FALMOUTH UNIVERSITY

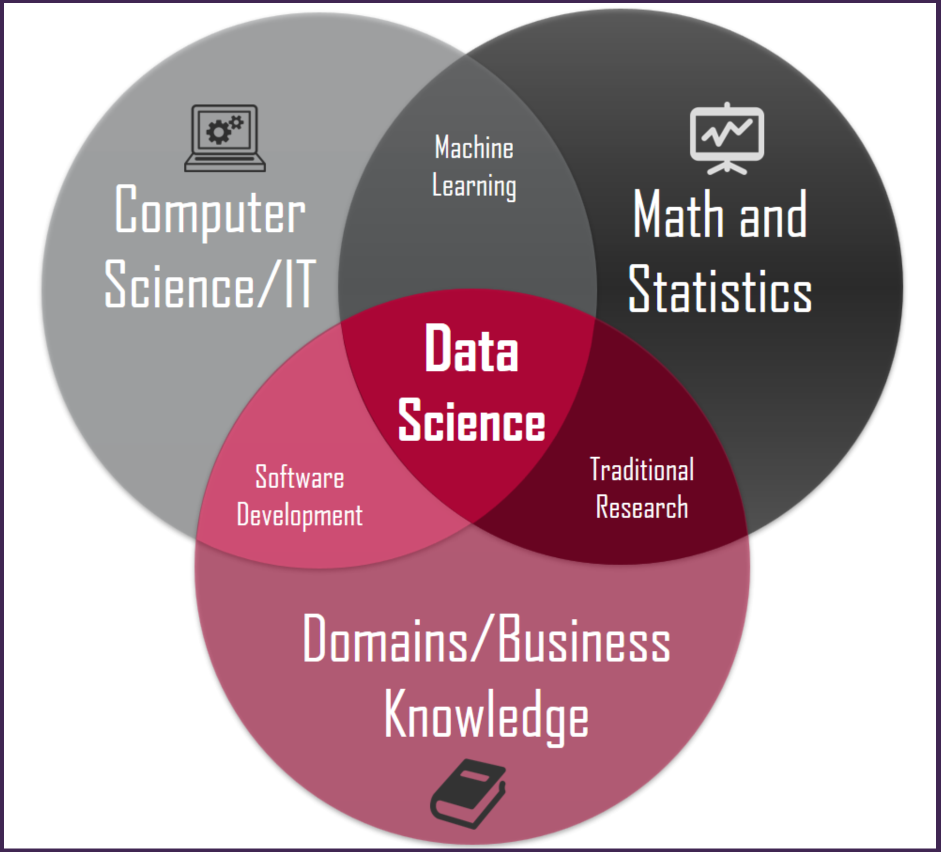
Lecture 2: Data Science pt. I

COMP704: Machine Learning
MSc Artificial Intelligence for Games

- Today’s session:
  - Dig into Data Science & Machine Learning
  - Look at data acquisition
  - Prepare for this week’s workshop

- Dig into Data Science & Machine Learning

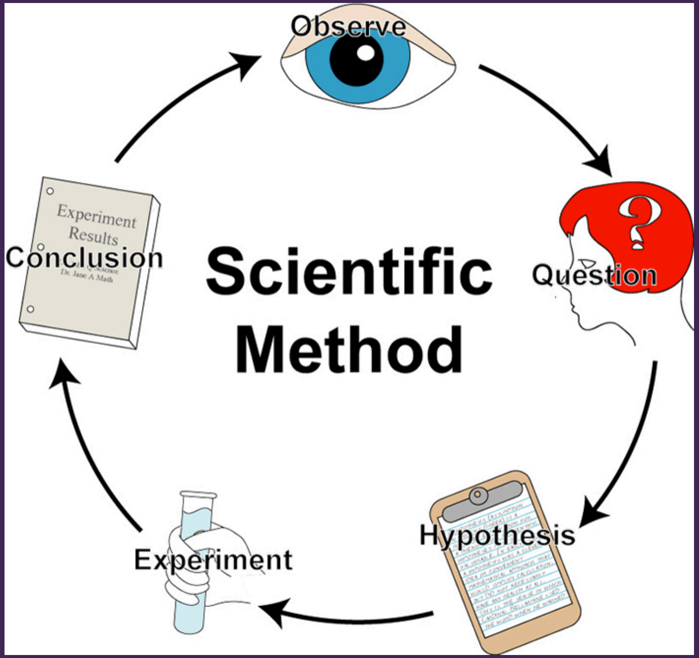
- Dig into Data Science & Machine Learning
  - Last week, we looked at DS & ML

