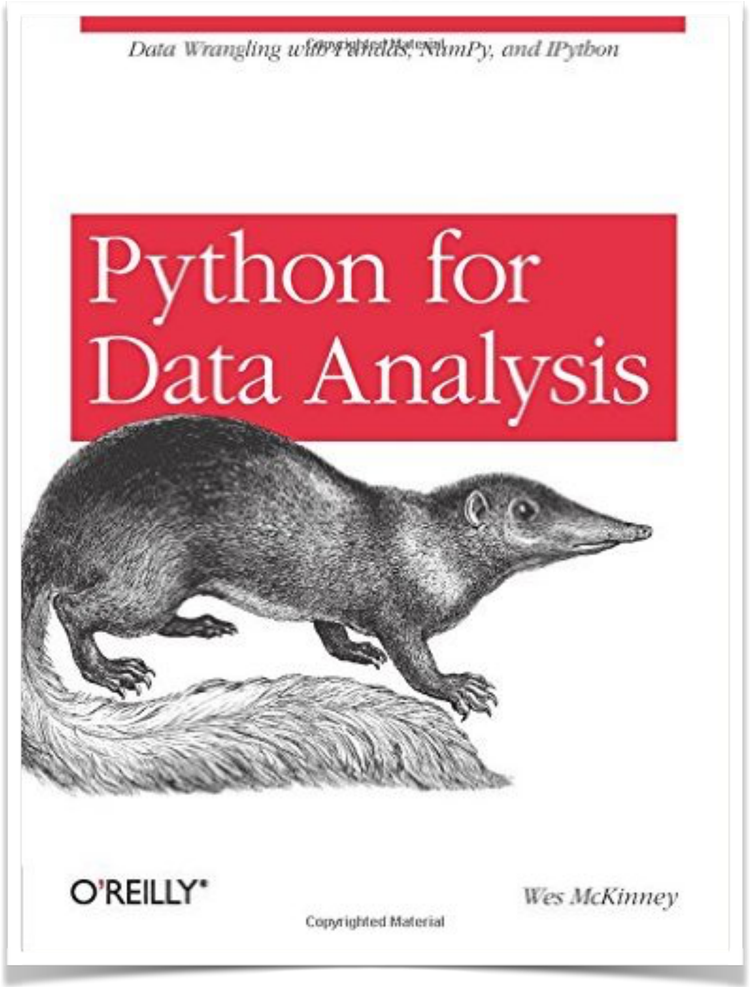

CAUTION
WET FLOOR



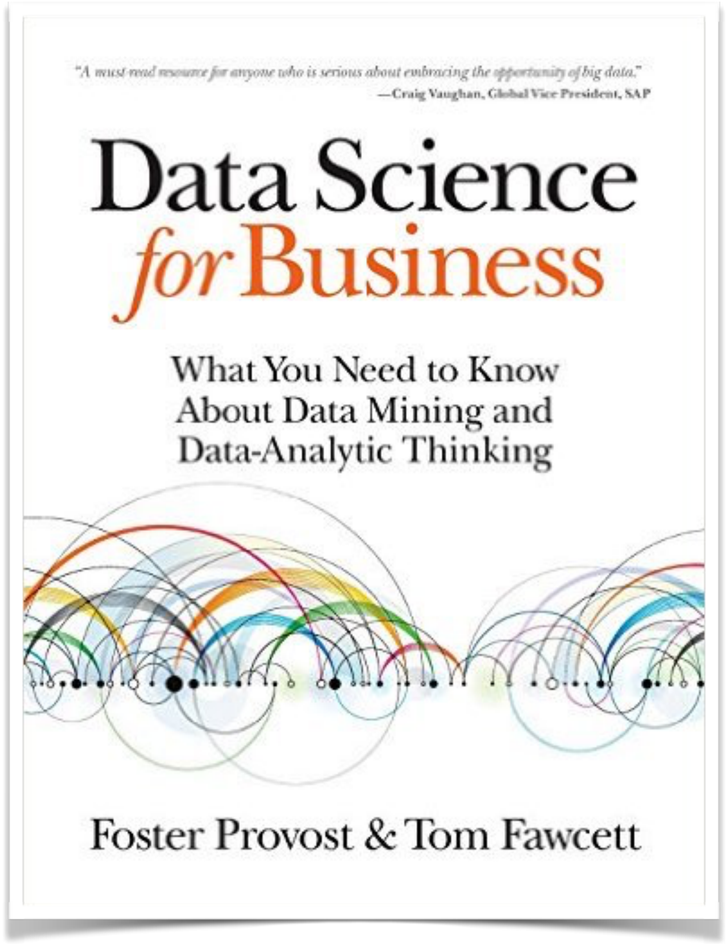
"Mr. Osborne, may I be excused?
My brain is full."


