

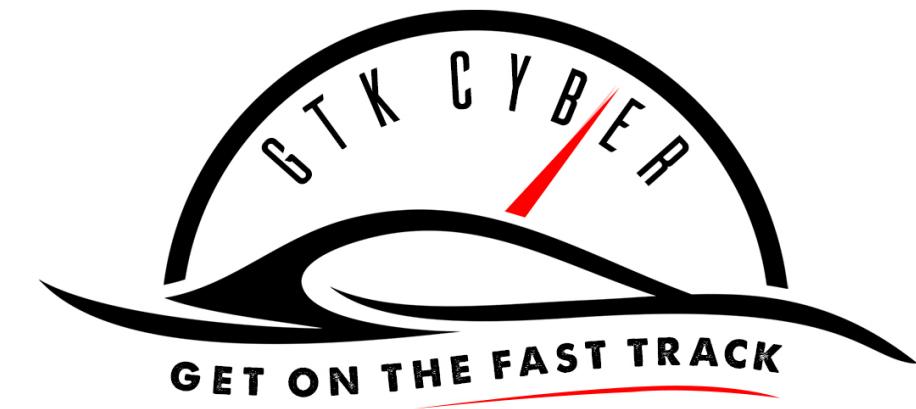




Applied Data Science for Cyber Security Professionals

www.gtkcyber.com

Joins the Slack Channel at: <http://bit.ly/2OZq4sK>



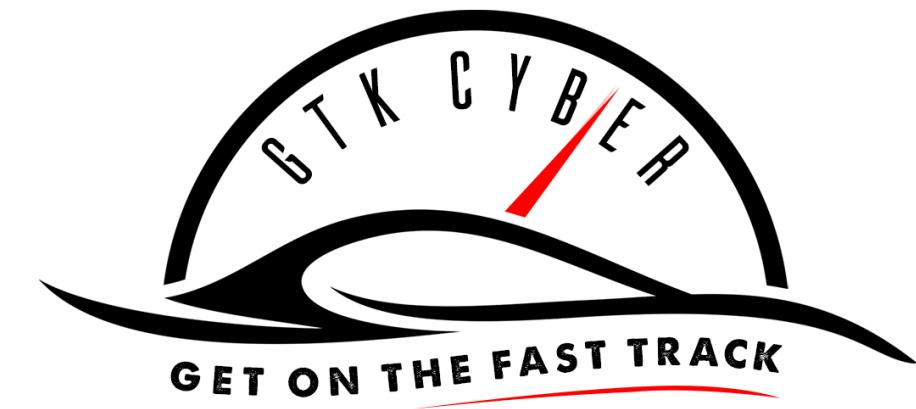
Course Agenda

Day 1

- Intro: What is Data Science?
 - Overview of Machine Learning & Cyber Applications
- Manipulating and Exploring Data
 - Exploratory Data Analysis in 1 Dimension
 - Exploratory Data Analysis in 2 Dimensions

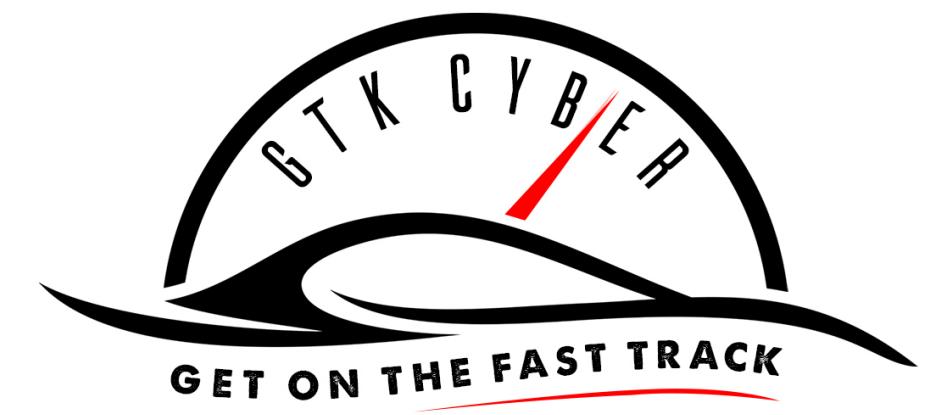
Day 2

- Data Visualization
- Machine Learning
 - Supervised & Unsupervised
- Hacking Machine Learning Models
- Introduction to Big Data Tools
 - PySpark, ELK & Kafka
 - Apache Drill
- Hunting with Data Science

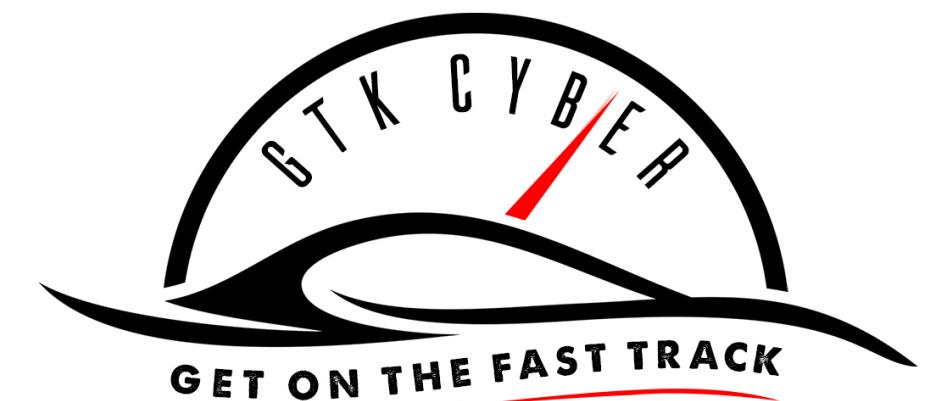


Expectations

- 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**.
- Join the conversation in slack!
- Have fun!

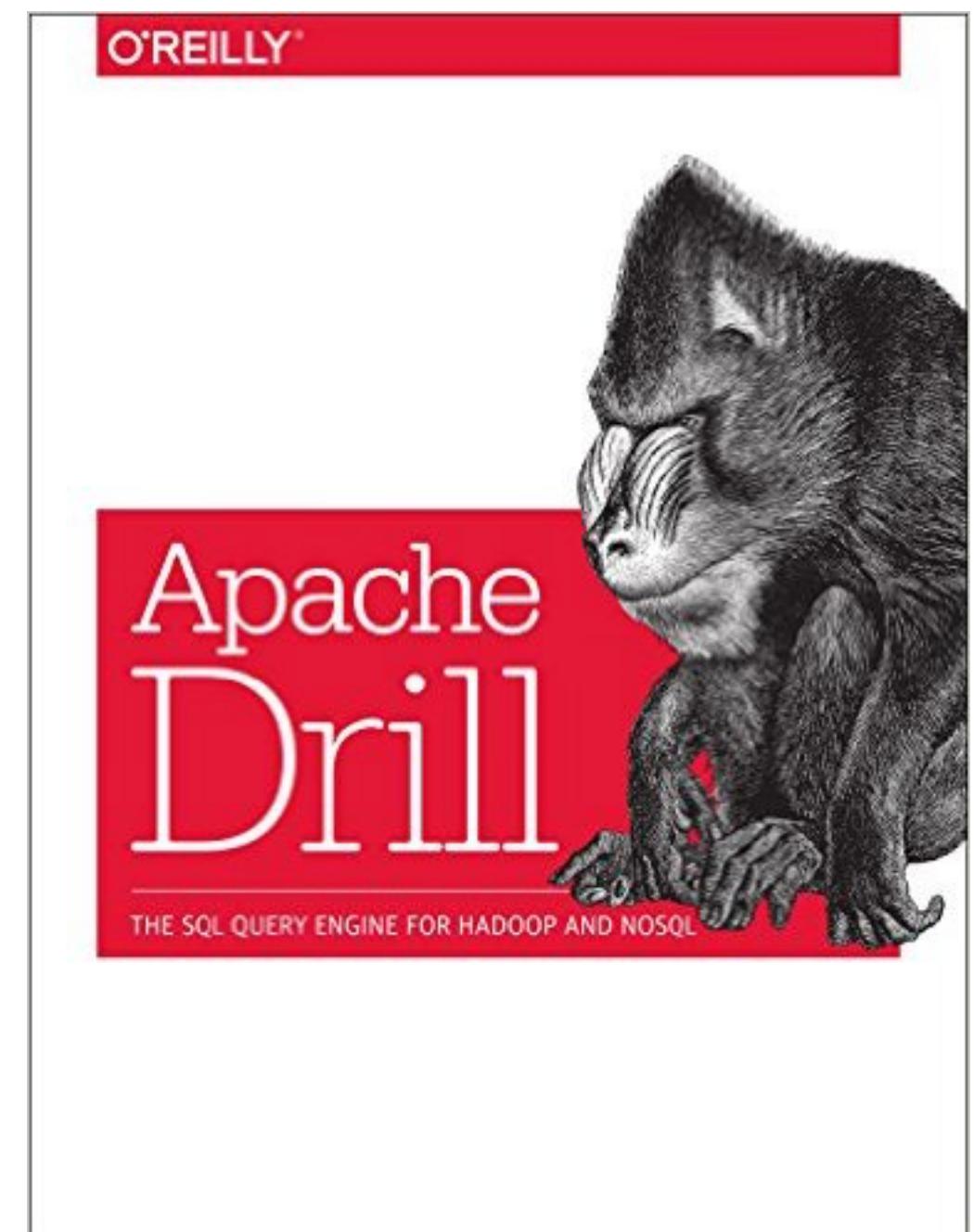


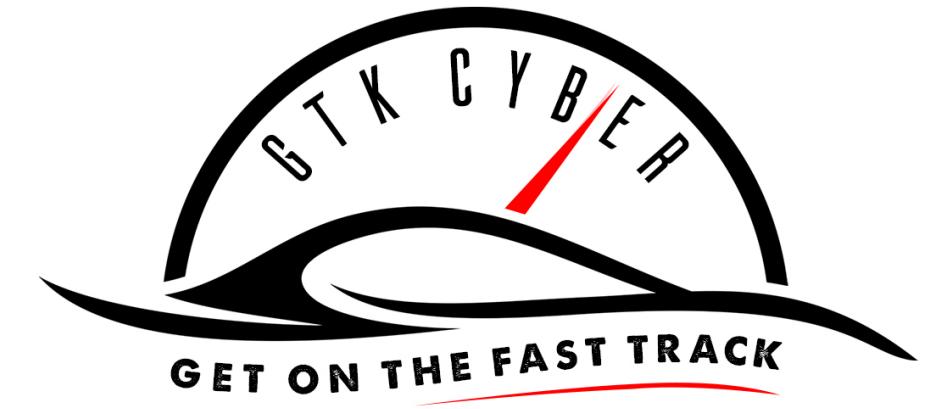
Introduction



Charles Givre, CISSP

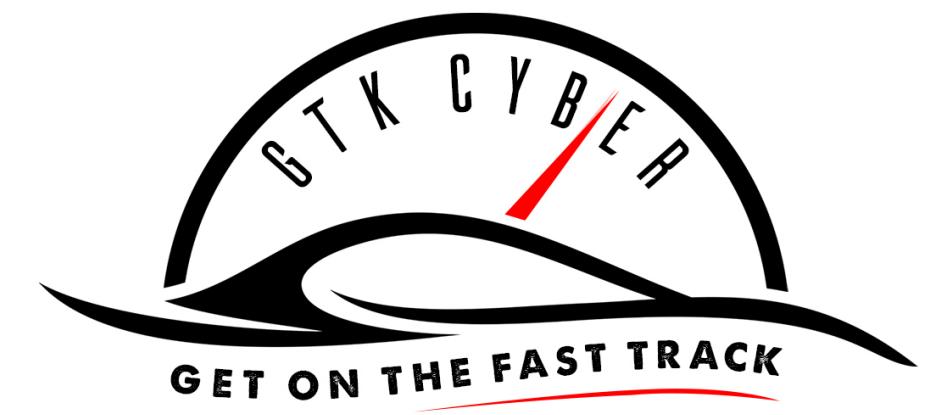
- Lead Data Scientist at Deutsche Bank
- Program Chair Strategic Analytics, Brandeis University
- Committer to Apache Drill Project
- Senior Lead Data Scientist @ Booz Allen
- 5 Years @ CIA
- Undergraduate in Comp.Sci & Music



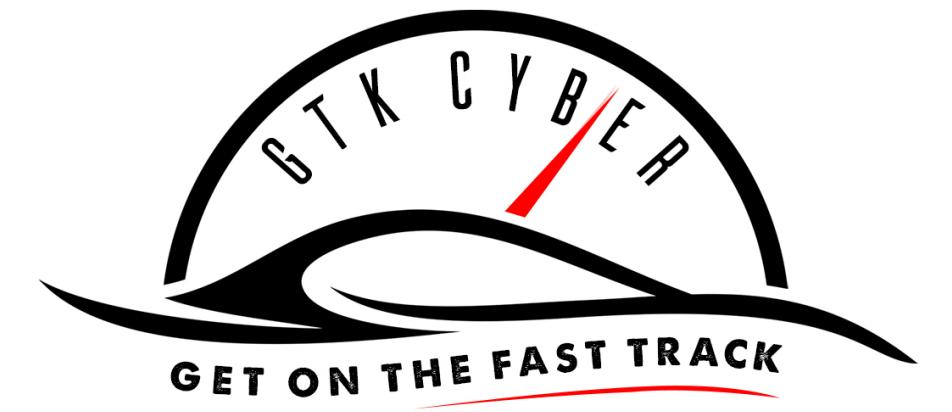


Who are you?

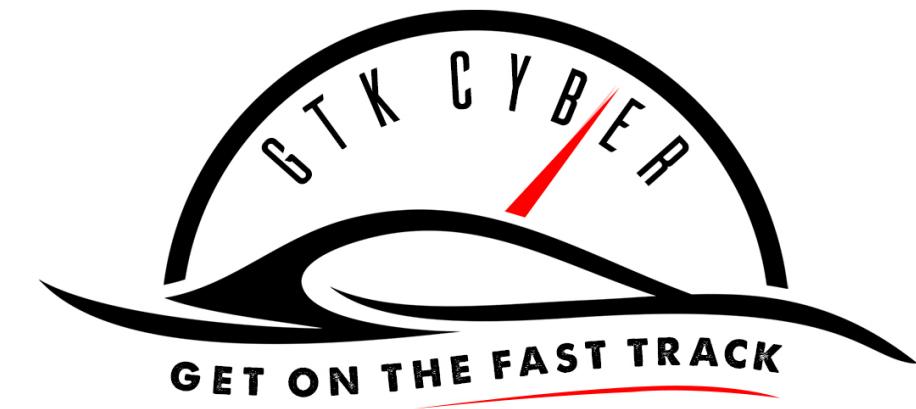
- Your name (or what you want me to call you)
- Where you work and/or your job role
- What you hope to get out of this class
- Your level of experience with coding



What is Data Science?

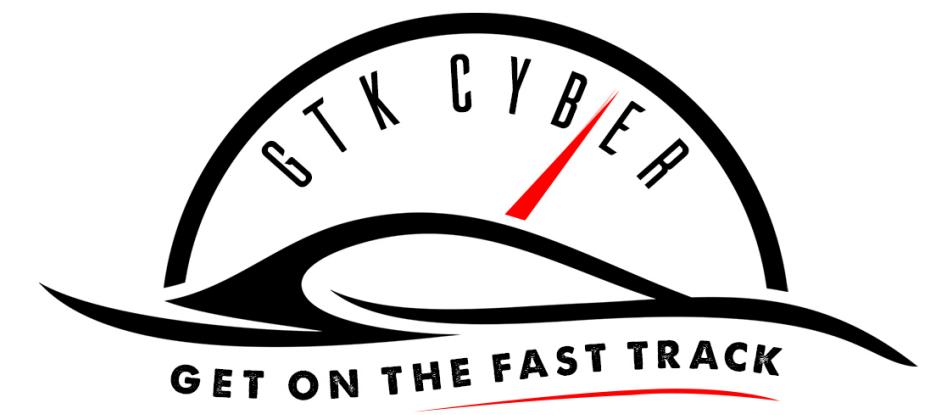


Data Science is the automated extraction of **information** from **raw data**.

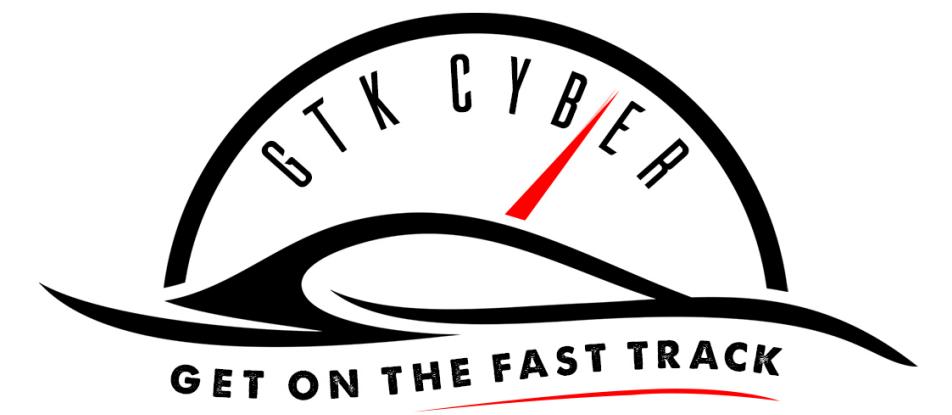


Data Science is the art of **turning data into actions**. This is accomplished through the creation of data products, which provide actionable information without exposing decision makers to the underlying data or analytics

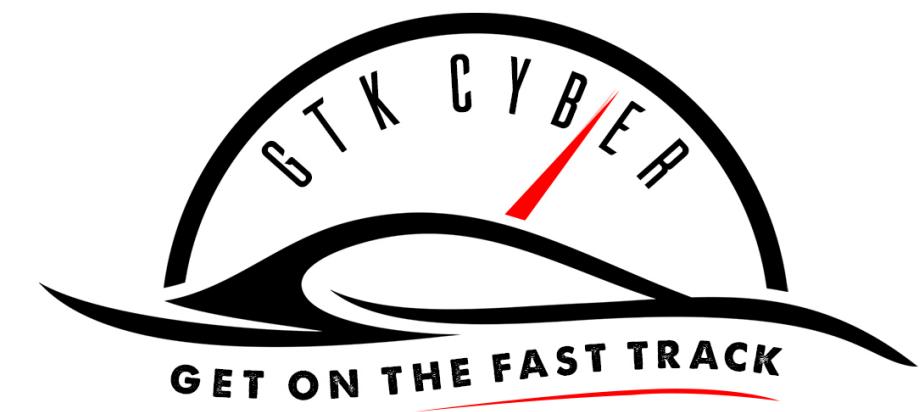
Booz Allen Hamilton, Field Guide to Data Science, Pg. 17



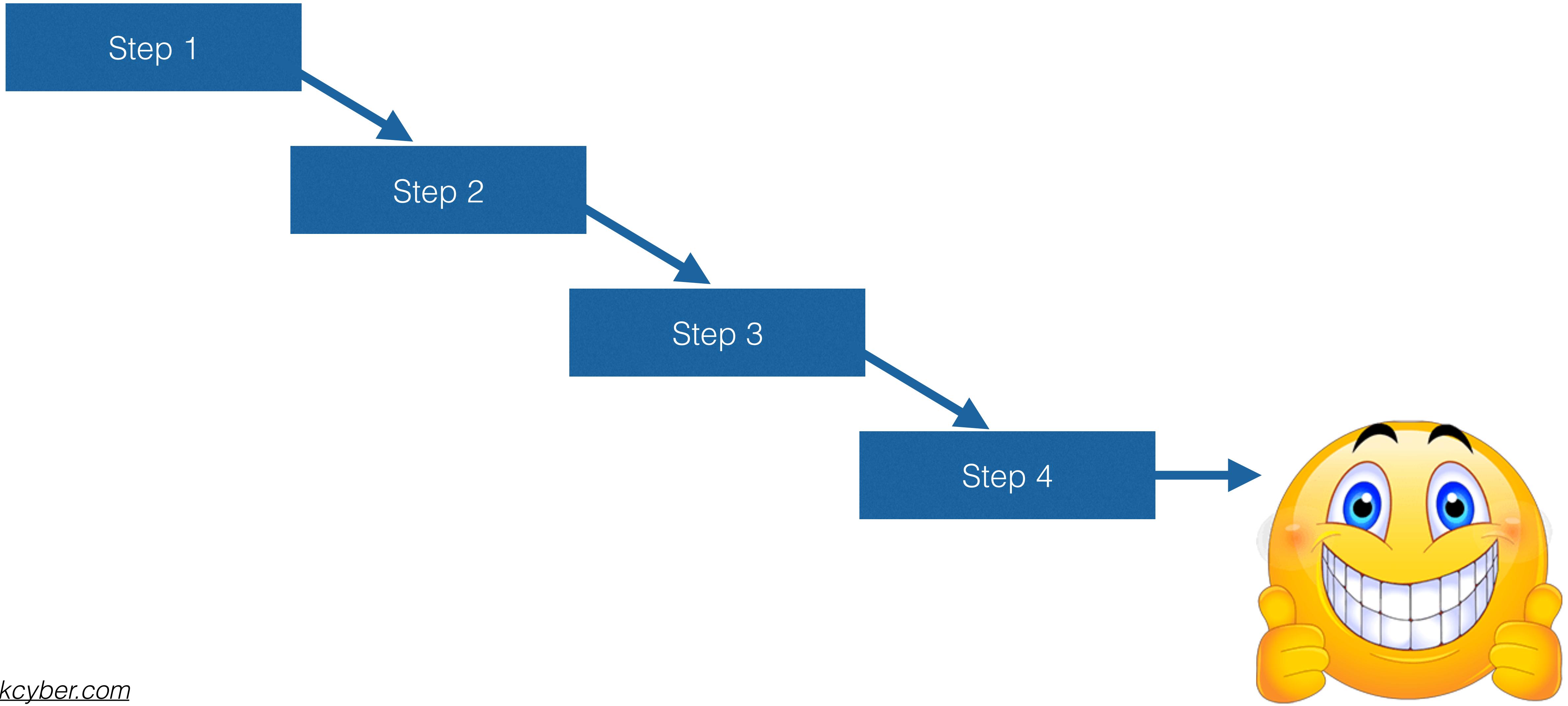
Analyst ← → Developer

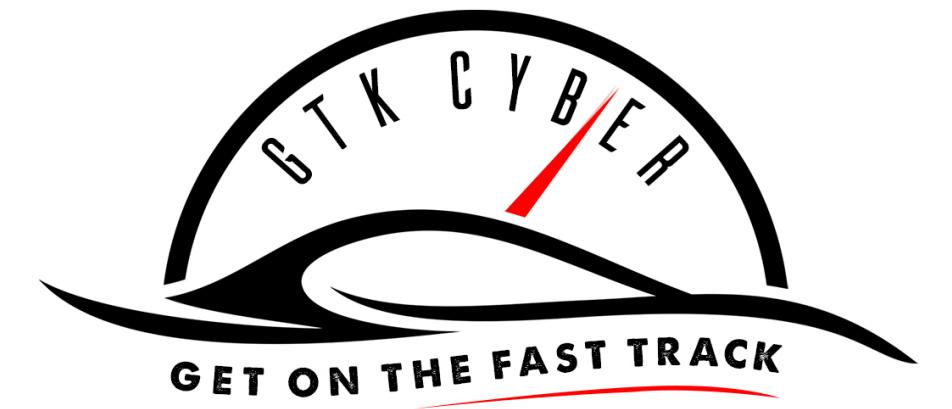


Analyst + Developer

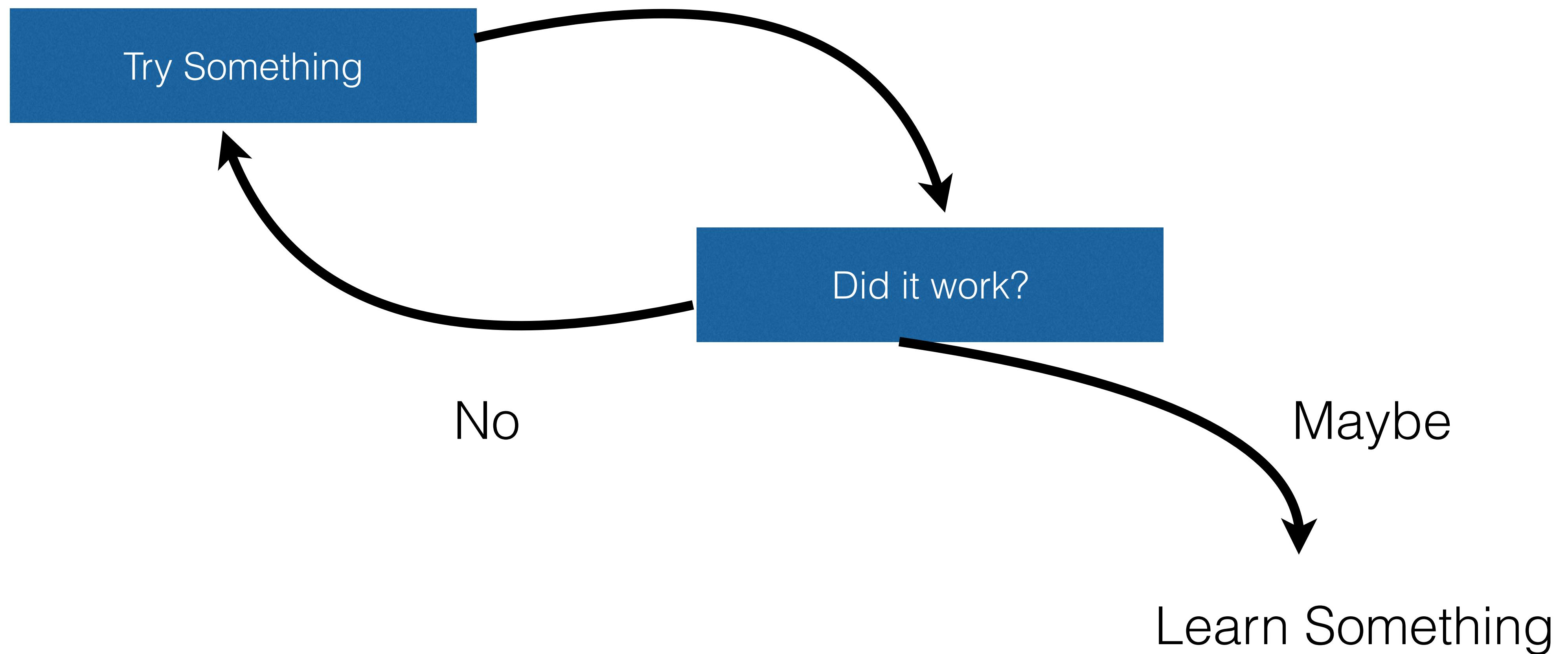


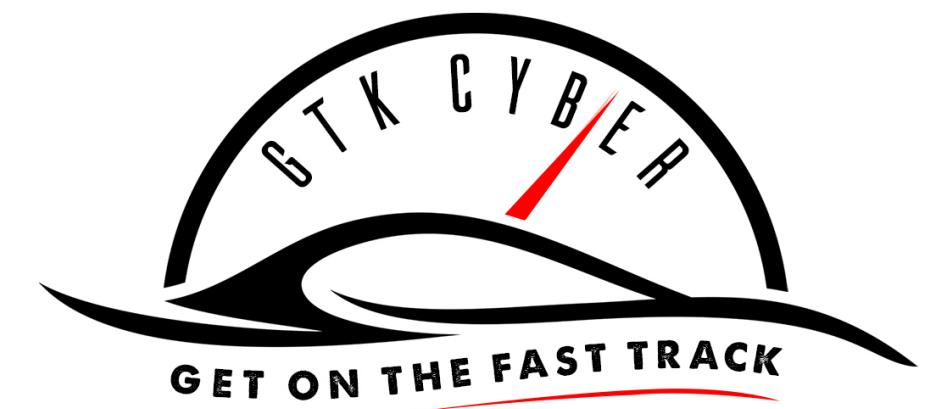
What Data Science is Not



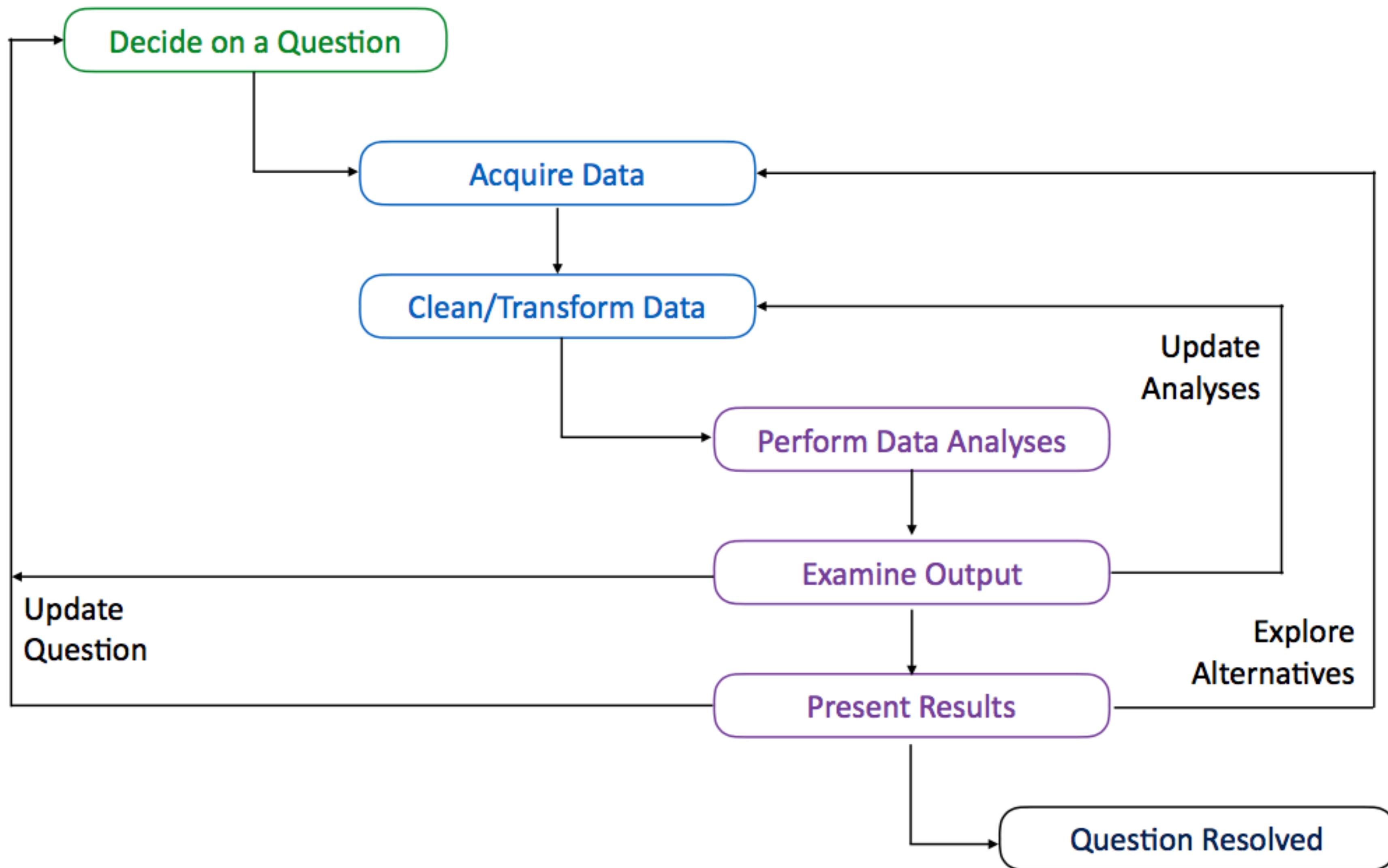


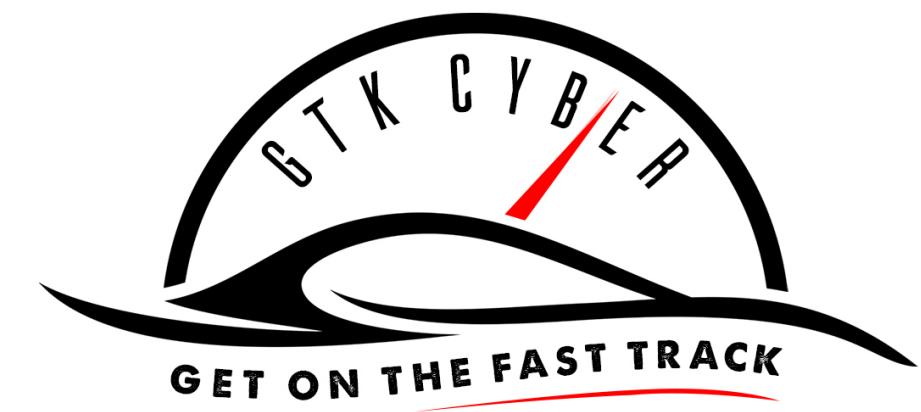
What Data Science is





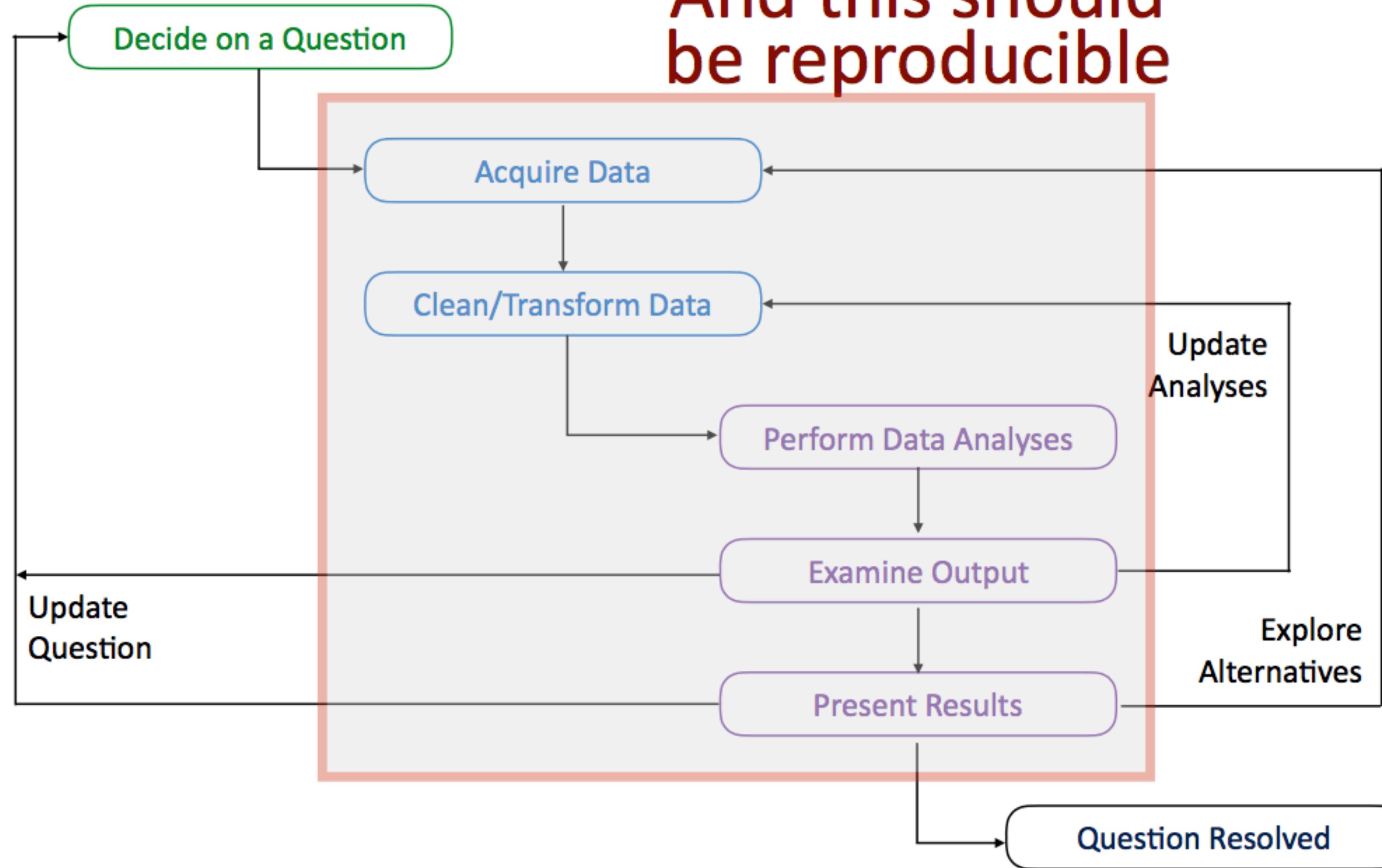
Research Process

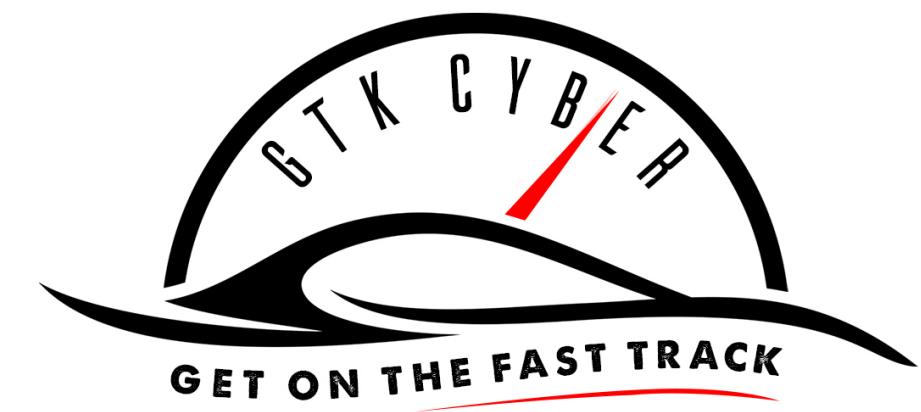




Research Process

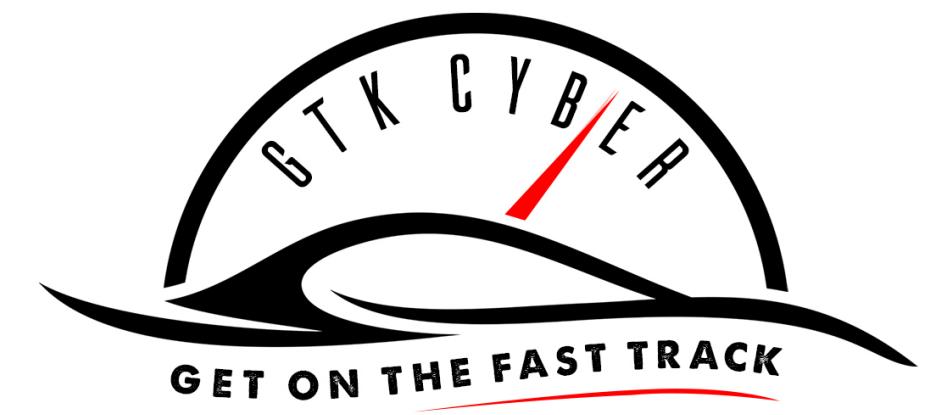
And this should
be reproducible



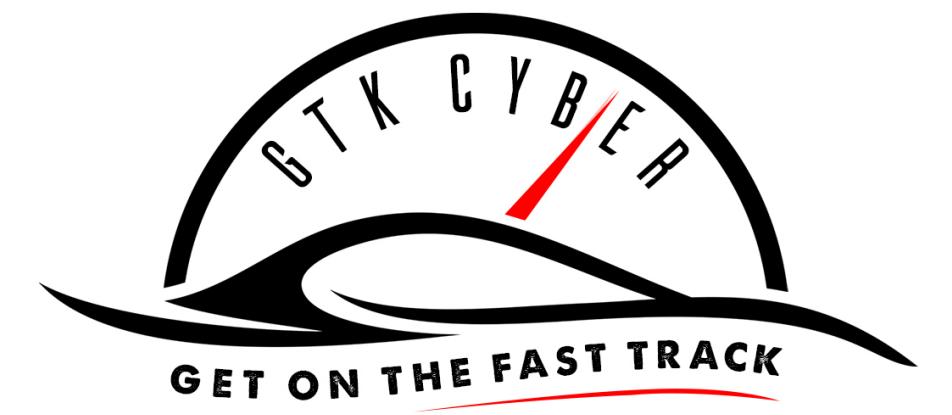


“The term "data scientist" will subside and may well sound dated five years from now. **The skills will become more commonplace and commoditized. When that happens, the real boom will begin**, because the technology will become widely adopted and thus more useful. ... **Instead, we need self-service 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/>