Buzzword

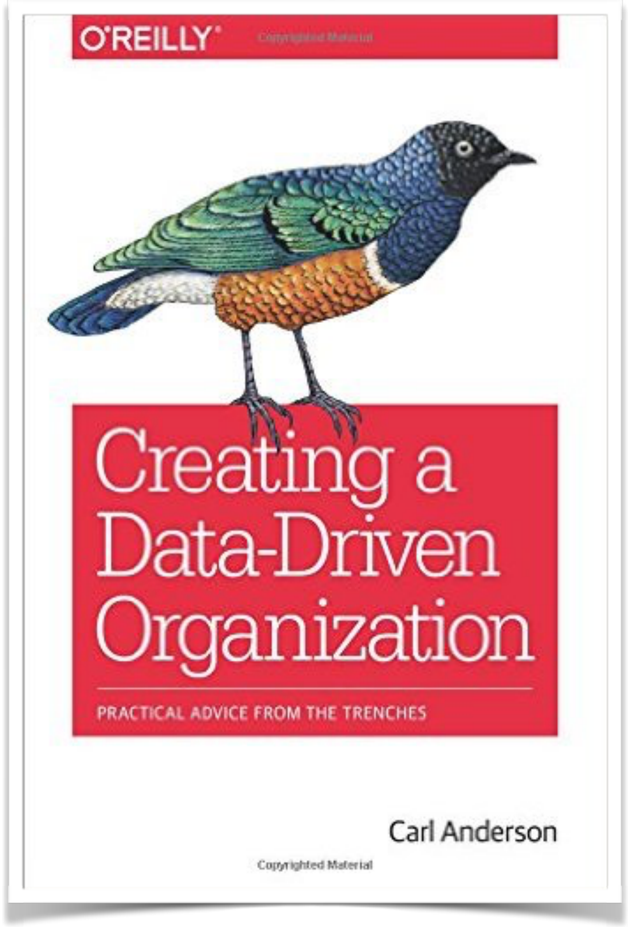
Recommended Reading



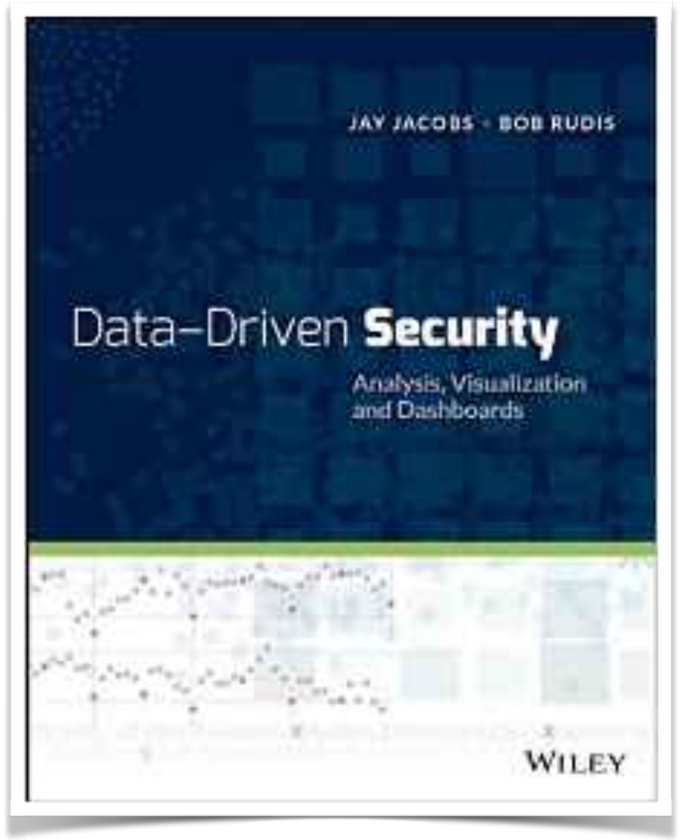
Recommended Reading



Recommended Reading



Recommended Reading

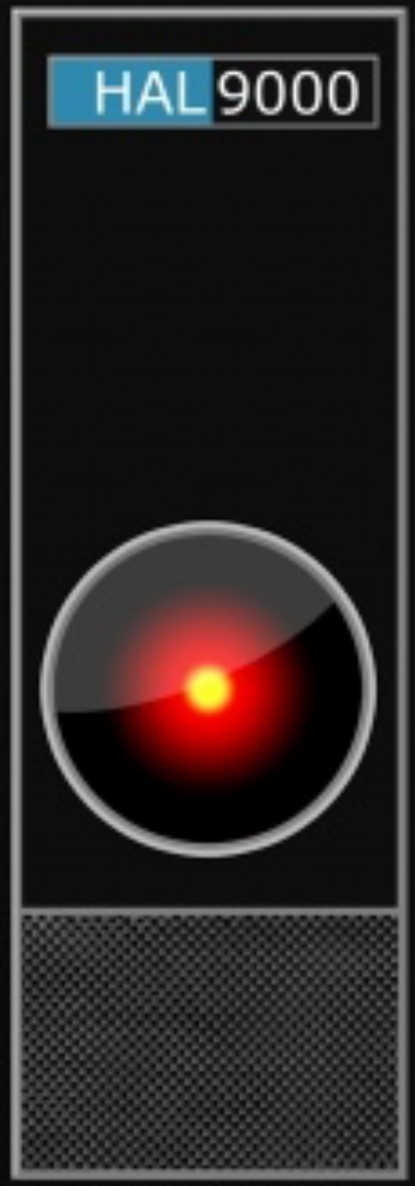


http://datadrivensecurity.info

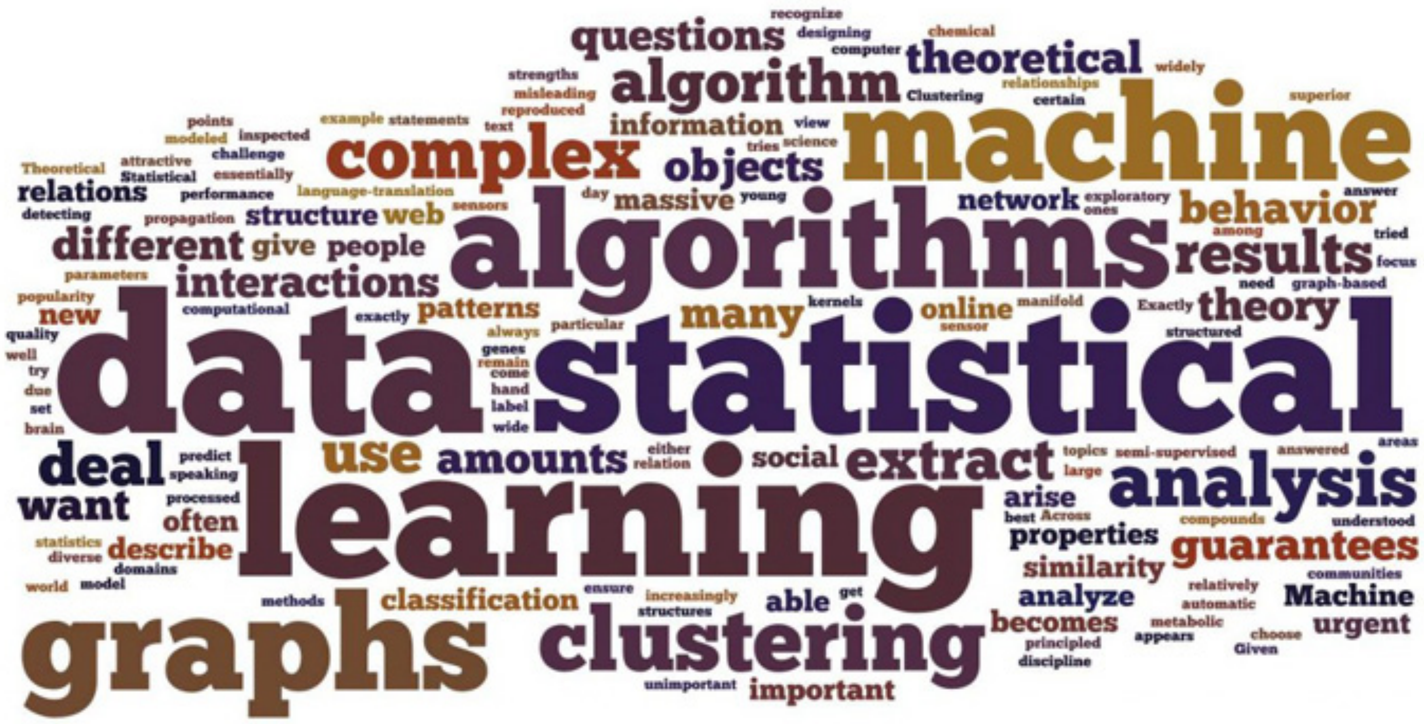
Recommended Reading

http://www.boozallen.com/media/file/The-Field-Guide-to-Data-Science.pdf

Machine Learning



What is
Machine Learning (ML)
Artificial Intelligence (AI)



“I have no idea. The latest buzzword? ”

–The guy in the back of the class

"Machine learning is the science of getting computers to **act without being explicitly programmed.** "

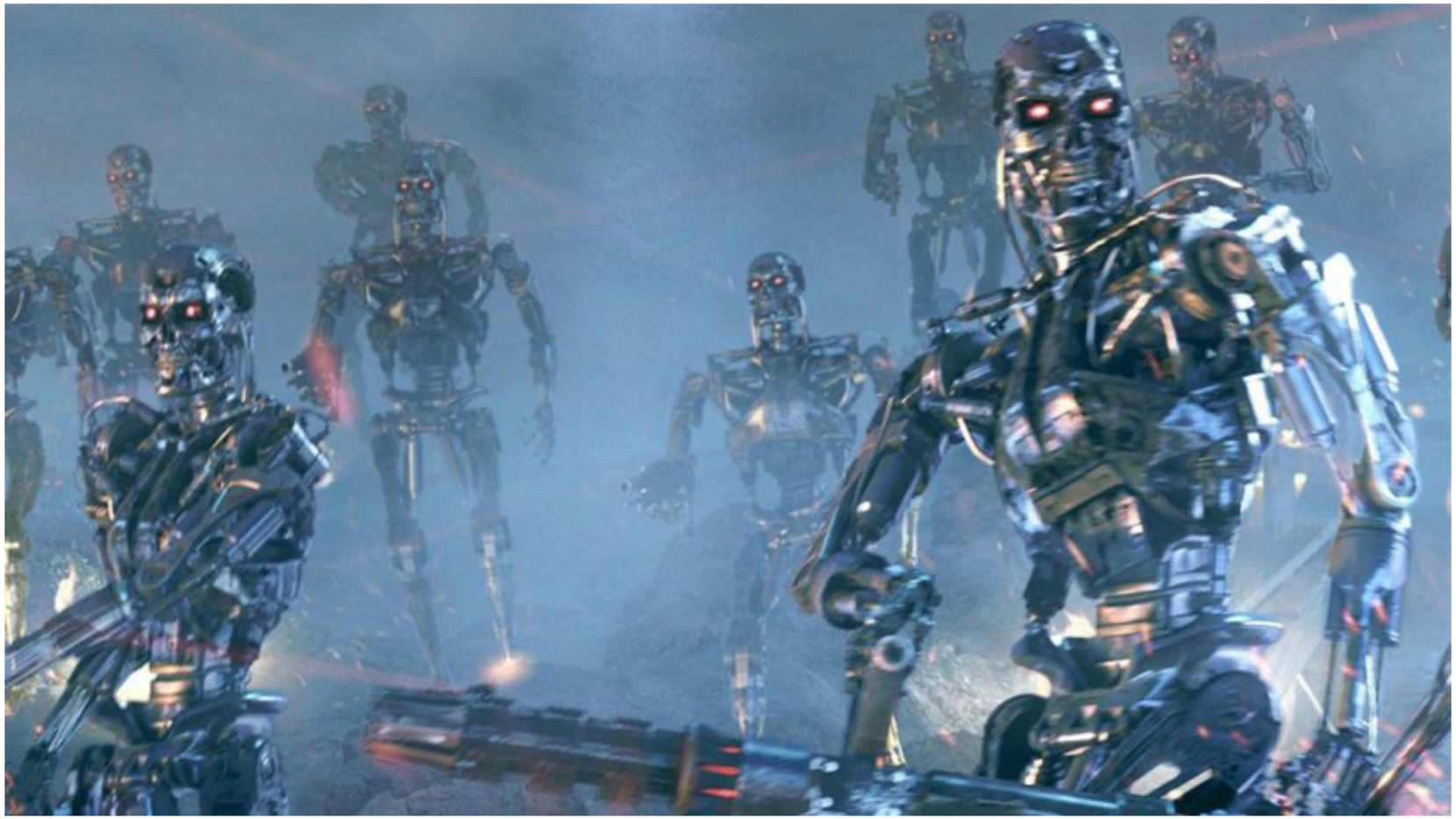
– *https://www.coursera.org/course/ml*

"A computer program is said to learn from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E."

–Tom Mitchell, Carnegie Mellon University

"Machine learning explores the construction and study of algorithms that can learn from and **make predictions on data.** Such algorithms operate by building a model from example inputs in order to make data-driven predictions or decisions, **rather than following strictly static program instructions.**"

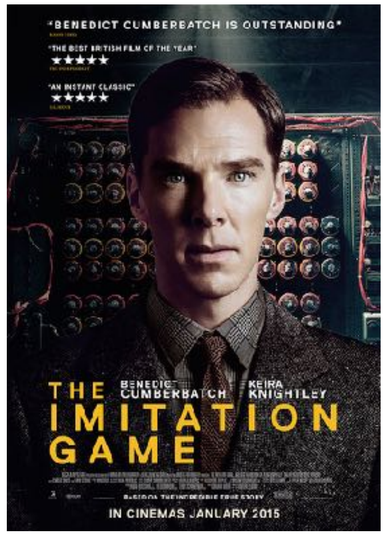
–*https://en.wikipedia.org/wiki/Machine_learning*



What it is not

History of AI and ML

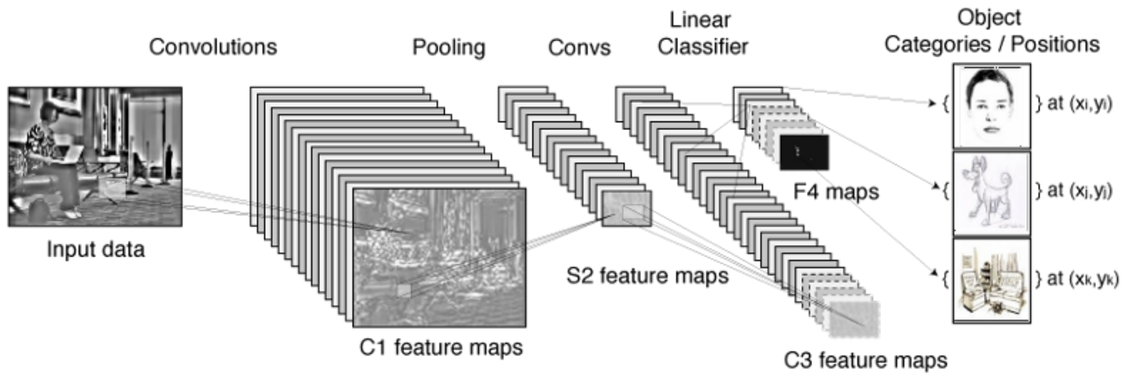
- Mythical figure Pygmalion: Breath of life in a statue (ancient Greece)
- Turing Test 1950s by Alan Turing: Test of a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human.
- Early AI: solve problems that are difficult for humans, but straightforward for computers (e.g. formal mathematical rules) IBM Deep Blue chess-playing system defeated world champion Garry Kasparov 1997.
- Real Challenge: Intuitive, easy problems for humans. They are hard to describe formally (e.g recognizing faces, words).



http://www.deeplearningbook.org/

Path to Artificial Intelligence?

- Hard-coding knowledge failed (e.g. Cyc 1989).
- **Gathering knowledge from experience** eliminates the need to formally specify all knowledge the computer needs.
- AI needs to acquire own knowledge by **extracting pattern from raw data.**
- Success depends heavily on **representation of data, aka features.**
- How to choose features?
- Is Deep Learning the answer?



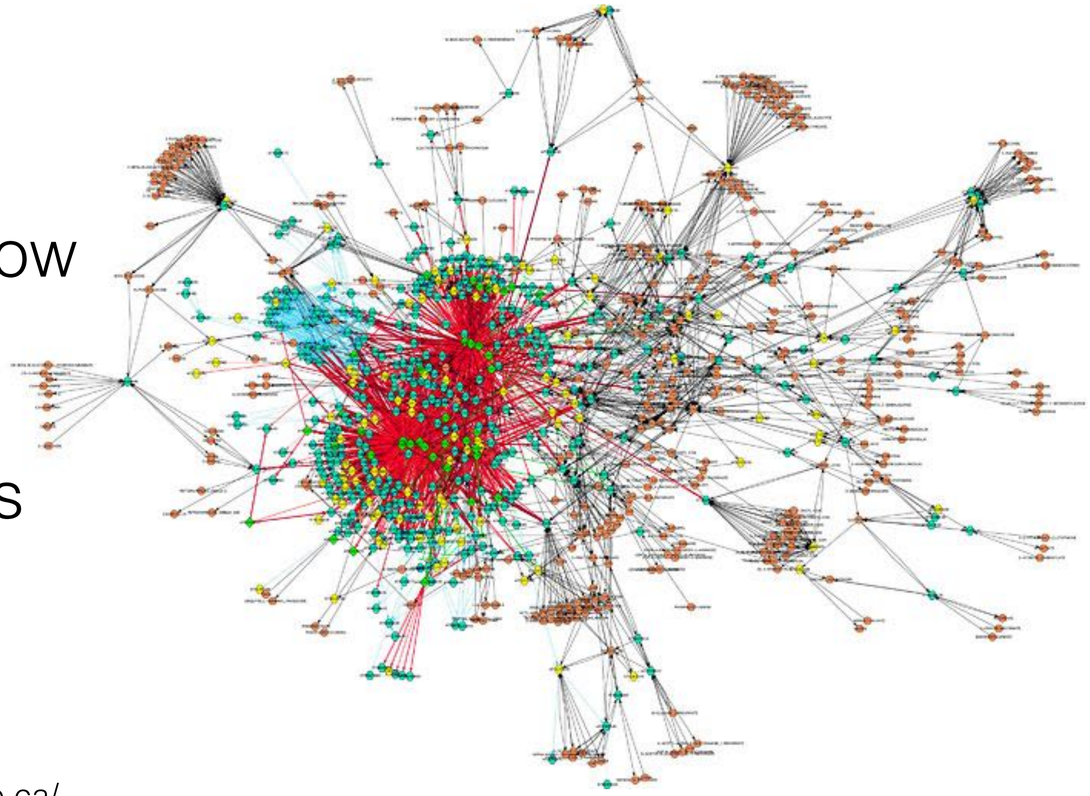
http://www.deeplearningbook.org/

Automating Decisions

Applications to Cyber

Network-Based Intrusion Detection

- Derive Features from Network Traffic Captures “pcap” at packet level or NetFlow level (tools: tshark, tcpdump, bro…)
- Example Features based on header information: 2s-windowing of connections > duration, protocol, src and dat bytes, service.
- Get data sets: http://www.netresec.com/?page=PcapFiles, https://maccdc.org/, http://www.westpoint.edu/crc/SitePages/DataSets.aspx http://www.unb.ca/cic/research/datasets/,