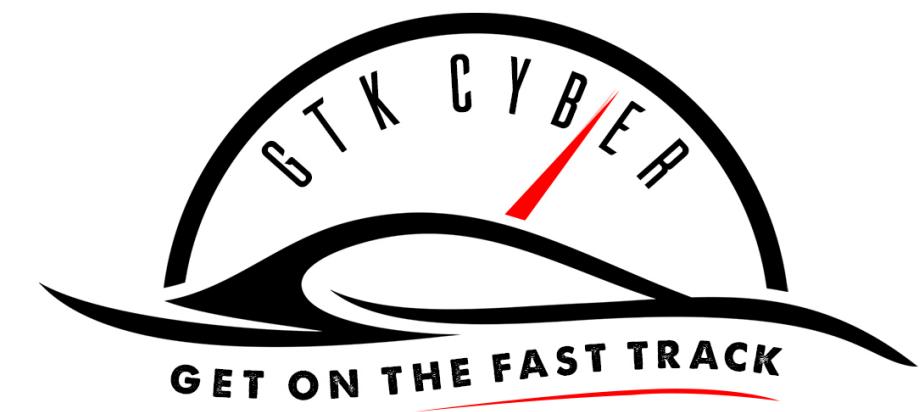


Time to Insight



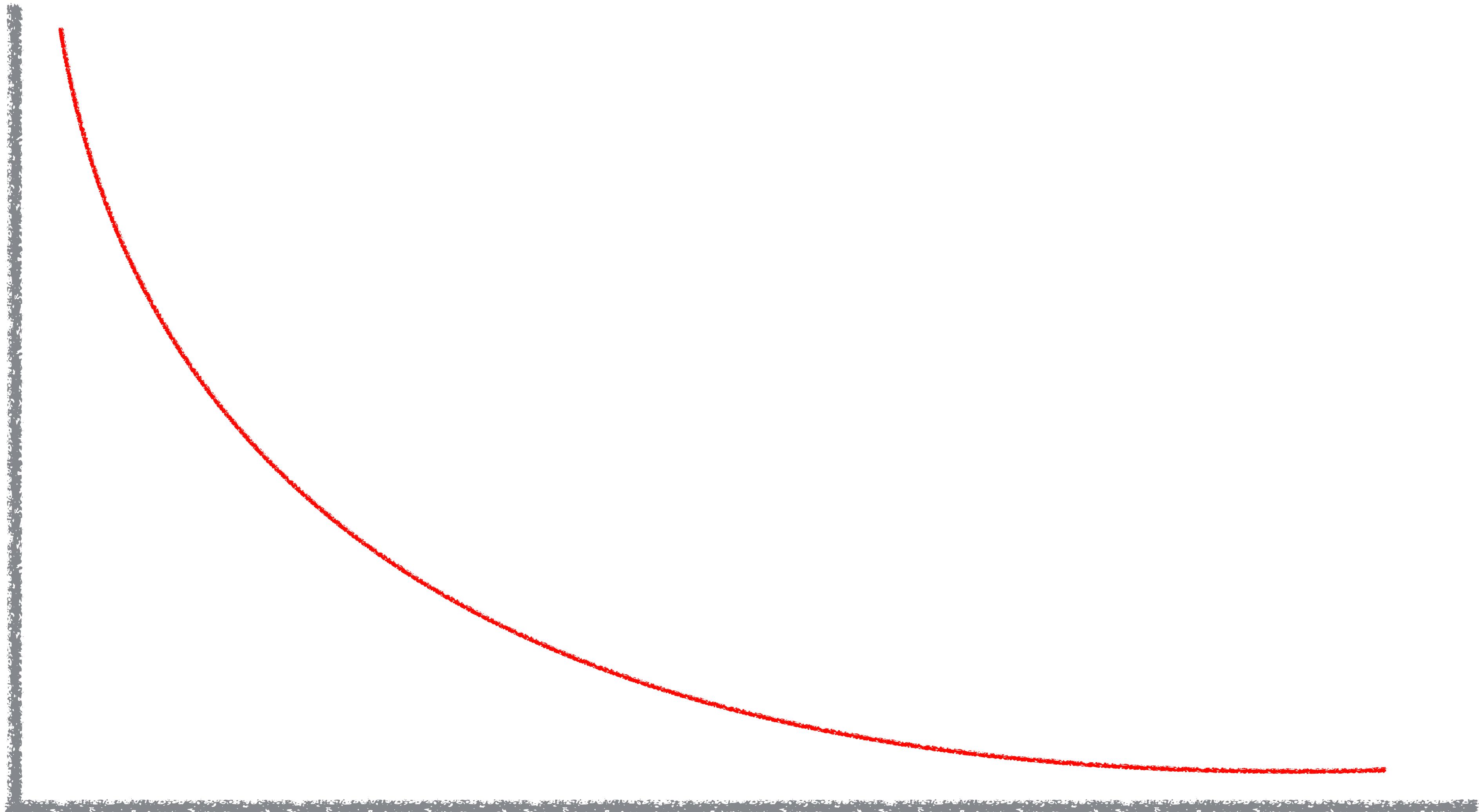
Time to Insight

Time = \$\$

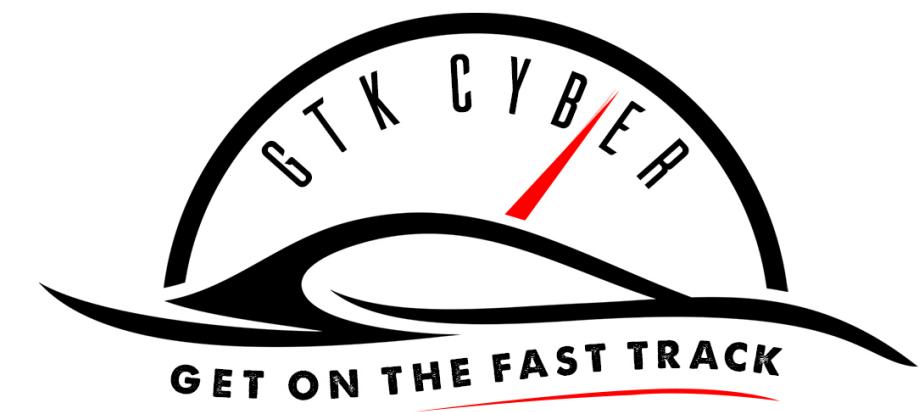


Value of Insights over Time

Value



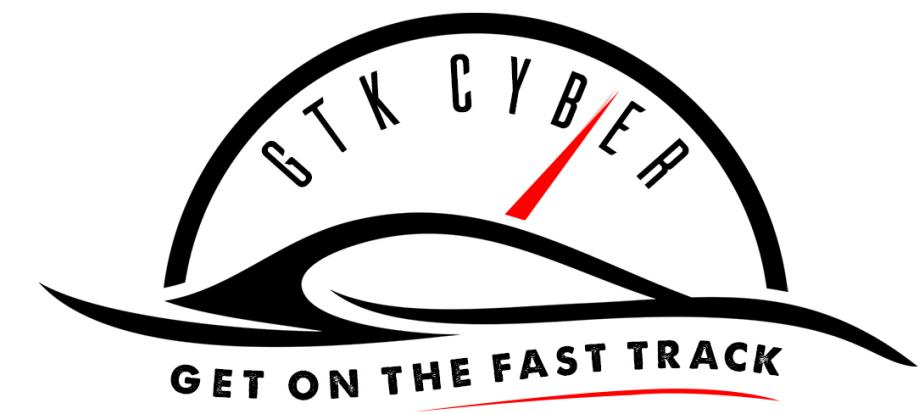
Time



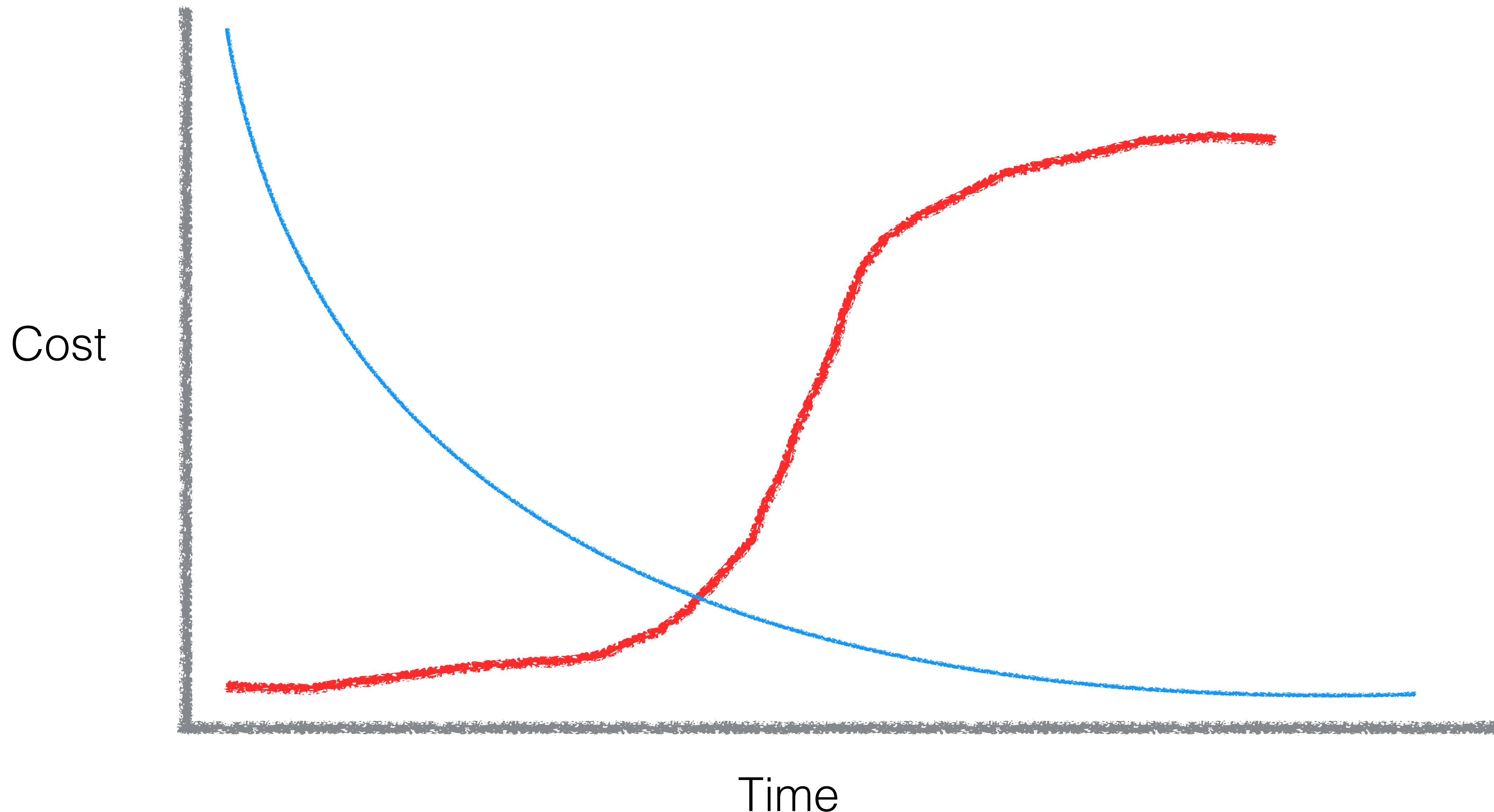
Cost of Insights over Time

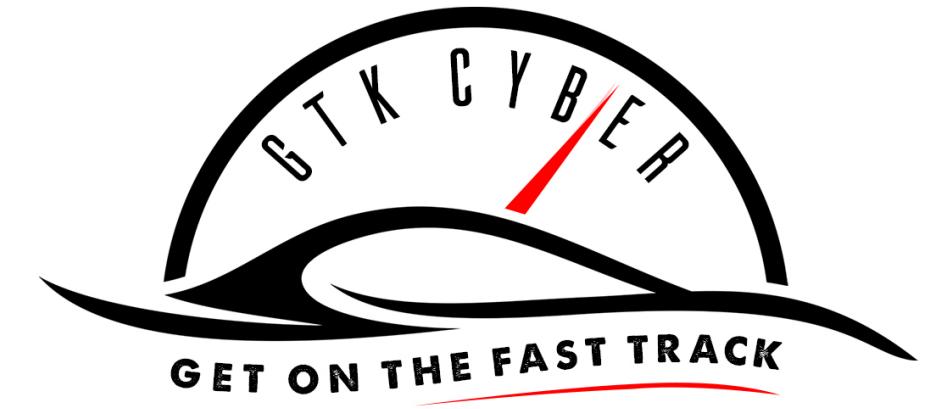
Cost

Time

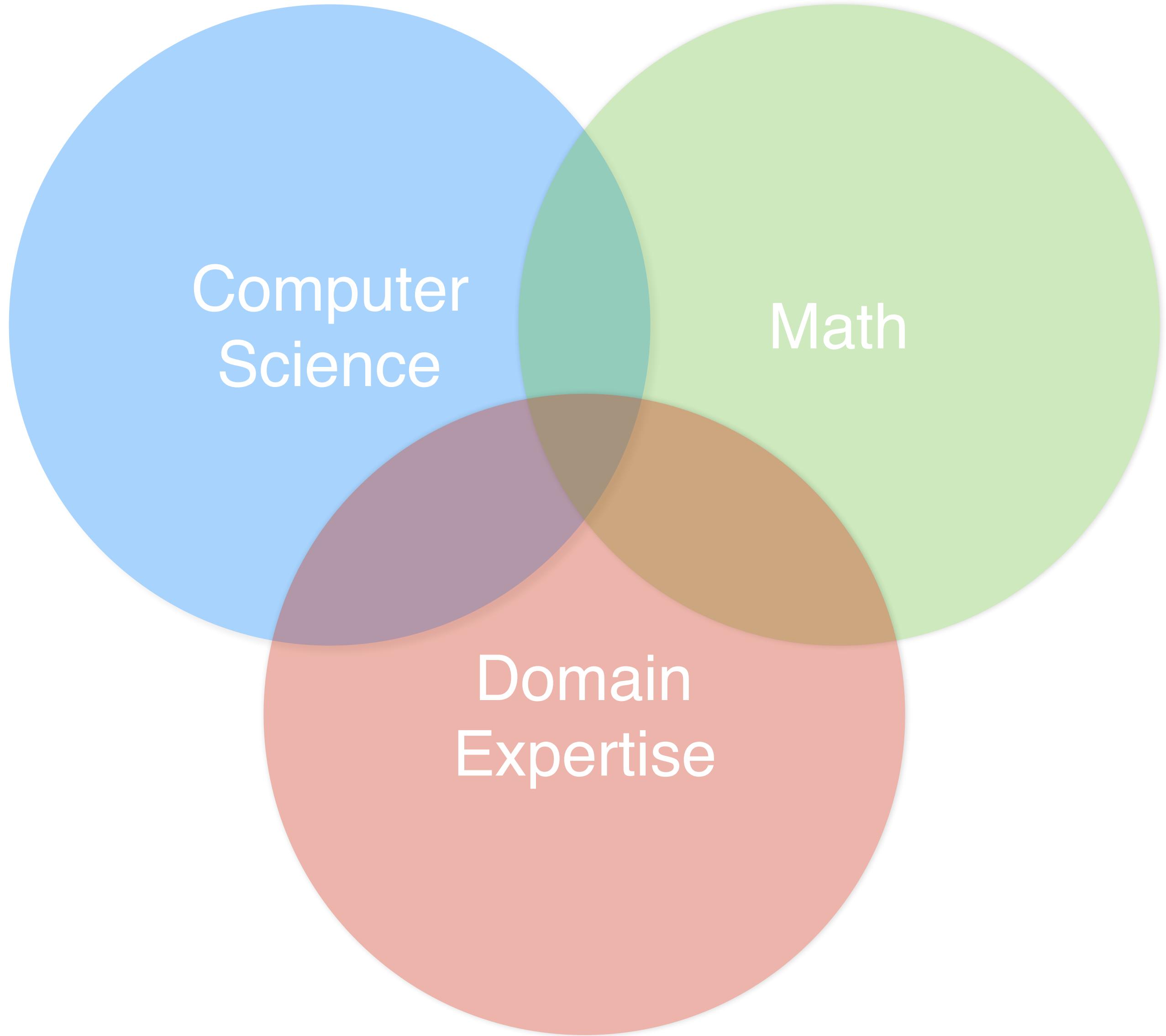
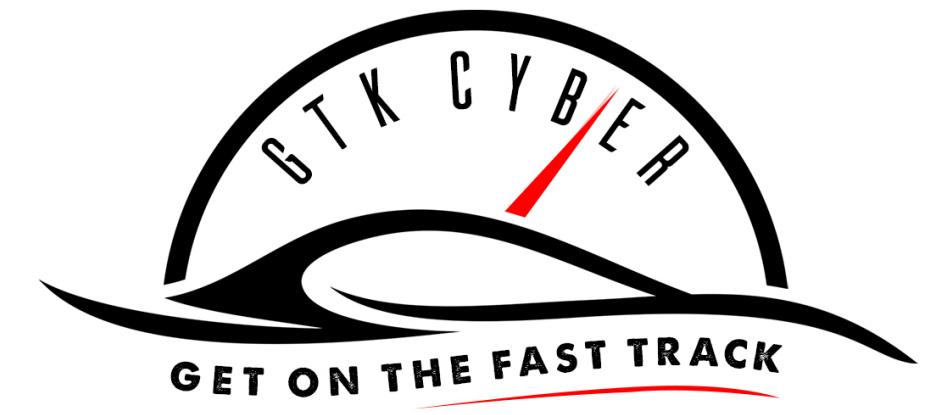


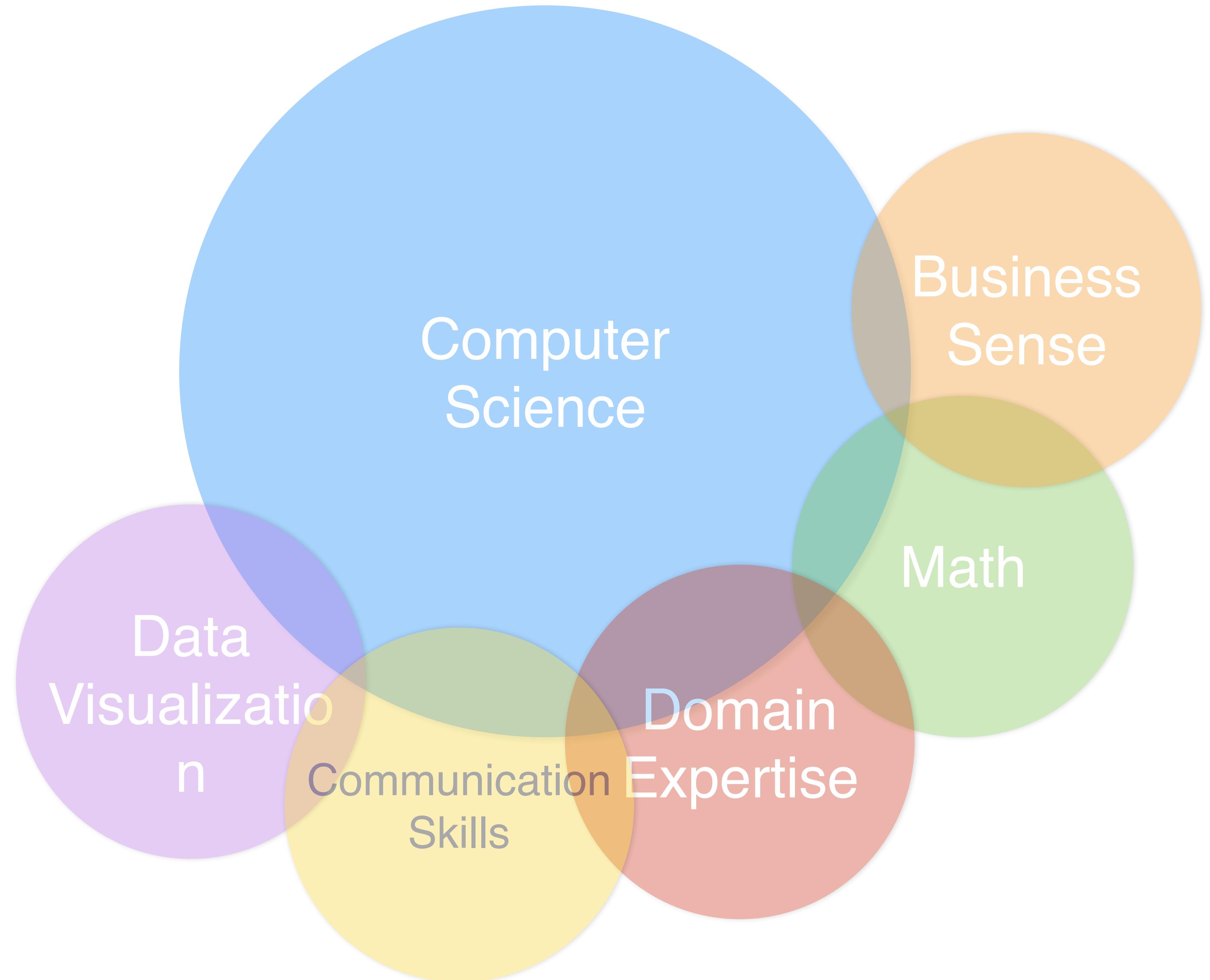
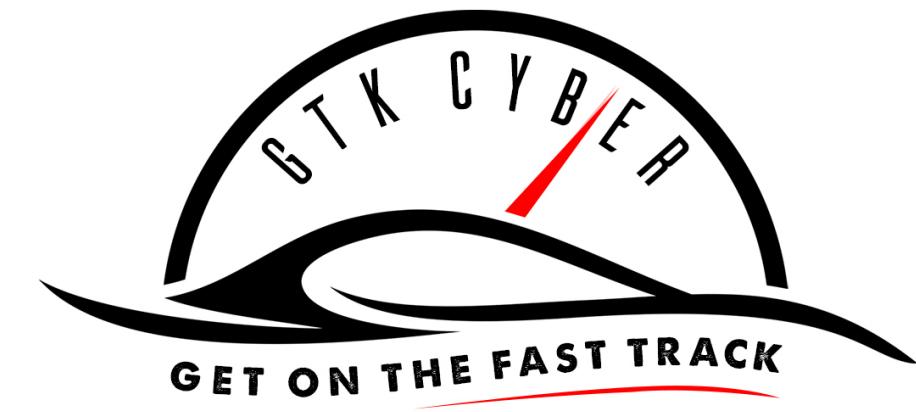
Cost of Insights over Time

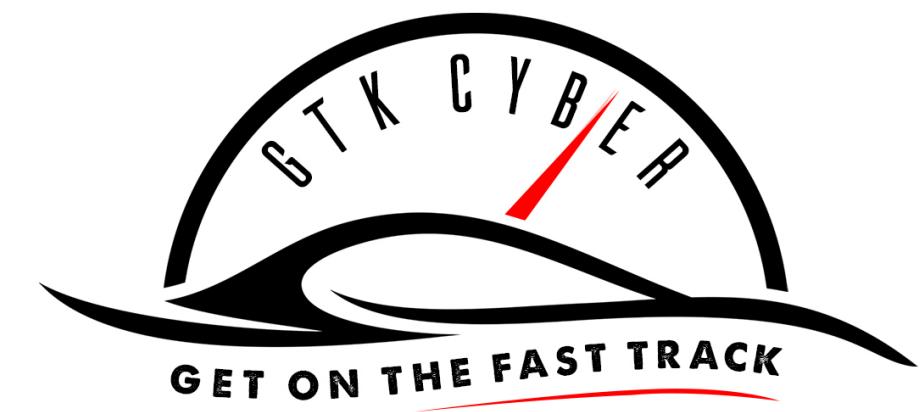




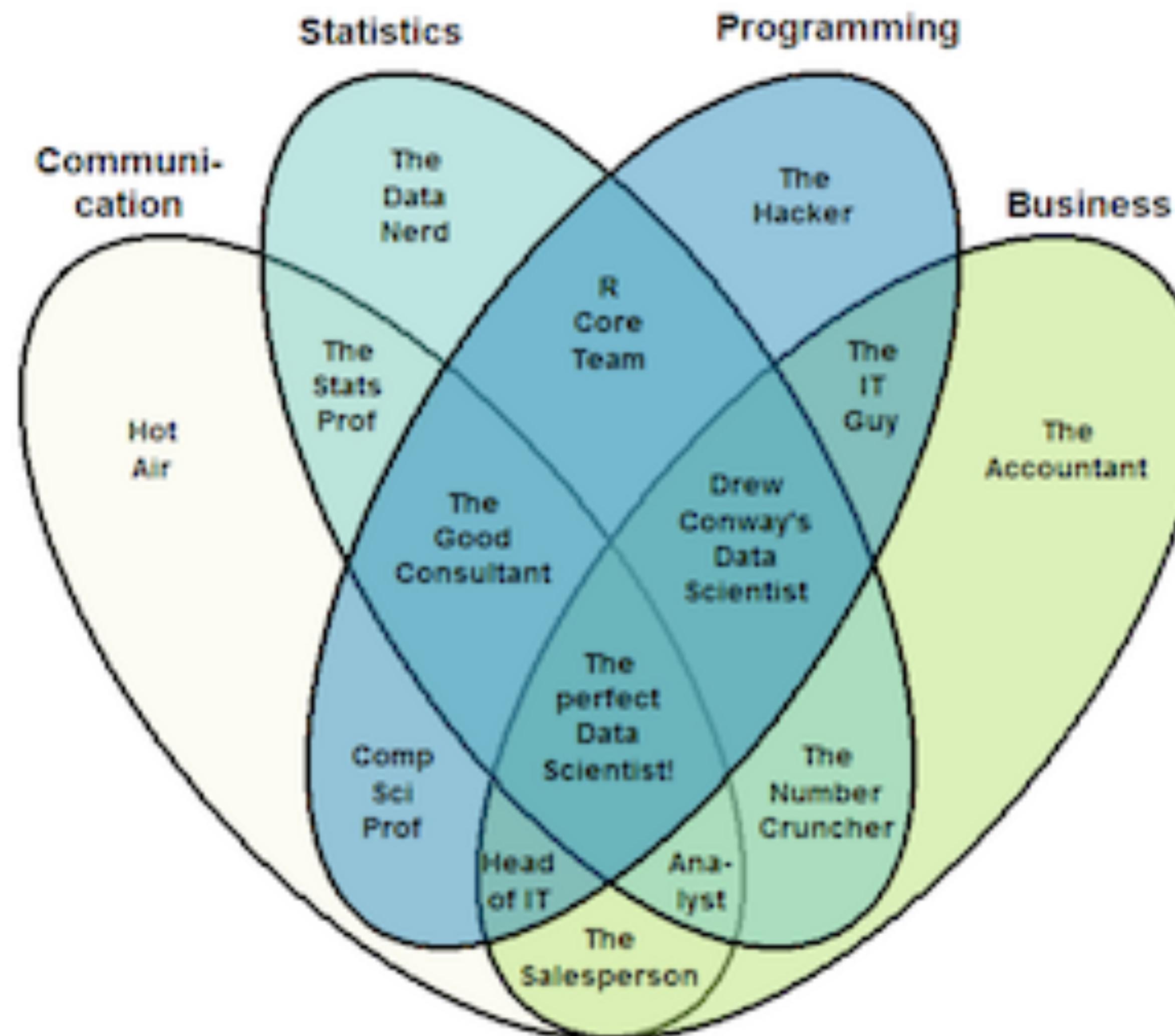
What skills does a data scientist need?

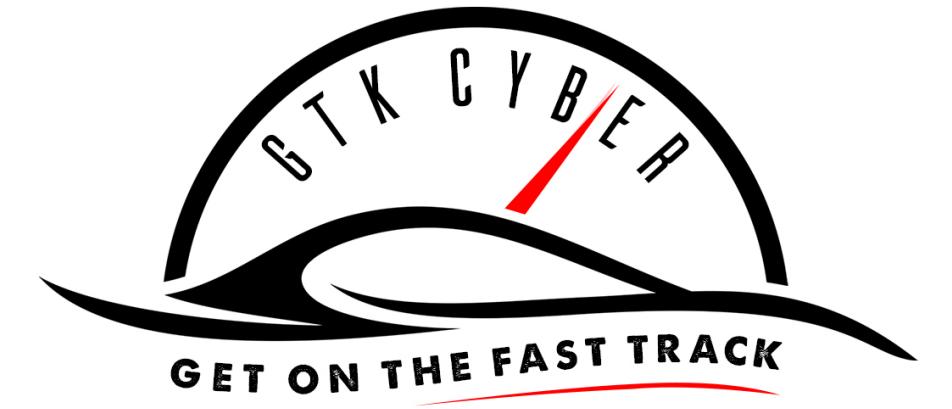




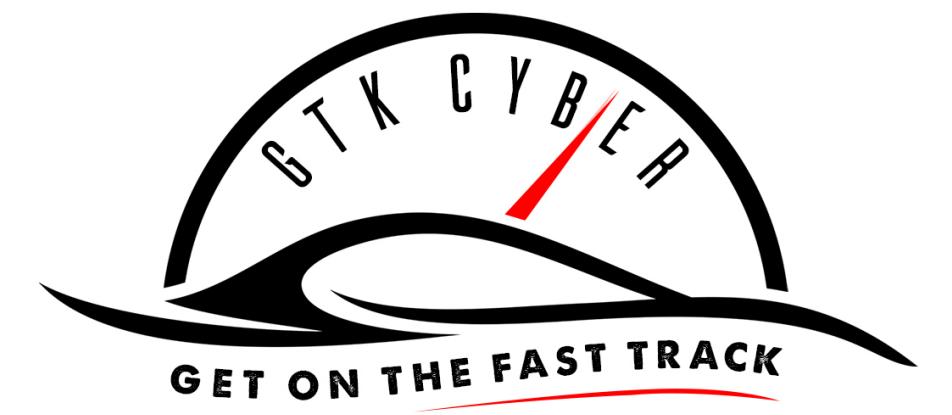


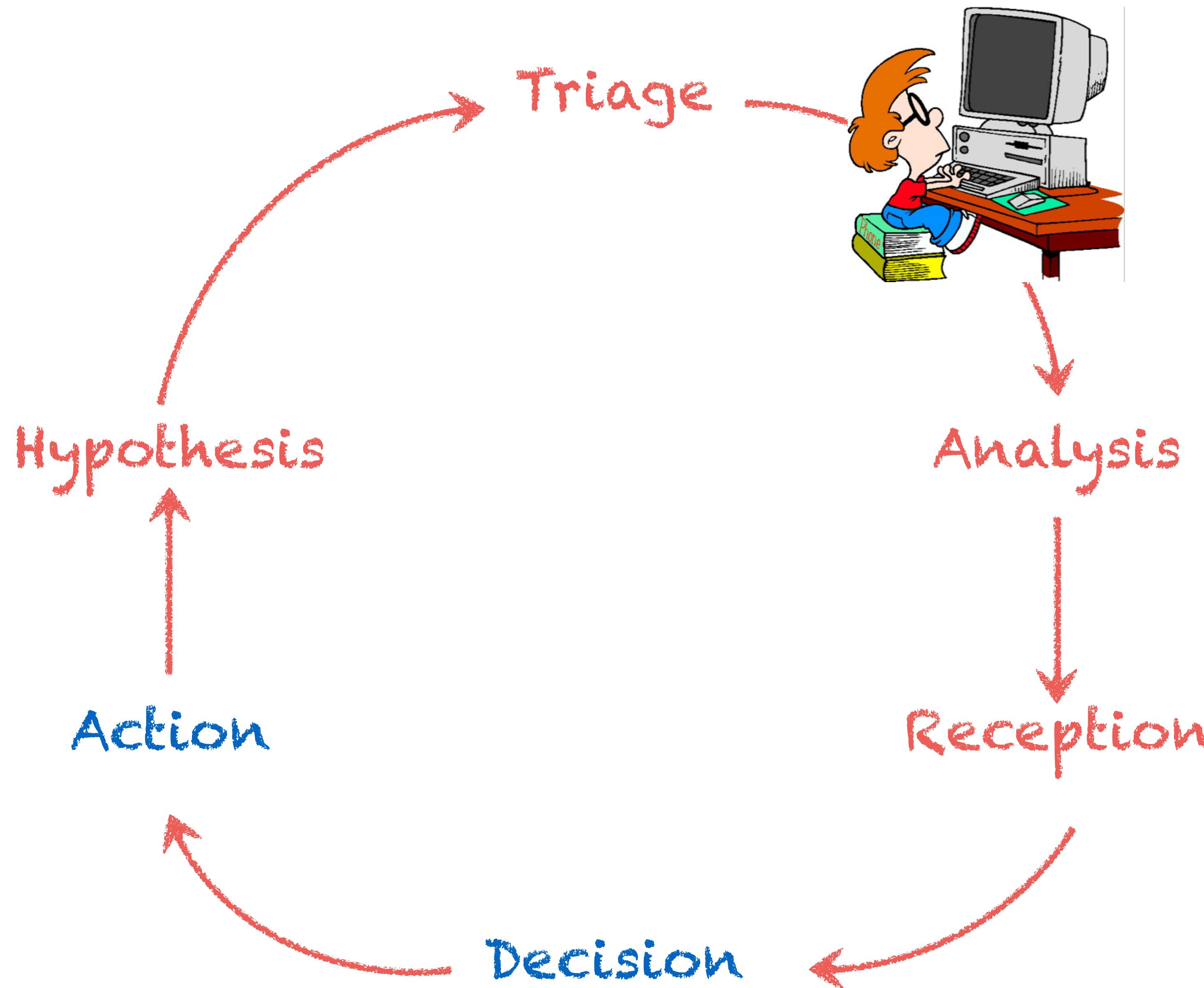
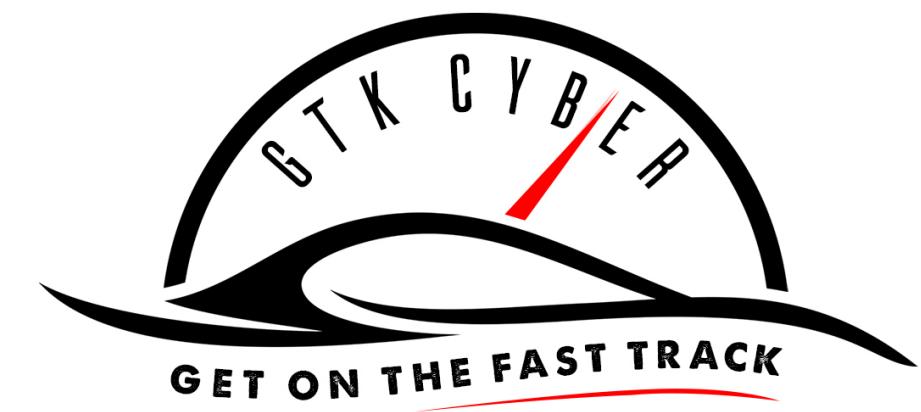
The Data Scientist Venn Diagram

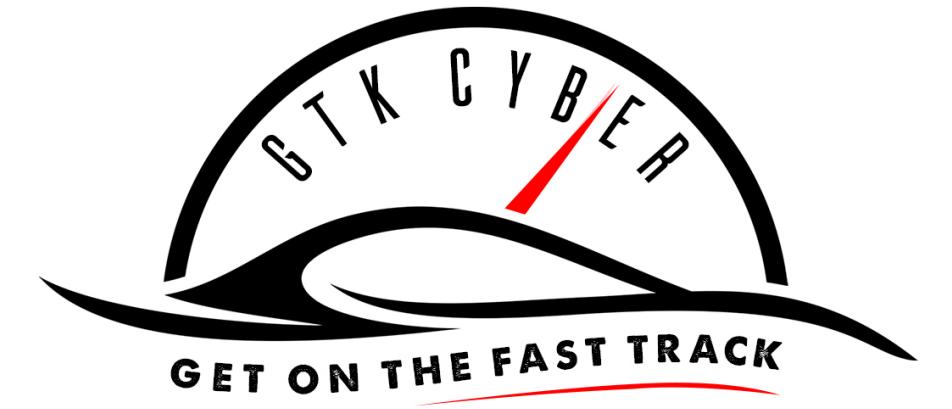




Data Scientists spend
50-90% of their time being...