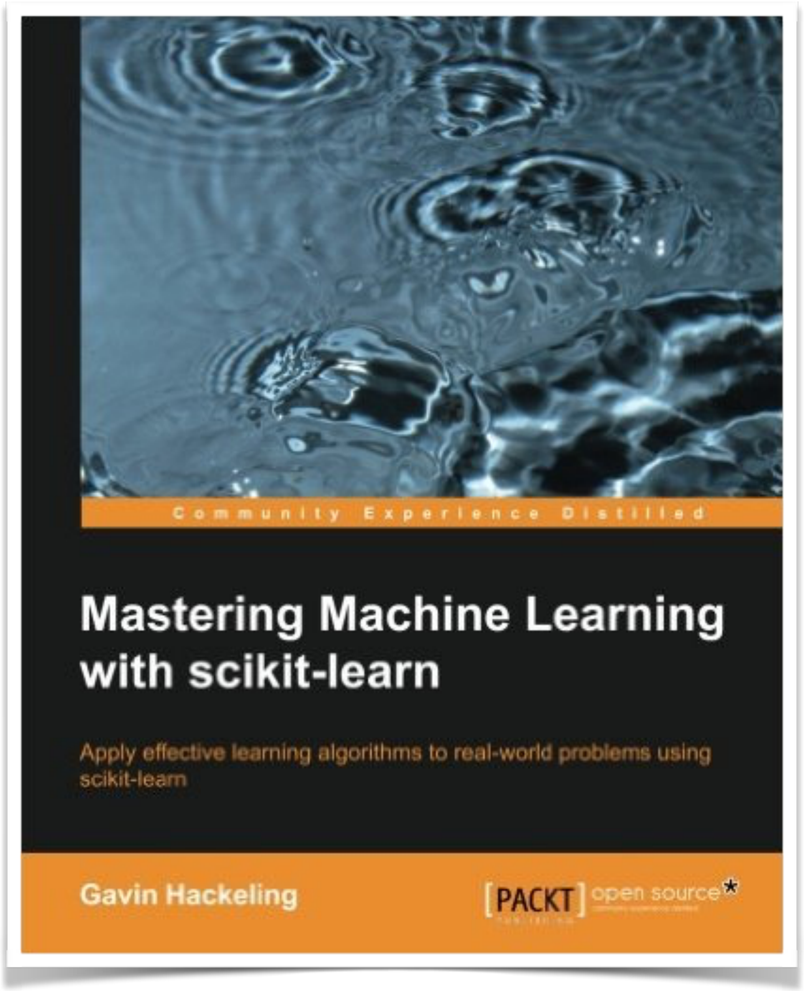
Malware Detection/Classification

- Derive Features from Binary Content and metadata manifest (function calls, string obtained from IDA Disassembler)
- Example Features: opcode count (n-grams), segment count, asm pixel intensity, n-gramming of bytes, function name.
- Featureless Deep Learning with word2vec embedding
- Get open source malware samples: Vx Heaven, Virus Share, Maltrieve, Open Malware

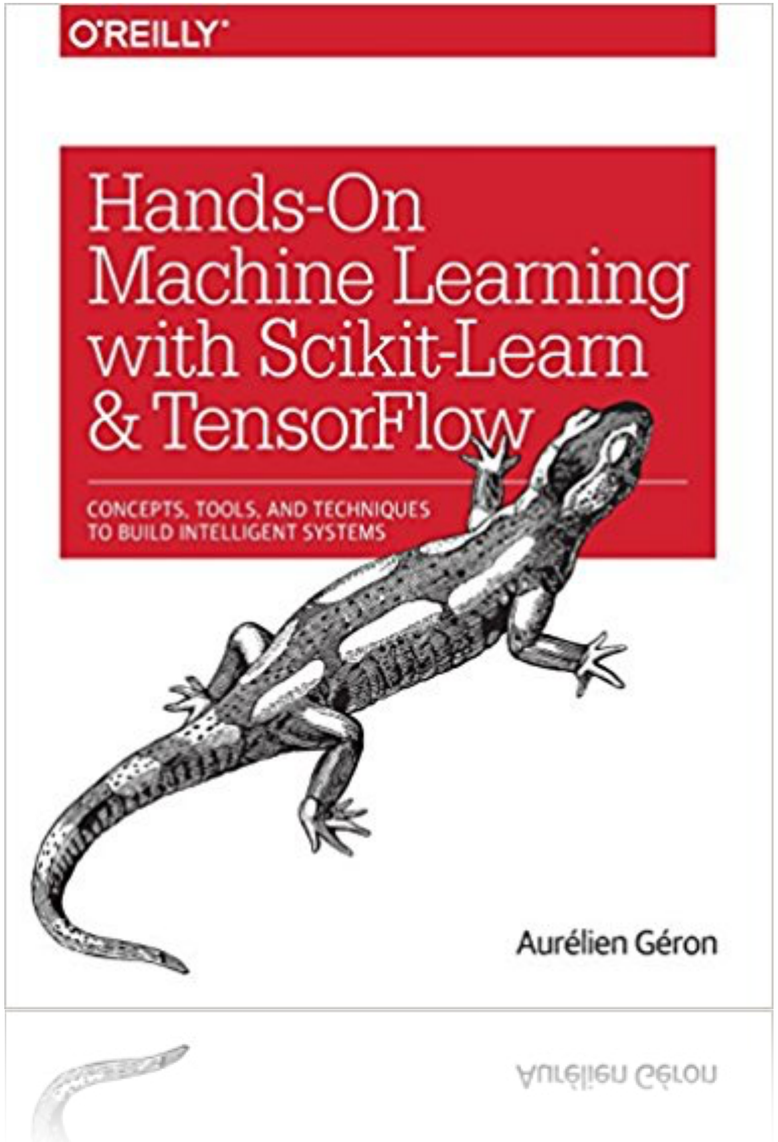
More Applications

- Domain Generation Algorithm (DGA) Detection
- **Malicious URL Detection**
- Network Traffic: Beaconing Detection
- Detection of new classes of malware
- General Network Traffic Anomaly Detection
- Log Analysis - Anomaly Detection
- Phishing Detection
- Identifying SQL Injection
- Identifying XSS cross-site scripting
- DOS/DDOS Detection
- Authentication

Recommended Reading



Recommended Reading



Exploratory Data Analysis

Part 1: One Dimensional Data

What is it?

Vectorized Data Structures let you **perform operations** on your data **all at once**


```
for x in range(0, len( data )):
    data[x] = data[x] + 1
```


```
for x in range(0, len( data )):
    data[x] = data[x] + 1
```

```
odds = evens + 1
```

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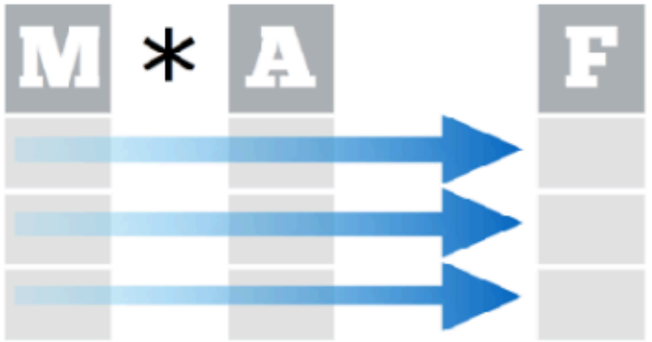
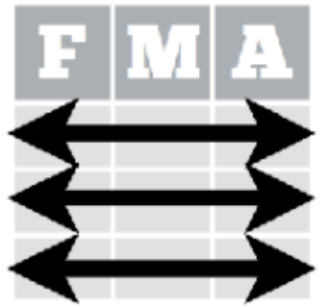
F = M * A



Each **variable** is saved in its own **column**

&



Each **observation** is saved in its own **row**

No loops

Dimensions	Name	Description
1	Series	Indexed 1 dimensional data structure
1	Timeseries	Series using timestamps as an index
2	DataFrame	A two dimensional table
3	Panel	A three dimensional mutable data structure

The Series Object

A **Series** is like a list

A **Series** is like a list or a dictionary

A **Series** is like a list or a dictionary **but BETTER!!**

The **Series** is the **primary building block** for all the other data structures we will discuss


```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```


```
myData  = pd.Series( <data>, index=<index> )
```

Creating a Series

```
series1 = pd.Series( ['a','b','c','d', 'e'])

series2 = pd.Series( {'firstName':'Charles',
'lastName':'Givre'} )
```

Accessing a Series

```
series1 = pd.Series( ['a','b','c','d', 'e'])
```

```
print( series1 )
```

```
0    a
1    b
2    c
3    d
4    e
dtype: object
```

Accessing a Series

```
series1 = pd.Series( ['a','b','c','d', 'e'])
```

```
print( series1[3] )
```

```
d
```

Accessing a Series

```
series1 = pd.Series( ['a','b','c','d', 'e'])
```

```
print( series1[1:3] )
```

```
1    b
2    c
dtype: object
```

Accessing a Series

```
series1 = pd.Series( ['a','b','c','d', 'e'])
```

```
print( series1[1:3] )
```

```
1    b
2    c
dtype: object
```

```
series2 = series1[1:3]
series2.reset_index( drop=True )
```

Accessing a Series

```
record = pd.Series(
    {‘firstname':'Charles',
     'lastname':'Givre',
    'middle':'classified' } )
```

```
record['firstname']                    Charles
```

Accessing a Series

```
record = pd.Series(
    {‘firstname':'Charles',
     'lastname':'Givre',
    'middle':'classified' } )


record[['firstname', ‘lastname']]

firstname    Charles
lastname       Givre
dtype: object
```

Accessing a Series

```
record = pd.Series(
   {‘firstname':'Charles',
    'lastname':'Givre',
   'middle':'classified' } )

record[0]

Charles
```

Accessing a Series

```
randomNumbers = pd.Series(
 np.random.random_integers(1, 100, 50) )

randomNumbers.head()
0    48
1    34
2    84
3    85
4    58
dtype: int64
```

Accessing a Series

```
randomNumbers = pd.Series(
 np.random.random_integers(1, 100, 50) )

randomNumbers.tail( 7 )
43    66
44    66
45    43
46    55
47    99
48    82
49    19
dtype: int64
```

Filtering Data in a Series