Thoughts for Data Science Success

Data is a Strategic Asset... not a cost



Align Projects to Corporate Strategy

Align Projects to Corporate Strategy



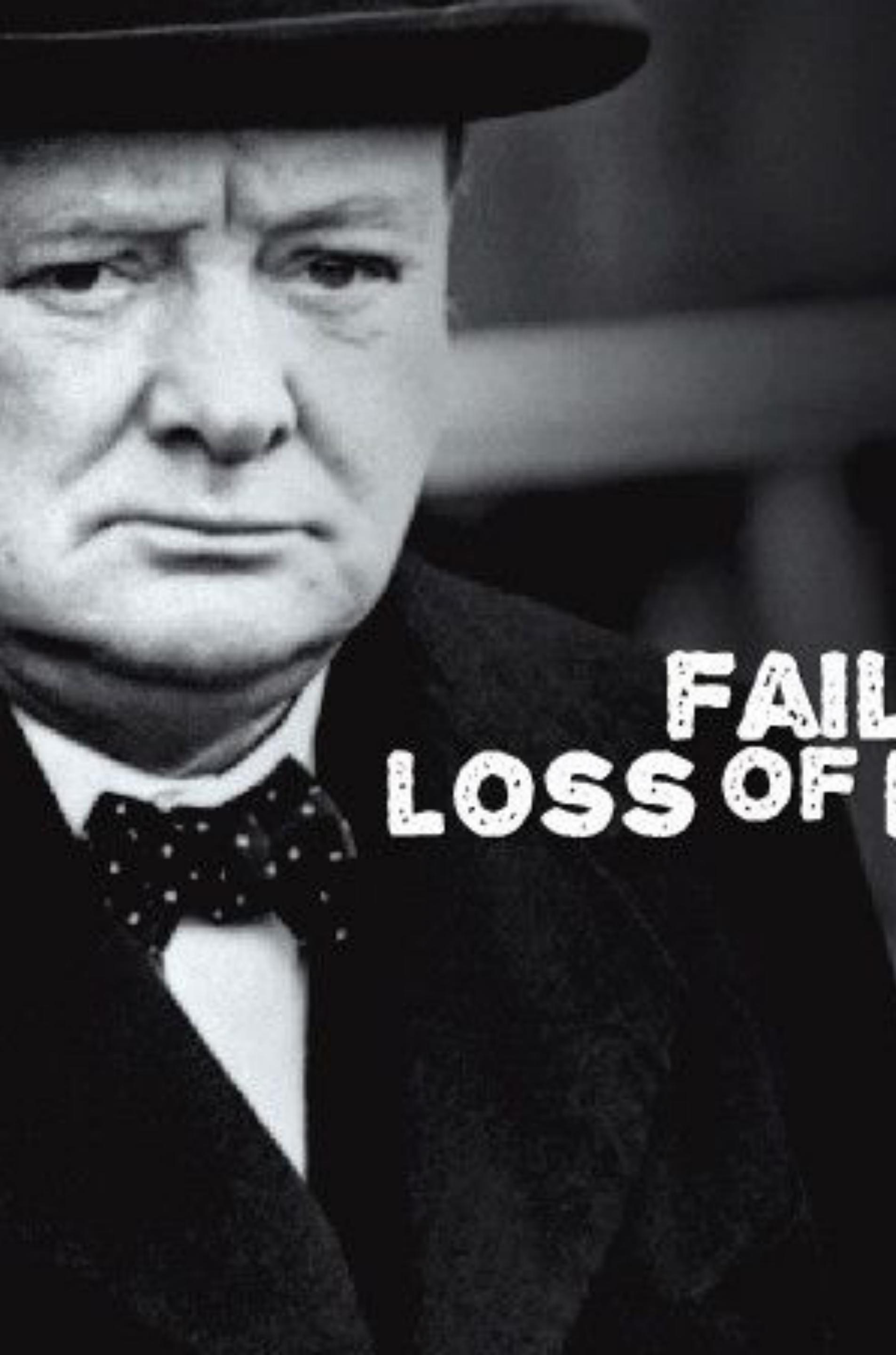
Your:
Time
Money
Job?

Build the right team for Data Initiatives



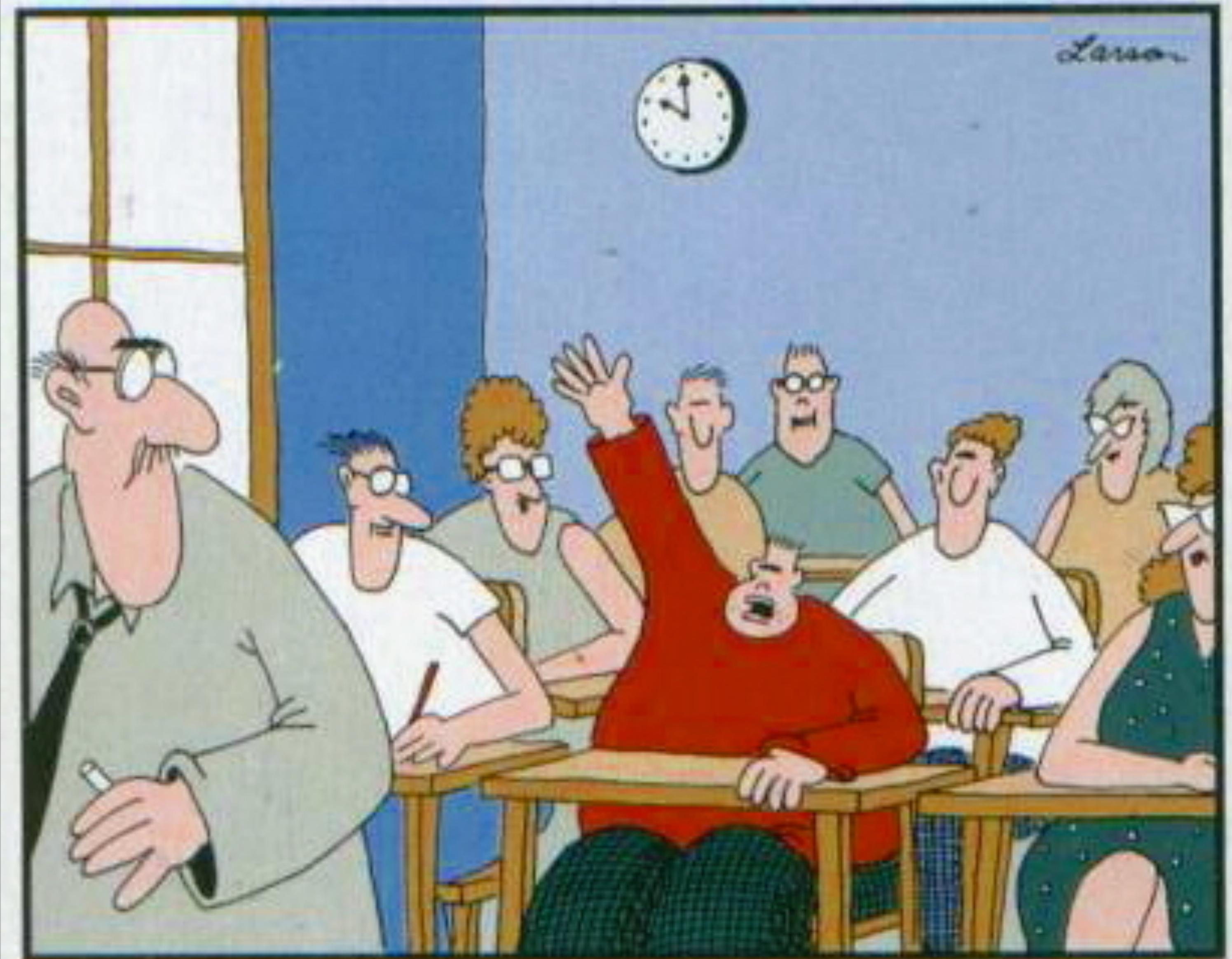
Prioritize building appropriate data platform



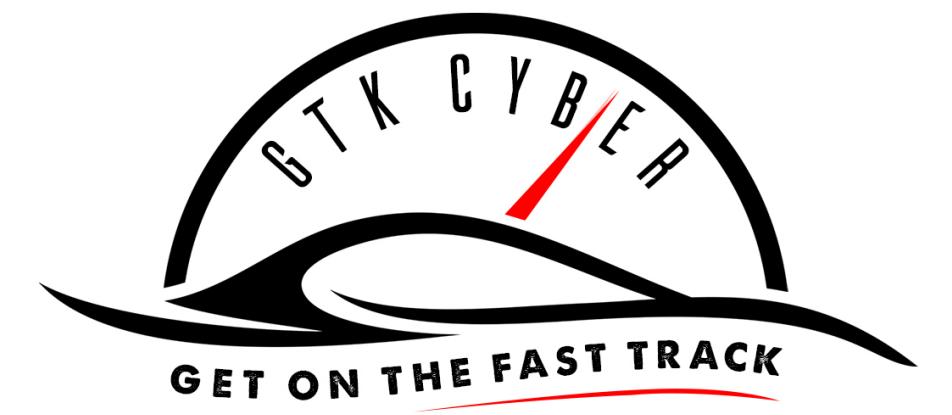


**"SUCCESS
CONSISTS OF
GOING FROM
FAILURE TO
FAILURE WITHOUT
LOSS OF ENTHUSIASM."**

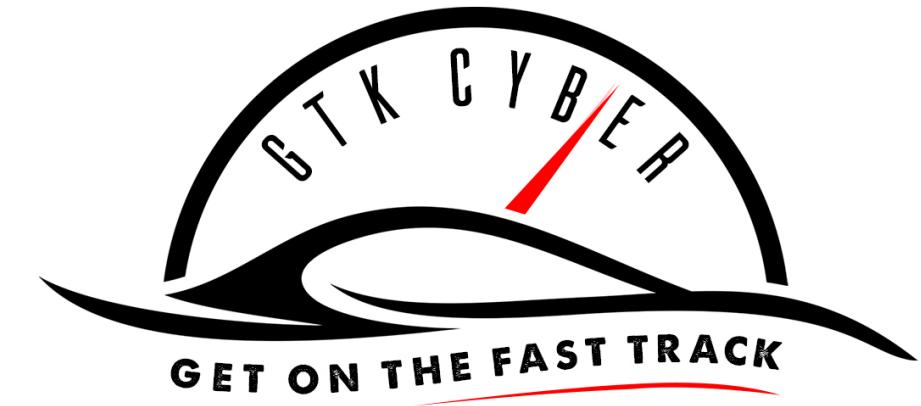
Winston Churchill



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

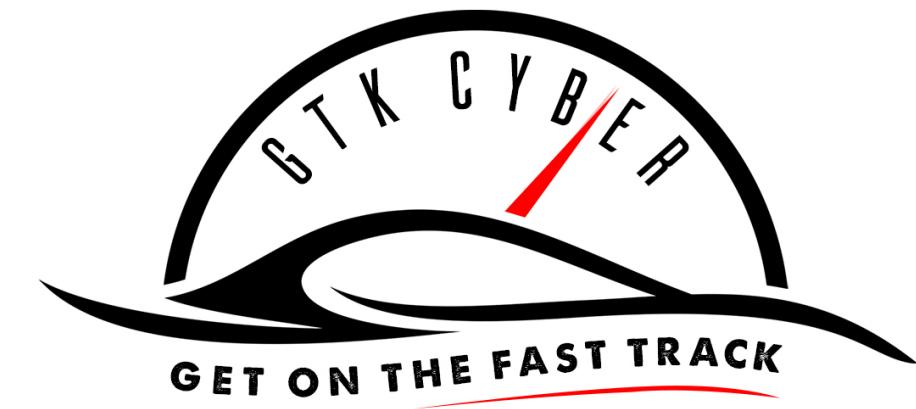


Building a Data Science Team



Building a Data Science Team

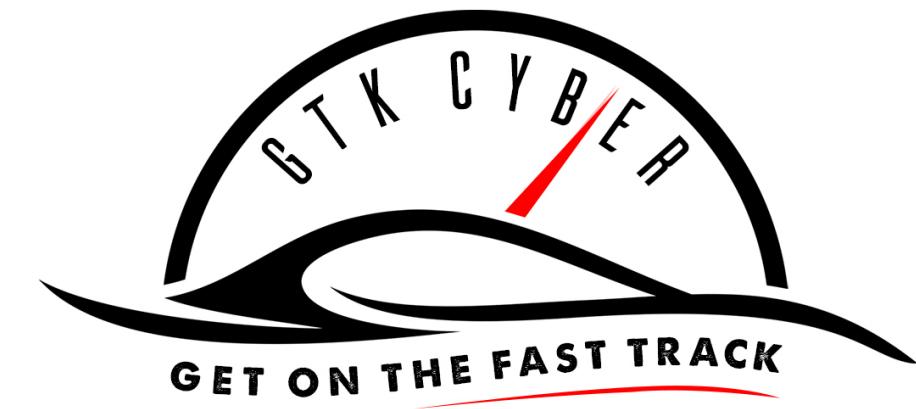
Programmer + Statistician + SME = DS Team?



Building a Data Science Team

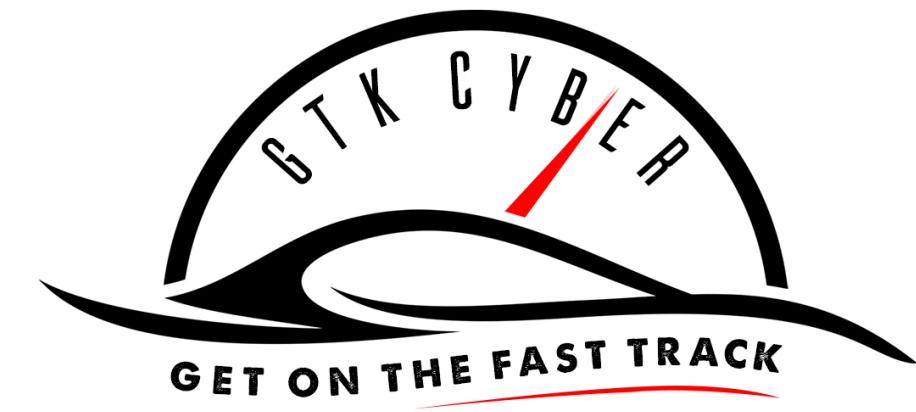
Programmer + Statistician + SME = DS Team?

Sort of...



Building a Data Science Team

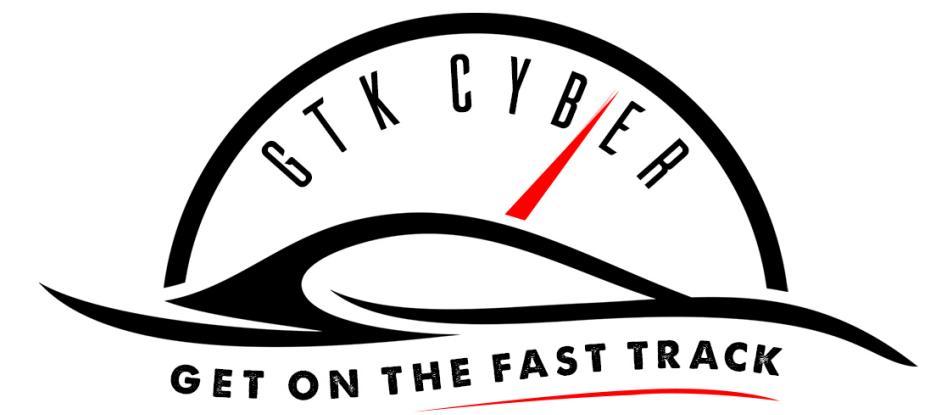
- Data Ambassador
- Data Scientist
- Data Storyteller
- Data Engineer

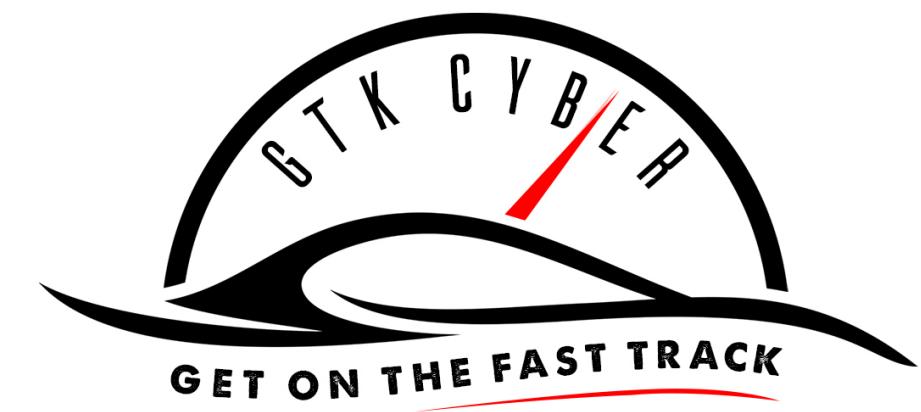


By the end of the class
you will be able to:

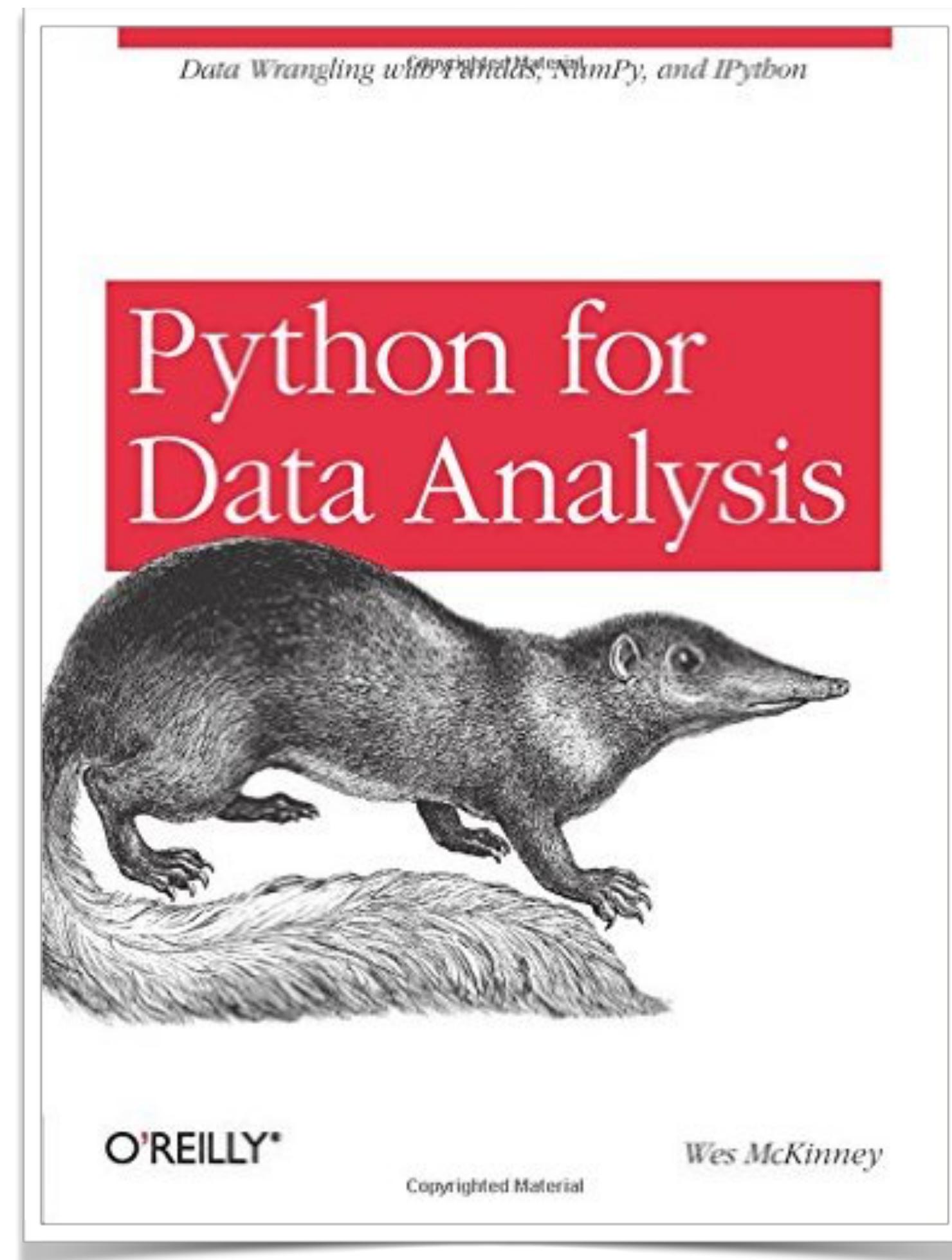
- Quickly and effectively prepare data for analysis
- Apply machine learning techniques to enhance security

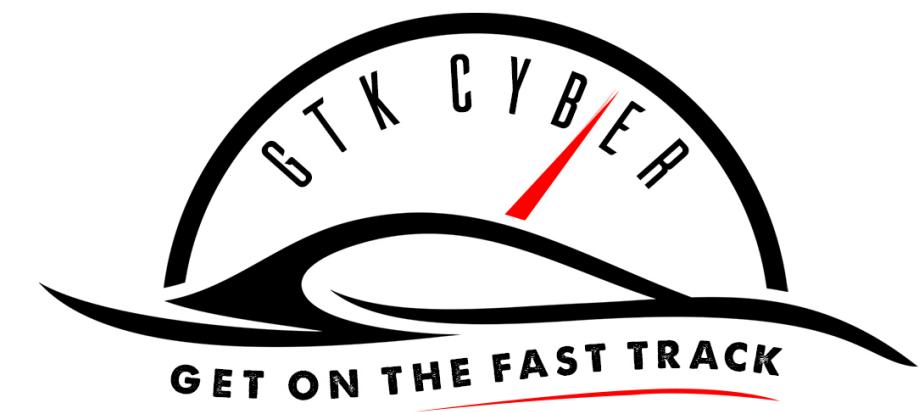




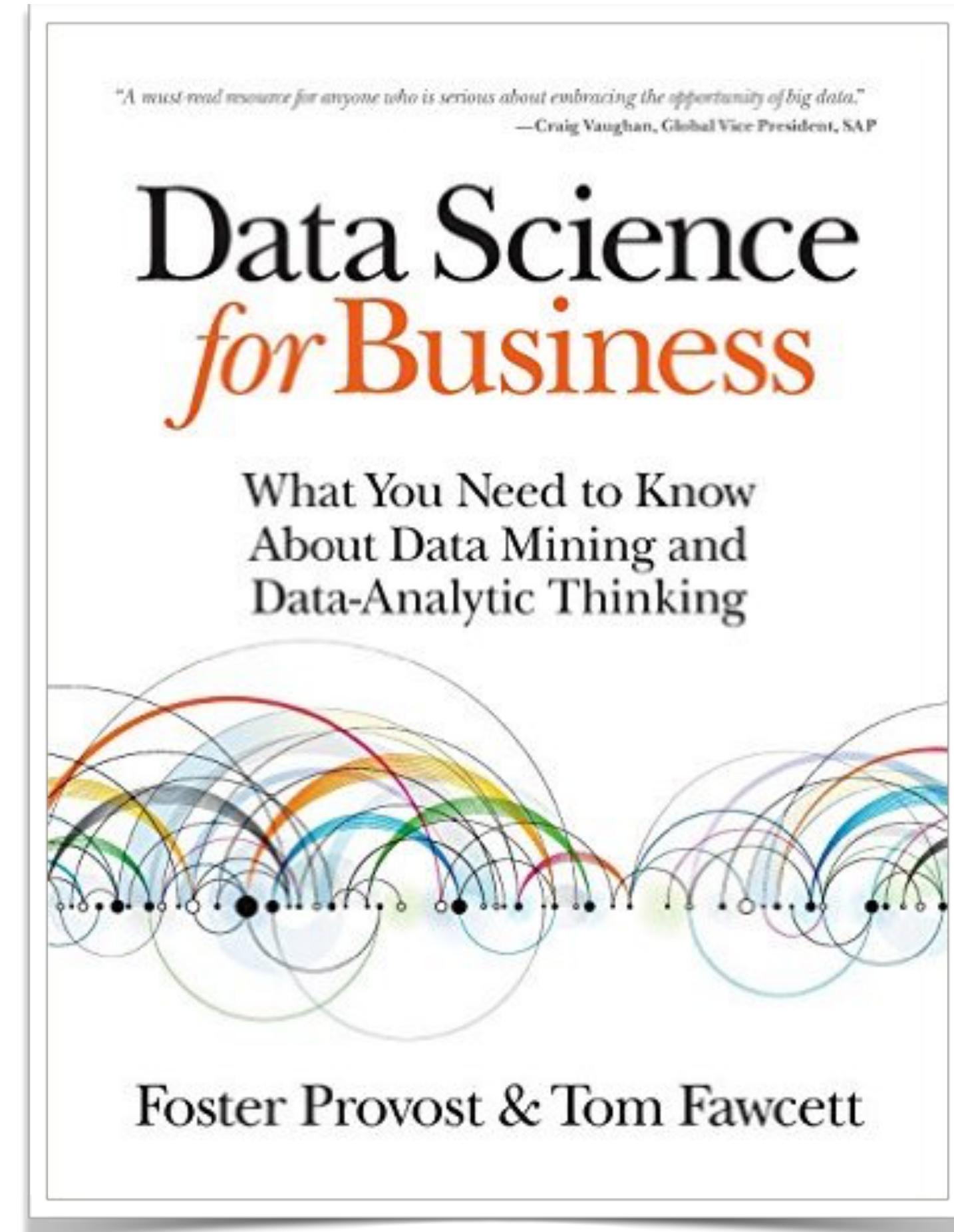


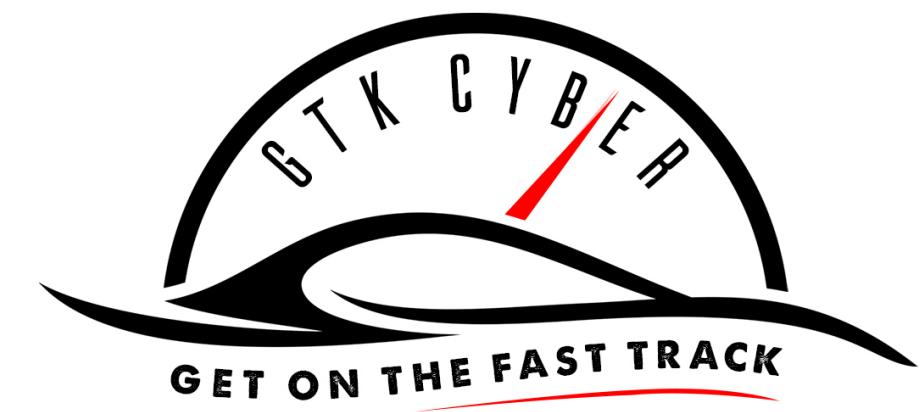
Recommended Reading



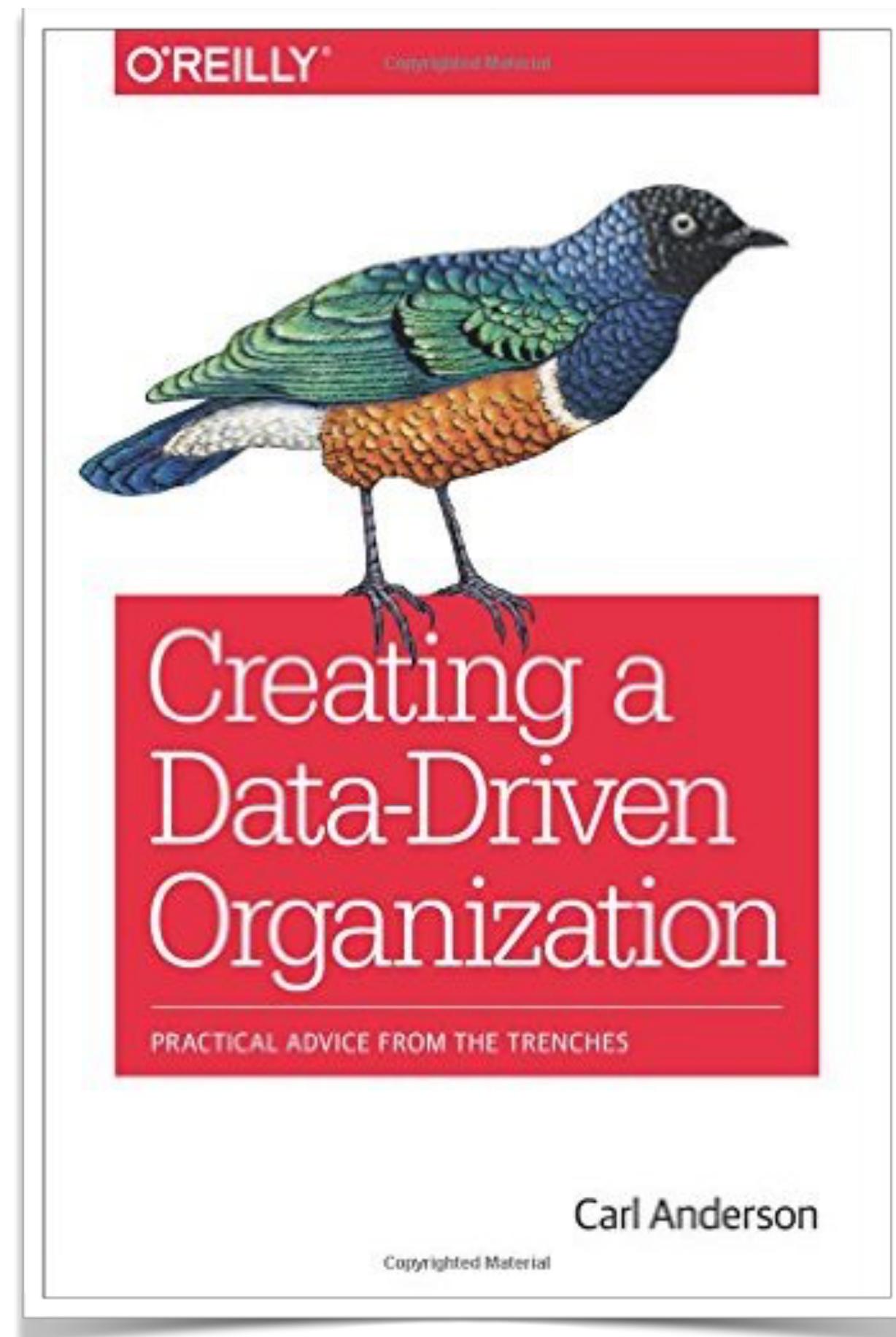


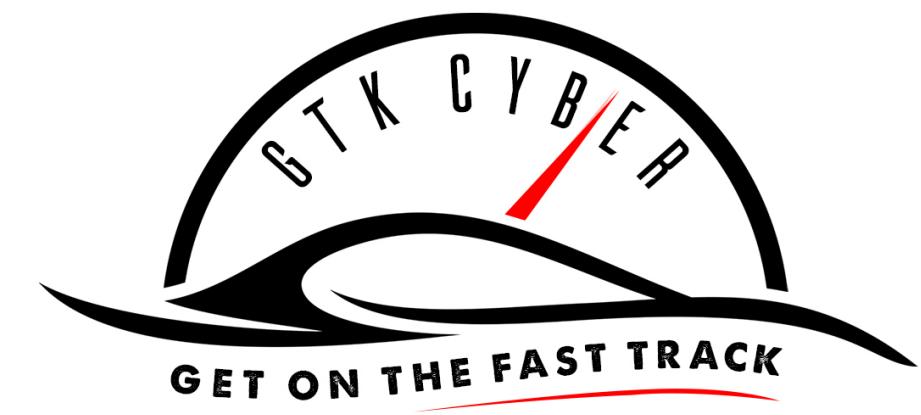
Recommended Reading



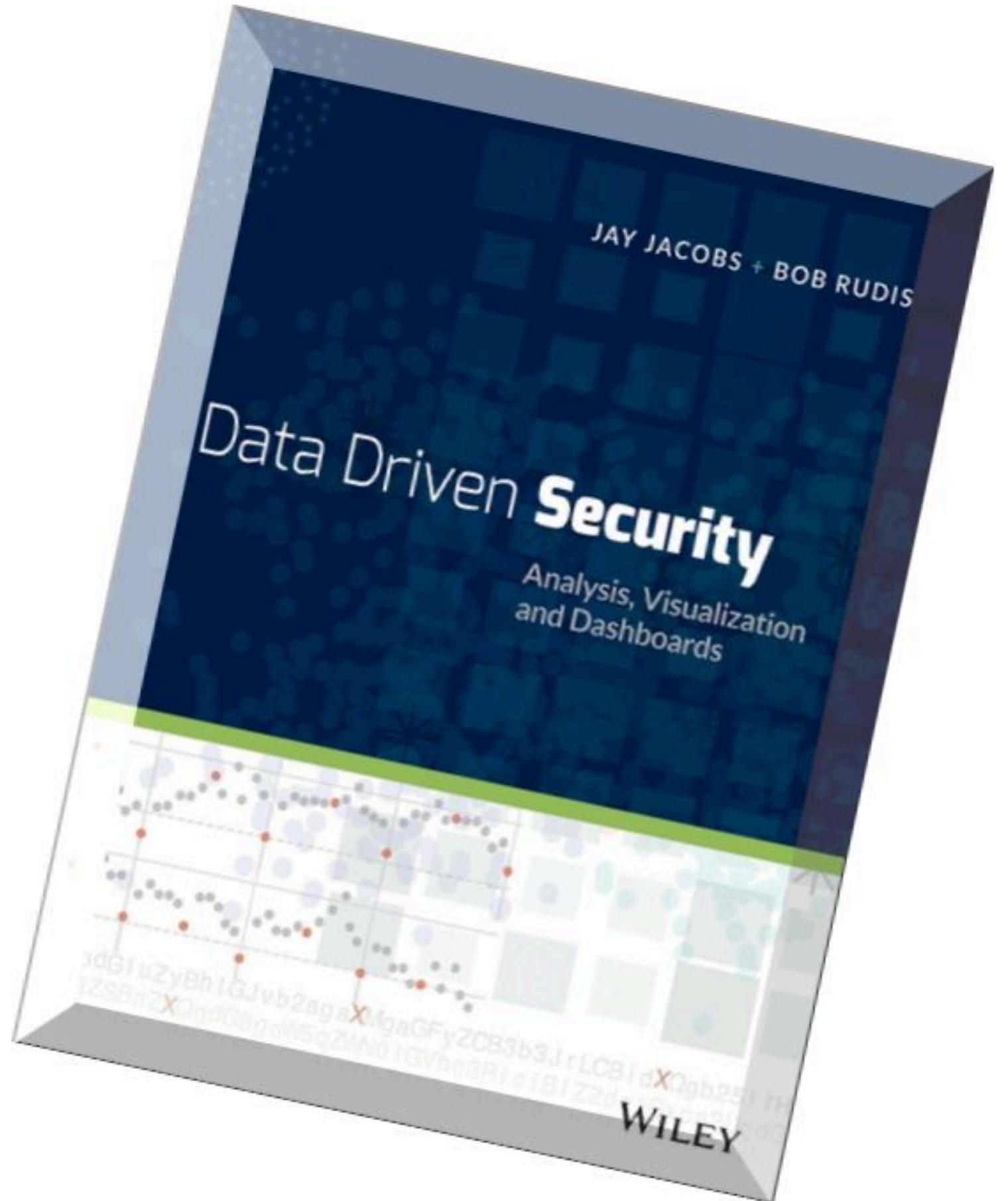


Recommended Reading



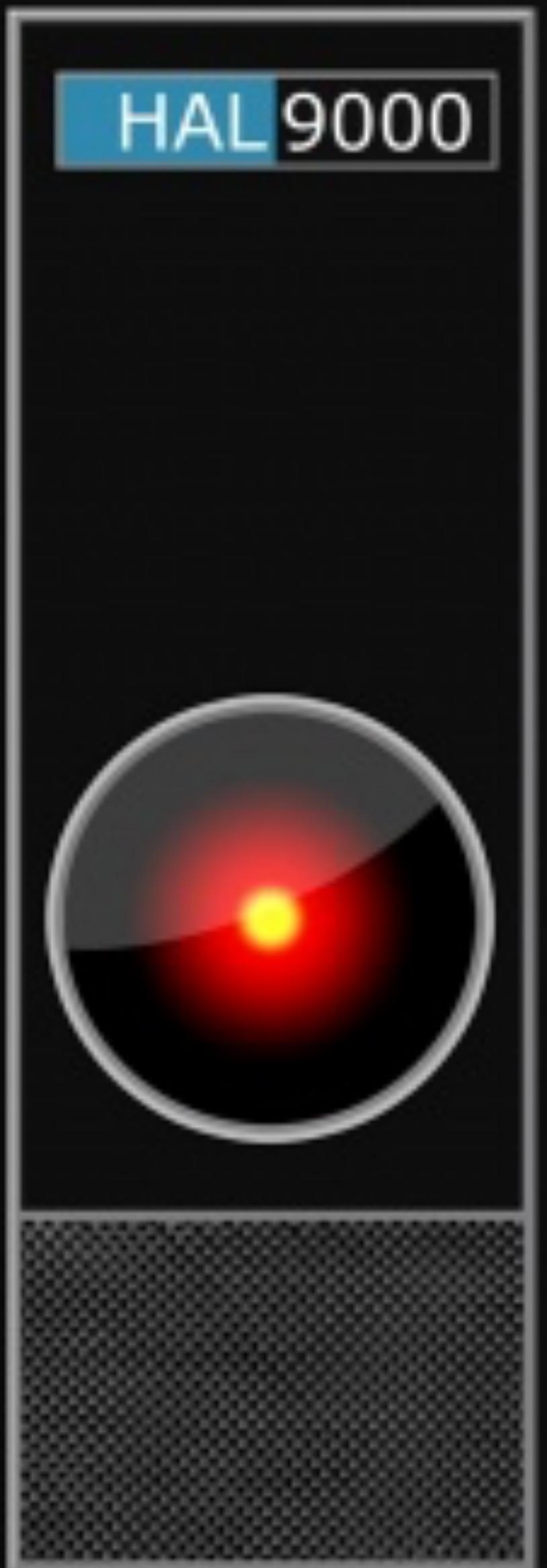


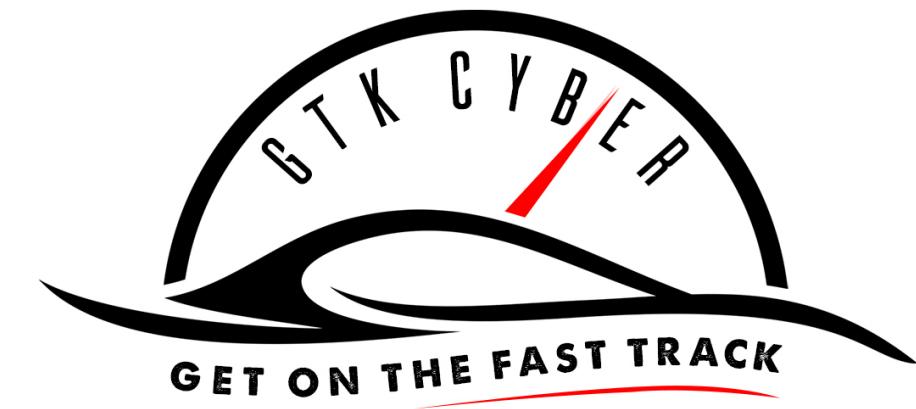
Recommended Reading



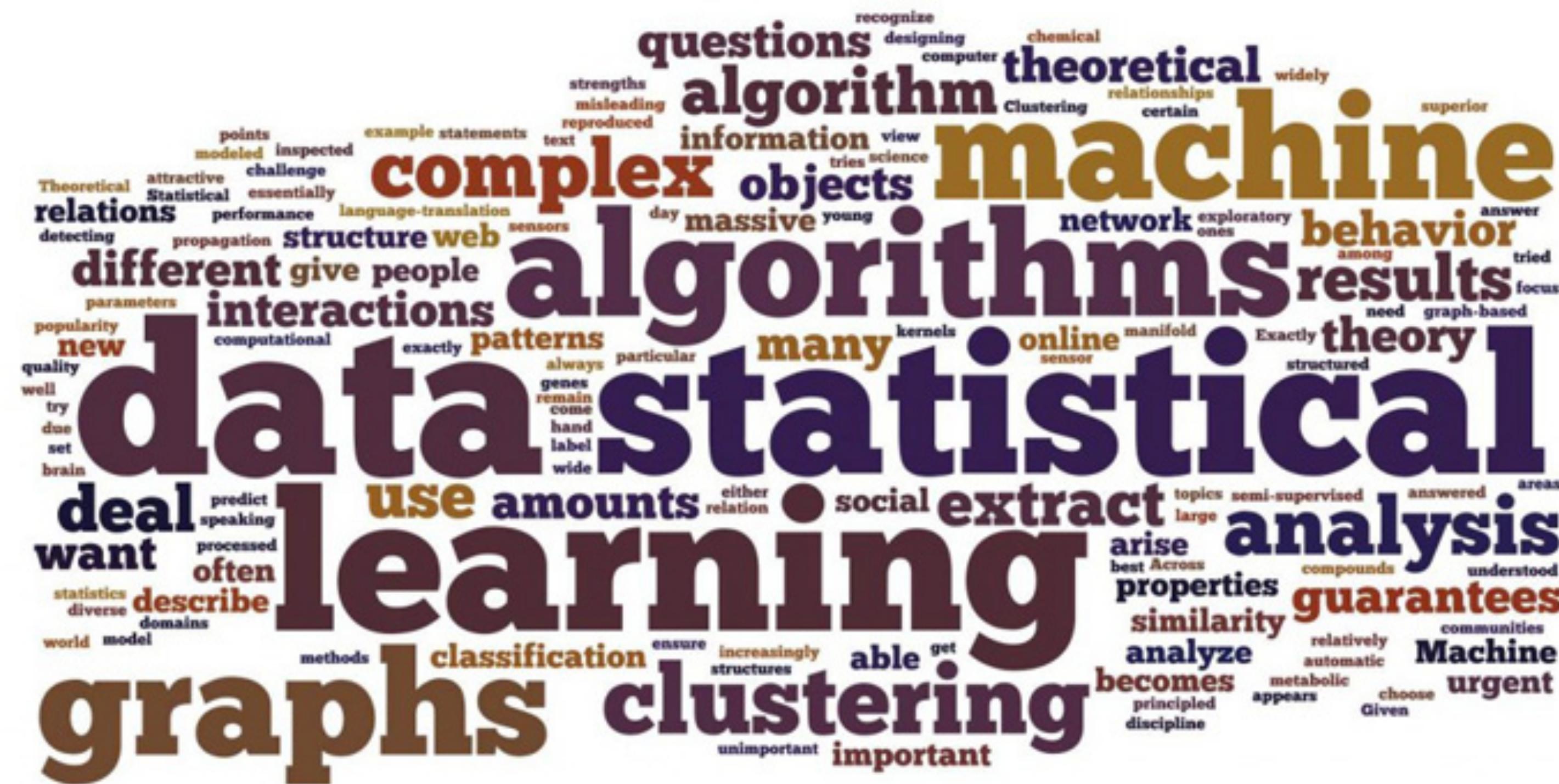
<http://datadrivensecurity.info>

Machine Learning



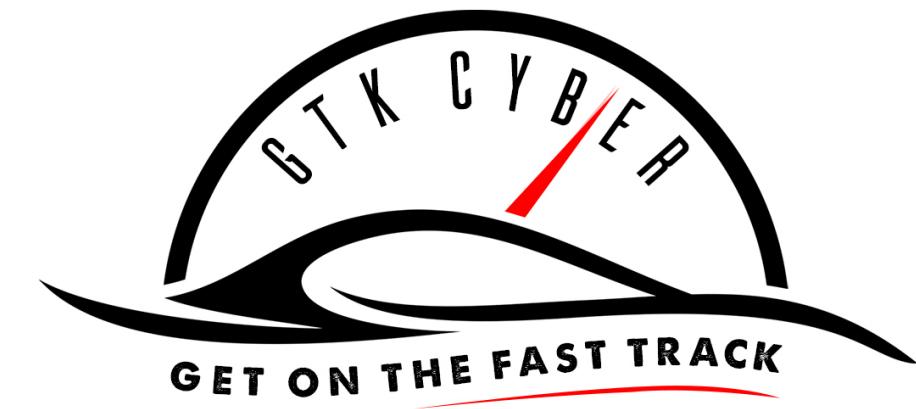


What is Machine Learning (ML) Artificial Intelligence (AI)