```
randomNumbers [ <boolean condition> ]
randomNumbers [ randomNumbers < 10 ]
```

```
12    5
21    2
24    1
27    1
29    1
dtype: int64
```


```
record.str.contains('Cha')
firstname      True
lastname      False
middle        False
dtype: bool

record[ record.str.contains('Cha') ]
firstname    Charles
dtype: object
```

String Functions

Function	Explanation
Series.str.contains(<pattern>)	Returns true/false if text matches a pattern
Series.str.count(<pattern>)	Returns number of occurrences of a pattern in a string
Series.str.extract(<pattern>)	Returns matching groups from a string
Series.str.find(<string>)	Returns index of first occurrences of a substring (Note: not regex)
Series.str.findall(<pattern>)	Returns all occurrences of a regex
Series.str.len()	Returns the length of text
Series.str.replace(<pat>, <replace>)	Replaces matches with a replacement string

Manipulating Data

Pandas Data Structures allow you
to **perform operations**
on your **entire data set at once.**


```
for x in range(0, len( data )):
    data[x] = data[x] + 1
```


```
for x in range(0, len( data )):
    data[x] = data[x] + 1
```

```
odds = evens + 1
```


```
combinedSeries = series1.add( series2 )
```


```
def addTwo( n ):
    return n + 2

odds.apply( addTwo )
```


```
odds.apply( lambda x: x + 1 )
```


```
Series.dropna()
Series.fillna(value="<something>")
```

Questions?

In Class Exercise

Please take 20 minutes and complete

Worksheet 1: Working with One Dimensional Data

Exercise 1

```
email_series = pd.Series(emails)
filtered_emails =
email_series[email_series.str.contains('.edu')]
```

```
2           mdixon2@cmu.edu
11      jjonesb@arizona.edu
15     eberryf@brandeis.edu
```

```
accounts = filtered_emails.str.split( '@').str[0]
```

```
2      mdixon2
11     jjonesb
15     eberryf
dtype: object
```

Exercise 2

```
pounds = pd.Series( weights )
kilos = pounds.apply( poundsToKilograms )
```

Exercise 3

```
IPData = pd.Series( hosts )
privateIPs = IPData[
   IPData.apply(
    lambda x : ip_address(x).is_private
    ) ]
```

The Data Frame


```
data = pd.DataFrame( <data>, <index>,
                     <column_names> )
```

CSV

```
data = pd.read_csv( <file> )
```

Excel

```
data = pd.read_excel( <file>, sheetname=<sheetname> )
```


```
[
   {
    “changed":"2015-04-0300:00:00",
    "created":"2014-04-10 00:00:00”,
    “dnssec":"False",
    "expires":"2016-04-10 00:00:00”,
    “isMalicious":0,
    “url":"nuteczki.com"
   },
…
]
```

JSON

```
data = pd.read_json( <file> )
or
data = pd.read_json( <url> )
```

From a Database

```
data = pd.read_sql( <query>, <connection> )
```

HTML

```
data = pd.read_html( <source> )
```

Log Files…


```
070823 21:00:32       1 Connect     root@localhost on test1
070823 21:00:48       1 Query       show tables
070823 21:00:56       1 Query       select * from category
070917 16:29:01      21 Query       select * from location
070917 16:29:12      21 Query       select * from location where id = 1 LIMIT 1
```


```
070823 21:00:32       1 Connect     root@localhost on test1
070823 21:00:48       1 Query       show tables
070823 21:00:56       1 Query       select * from category
070917 16:29:01      21 Query       select * from location
070917 16:29:12      21 Query       select * from location where id = 1 LIMIT 1
```

```
logdf = pd.read_table('../data/mysql.log', names=['raw'])
```

	raw
0	070823 21:00:32 1 Connect root@local...
1	070823 21:00:48 1 Query show tables
2	070823 21:00:56 1 Query select * f...
3	070917 16:29:01 21 Query select * f...
4	070917 16:29:12 21 Query select * f...


```
logdf = pd.read_table('../data/mysql.log', names=['raw'])
logdf['raw'].str.extract('(\d{6}\s\d{2}:\d{2}:\d{2})\s+(\d+)\s(\S+)
\s(.+)', expand=False)
```

	0	1	2	3
0	070823 21:00:32	1	Connect	root@localhost on test1
1	070823 21:00:48	1	Query	show tables
2	070823 21:00:56	1	Query	select * from category
3	070917 16:29:01	21	Query	select * from location
4	070917 16:29:12	21	Query	select * from location where id = 1 LIMIT 1


```
logdf = pd.read_table('../data/mysql.log', names=['raw'])
logdf['raw'].str.extract('(?P<date>\d{6}\s\d{2}:\d{2}:\d{2})\s+(?
P<PID>\d+)\s(?P<Action>\S+)\s(?P<Query>.+)', expand=False)
```

	Date	PID	Action	Query
0	070823 21:00:32	1	Connect	root@localhost on test1
1	070823 21:00:48	1	Query	show tables
2	070823 21:00:56	1	Query	select * from category
3	070917 16:29:01	21	Query	select * from location
4	070917 16:29:12	21	Query	select * from location where id = 1 LIMIT 1

Web Server Logs

Web Server Logs

```
195.154.46.135 - - [25/Oct/2015:04:11:25 +0100] "GET /linux/
doing-pxe-without-dhcp-control HTTP/1.1" 200 24323 "http://
howto.basjes.nl/" "Mozilla/5.0 (Windows NT 5.1; rv:35.0)
Gecko/20100101 Firefox/35.0"
```

Web Server Logs

```
195.154.46.135 - - [25/Oct/2015:04:11:25 +0100] "GET /linux/
doing-pxe-without-dhcp-control HTTP/1.1" 200 24323 "http://
howto.basjes.nl/" "Mozilla/5.0 (Windows NT 5.1; rv:35.0)
Gecko/20100101 Firefox/35.0"
```

```
import apache_log_parser
line_parser = apache_log_parser.make_parser("%h %l %u %t
\"%r\" %>s %b \"%{Referer}i\" \"%{User-agent}i\"")
```

Web Server Logs

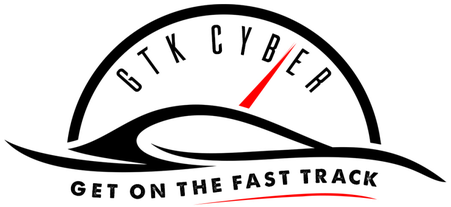
```
import apache_log_parser
line_parser = apache_log_parser.make_parser("%h %l %u %t
\"%r\" %>s %b \"%{Referer}i\" \”%{User-agent}i\”")

server_log = open(“../data/hackers-access.httpd”, "r")
parsed_server_data = []
for line in server_log:
    data = {}
    data = line_parser(line)
    parsed_server_data.append( data )

server_df = pd.DataFrame( parsed_server_data  )
```

Web Server Logs

er	request_first_line	request_header_referer	request_header_user_agent	request_http_ver	request_method	request_url
	GET /linux/doing-pxe-without-dhcp-control HTTP...	http://howto.basjes.nl/	Mozilla/5.0 (Windows NT 5.1; rv:35.0) Gecko/20...	1.1	GET	/linux/doing-pxe-v
	GET /join_form HTTP/1.0	http://howto.basjes.nl/	Mozilla/5.0 (Windows NT 5.1; rv:35.0) Gecko/20...	1.0	GET	/join_form
	POST /join_form HTTP/1.1	http://howto.basjes.nl/join_form	Mozilla/5.0 (Windows NT 5.1; rv:35.0) Gecko/20...	1.1	POST	/join_form
	GET /join_form HTTP/1.0	http://howto.basjes.nl/	Mozilla/5.0 (Windows NT 6.3; WOW64; rv:34.0) G...	1.0	GET	/join_form
	POST /join_form HTTP/1.1	http://howto.basjes.nl/join_form	Mozilla/5.0 (Windows NT 6.3; WOW64; rv:34.0) G...	1.1	POST	/join_form
	GET /acl_users/credentials_cookie_auth/require...	http://howto.basjes.nl/join_form	Mozilla/5.0 (Windows NT 6.3; WOW64; rv:34.0) G...	1.1	GET	/acl_users/creden

GTK CYBER
GET ON THE FAST TRACK

Nested Data?



Nested Data?