“I have no idea. The latest buzzword? ”

-The guy in the back of the class



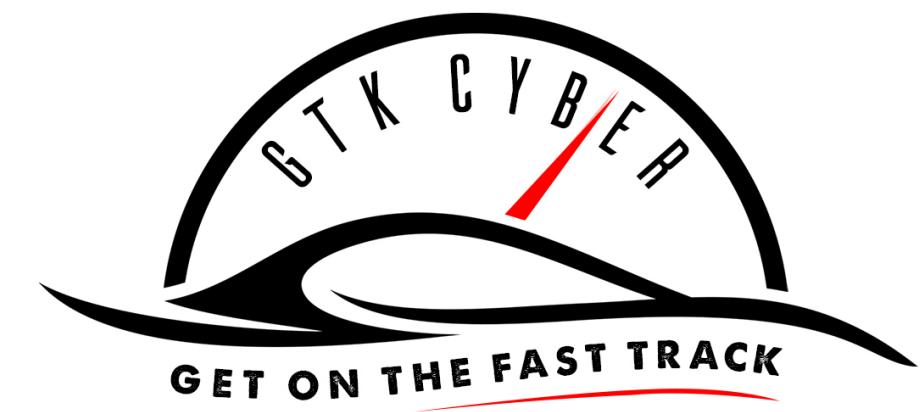
“Machine learning is the science of getting computers to **act without being explicitly programmed.** ”

– <https://www.coursera.org/course/ml>



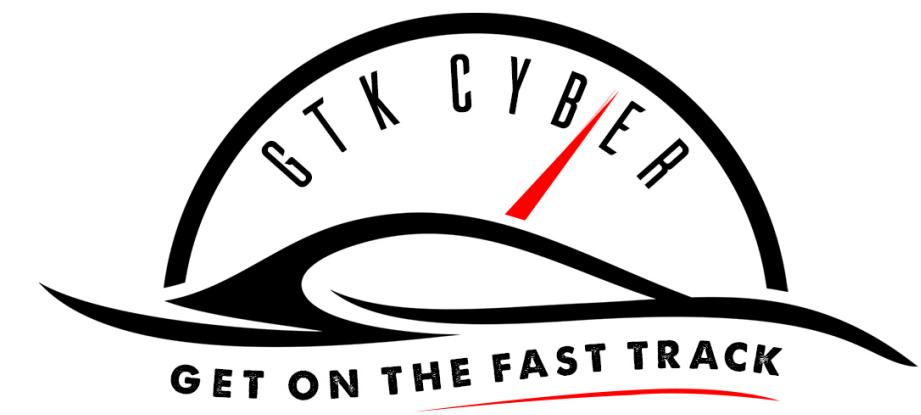
“A computer program is said to learn from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E.”

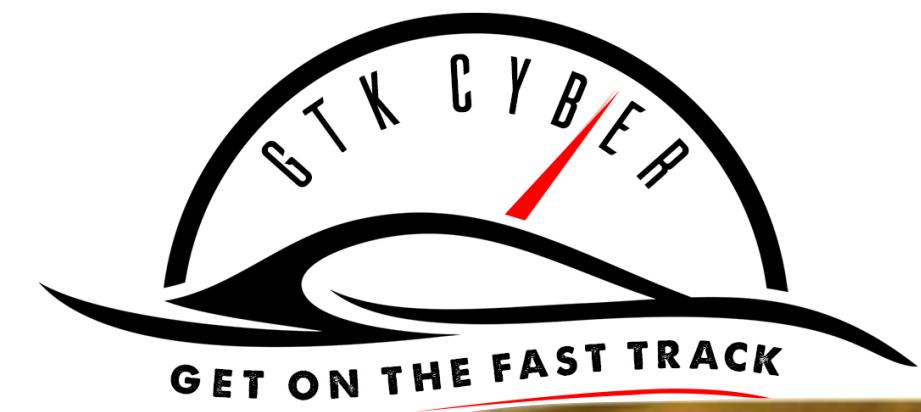
–Tom Mitchell, Carnegie Mellon University

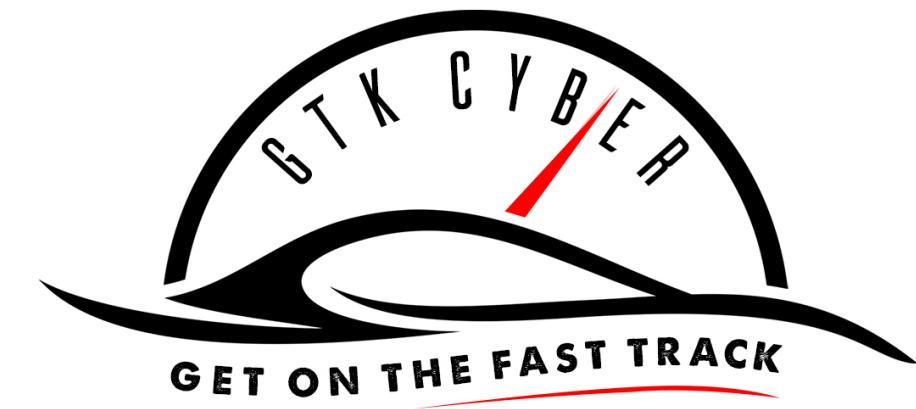


“Machine learning explores the construction and study of algorithms that can learn from and **make predictions on data**. Such algorithms operate by building a model from example inputs in order to make data-driven predictions or decisions, **rather than following strictly static program instructions.**”

—https://en.wikipedia.org/wiki/Machine_learning







- Blacklists
- Simple keyword matching
- Naive Bayesian Classifiers
- Deep Learning



Artificial Intelligence

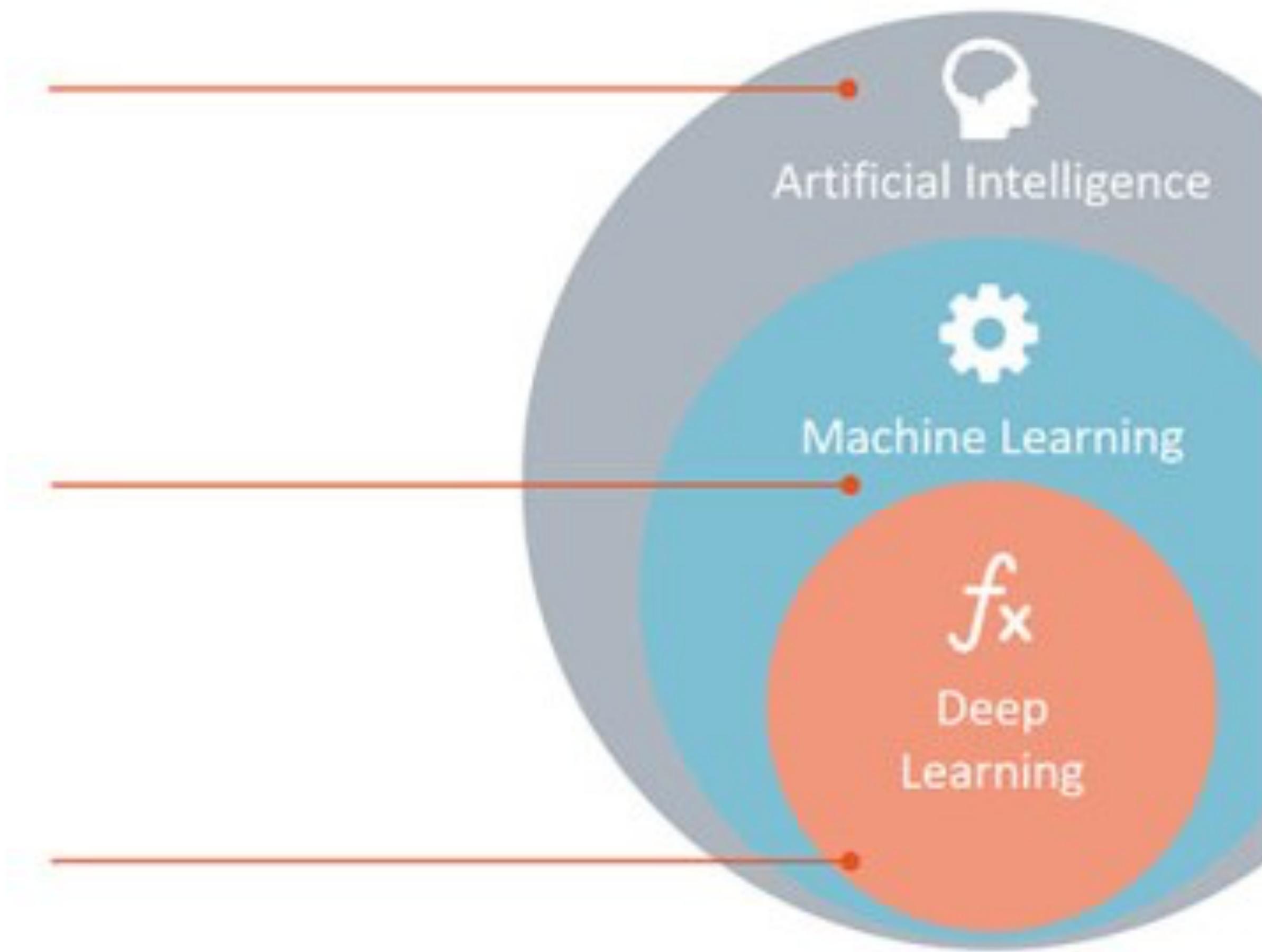
Any technique which enables computers to mimic human behavior.

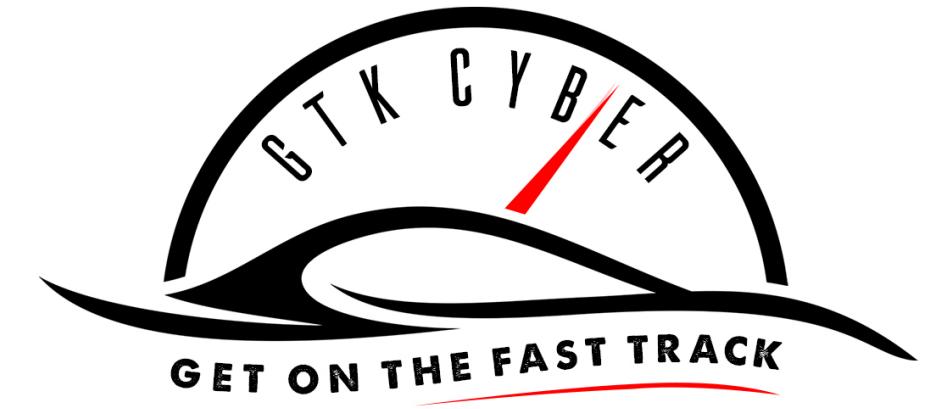
Machine Learning

Subset of AI techniques which use statistical methods to enable machines to improve with experiences.

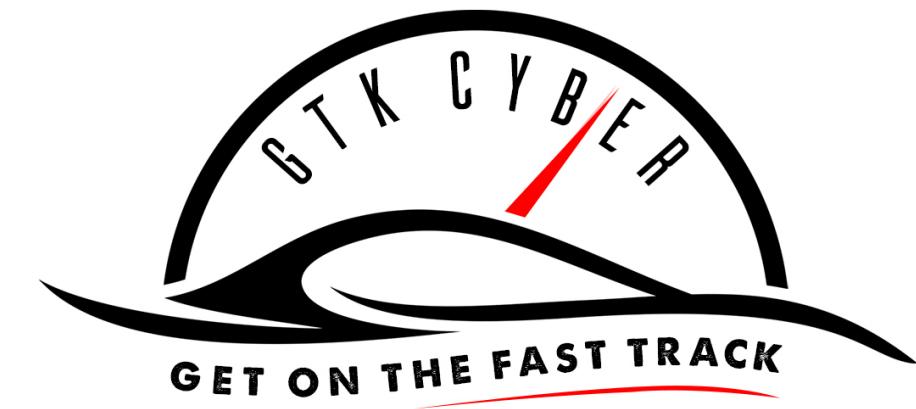
Deep Learning

Subset of ML which make the computation of multi-layer neural networks feasible.



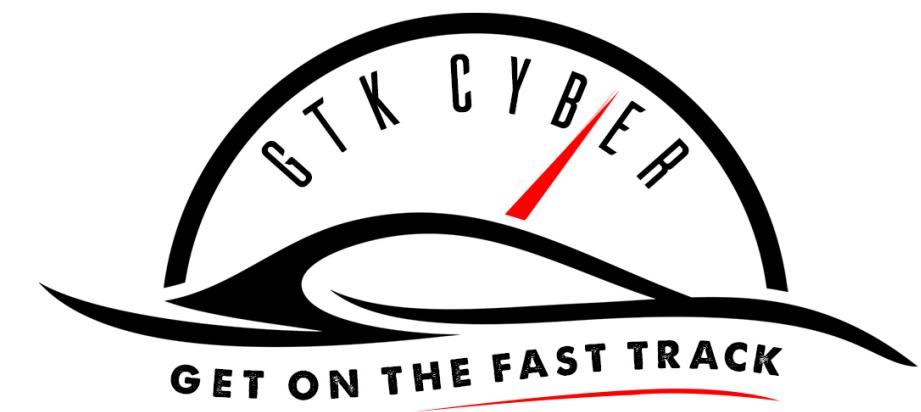


@katherinebailey Because marketing? Every time someone calls simple linear regression “AI” Gauss turns over in his grave.



Machine Learning Problems

- **Supervised Learning:** Supervised Learning is a class of Machine Learning in which a model is "trained" using a set of pre-existing labeled data.
- **Unsupervised Learning:** A class of Machine Learning algorithms in which a model is built without the use of labeled data.

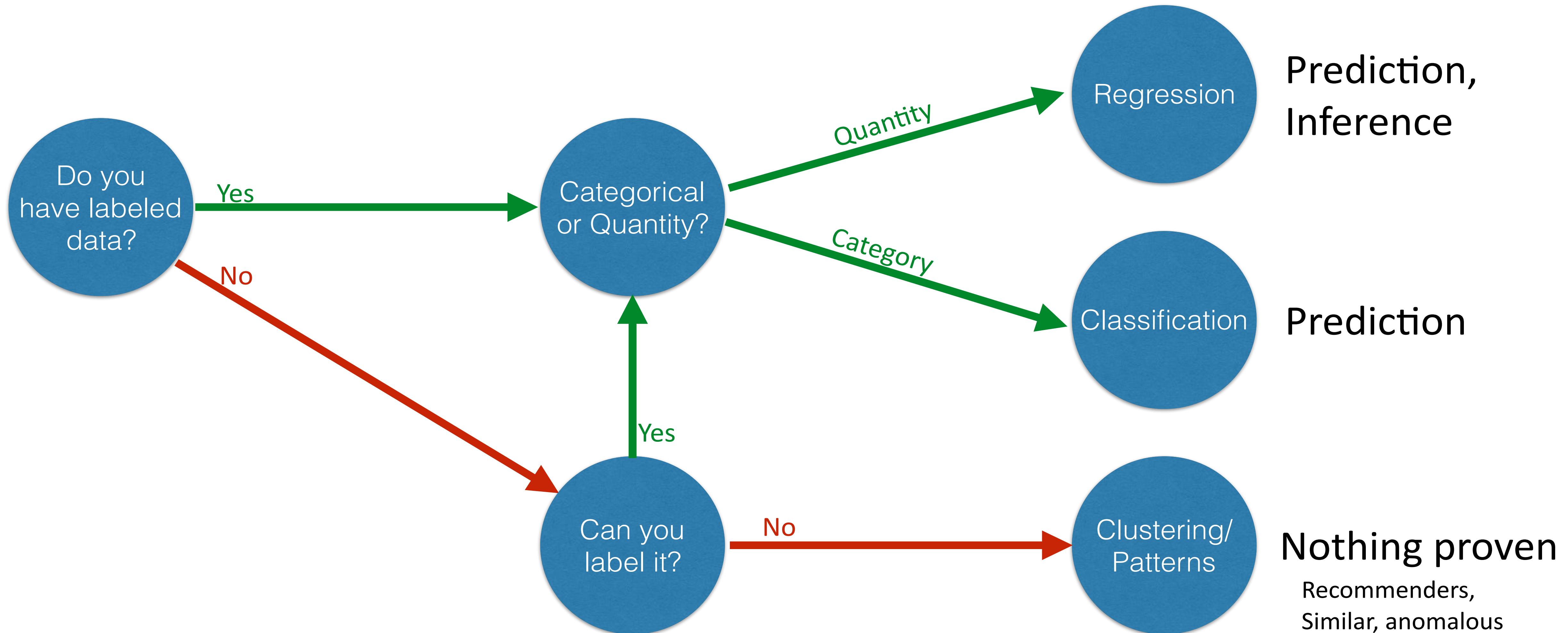


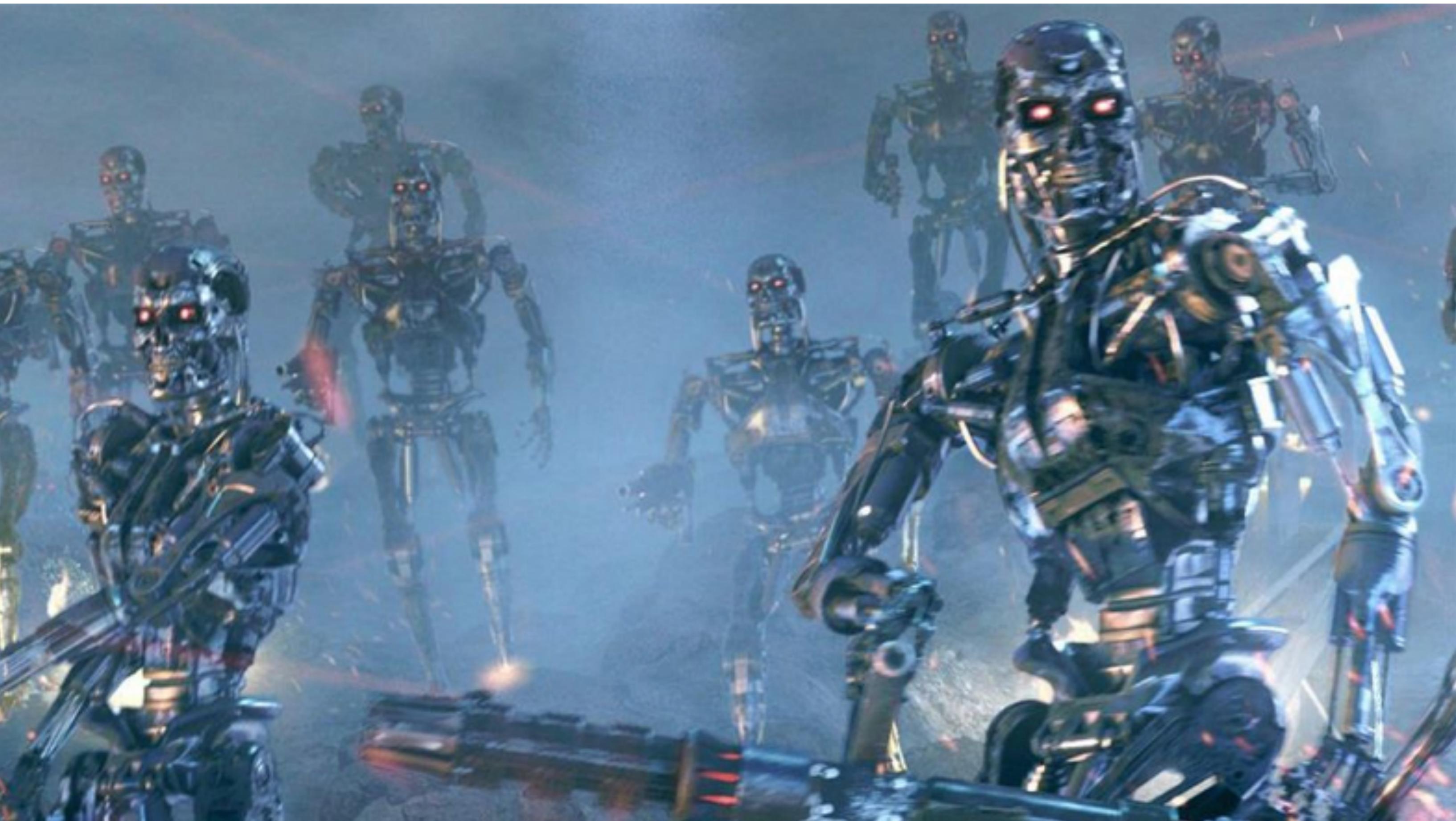
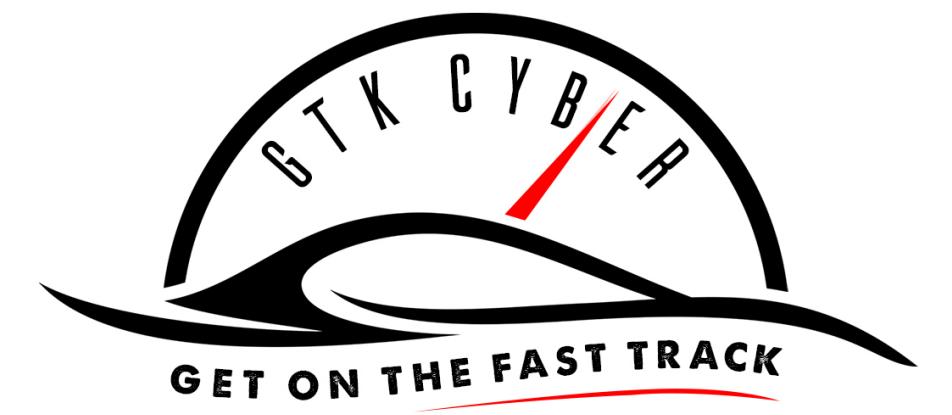
Machine Learning Problem Types

- **Classification:** Assigning or predicting a observation's membership in discrete class
- **Regression:** Predicting a continuous value based on the observations' features
- **Clustering:** Identifying groupings within a dataset
- **Dimensionality Reduction:** Reducing the number of variables in a feature set

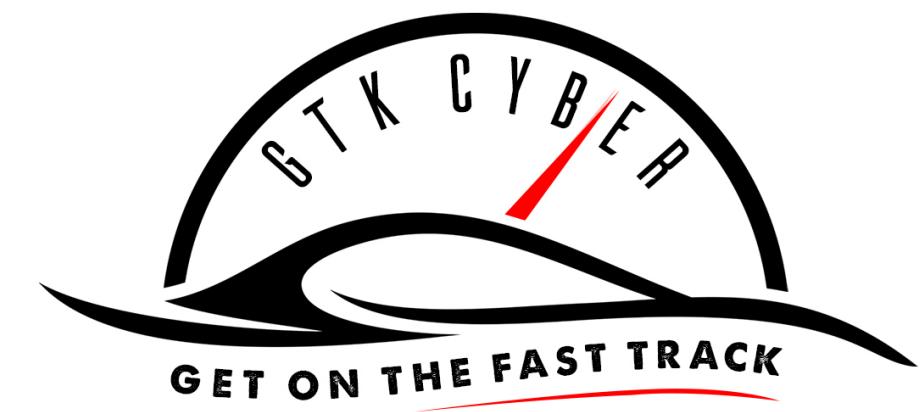


What Problem am I solving?

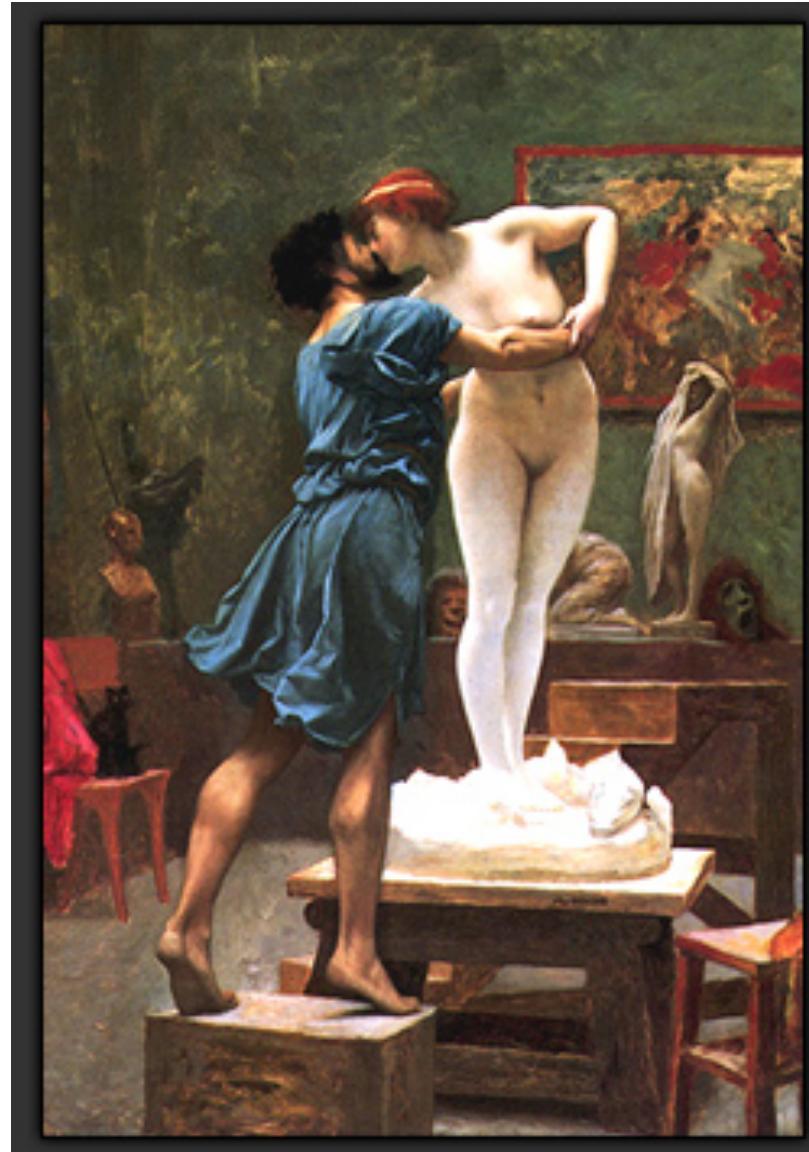




What it is not

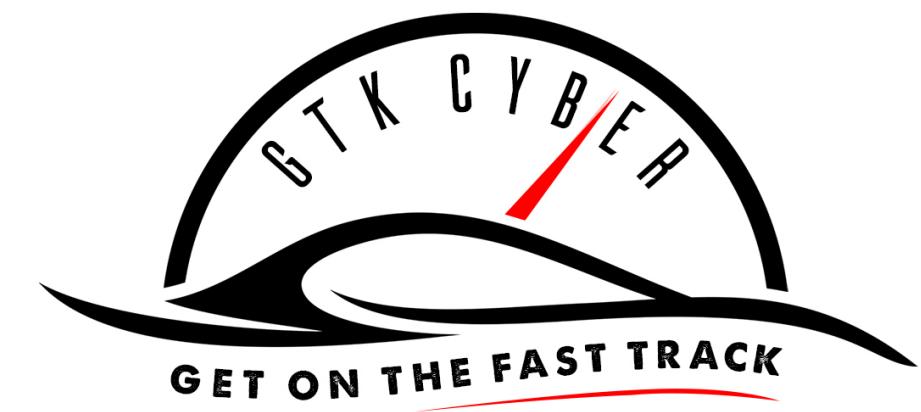


History of AI and ML



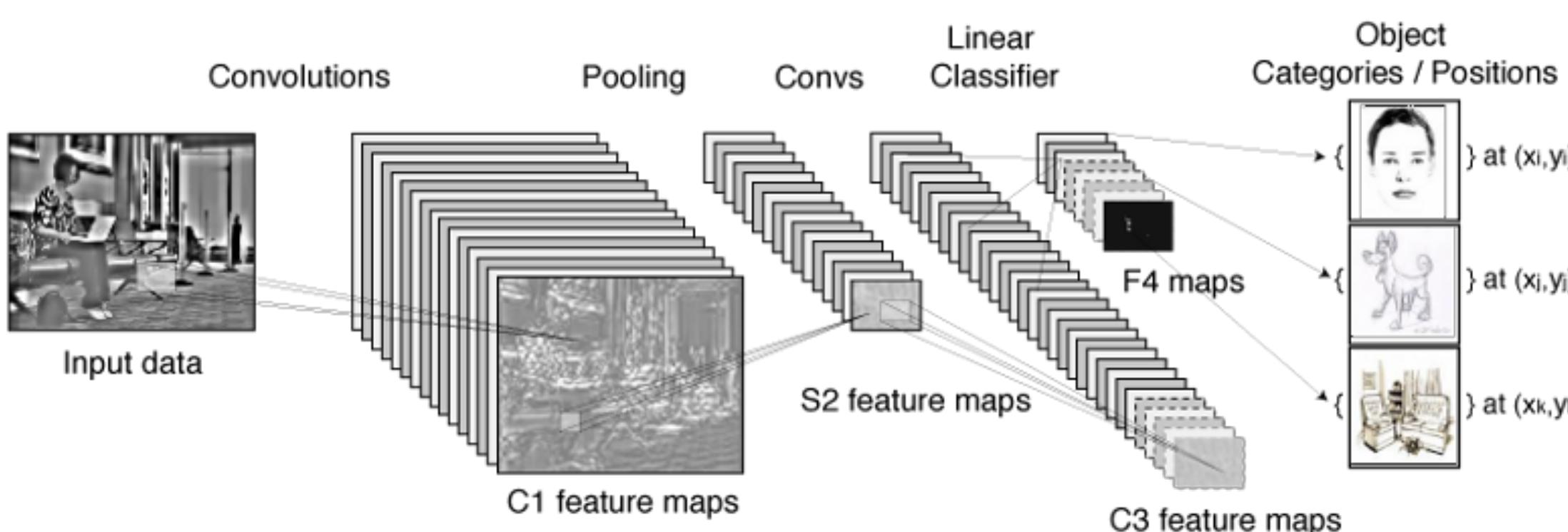
- Mythical figure Pygmalion: Breath of life in a statue (ancient Greece)
- Turing Test 1950s by Alan Turing: Test of a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human.
- Early AI: solve problems that are difficult for humans, but straightforward 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).

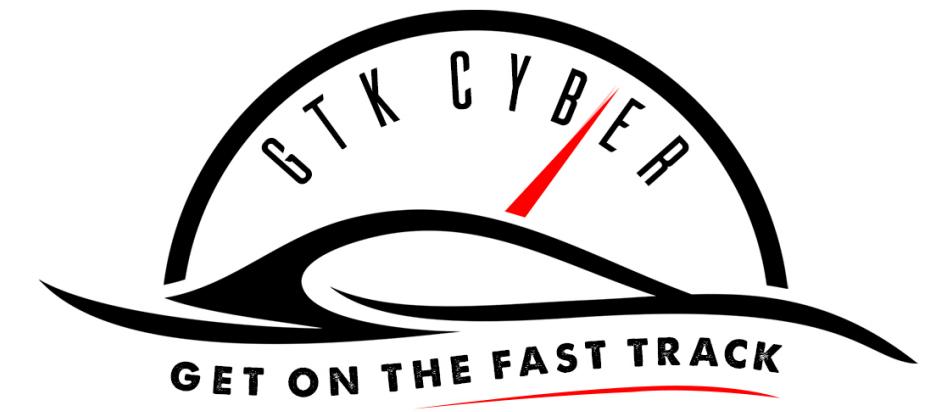




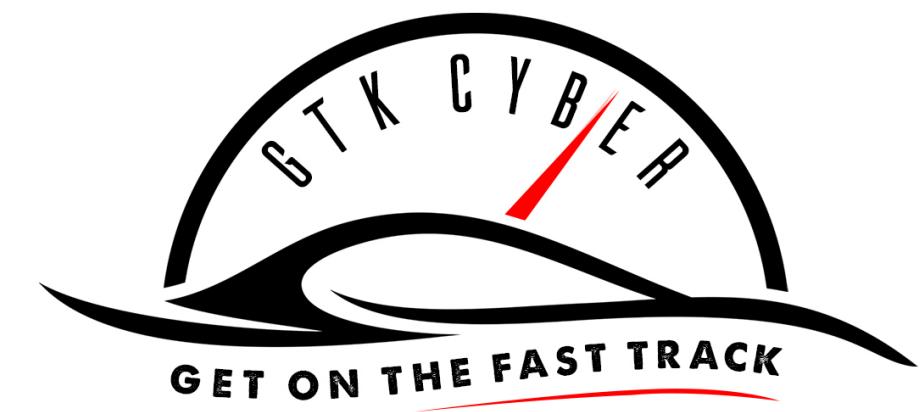
Path to Artificial Intelligence?

- Hard-coding knowledge failed (e.g. Cyc 1989).
- **Machine Learning: 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.**





Applications to Security

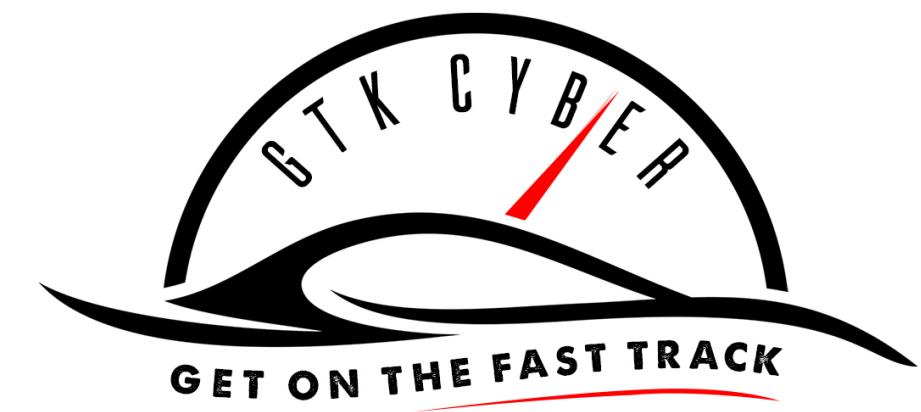


Regression Example

Server Capacity Prediction: Regression analysis can be used to predict a server's capacity (or CPU usage) based on the server's historical performance.

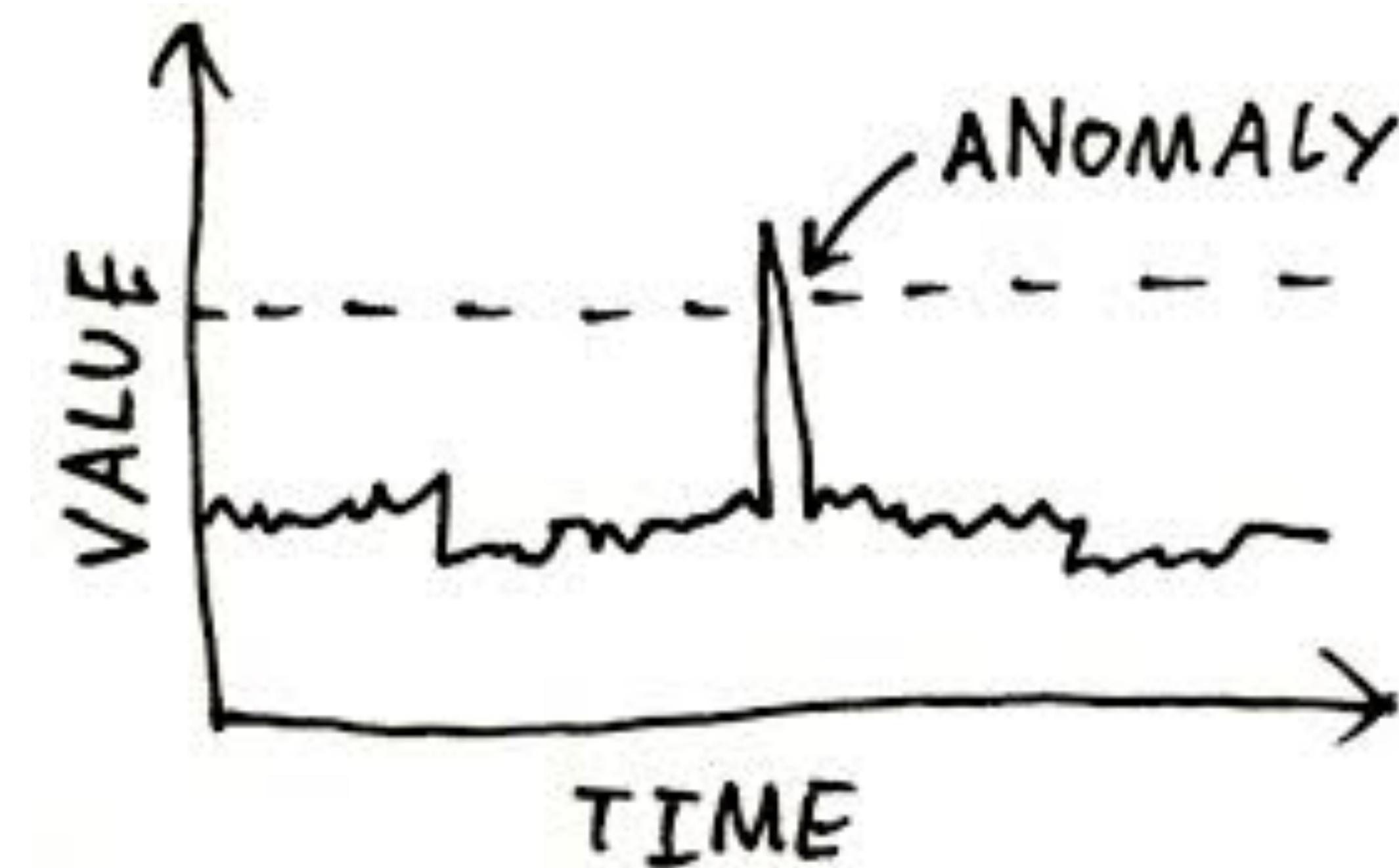


https://www.researchgate.net/publication/256645877_LiRCUP_Linear_Regression_based_CPU_Usage_Prediction_Algorithm_for_Live_Migration_of_Virtual_Machines_in_Data_Centers



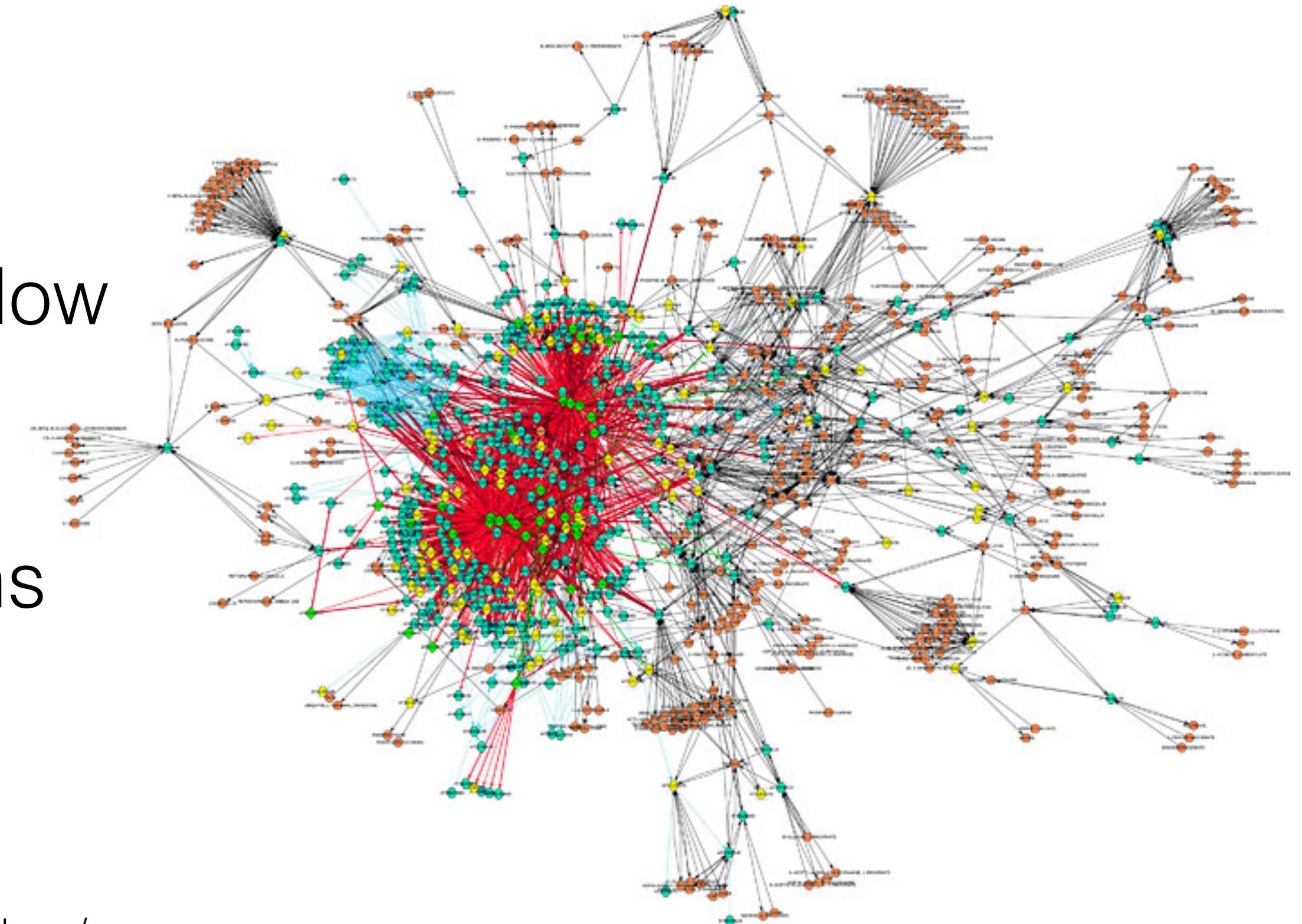
Clustering Example

Anomaly Detection: Clustering techniques can be used to detect anomalous traffic or loads or anything really.



Network-Based Intrusion Detection

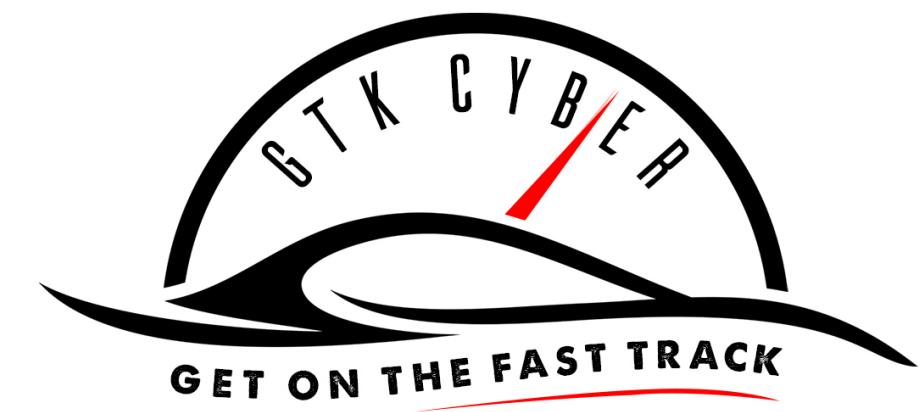
- Derive Features from Network Traffic
Captures “pcap” at packet level or NetFlow level (tools: tshark, tcpdump, bro...)
- Example Features based on header information: 2s-windowing of connections
> duration, protocol, src and dat bytes, service.
- Get data sets: <http://www.netresec.com/?page=PcapFiles>,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



Malware Detection/Classification

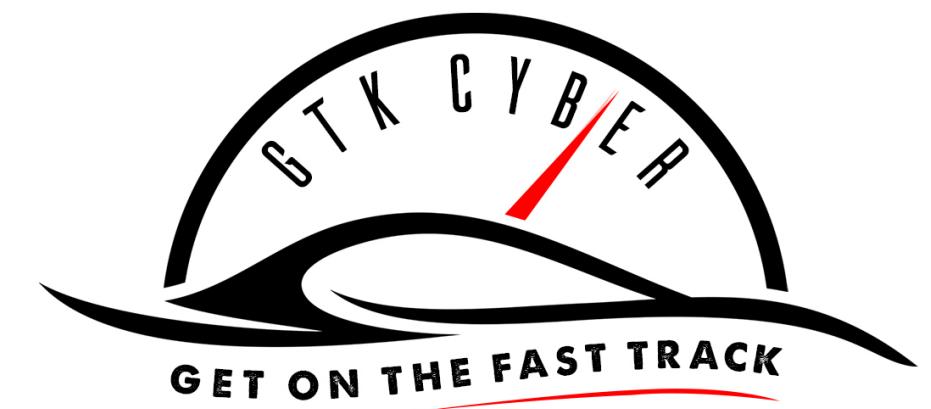
- Derive Features from Binary Content and metadata manifest (function calls, string obtained from IDA Disassembler)
- Example Features: opcode count (n-grams), segment count, asm pixel intensity, n-gramming of bytes, function name.
- Featureless Deep Learning with word2vec embedding
- Get open source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



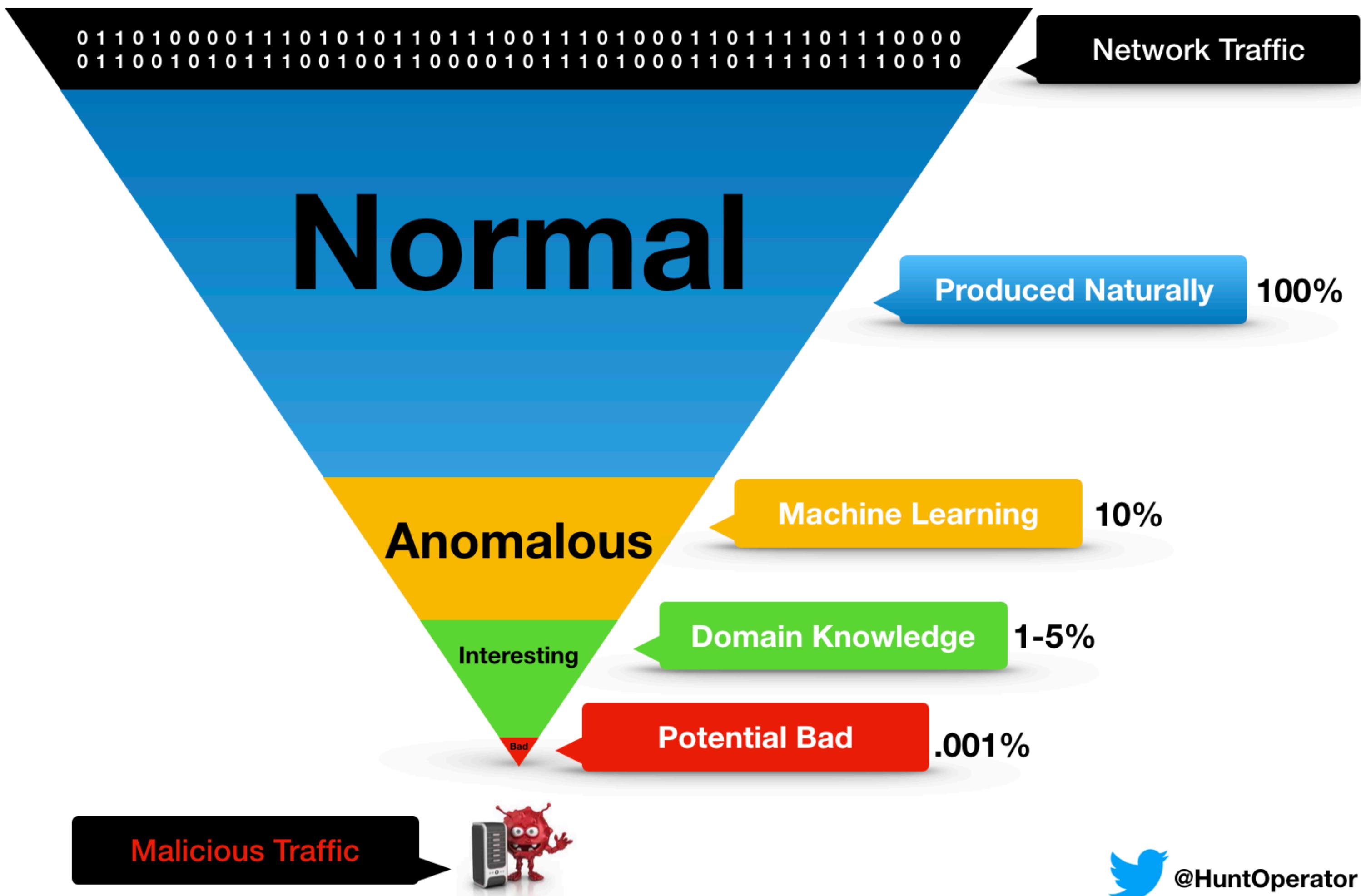


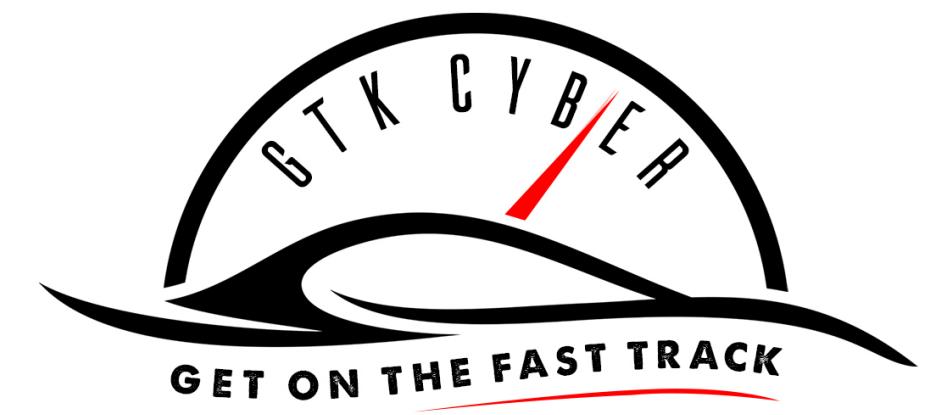
Security Applications of Machine Learning

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

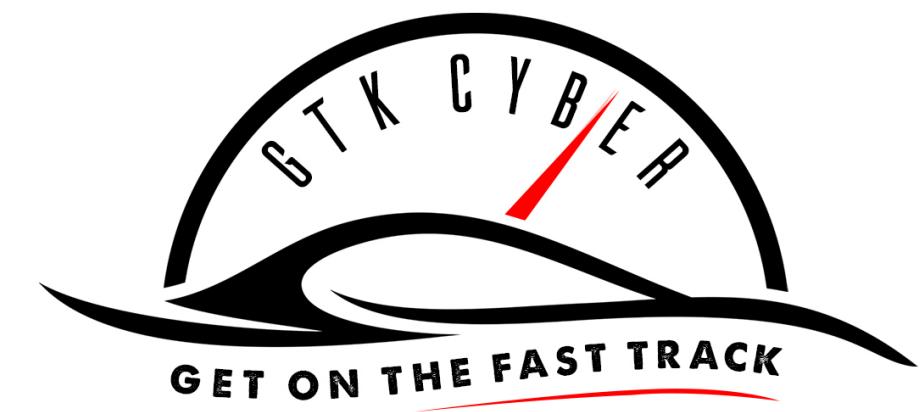


Data Science Hunting Funnel

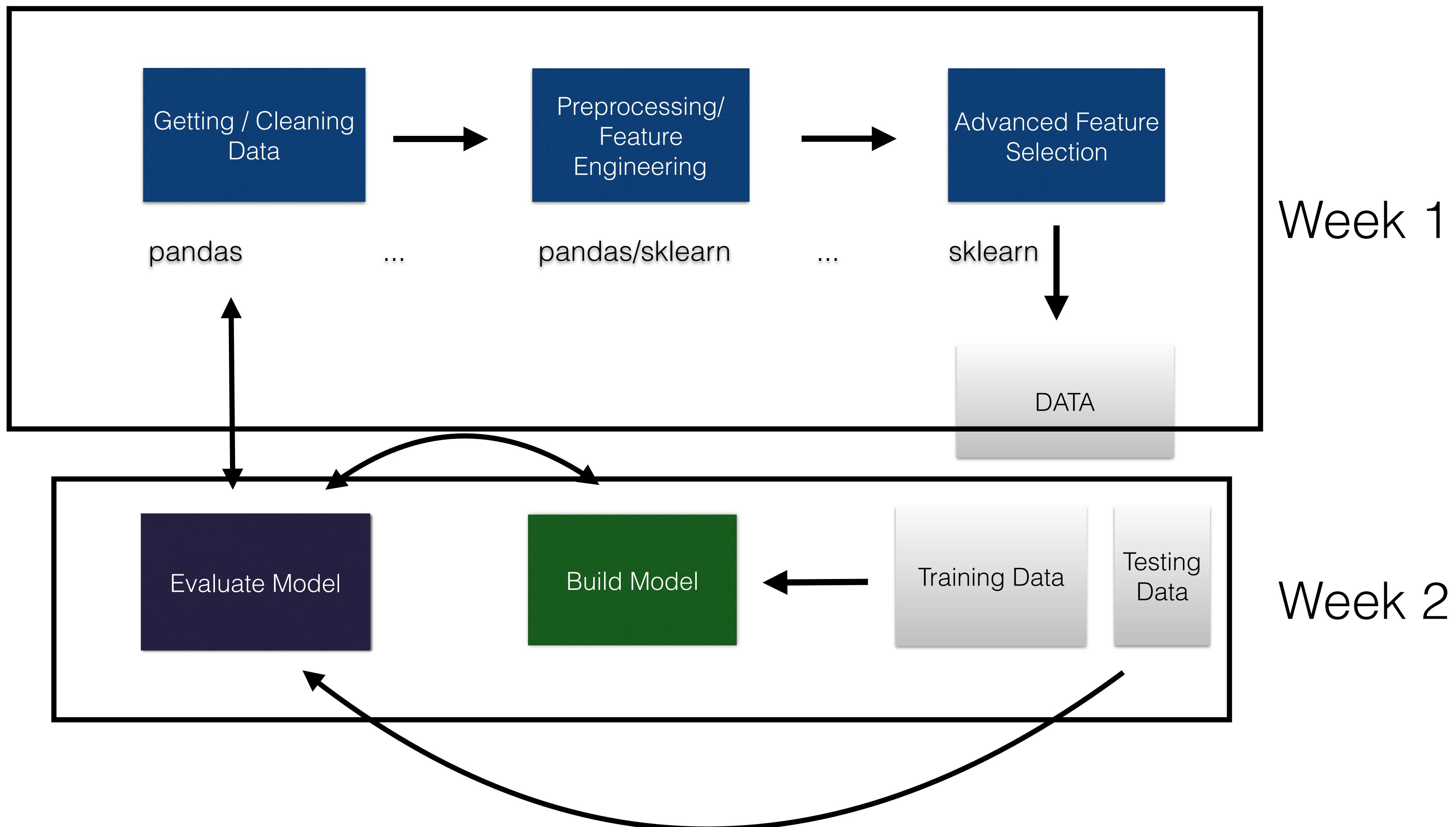


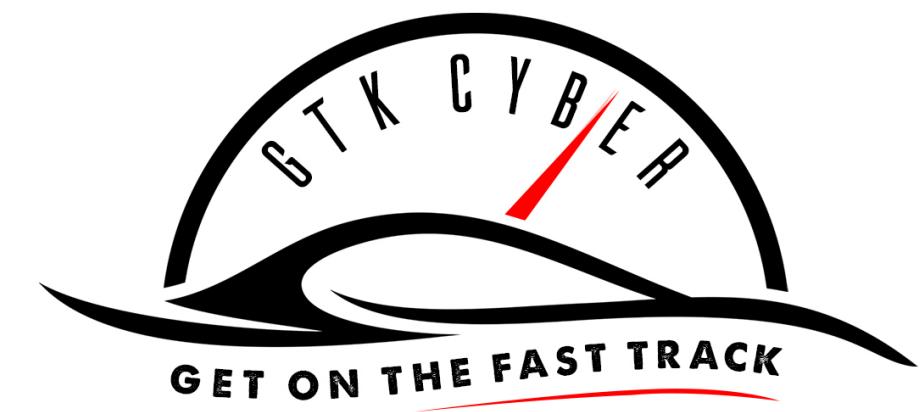


The Machine Learning Process

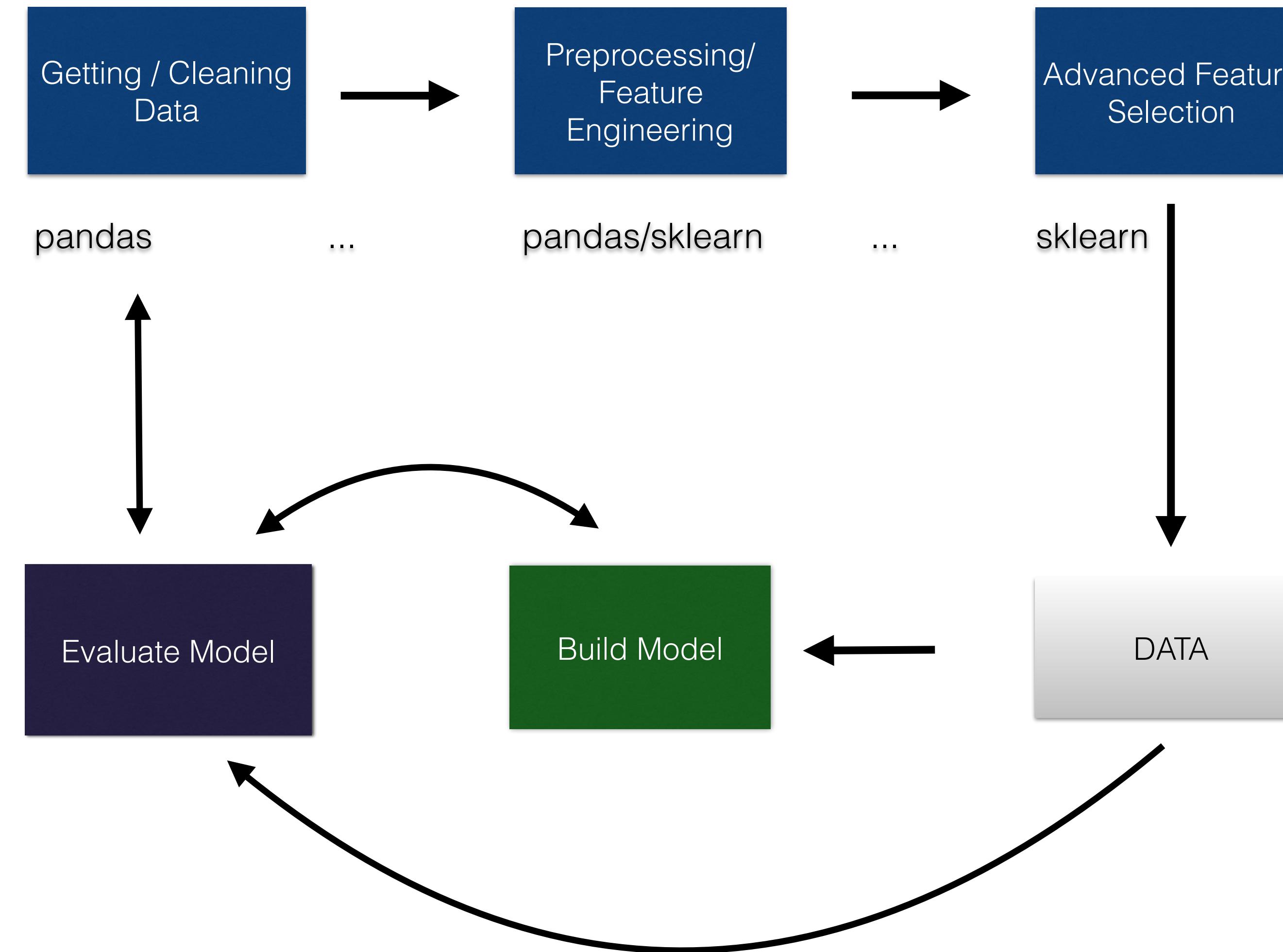


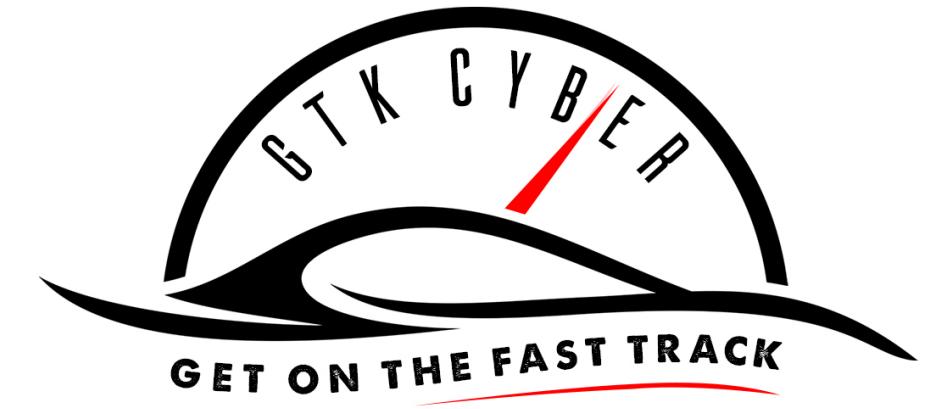
Supervised Machine Learning Process



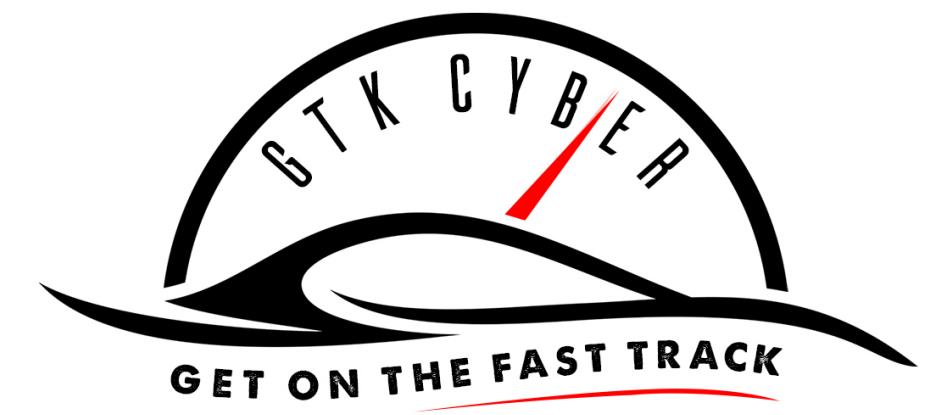


Unsupervised Machine Learning Process

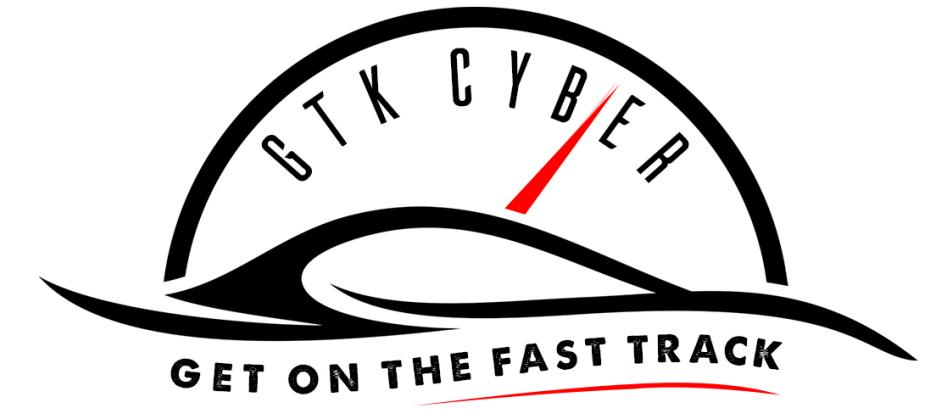




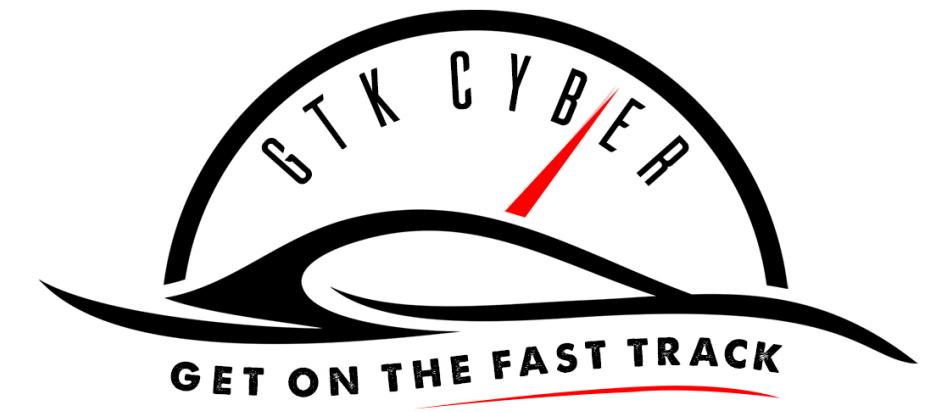
First, define your analytic
question.



What are you trying to do?

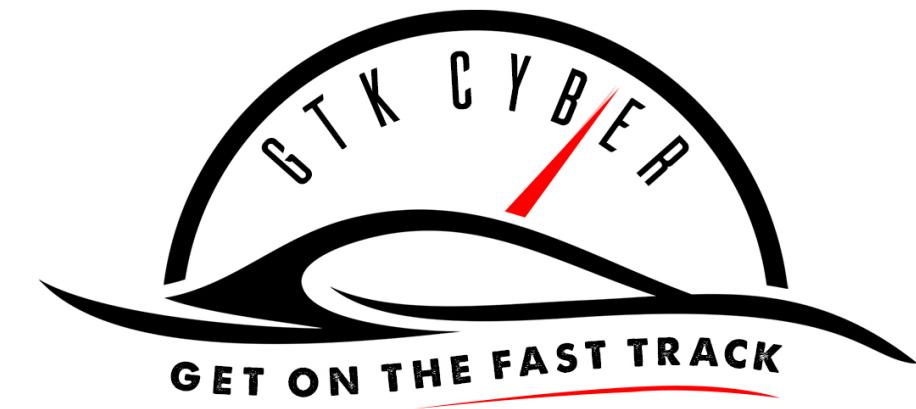


How do you define success?
What are you measuring?



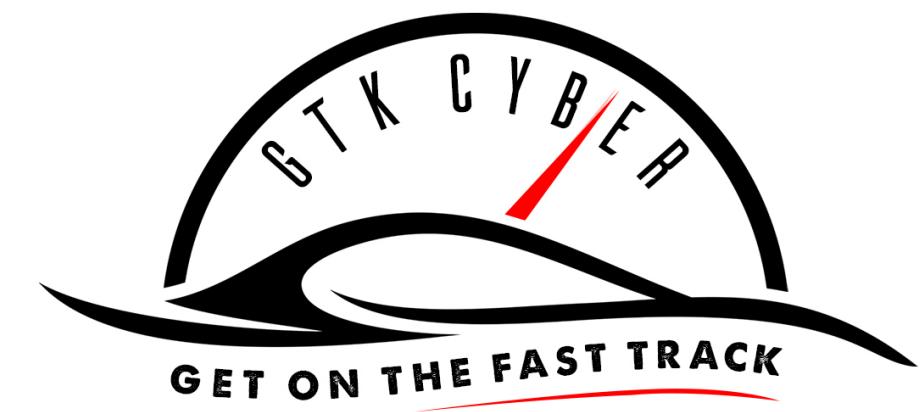
Choose data sources

- What is available?
- Is it enough?
- Is the data reliable/clean/consistent?
- What other data could you use?

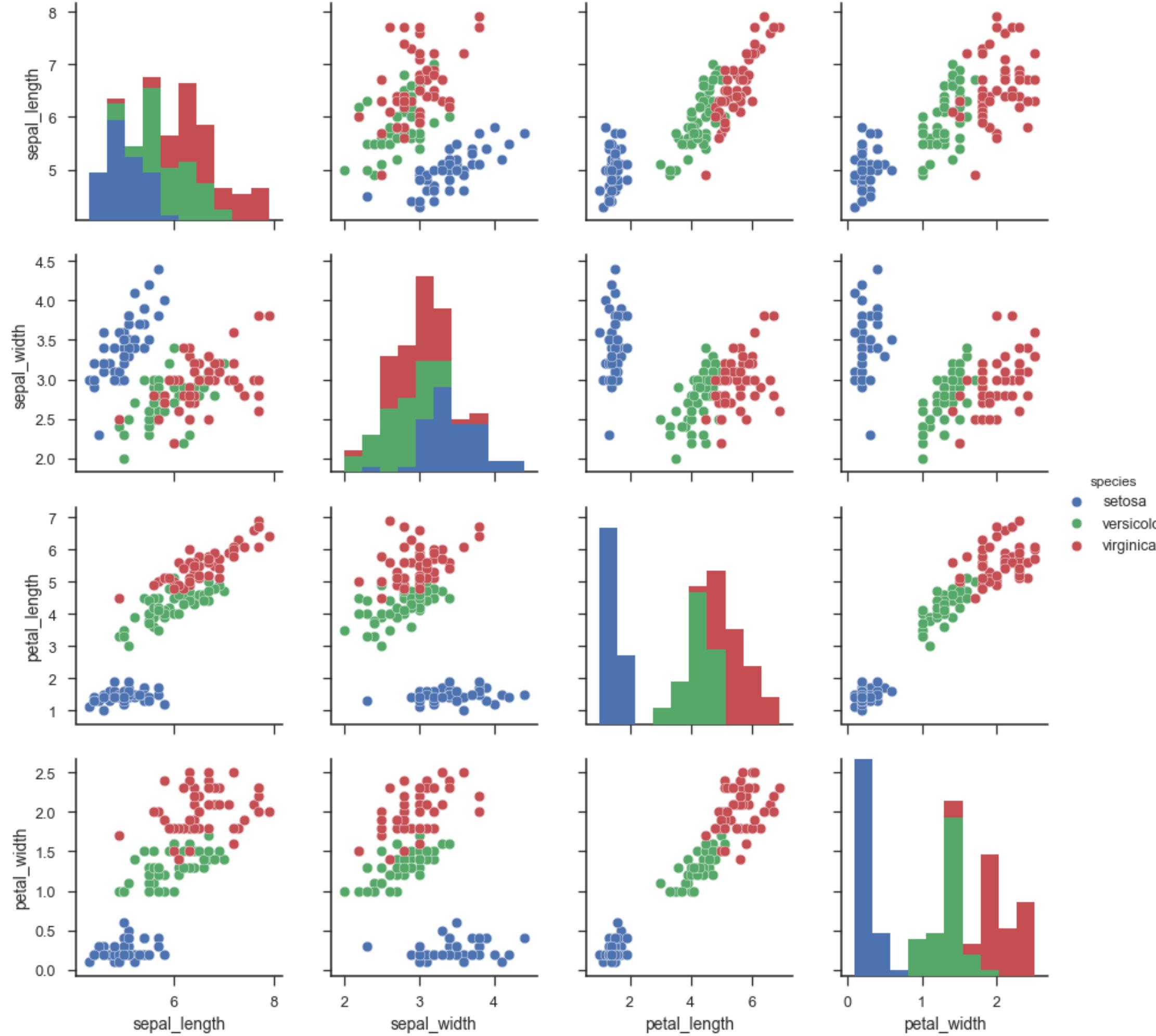


Other Considerations

- Policies
- Legal constraints
- Biases in Data
- Latency
- Data size



Gather and Explore Your Data

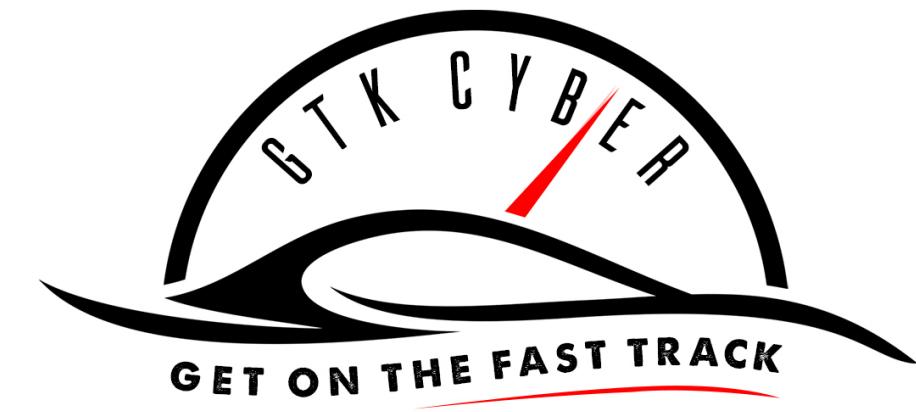


Is the data good enough?

What are the rules governing its use?

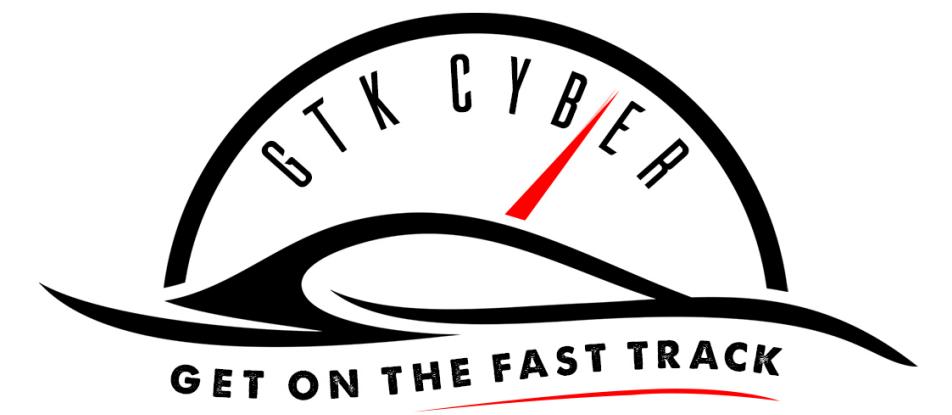
Do I have enough?

Do problems or biases exist in the data that could cause problems?