```
{"time": 1084443427.311224,
 "timestamp": "2004-05-13T10:17:07.311224",
"IP": {
   "version": 4,
   "ttl": 128,
   "proto": 6,
   "options": [],
   "len": 48,
   "dst": "65.208.228.223",
   "frag": 0,
   "flags": 2, "src": “145.254.160.237",
   "chksum": 37355
   },
   "Ethernet": {"src": "00:00:01:00:00:00", "type": 2048, "dst": “fe:ff:20:00:01:00"},
   …
```

Nested Data

```
pd.read_json( ‘nested_data.json’ )
```

Nested Data

```
pd.read_json( 'nested_data.json' )
```

	DNS	Ethernet	IP	TCP	UDP	time	timestamp
0	NaN	{'type': 2048, 'dst': 'fe:ff:20:00:01:00', 'sr...	{'dst': '65.208.228.223', 'len': 48, 'version'...	{'window': 8760, 'chksum': 49932, 'sport': 337...	NaN	1.084443e+09	2004-05-13 10:17:07.311224
1	NaN	{'type': 2048, 'dst': '00:00:01:00:00:00', 'sr...	{'dst': '145.254.160.237', 'len': 48, 'version...	{'window': 5840, 'chksum': 23516, 'sport': 80,...	NaN	1.084443e+09	2004-05-13 10:17:08.222534
2	NaN	{'type': 2048, 'dst': 'fe:ff:20:00:01:00', 'sr...	{'dst': '65.208.228.223', 'len': 40, 'version'...	{'window': 9660, 'chksum': 31076, 'sport': 337...	NaN	1.084443e+09	2004-05-13 10:17:08.222534
3	NaN	{'type': 2048, 'dst': 'fe:ff:20:00:01:00', 'sr...	{'dst': '65.208.228.223', 'len': 519, 'version...	{'window': 9660, 'chksum': 43352, 'sport': 337...	NaN	1.084443e+09	2004-05-13 10:17:08.222534
4	NaN	{'type': 2048, 'dst': '00:00:01:00:00:00', 'sr...	{'dst': '145.254.160.237', 'len': 40, 'version...	{'window': 6432, 'chksum': 33825, 'sport': 80,...	NaN	1.084443e+09	2004-05-13 10:17:08.783340

Nested Data

```
from pandas.io.json import json_normalize
import json
import pandas as pd

with open('nested.json') as data_file:
    pcap_data = json.load(data_file)

df = pd.DataFrame( json_normalize(pcap_data) )
```

Nested Data

```
df = pd.DataFrame( json_normalize(pcap_data) )
```

...	TCP.seq	TCP.sport	TCP.urgptr	TCP.window	L
...	951057939.0	3372.0	0.0	8760.0	
...	290218379.0	80.0	0.0	5840.0	
...	951057940.0	3372.0	0.0	9660.0	
...	951057940.0	3372.0	0.0	9660.0	
...	290218380.0	80.0	0.0	6432.0	

Manipulating a DataFrame


```
df = data['column1']
```

Returns a series

```
df['ip'].value_counts().head()
```


```
df = data[['column1','column2','column3']]
```

Returns a DataFrame

Filtering a DataFrame

```
df[<boolean condition>]
```

```
df[['col1','col2']][col3 > 5]
```

Columns

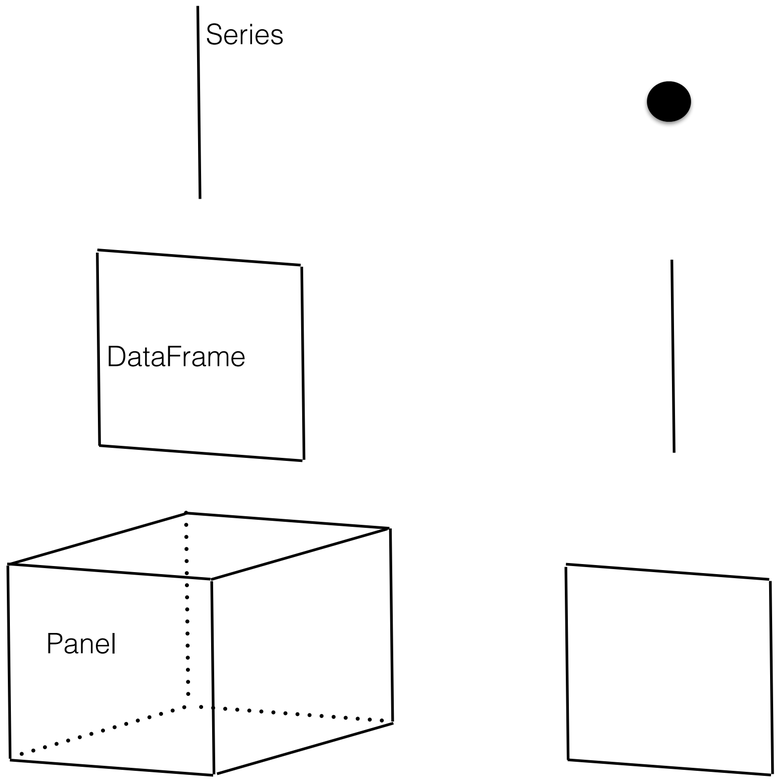
Filter


```
data.loc[<index>]
data.loc[<list of indexes>]
data.sample(<n>)
```

data.apply(<function>)

IF
Call Apply On...

THEN
Function
Receives



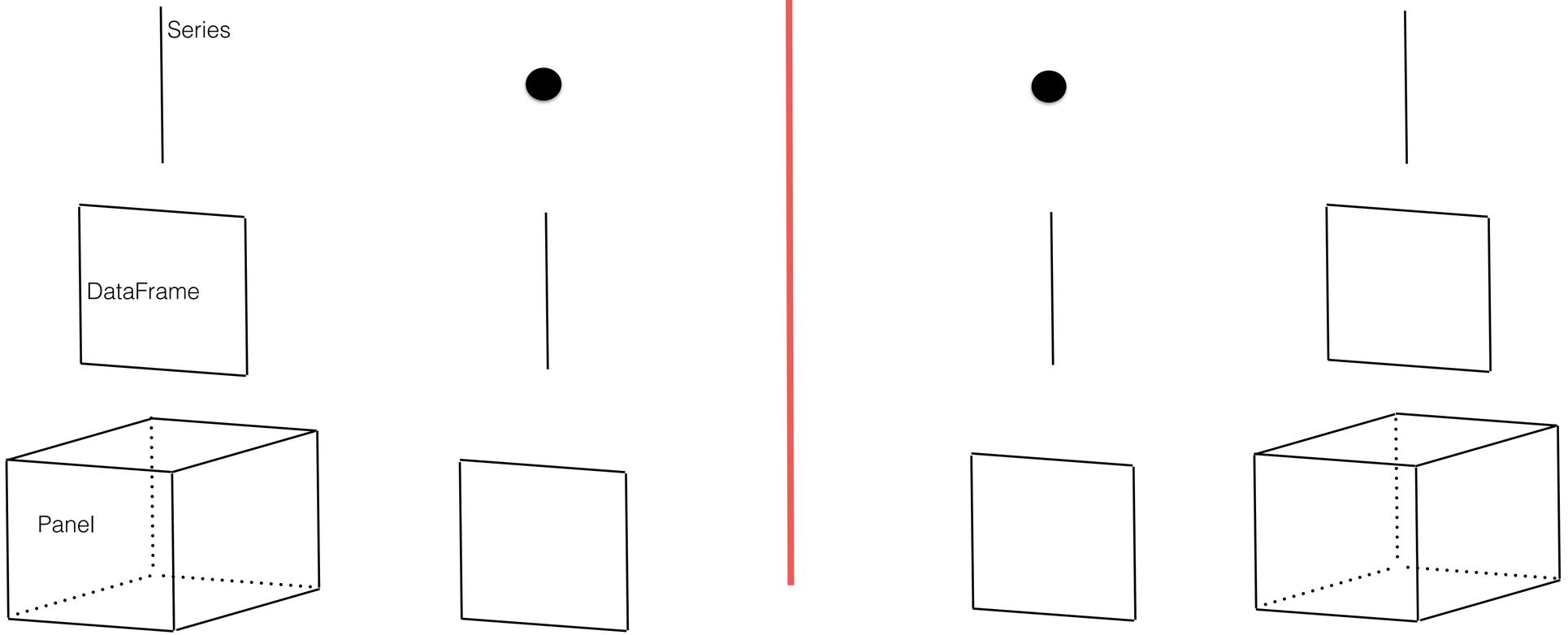
data.apply(<function>)

IF
Call Apply On...

THEN
Function
Receives

IF
Function
Returns

THEN
Apply
Returns...



1	2	3
4	5	6
7	8	9

`data.T`

1	4	7
2	5	8
3	6	9


```
#Gets you the sum of columns
data.sum( axis=0 )