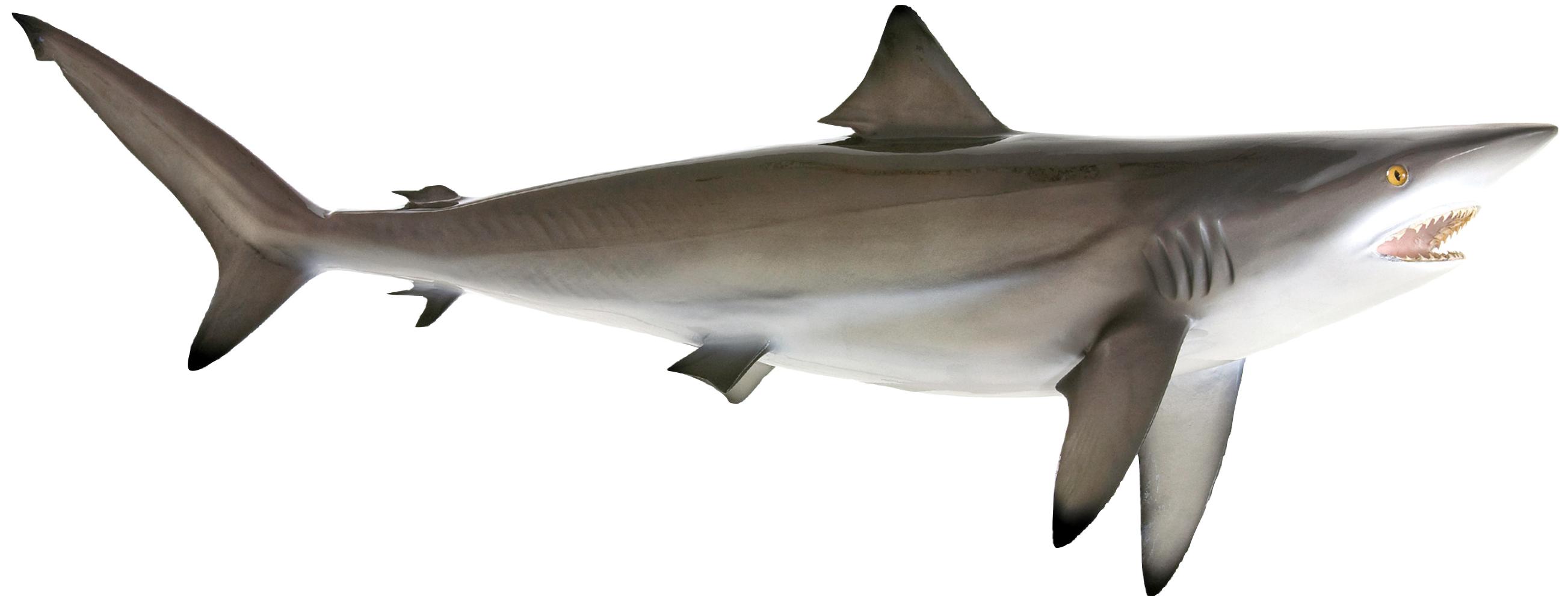


Feature Engineering

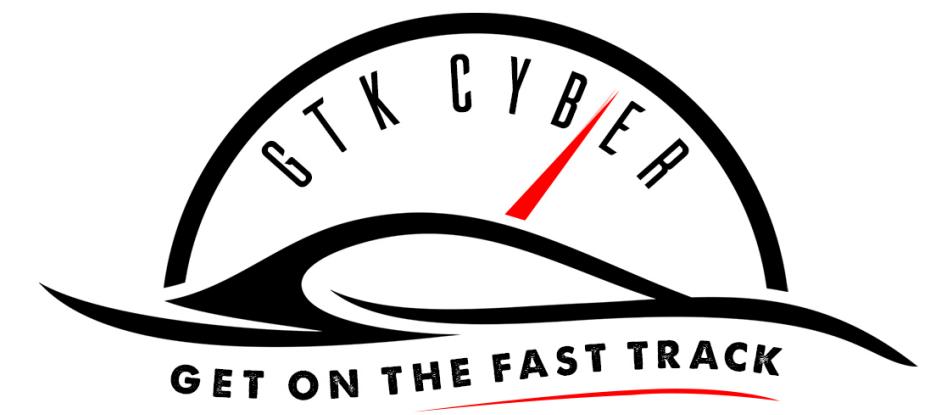
- Define what you are trying to measure. These will become the observations or rows of your final dataset
- Define how you will mathematically represent your data. This will become the features or columns of your final dataset.



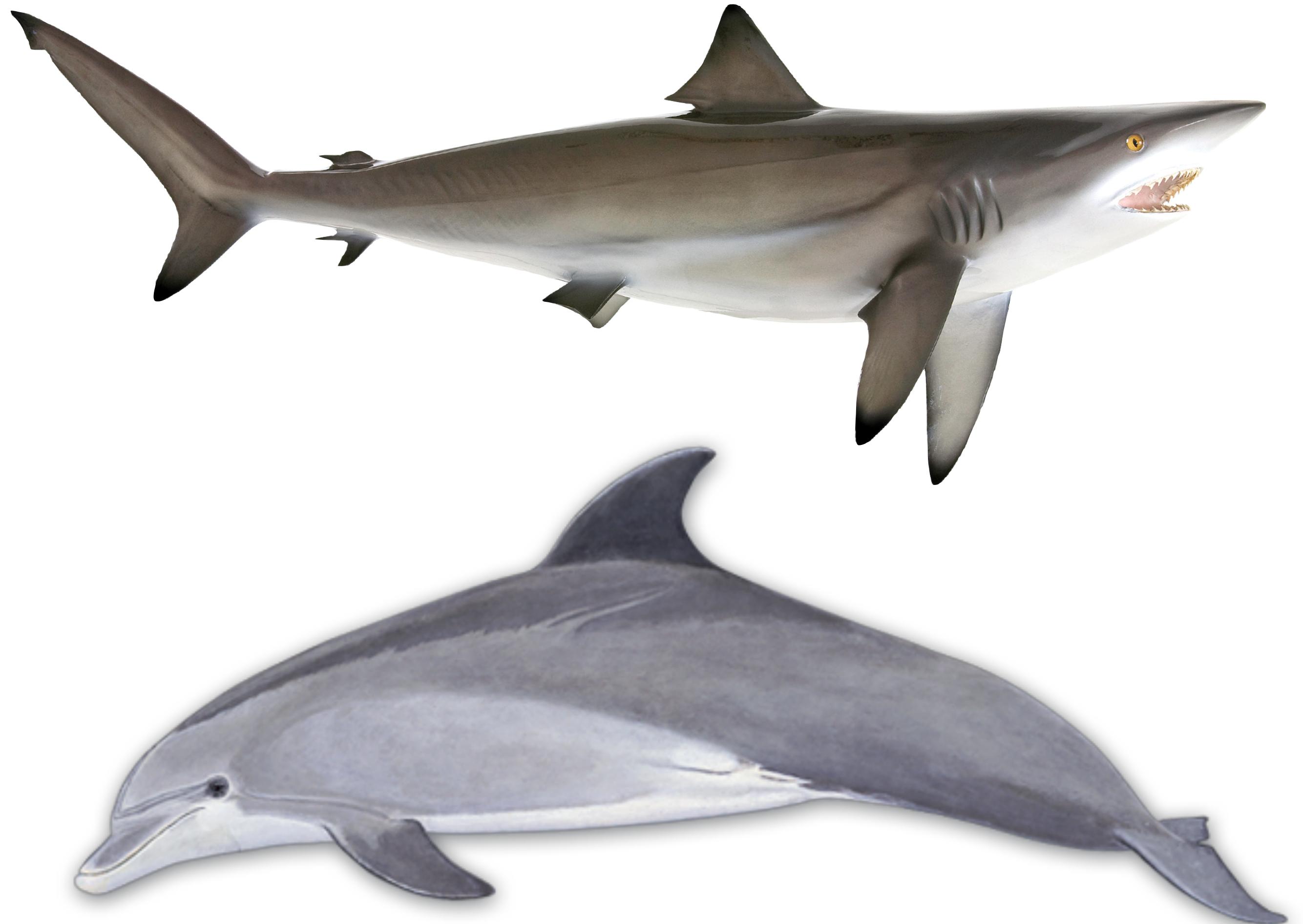
Feature Engineering



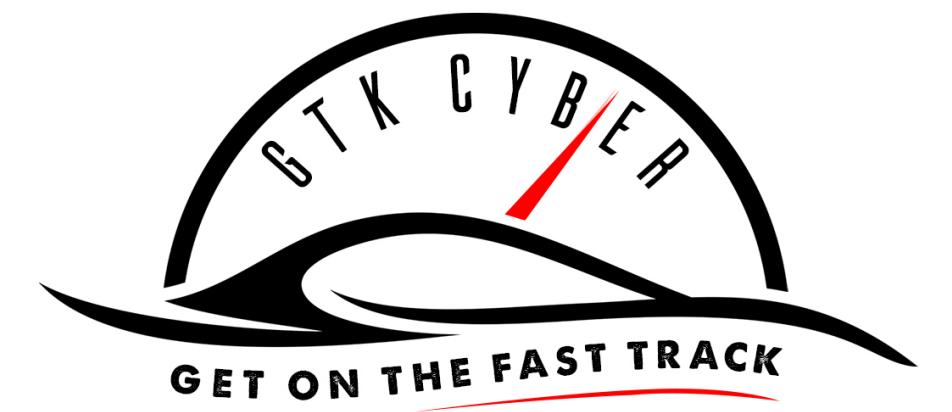
Feature	Value
Color	Gray
Fins	7
Predator	TRUE



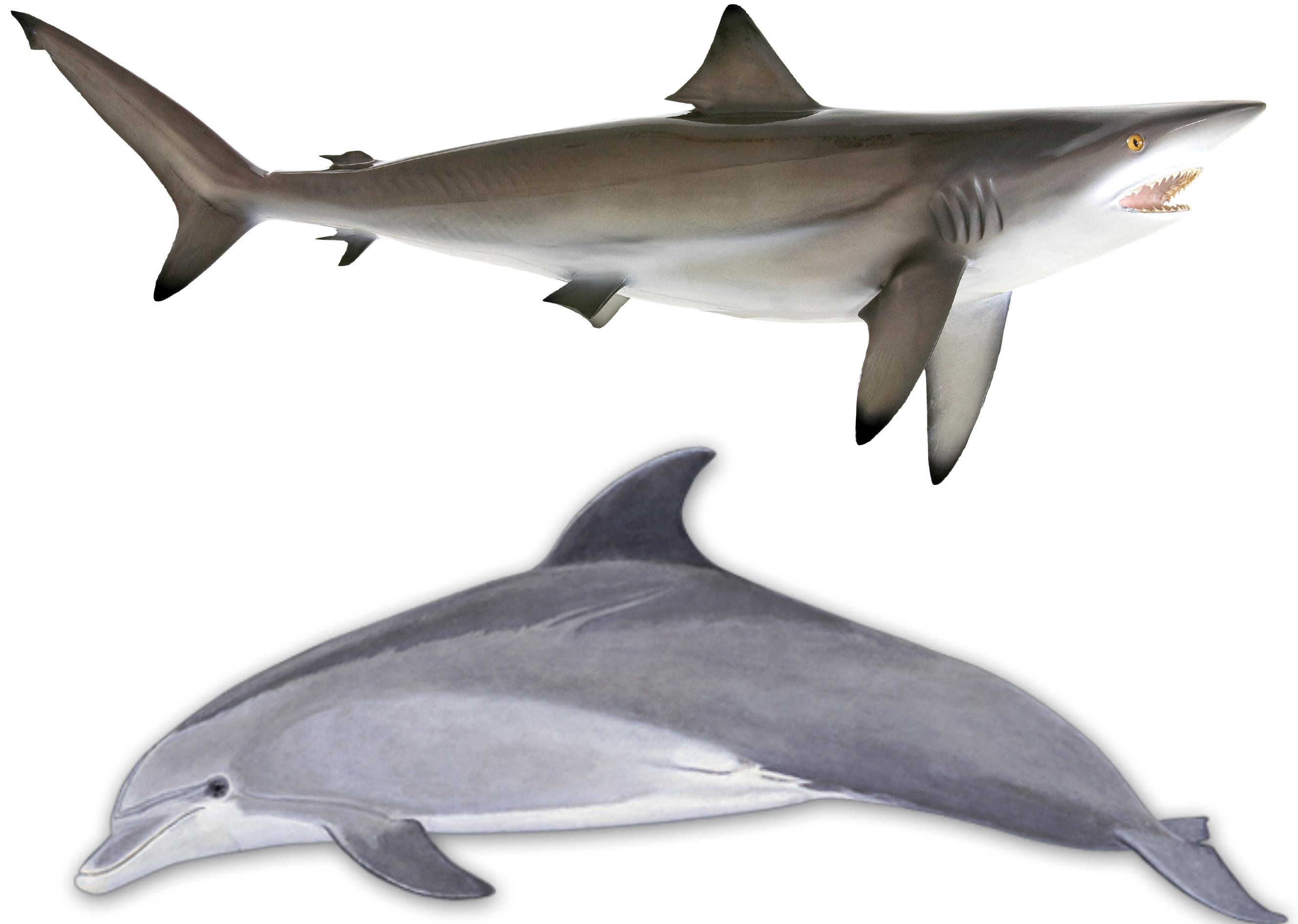
Feature Engineering



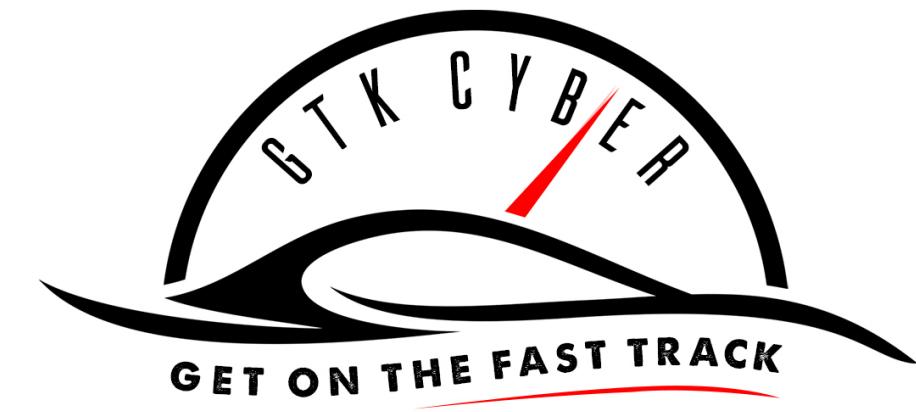
Feature	Value
Color	Gray
Fins	7
Predator	TRUE



Feature Engineering

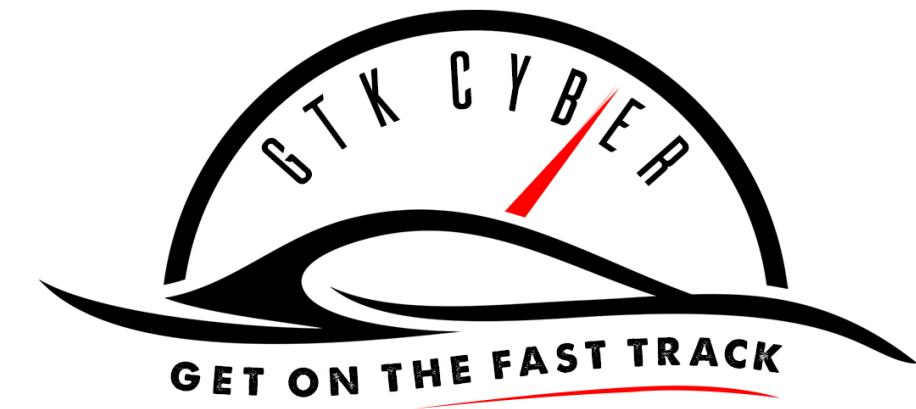


Feature	Value
Color	Gray
Fins	7
Predator	TRUE
Mammal	TRUE



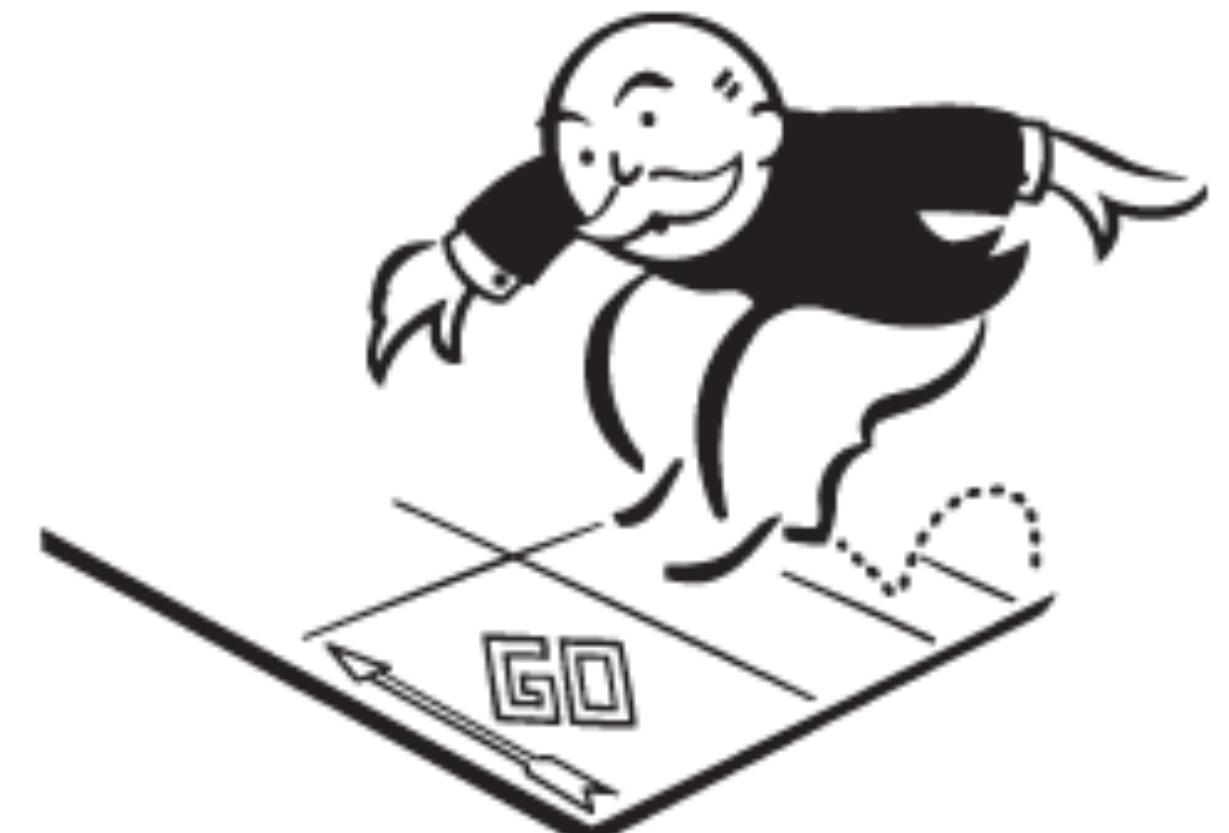
Build and Tune your Model

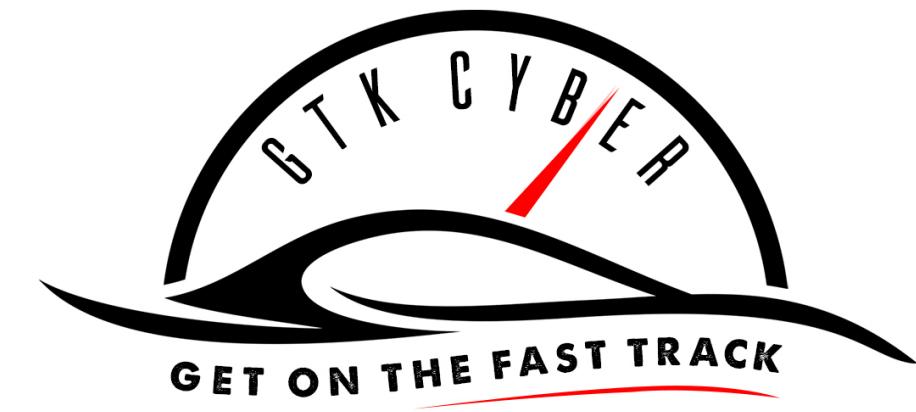
- Believe it or not, this is the easy part.
- Most of this is **done using libraries** like scikit-learn, mllib, tensorflow, caret or keras, and **many steps can be automated**.
- You can even do it in Splunk.



Evaluate Performance

- Use various scoring methods, or write your own to determine model performance.
- Go back to step 1 and repeat! (Do not pass go, do not collect \$200)



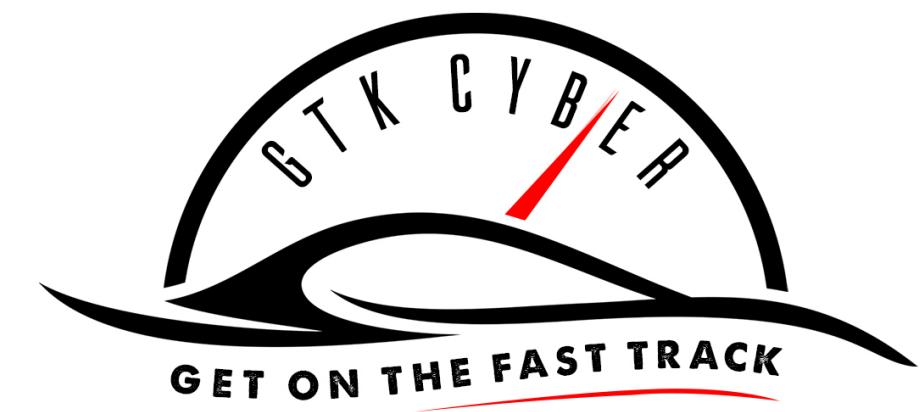


The Python Data Science Ecosystem

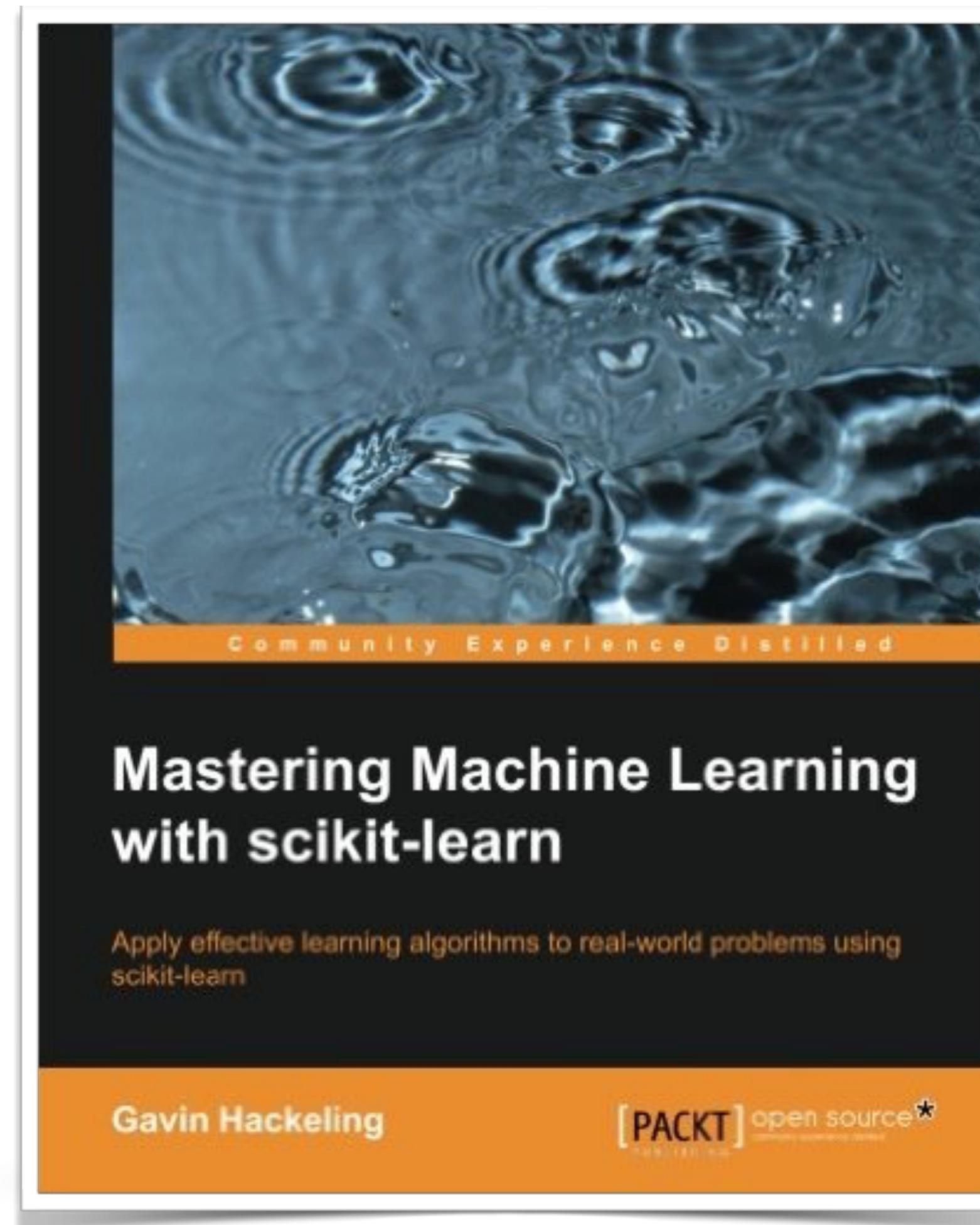


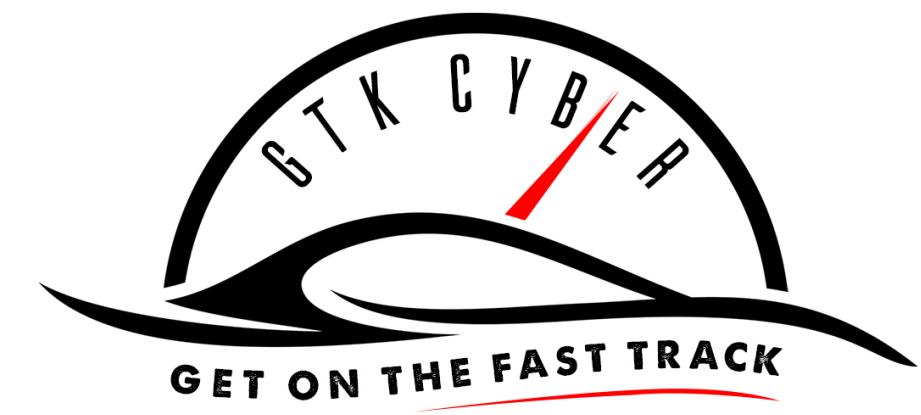
Machine Learning Ecosystem

- **Data Gathering:** Pandas, Drill, BeautifulSoup, PyDBAPI, PyDAL, Boto3
- **Feature Extraction:** Pandas, NumPy, Featuretools
- **Machine Learning**
 - **"Regular" ML:** Scikit-learn (sklearn), h2o, mllib (PySpark)
 - **Deep Learning:** Tensorflow, Keras, Theano, Caffe, PyTorch
- **Visualization:** Matplotlib, Seaborn, Yellowbrick, LIME, ggplot, plot.ly,

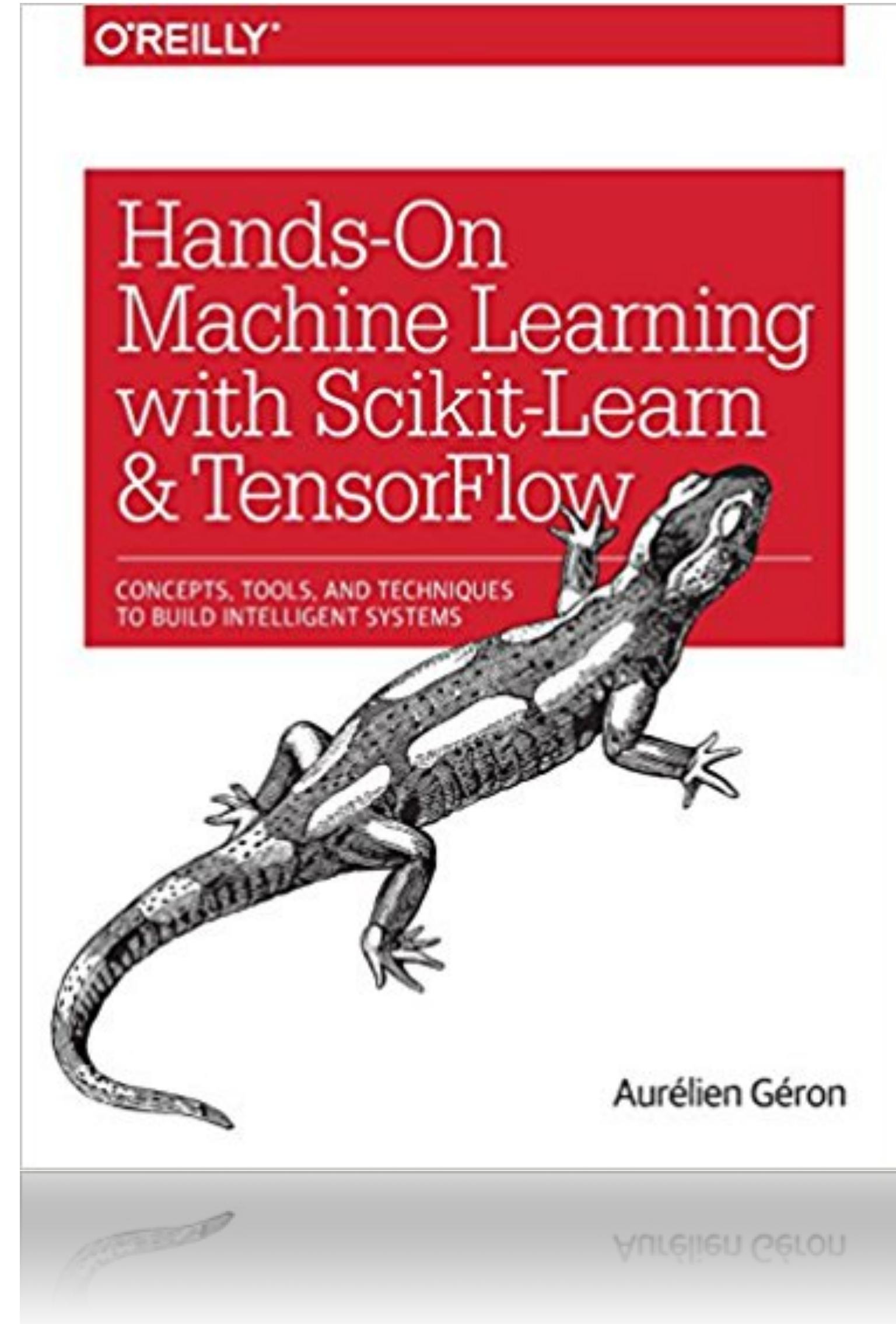


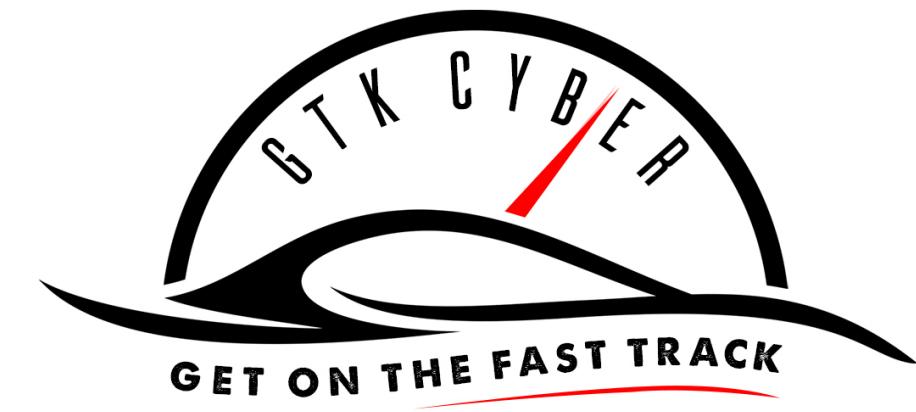
Recommended Reading



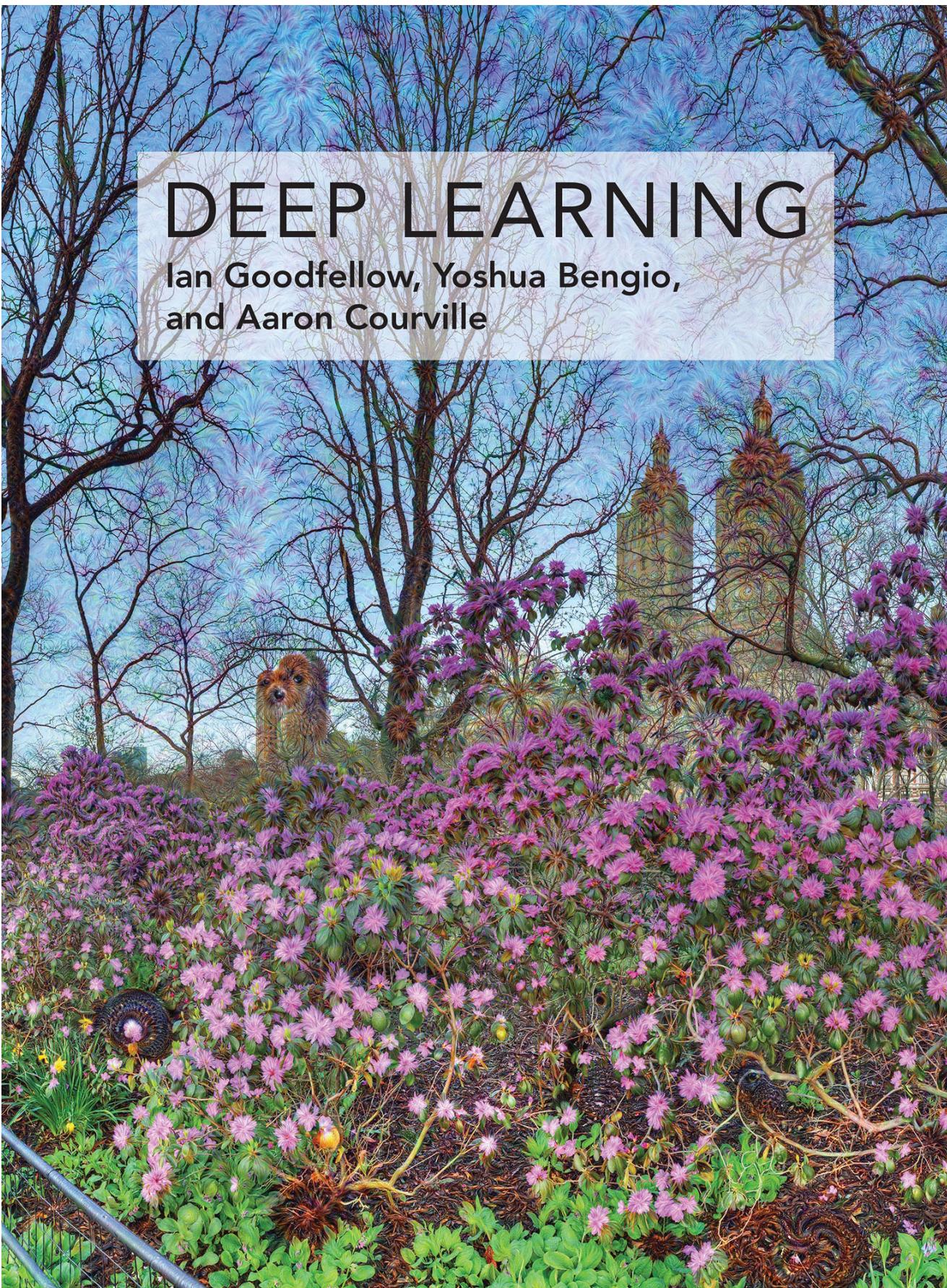


Recommended Reading

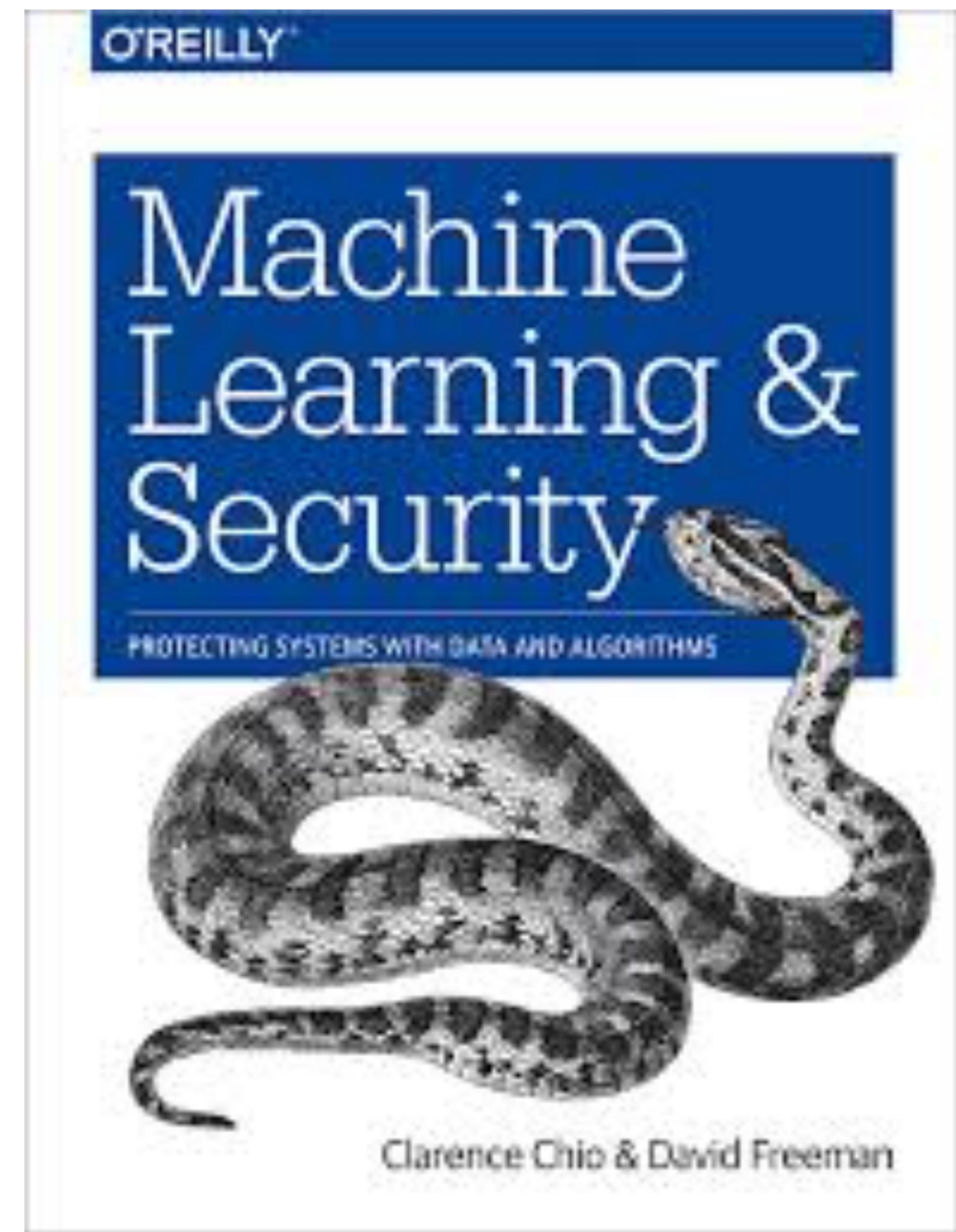
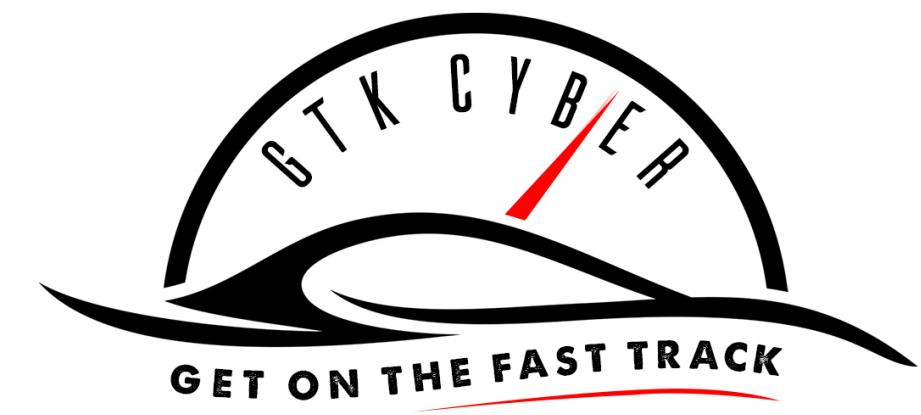


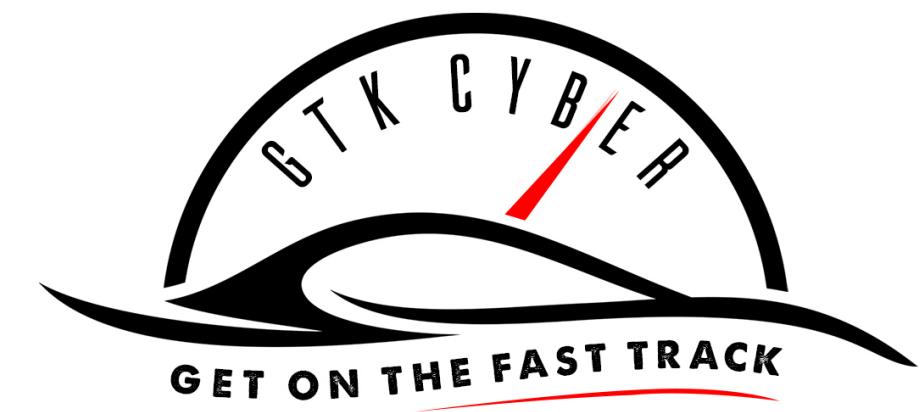


Recommended Reading



<http://www.deeplearningbook.org/>





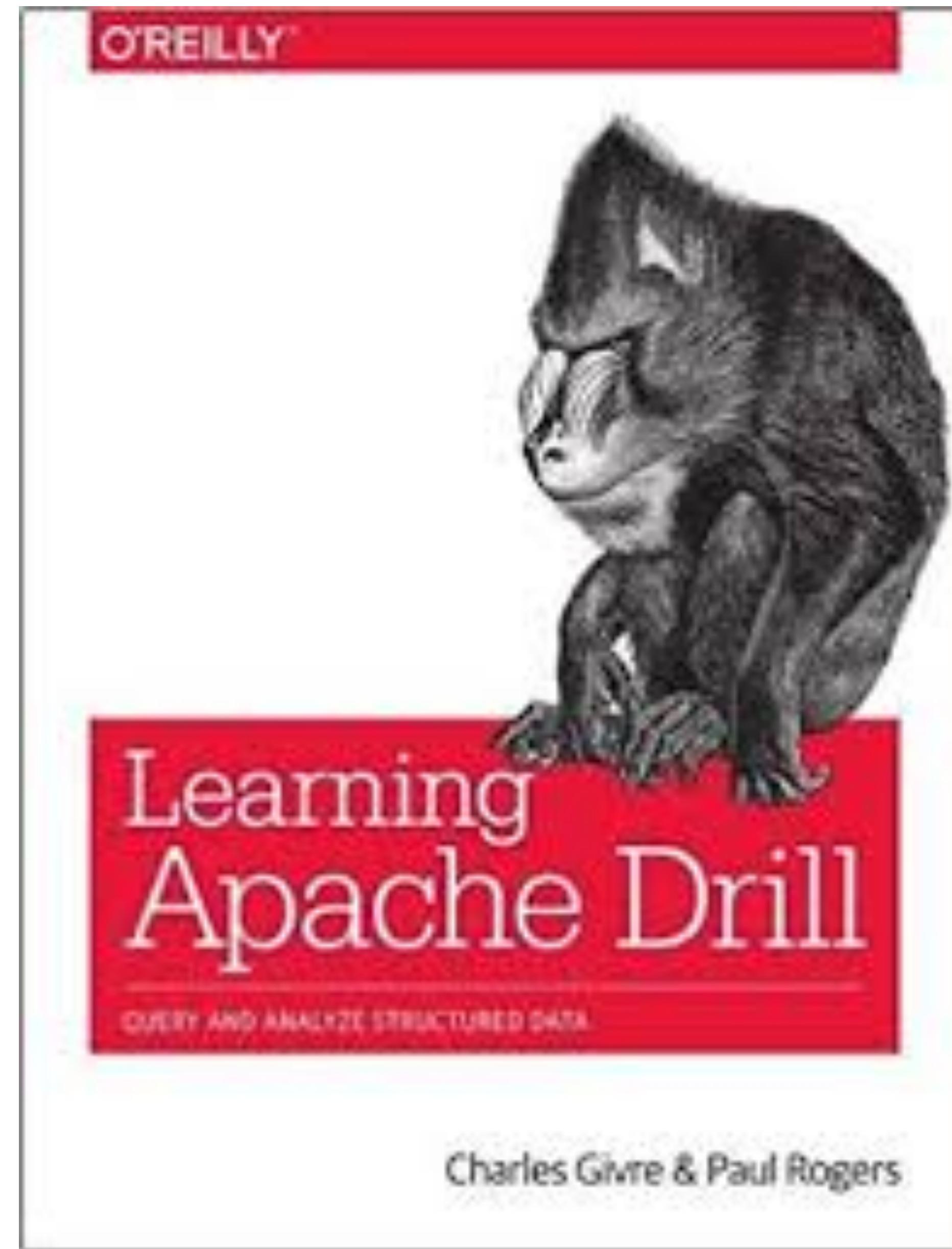
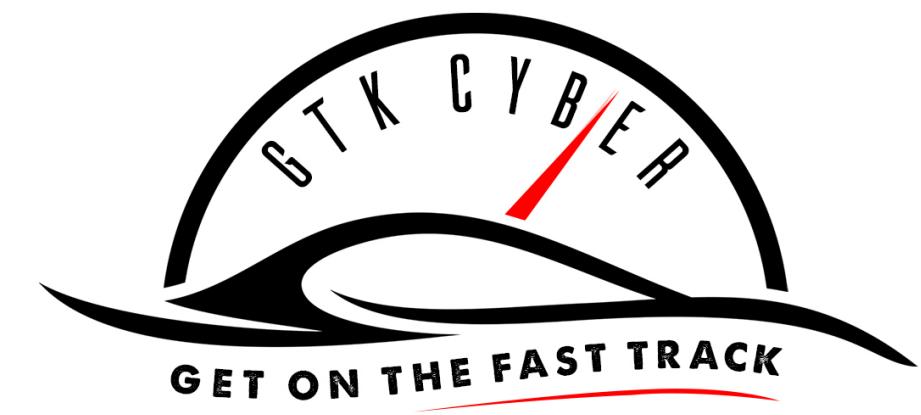
O'REILLY®

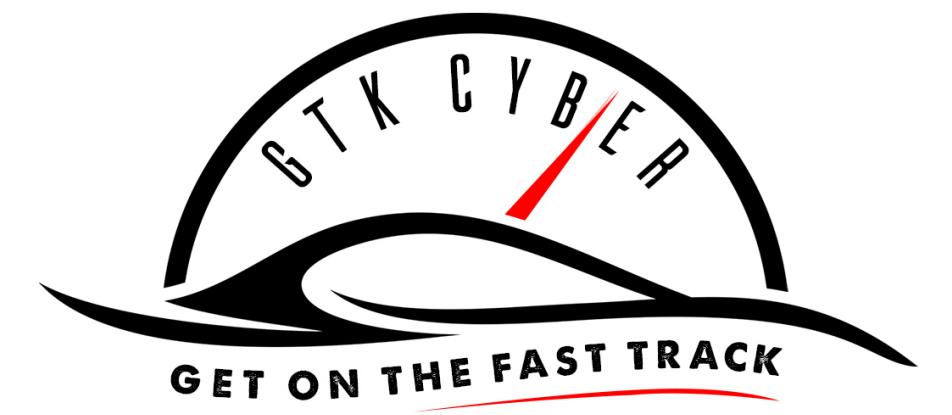


Feature Engineering for Machine Learning

PRINCIPLES AND TECHNIQUES FOR DATA SCIENTISTS

Alice Zheng & Amanda Casari

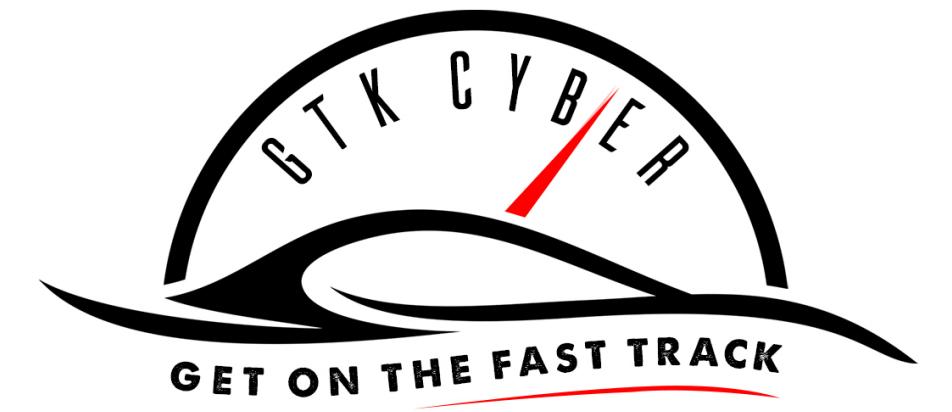




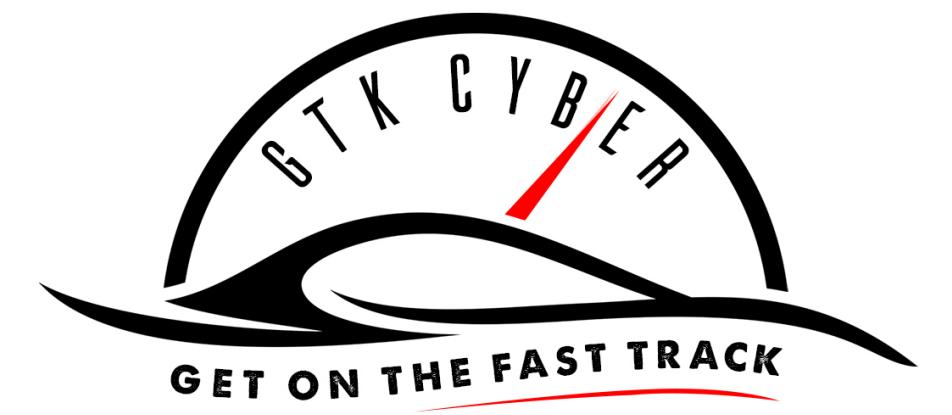
The Virtual Machine: Griffon



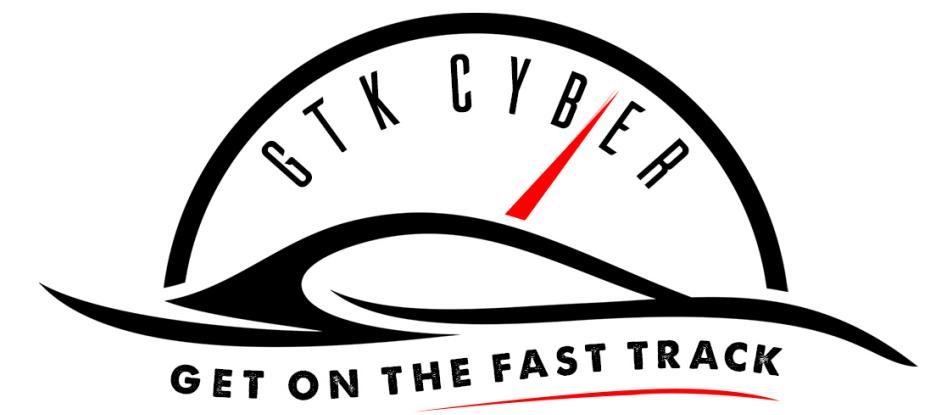
```
File Edit View Search Terminal Help
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/usr/lib/hbase/hbase-1.1.3/lib/slf4j-log4j12-1
.7.5.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: Found binding in [jar:file:/usr/local/hadoop/share/hadoop/common/lib/slf4
j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
2016-05-16 13:04:54,887 WARN  [main] util.NativeCodeLoader: Unable to load nativ
e-hadoop library for your platform... using builtin-jar classes where applicabl
e
2016-05-16 13:05:11,827 ERROR [main] zookeeper.RecoverableZooKeeper: ZooKeeper exists faile
d after 4 attempts
2016-05-16 13:05:11,828 WARN  [main] zookeeper.ZKUtil: hconnection-0x46a145ba0x0, quorum=lo
calhost:2181, baseZNode=/hbase Unable to set watcher on znode (/hbase/hbaseid)
org.apache.zookeeper.KeeperException$ConnectionLossException: KeeperErrorCode = ConnectionL
oss for /hbase/hbaseid
        at org.apache.zookeeper.KeeperException.create(KeeperException.java:99)
        at org.apache.zookeeper.KeeperException.create(KeeperException.java:51)
        at org.apache.zookeeper.ZooKeeper.exists(ZooKeeper.java:1045)
        at org.apache.hadoop.hbase.zookeeper.RecoverableZooKeeper.exists(RecoverableZooKeep
er.java:221)
        at org.apache.hadoop.hbase.zookeeper.ZKUtil.checkExists(ZKUtil.java:541)
        at org.apache.hadoop.hbase.zookeeper.ZKClusterId.readClusterIdZNode(ZKClusterId.jav
a:65)
        at org.apache.hadoop.hbase.client.ZooKeeperRegistry.getClusterId(ZooKeeperRegistry.
java:105)
```



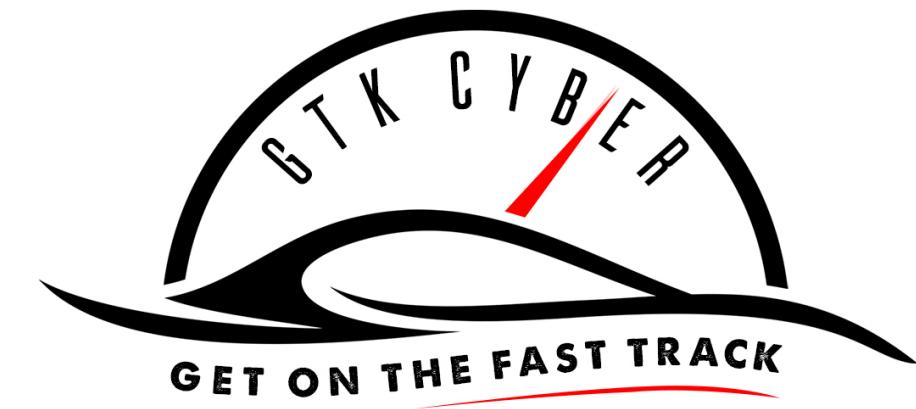
Do Data Science, Not Sysadmin



Built on Ubuntu MATE



Easy to Use

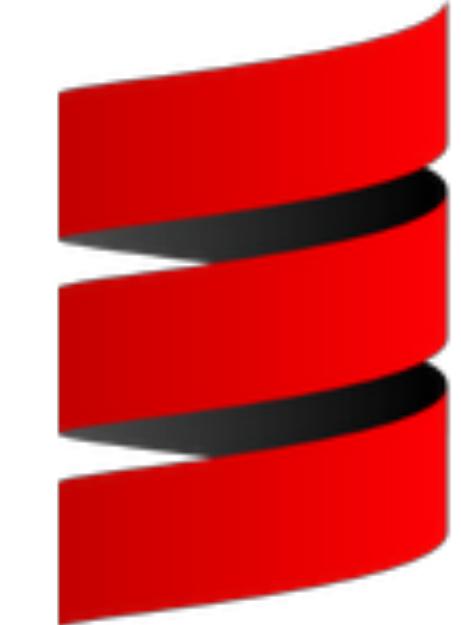
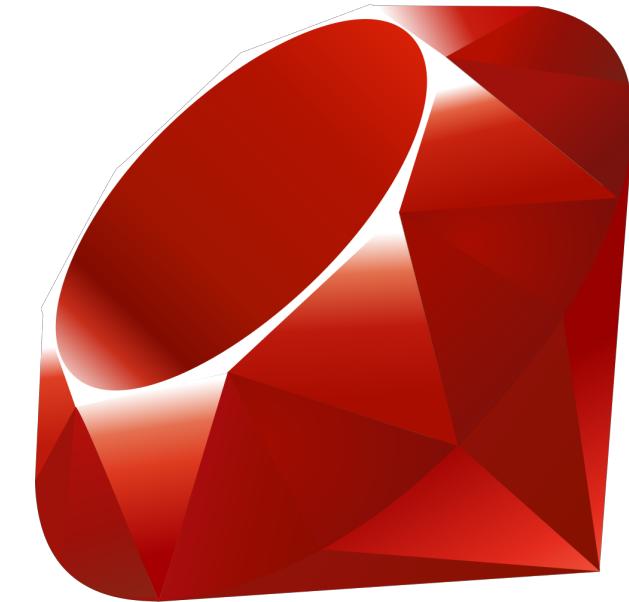
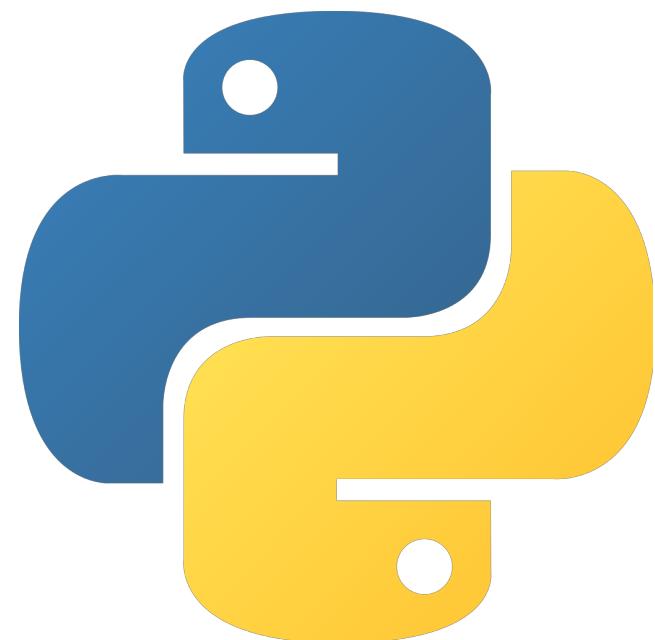


Programming Languages

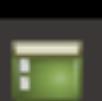
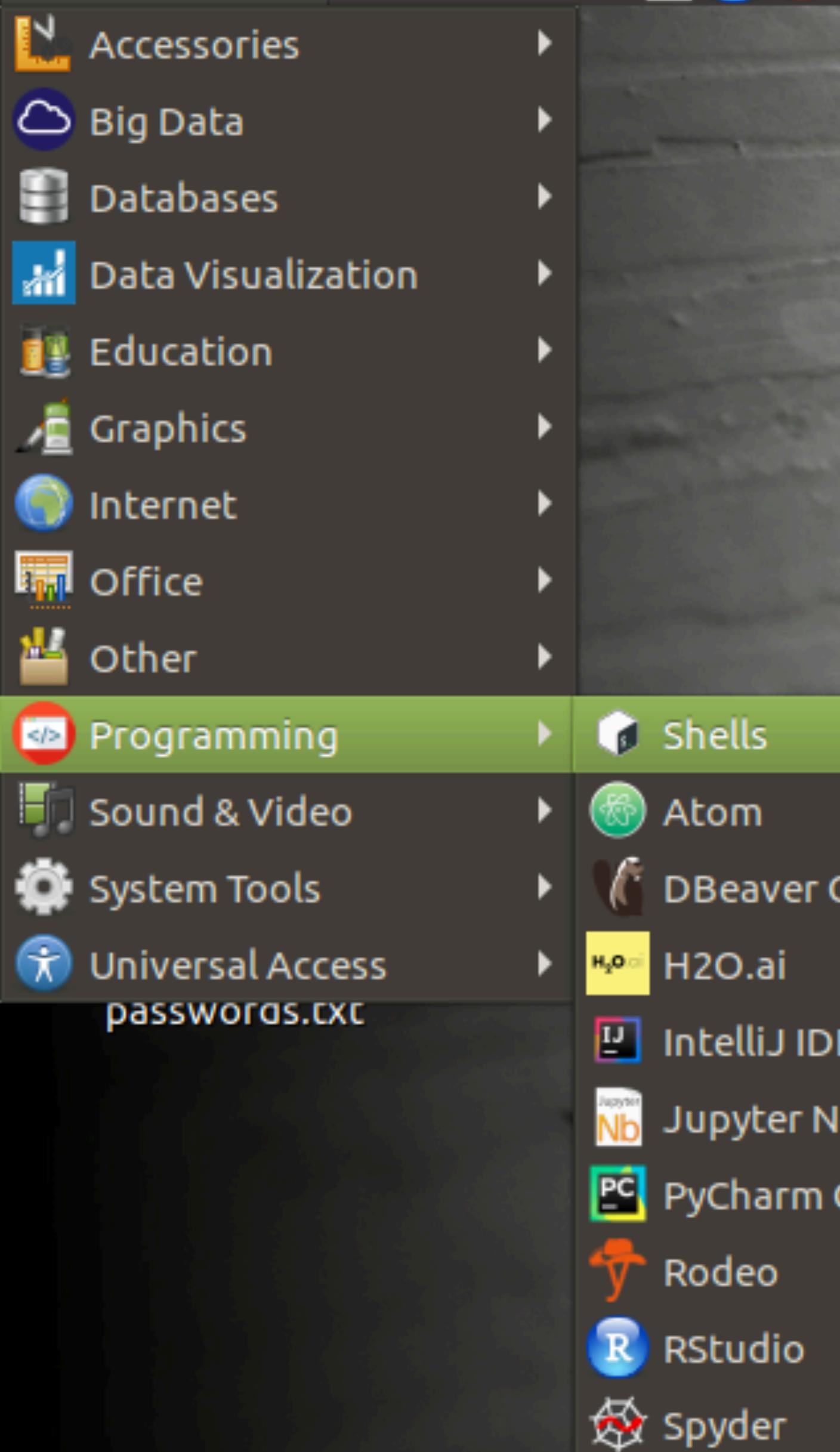
- Languages
- Libraries
- Editors and Notebooks
- Databases + Administrative tools
- Big Data Tools
- Machine Learning Libraries
- Data Visualization

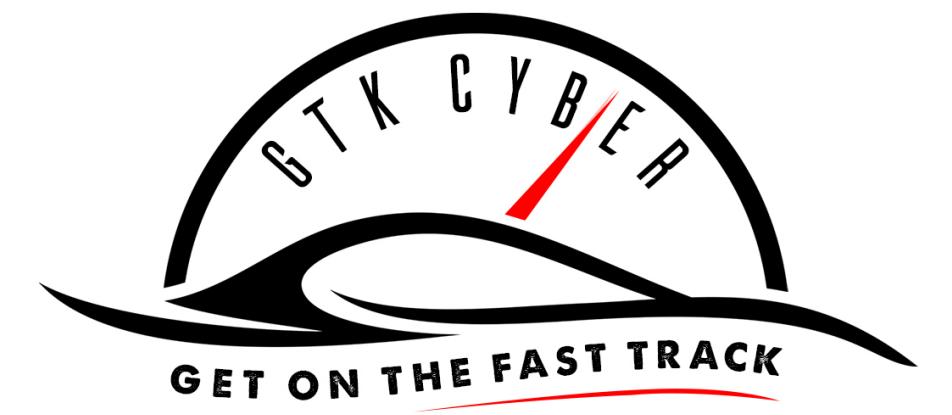


Scripting Languages

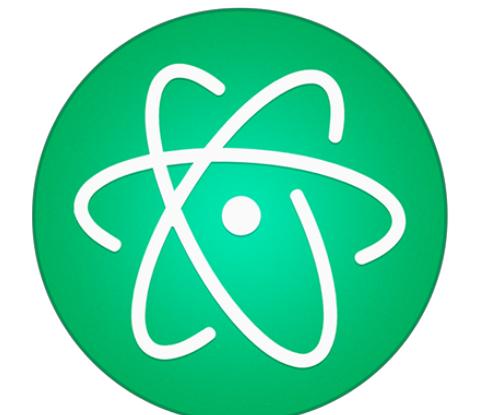
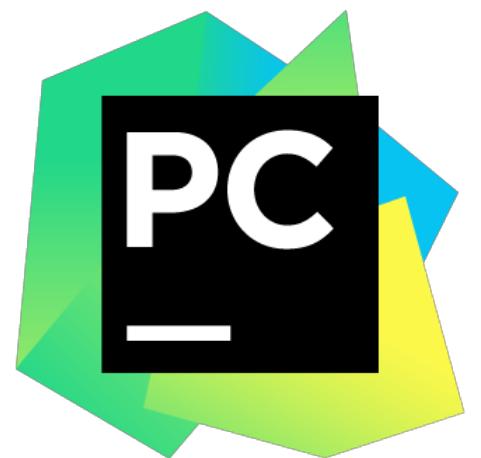
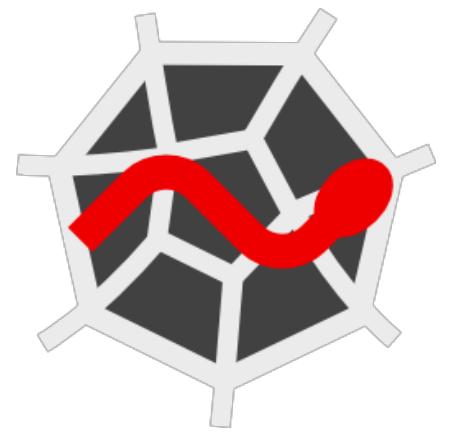


Applications Places System

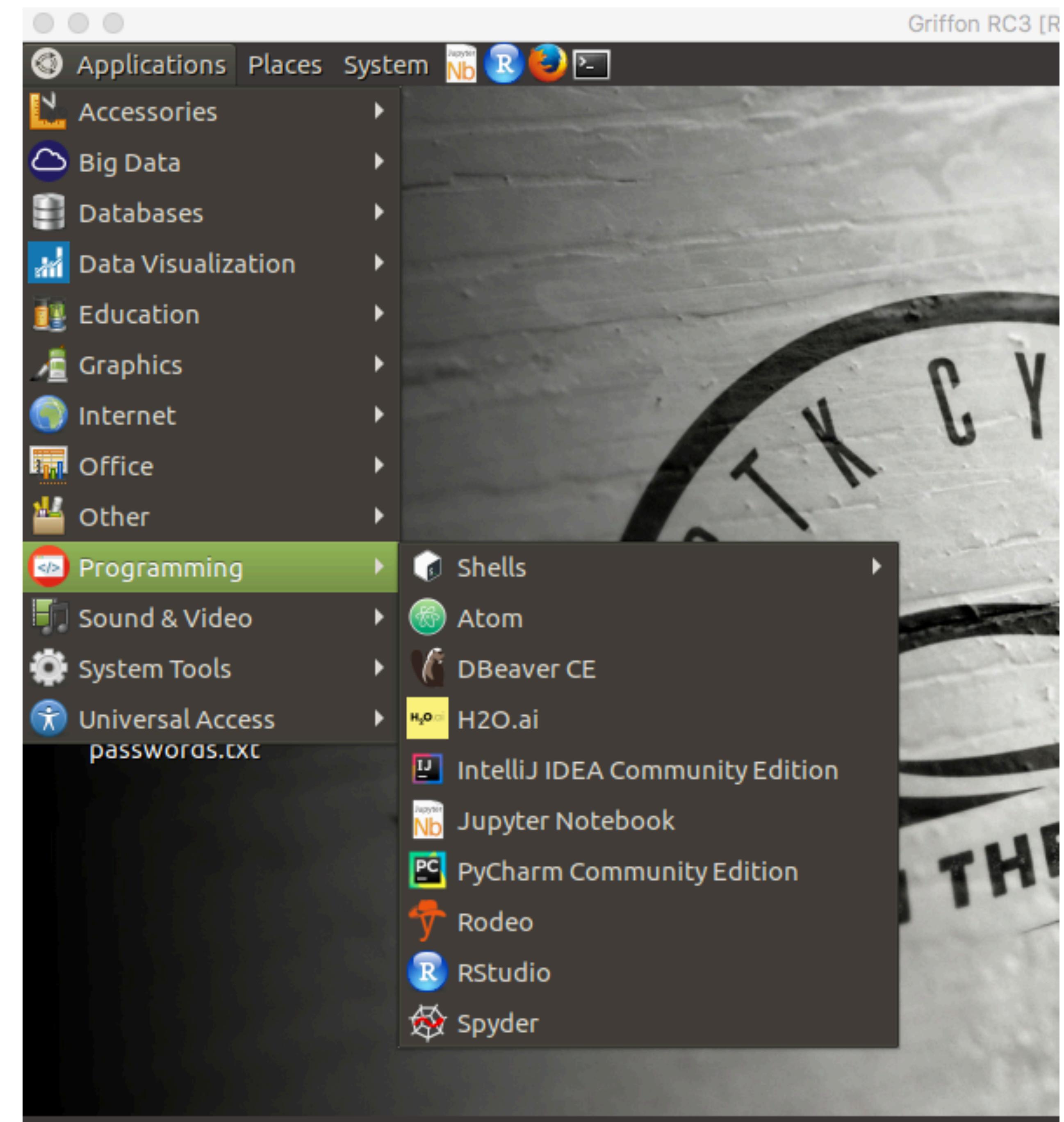


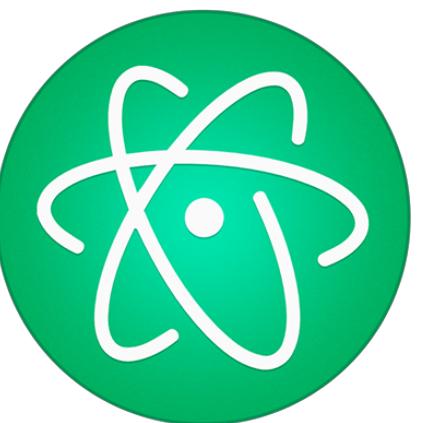
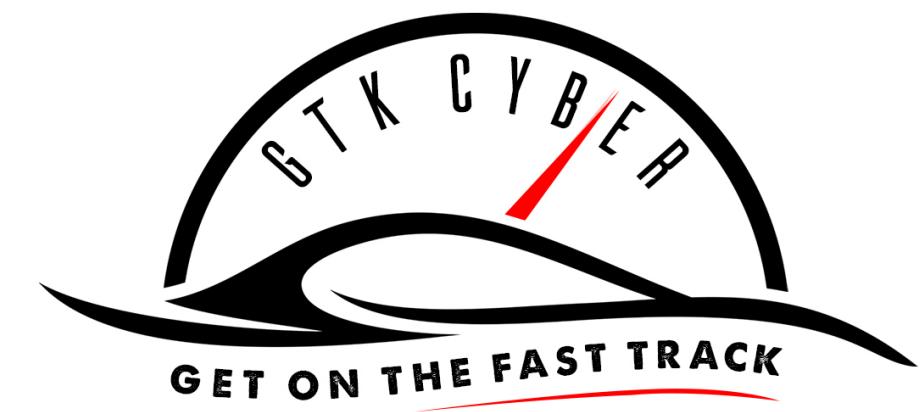


Editors & Notebooks



gtkcyber.com





Atom

Project Merlin Beta 3 (Small updates) [Running]

Applications Places System R Jupyter Nb Mon Aug 15, 12:26

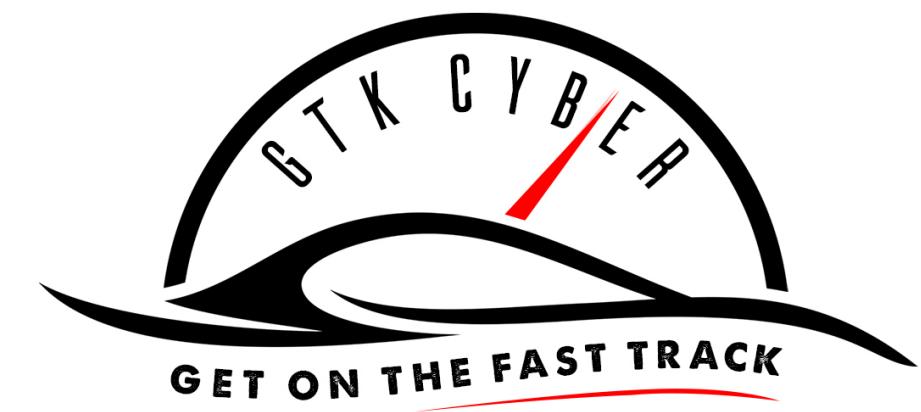
python_demo.py — /usr/share/atom/resources — Atom

File Edit View Selection Find Packages Help

resources

python_demo.py

```
1 import pandas as pd
2 df = pd.DataFrame([2,3,4,5,6,7,8])
```



gtkcyber.com

The screenshot shows a Jupyter Notebook interface running in a Mozilla Firefox browser window titled "Project Merlin Development Version (Alpha 0.2) [Running]". The browser's toolbar includes icons for Applications, Places, System, Firefox, R, and Nb. The main content area displays the Jupyter logo and a file tree under the "Files" tab. The file tree lists several directories: anaconda3, Desktop, Documents, Downloads, metastore_db, Music, and node_modules. To the right of the file tree is a sidebar with a "New" dropdown menu containing options for Text File, Folder, Terminal, Notebooks, Julia 0.4.2, Python 2, Python 3, R, Ruby 2.1.5, Scala 2.11, and pySpark (Spark 1.6.0). The status bar at the bottom shows the date and time: "Tue May 10, 23:47".

Project Merlin Development Version (Alpha 0.2) [Running]

Applications Places System

Tue May 10, 23:47

File Edit View History Bookmarks Tools Help

Home - Mozilla Firefox

Home

localhost:8888/tree

jupyter

Files Running Clusters

Select items to perform actions on them.