#Gets you the sum of the rows
data.sum( axis=1 )
```


```
DataFrame.drop(labels,
axis=0,
level=None,
inplace=False,
errors='raise')¶
```

Merging Data Sets

Union

Union

Series 1

Index	Value
0	6
1	4
2	2
3	3

Union

Series 1

Index	Value
0	6
1	4
2	2
3	3

Series 2

Index	Value
0	7
1	5
2	3
3	4

Union

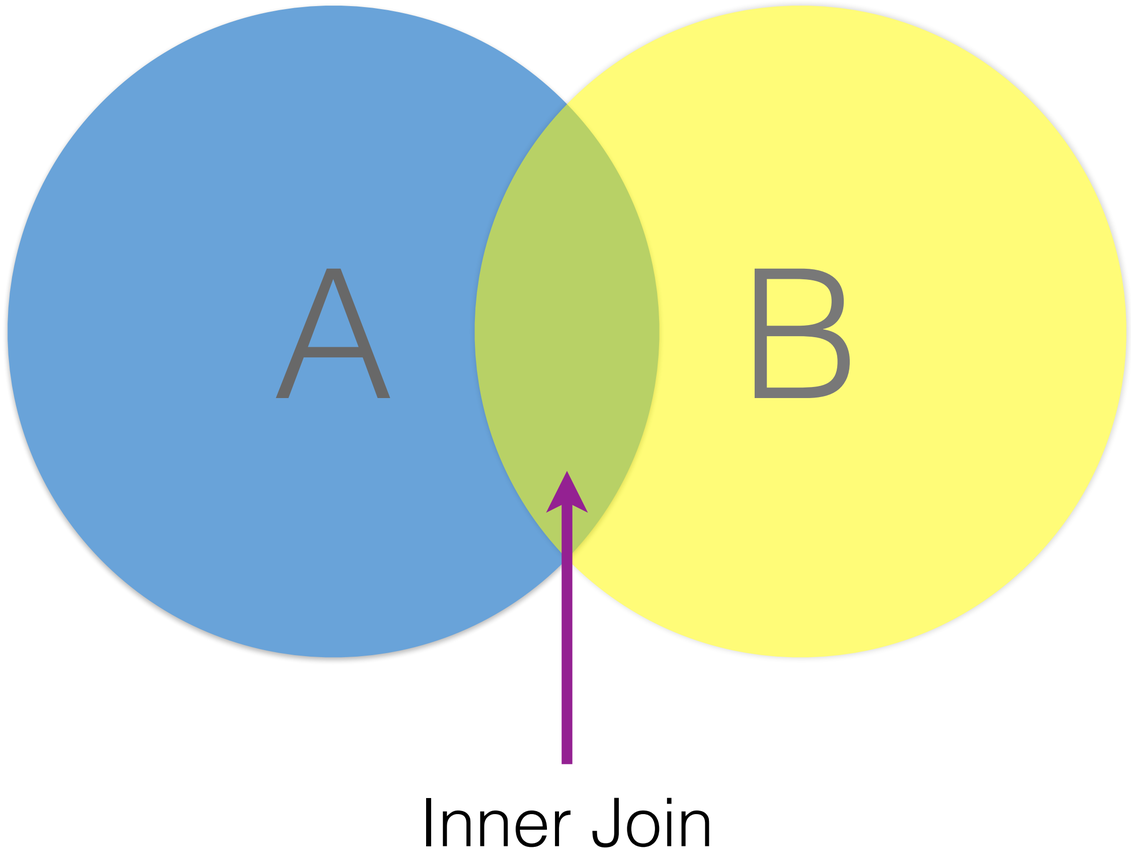
combinedSeries

Index	Value
0	6
1	4
2	2
3	3
4	7
5	5
6	3
7	4

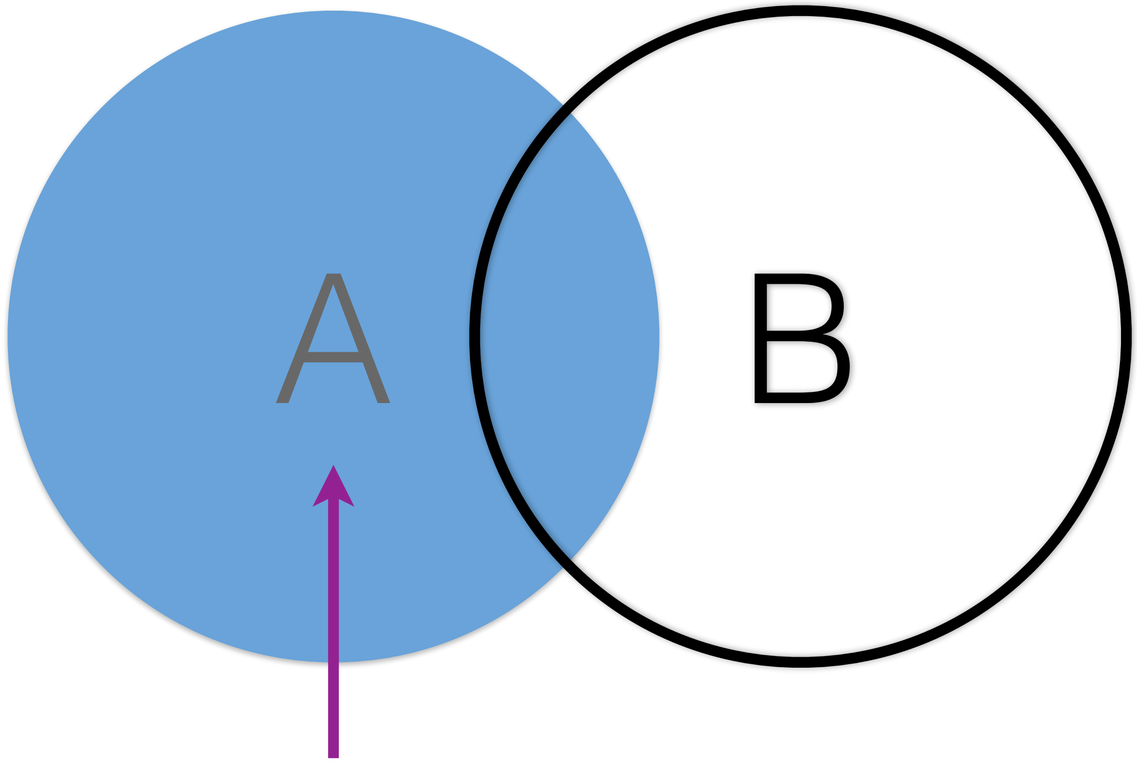

```
combinedSeries = pd.concat(
[series1, series2],
ignore_index=True )
```

Joins

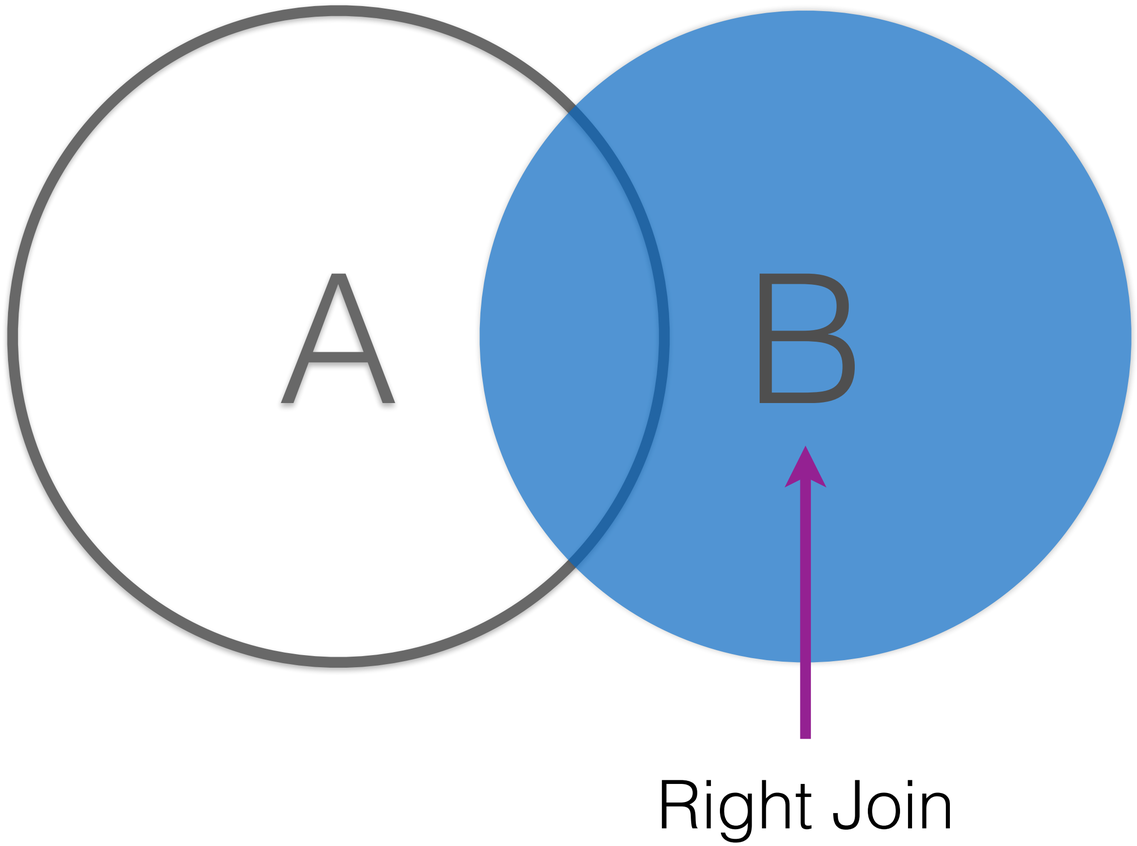
Inner Join (Intersection)



Left Join



Right Join




```
pd.merge( leftData, rightData )
```


```
pd.merge( leftData, rightData, how="<join type>" )
```


```
pd.merge( leftData, rightData, how="<join type>" )
```

Option	SQL Equivalent	Description
inner	INNER JOIN	Intersection
left	LEFT OUTER JOIN	Returns items in Set A, but not in Set B
right	RIGHT OUTER JOIN	Returns items in Set B, but not in Set A
outer	FULL OUTER JOIN	Returns the union of both sets


```
pd.merge( leftData, rightData,
how="<join type>",
on=<field list> )
```

Grouping and Aggregating Data


```
df_grouped = df.groupby(
['Protocol', 'Source','Destination'])
print(df_grouped.size())
```

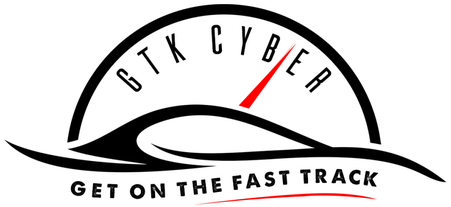
```
Protocol  Source              Destination
ARP       MoxaTech_27:8c:37   Westermo_1a:61:83      610
          Pegatron_3a:0d:e8   Ruggedco_64:85:c2      871
          Ruggedco_64:85:c2   Pegatron_3a:0d:e8      871
          SiemensN_27:64:11   Siemens-_89:59:82      428
          Westermo_1a:61:83   MoxaTech_27:8c:37      610
DNS       192.168.88.1        192.168.88.61         9938
          192.168.88.61       192.168.88.1          9937
          192.168.89.2        8.8.8.8               2194
ICMP      192.168.89.1        192.168.89.2          2194
LOOP      CiscoInc_95:1d:8b   CiscoInc_95:1d:8b     1992
S7COMM    10.10.10.10         10.10.10.20          19913
          10.10.10.20         10.10.10.10          19914
TCP       10.10.10.10         10.10.10.20          23409
          10.10.10.20         10.10.10.10          59739
Name: Protocol, dtype: int64
```


```
Stats_Packets = df_grouped['Length'].agg({'No
Packets': len, 'Volume': sum,\
        'SD': lambda x: np.std(x, ddof=1) if
len(x)>2 else 0})
```

Protocol	Source	Destination	Volume	SD	No Packets
ARP	MoxaTech_27:8c:37	Westermo_1a:61:83	45140	0.000000	610
	Pegatron_3a:0d:e8	Ruggedco_64:85:c2	52260	0.000000	871
	Ruggedco_64:85:c2	Pegatron_3a:0d:e8	52260	0.000000	871
	SiemensN_27:64:11	Siemens-_89:59:82	25680	0.000000	428
	Westermo_1a:61:83	MoxaTech_27:8c:37	36600	0.000000	610
DNS	192.168.88.1	192.168.88.61	725474	0.000000	9938
	192.168.88.61	192.168.88.1	725401	0.000000	9937
	192.168.89.2	8.8.8.8	152391	1.442727	2194
ICMP	192.168.89.1	192.168.89.2	213823	1.442727	2194
LOOP	CiscoInc_95:1d:8b	CiscoInc_95:1d:8b	119520	0.000000	1992
S7COMM	10.10.10.10	10.10.10.20	2070952	0.000000	19913
	10.10.10.20	10.10.10.10	3046842	0.000000	19914
TCP	10.10.10.10	10.10.10.20	2280712	15.683145	23409
	10.10.10.20	10.10.10.10	5436249	43.840987	59739

In Class Exercise:

Please complete Worksheet 2: Exploring Two Dimensional Data

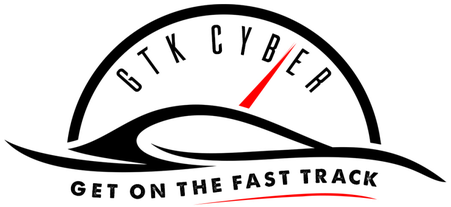


Exercise 1

#Data1

```
{“first_name":{“0":"Robert","1":"Steve","2":"Anne","3":"Alice"},
“last_name":{"0":"Hernandez","1":"Smith","2":"Raps","3":"Muller"},
“birthday":{"0":"5\\/3\\/67","1":"8\\/4\\/84","2":"9\\/13\\/
91","3":"4\\/15\\/75"}
}
```

```
df1 = pd.read_json('../data/data1.json')
```

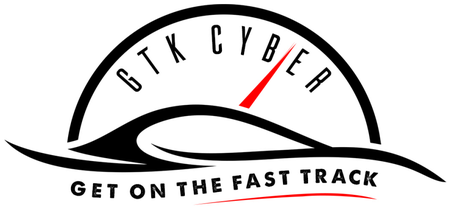


Exercise 1

#Data2

{“0”:{"first_name":"Robert","last_name":"Hernandez","birthday":"5\\/3\
\/67"},
“1":{"first_name":"Steve","last_name":"Smith","birthday":"8\\/4\\/
84"},
“2":{"first_name":"Anne","last_name":"Raps","birthday":"9\\/13\\/91"},
"3":{"first_name":"Alice","last_name":"Muller","birthday":"4\\/15\\/
75"}}

```
df2 = pd.read_json('../data/data2.json', orient='index')
```



Exercise 1

#Data3

```
[
{“first_name":"Robert","last_name":"Hernandez","birthday":"5\\/3\\/
67"},
{"first_name":"Steve","last_name":"Smith","birthday":"8\\/4\\/84"},
{"first_name":"Anne","last_name":"Raps","birthday":"9\\/13\\/91"},
{"first_name":"Alice","last_name":"Muller","birthday":"4\\/15\\/75"}]
```

```
df3 = pd.read_json('../data/data3.json',
orient='columns')
```

Exercise 1

#Data4

```
{“columns":["first_name","last_name","birthday"],
“index":[0,1,2,3],
"data":[["Robert","Hernandez","5\\/3\\/67"],["Steve","Smith","8\\/4\\/
84"],["Anne","Raps","9\\/13\\/91"],["Alice","Muller","4\\/15\\/75"]]}
```

```
df4 = pd.read_json('../data/data4.json', orient='split')
```

Exercise 2

```
#Write the functions
def get_os(x):
    user_agent = parse(x)
    return user_agent.os.family

def get_browser(x):
    user_agent = parse(x)
    return user_agent.browser.family
```

Exercise 2

```
#Apply the functions to the dataframe
server_df['os'] =
server_df['request_header_user_agent'].apply( get_os )
server_df['browser'] =
server_df['request_header_user_agent'].apply( get_browser )
```

Exercise 2

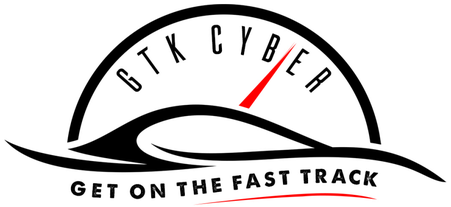
```
#Apply the functions to the dataframe
server_df['os'] =
server_df['request_header_user_agent'].apply( get_os )
server_df['browser'] =
server_df['request_header_user_agent'].apply( get_browser )
```

```
#Get the top 10 values
server_df['os'].value_counts().head(10)
```

Exercise 2

```
#Get the top 10 values
server_df['os'].value_counts().head(10)
```

```
Windows 7          2041
Windows Vista       500
Windows XP          423
Windows 8.1         221
Linux               125
Mac OS X             80
Chrome OS            60
Ubuntu                6
```



Exercise 3

```
bots = pd.read_csv('../data/dailybots.csv')
gov_bots = bots[['botfam', 'hosts']][bots['industry'] ==
"Government/Politics"]

gov_bots.groupby('botfam', as_index=False).sum()
```

Questions?