Upload New

Text File
Folder
Terminal

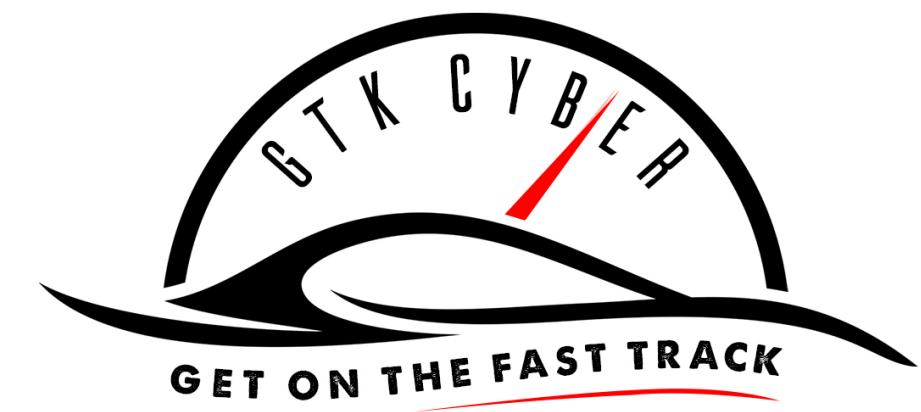
Notebooks
Julia 0.4.2
Python 2
Python 3
R
Ruby 2.1.5
Scala 2.11
pySpark (Spark 1.6.0)

anaconda3
Desktop
Documents
Downloads
metastore_db
Music
node_modules



Jupyter Notebook

- Python 2 & 3
- R
- Ruby
- Scala
- PySpark

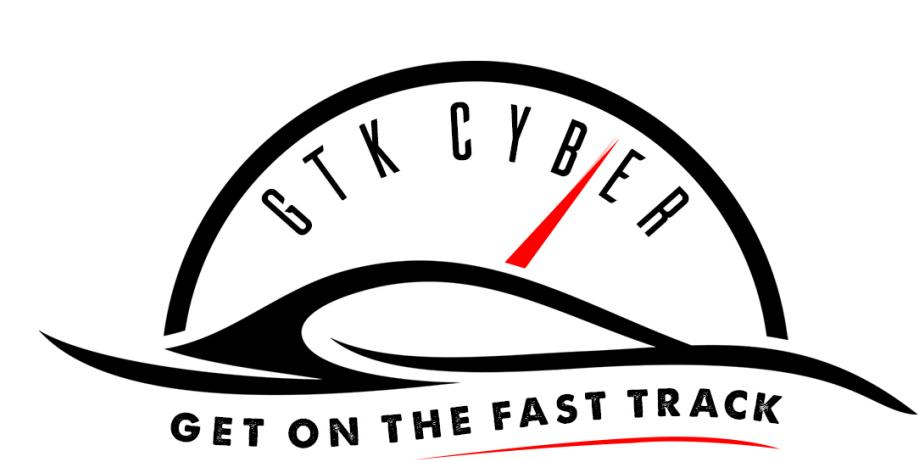


gtkcyber.com



mongoDB®





MySQL®

Project Merlin Beta 3 (Before beaker 1.6 update) [Running]

Fri Aug 19, 00:14

MySQL Workbench

Local instance 3306 Local instance 3306

File Edit View Query Database Server Tools Scripting Help

SQL

MANAGEMENT

- Server Status
- Client Connections
- Users and Privileges
- Status and System Variables
- Data Export
- Data Import/Restore

INSTANCE

- Startup / Shutdown
- Server Logs
- Options File

PERFORMANCE

- Dashboard
- Performance Reports
- Performance Schema Setup

SCHEMAS

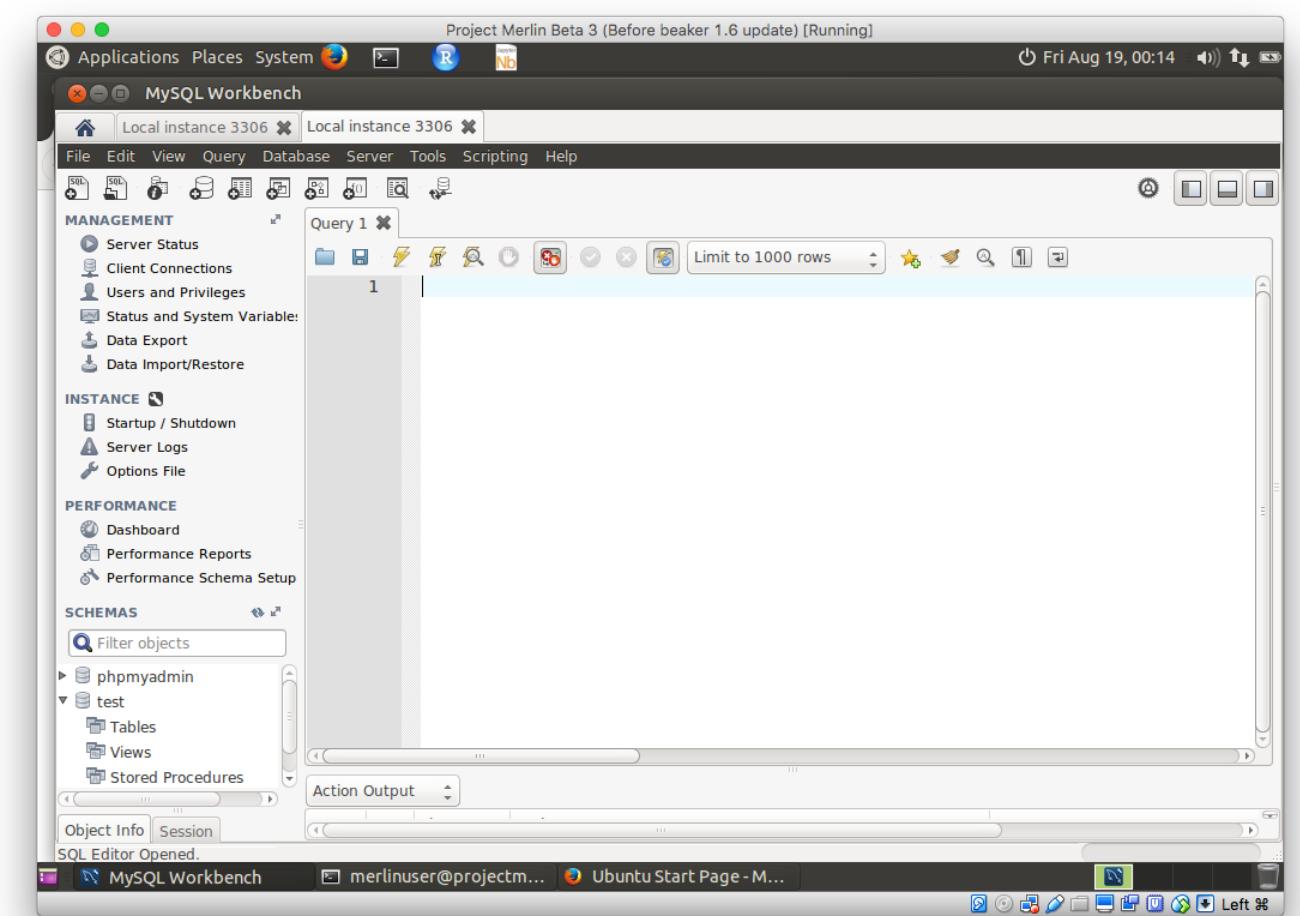
Filter objects

- phpmyadmin
- test
 - Tables

Query 1

Limit to 1000 rows

1



Project Merlin Beta 3 (Before beaker 1.6 update) [Running]

Fri Aug 19, 00:14

localhost / localhost | phpMyAdmin 4.4.13.1deb1 - Mozilla Firefox

PMA localhost / localhost... +

localhost / phpmyadmin/index.php?token=62fb6ffb630fba16f23788ee21dc4e

Search

Applications Places System R Nb

phpMyAdmin

Server: localhost

Databases SQL Status Users Export Import Settings More

General Settings

Change password

Server connection collation: utf8mb4_unicode_ci

Database server

- Server: Localhost via UNIX socket
- Server type: MySQL
- Server version: 5.6.31-0ubuntu0.15.10.1 - (Ubuntu)
- Protocol version: 10
- User: merlinuser@localhost
- Server charset: UTF-8 Unicode (utf8)

Appearance Settings

Language: English

Theme: pmahomme

Font size: 82%

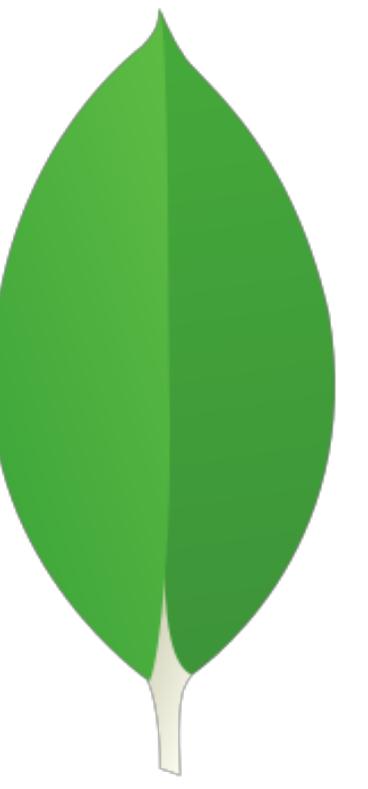
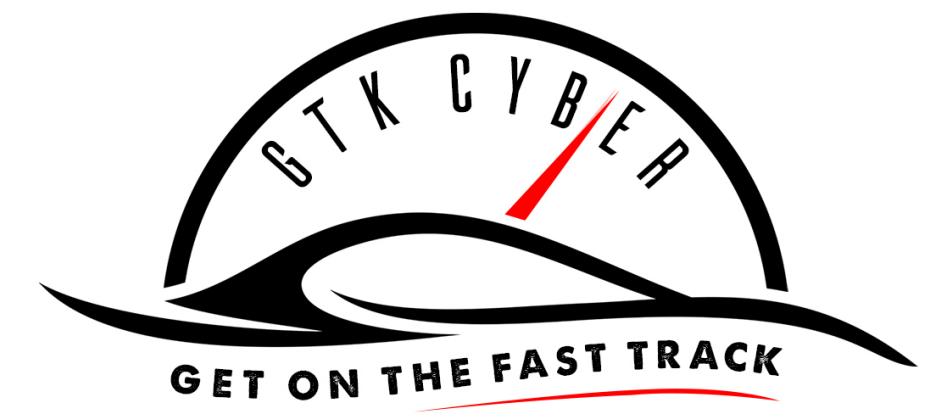
More settings

Web server

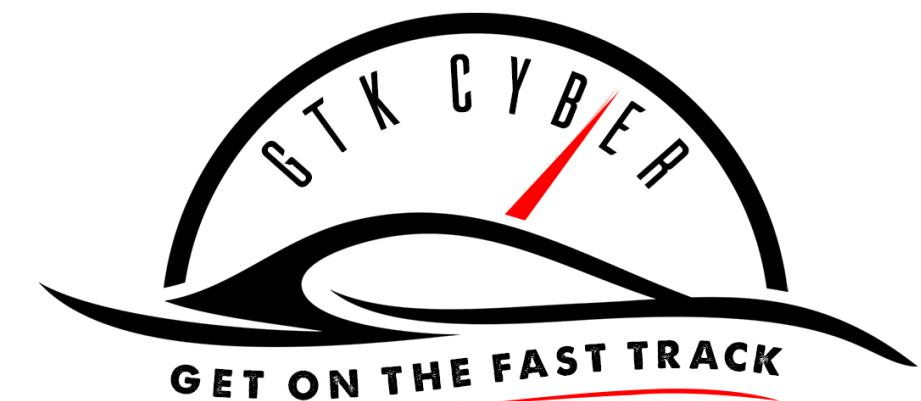
- nginx/1.10.1
- Database client version: libmysql - 5.6.31
- PHP extension: mysqli
- PHP version: 5.6.11-1ubuntu3.4

phpMyAdmin

The screenshot shows the MySQL Workbench interface on the left and the phpMyAdmin interface on the right. The phpMyAdmin interface is running on a local host and displays various configuration settings. The General Settings section includes a 'Change password' link and a dropdown for 'Server connection collation' set to 'utf8mb4_unicode_ci'. The Database server section lists the server details: Localhost via UNIX socket, MySQL server type, version 5.6.31-0ubuntu0.15.10.1 (Ubuntu), protocol version 10, user merlinuser@localhost, and server charset UTF-8 Unicode (utf8). The Appearance Settings section allows changing the language to English, theme to pmahomme, and font size to 82%. The Web server section lists the nginx/1.10.1 web server, database client libmysql version 5.6.31, PHP extension mysqli, and PHP version 5.6.11-1ubuntu3.4.



mongoDB®



Applications Places System

Fri Aug 19, 01:27

File Edit View History Bookmarks Tools Help

db - Mongo Express * +

localhost:8081/db/db

Search

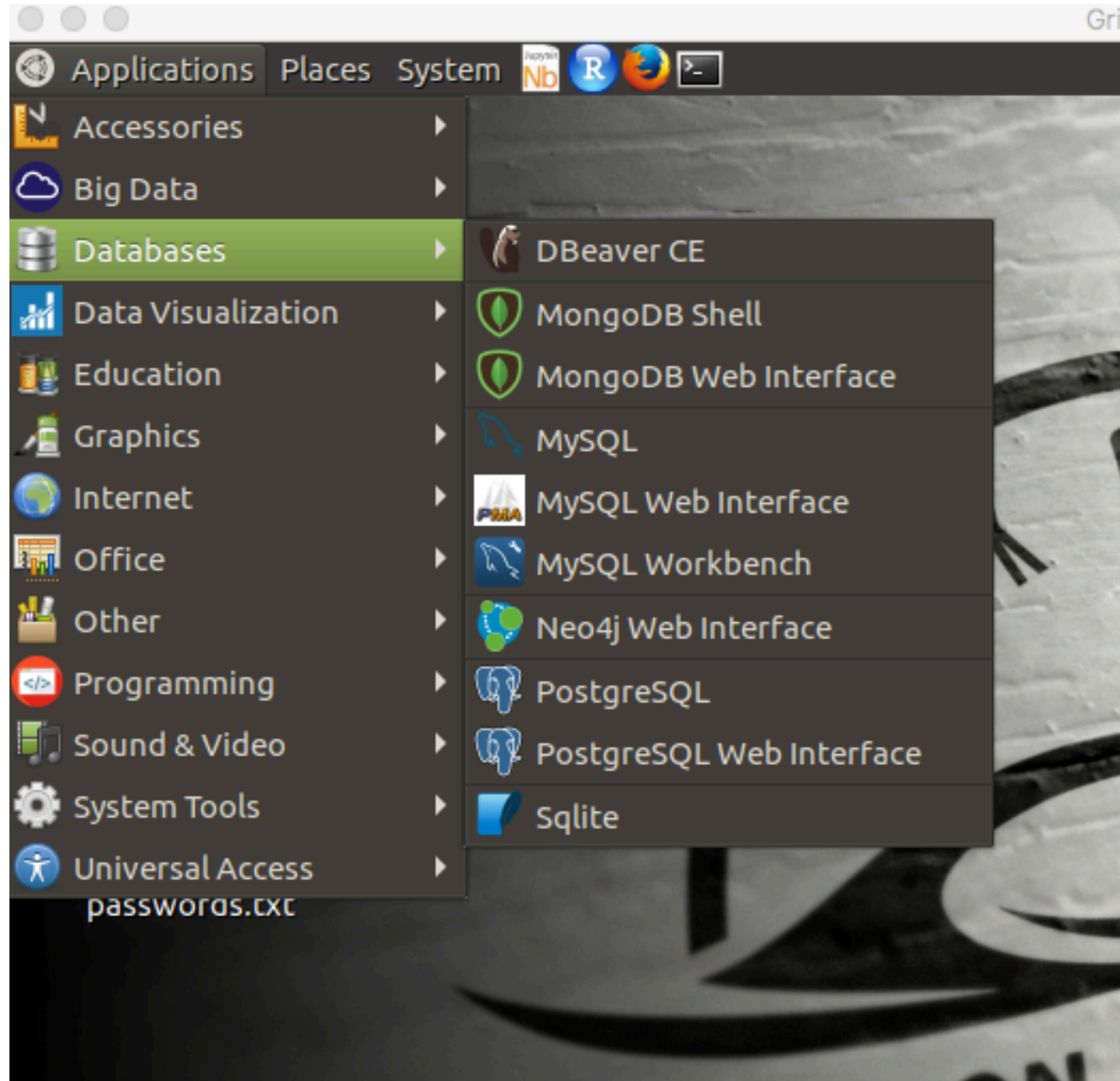
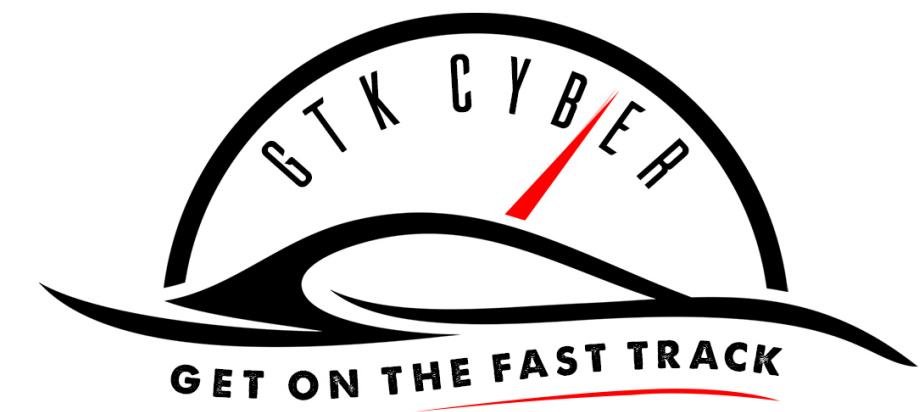
Mongo Express Database: db

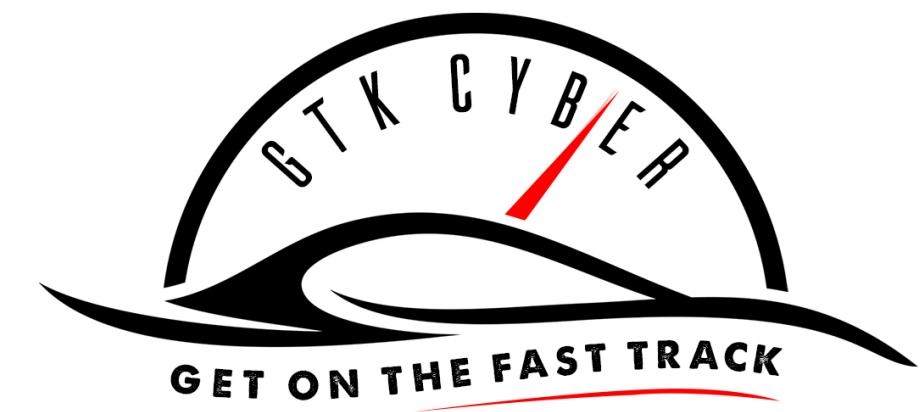
Collection "test" deleted!

Collections Collection Name + Create collection

View Export [JSON] system.indexes Del

gtkcyk



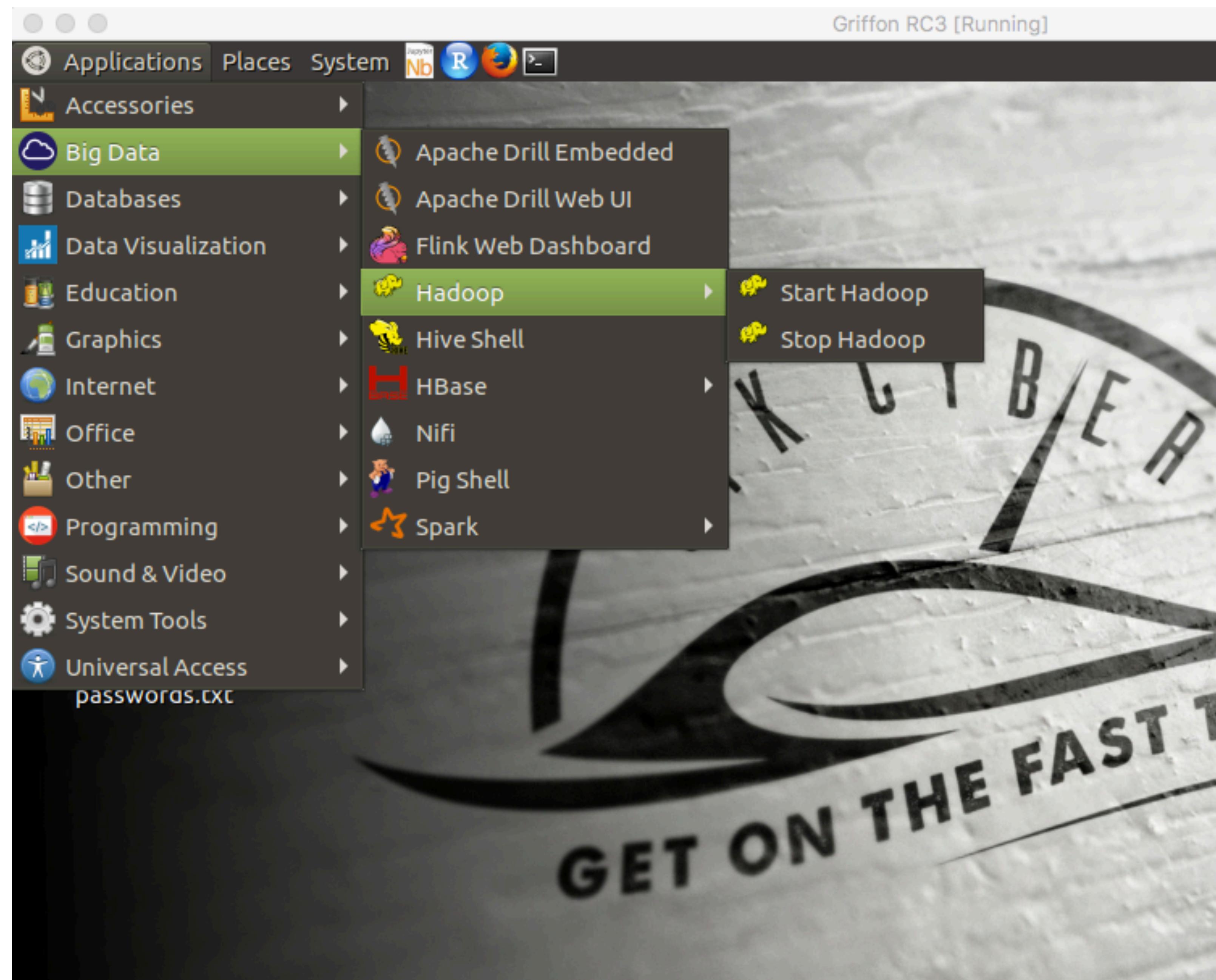


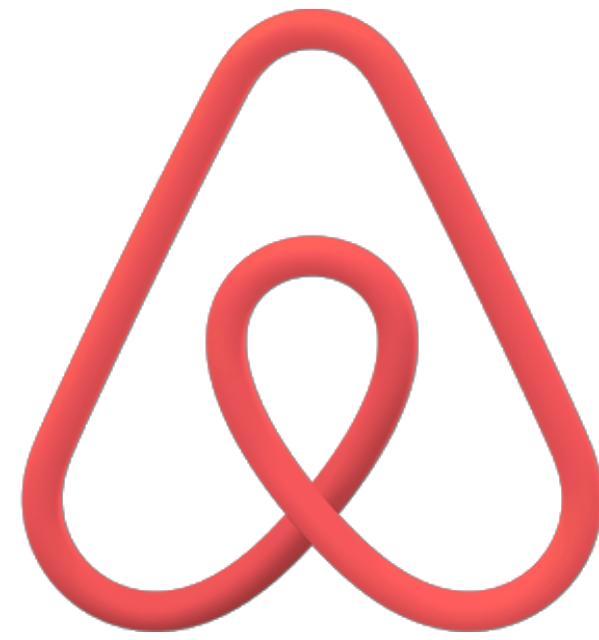
Griffon RC3 [Running]

```
merlin@projectmerlin:/usr/local/hadoop/sbin$ ./start-dfs.sh
16/05/11 23:23:39 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
Starting namenodes on [localhost]
merlinuser@localhost's password: 
merlinuser@localhost's password: localhost: Permission denied, please try again.

merlinuser@localhost's password: localhost: Permission denied, please try again.

localhost: Permission denied (publickey, password).
merlinuser@localhost's password:
merlinuser@localhost's password: localhost: Permission denied, please try again.
```

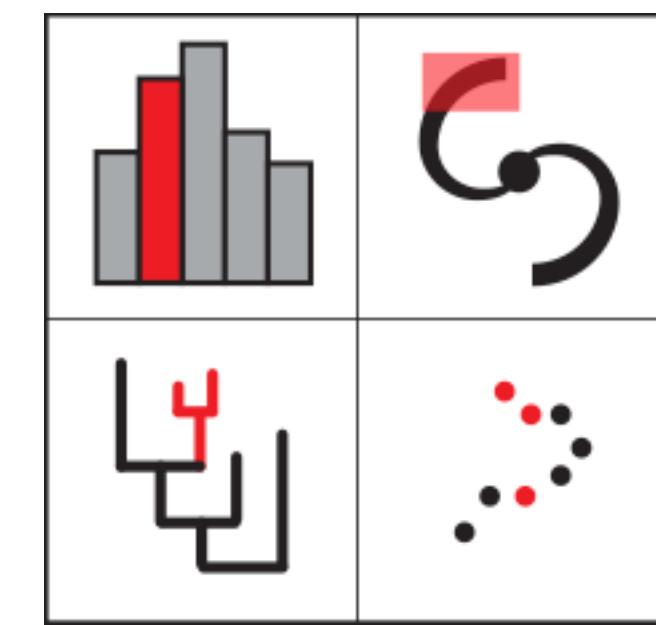


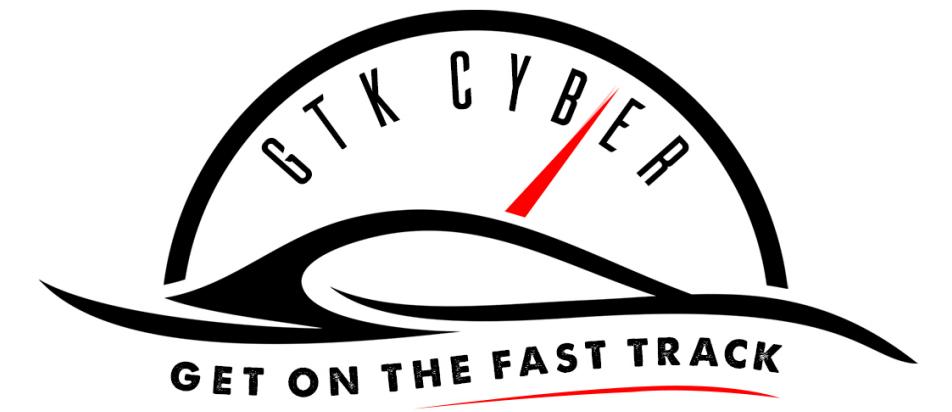


gtkcyber.com



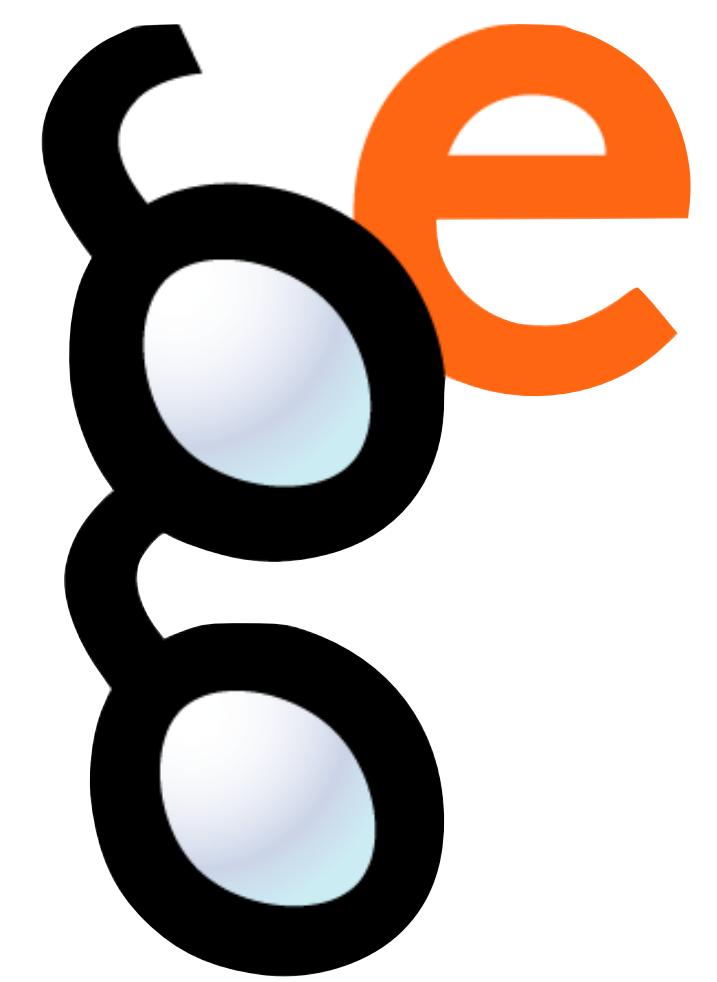
orange
DATA MINING
FRUITFUL&FUN

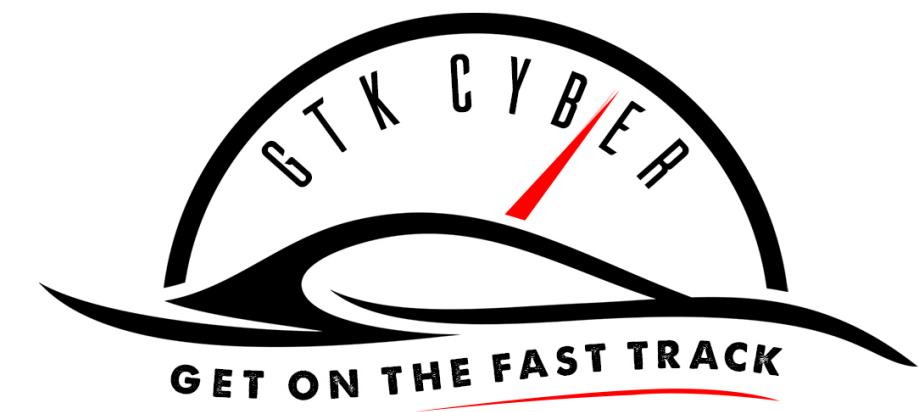




orange

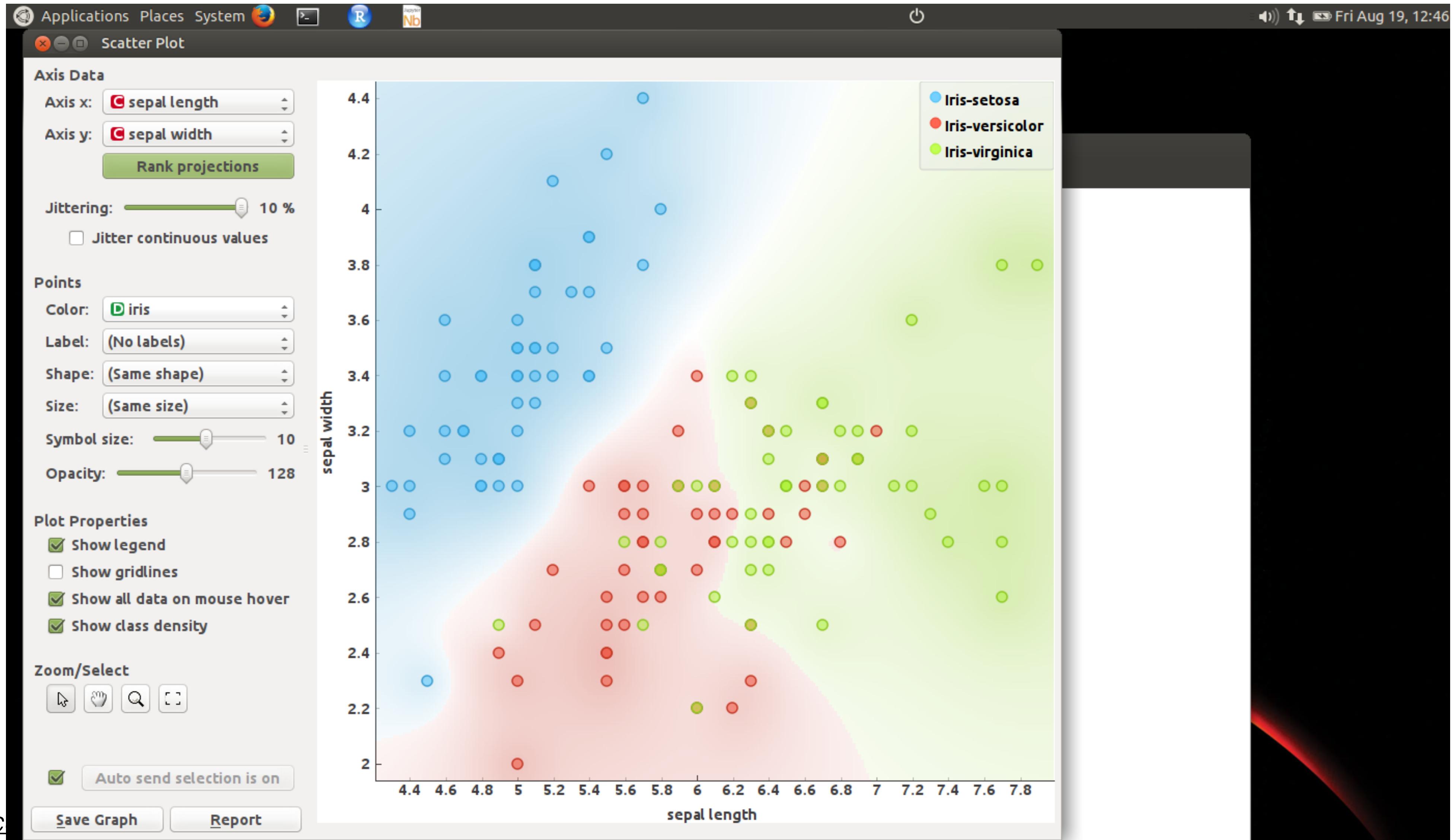
DATA MINING
FRUITFUL&FUN

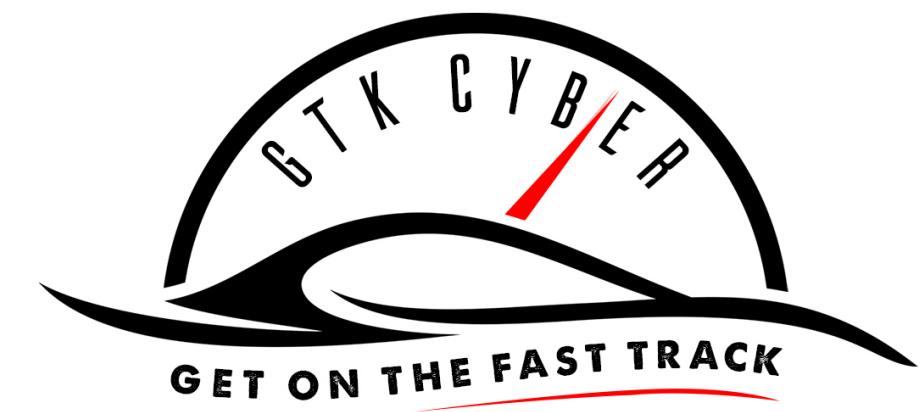




orange

DATA MINING
FRUITFUL&FUN





orange

DATA MINING
FRUITFUL&FUN

Applications Places System R Fri Aug 19, 12:47

Classification Tree Viewer

Tree
13 nodes, 7 leaves

Display

- Zoom
- Width
- Depth
- Edge width
- Target class

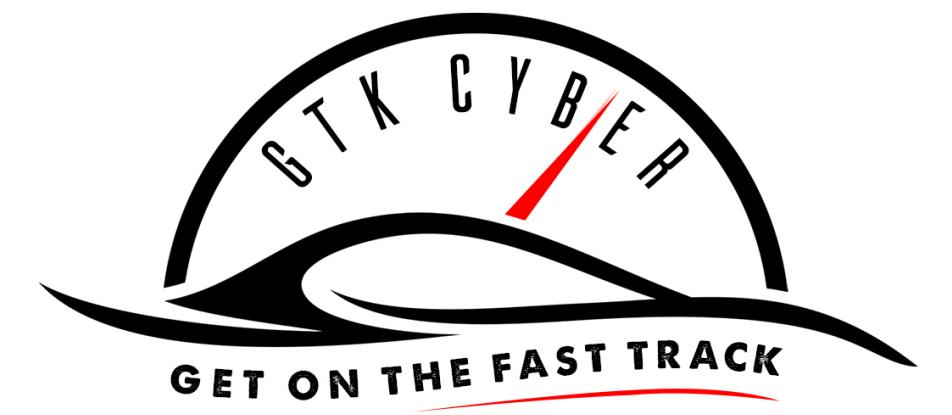
[Save Graph](#) [Report](#)

VirtualBox
Dropped Files

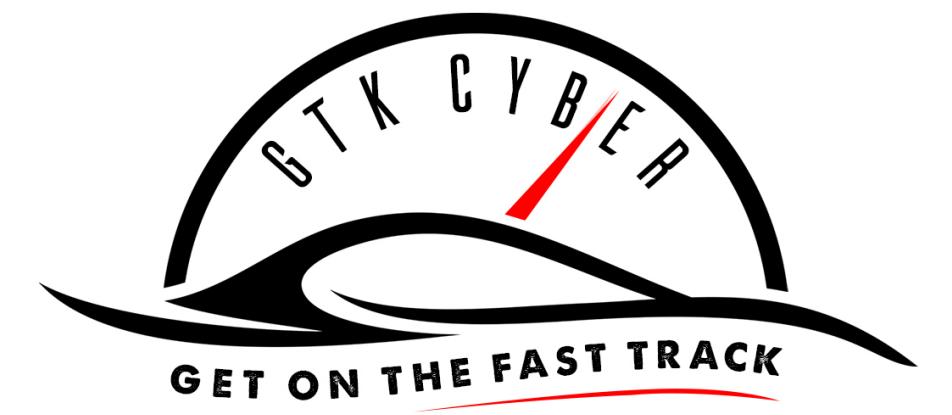
Unsupervised
Prototypes

This workflow works best if you have Tree
Viewer, Scatter Plot and Box Plot all open
at the same time.

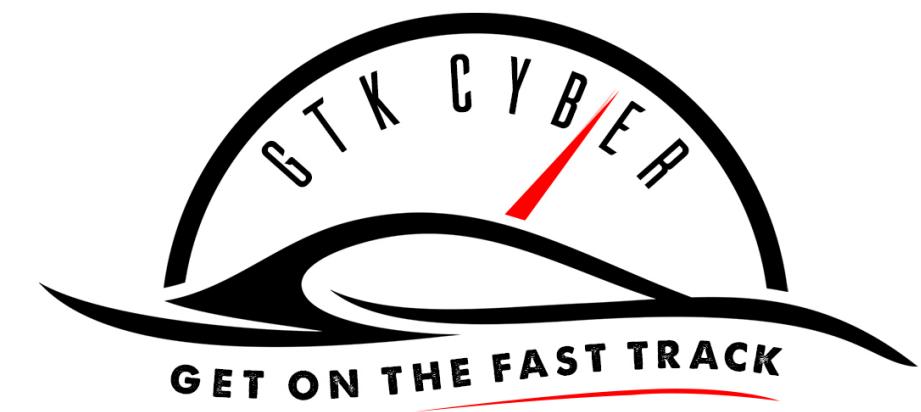
the tree viewer
propagates to all the
downstream widgets



Questions?



Using Jupyter Notebook



Using Jupyter Notebook

jupyter

Open a notebook

Files Running Clusters Formgrader Assignments BeakerX Nbextensions

Select items to perform actions on them.

0 /

- anaconda3
- Desktop
- Documents
- Downloads
- drill
- metastore_db
- Music
- Pictures
- Public
- snap
- sqlpad
- Templates
- Videos

Name ↓

Upload New ▾

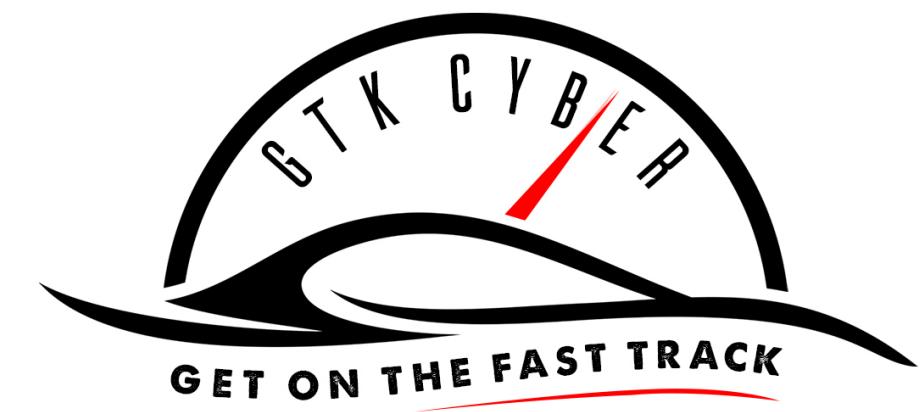
Notebook:

- Bash
- Clojure
- Groovy
- Java
- Javascript (Node.js)
- Kotlin
- PHP
- Python 3
- R
- Ruby 2.5.1
- SQL
- Scala

Other:

- Text File
- Folder
- Terminal

14 days ago



Using Jupyter Notebook

jupyter Untitled Last Checkpoint: 13 minutes ago (unsaved changes)

File Edit View Insert Cell Kernel Navigate Widgets Help Snippets Trust

Run

Demo Notebook

This is a markdown cell. It contains the instructions as to how to do the exercises.

In [1]:

```
1 #This is an executable cell
2 print( "This is a python cell")
```

This is a python cell

In []:

```
1 |
```

Run a cell



Using Jupyter Notebook

jupyter Untitled Last Checkpoint: 18 minutes ago (unsaved changes) Logout

File Edit View Insert Cell Kernel Navigate Widgets Help Snippets Trusted Python 3

In [1]:

```
1 #This is an executable cell
2 print( "This is a python cell")
This is a python cell
```

In [2]:

```
1 x = [4,5,6]
```

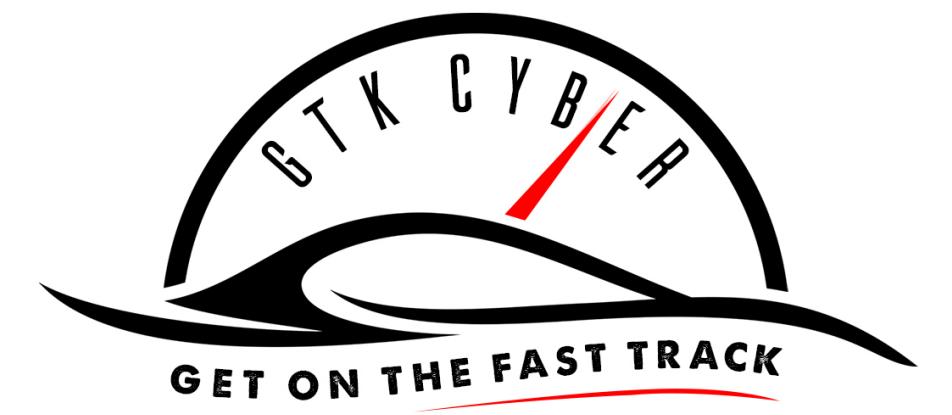
Demo Notebook

This is a markdown cell. It contains the instructions as to how to do the exercises.

Variable Explorer

Variable Inspector

x x list 88 [4, 5, 6]



Questions?