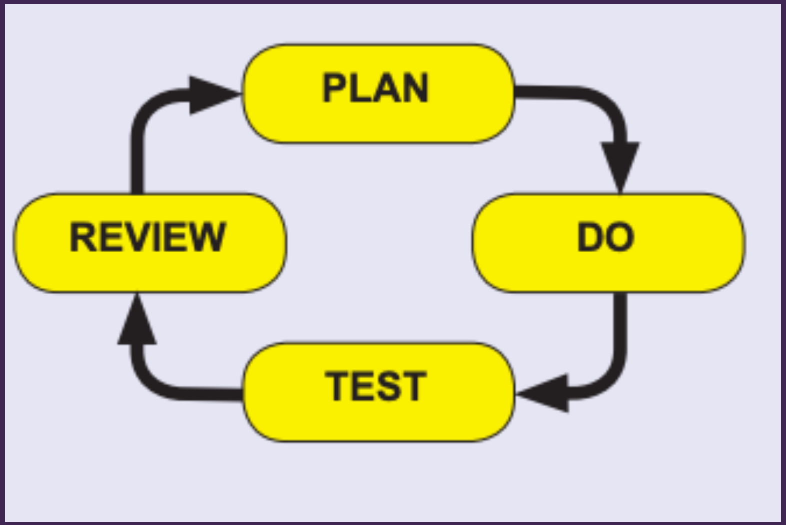


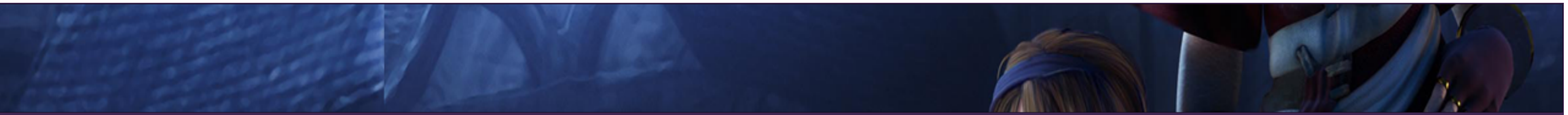
Data Science is the overall activity

Machine Learning is the fun part ;)

- Dig into Data Science & Machine Learning
  - Data Science as a process
    - Science is the key part of data science



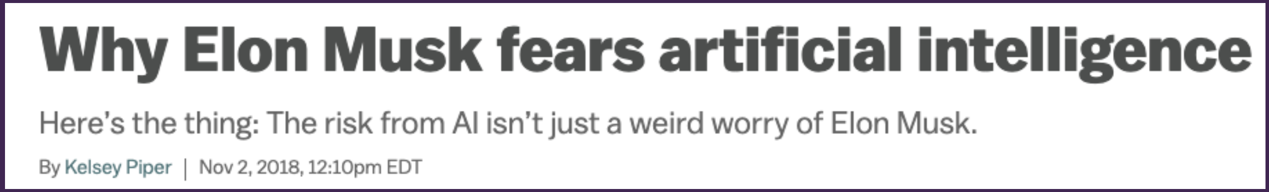




- Dig into Data Science & Machine Learning
  - Machine Learning as a process
    - Learning is the key part of Machine Learning
    - What does Searle tell us about learning in the Chinese Room?
      - Learning is ‘getting better’
      - Learning is not meaning
      - Learning is not knowledge
      - Often, a strong relationship between knowledge and introspection & reflective practice
        - » As much as I said domain experts will often use tactic or heuristic knowledge in their fields, they can normally go back to first principles to explain their processes (it may be painful)
      - Be mindful of domain specificity when talking about learning & knowledge ;)

- Dig into Data Science & Machine Learning
  - Machine Learning in practice

- Dig into Data Science & Machine Learning
  - Types of Machine Learning
    - Given that ML is the intersection of compsci and stats, we need to think of learning as *error reduction*
    - Already said that ML is not knowledge-based so ‘self-awareness’ is unlikely to happen



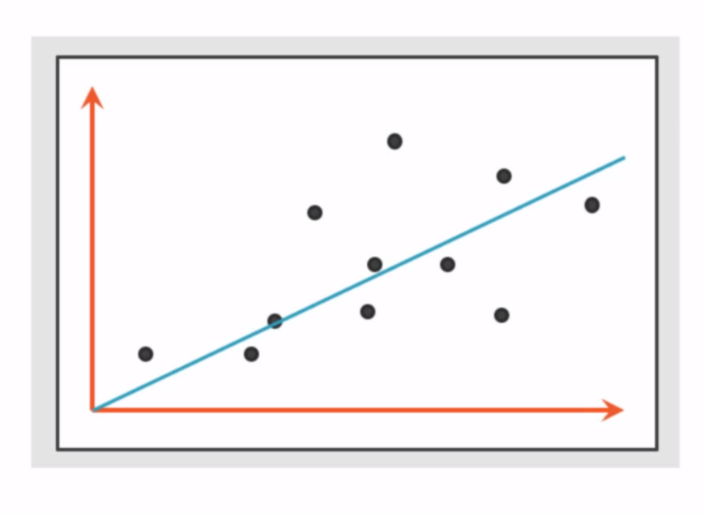
Why Elon Musk fears artificial intelligence

Here’s the thing: The risk from AI isn’t just a weird worry of Elon Musk.

By Kelsey Piper | Nov 2, 2018, 12:10pm EDT

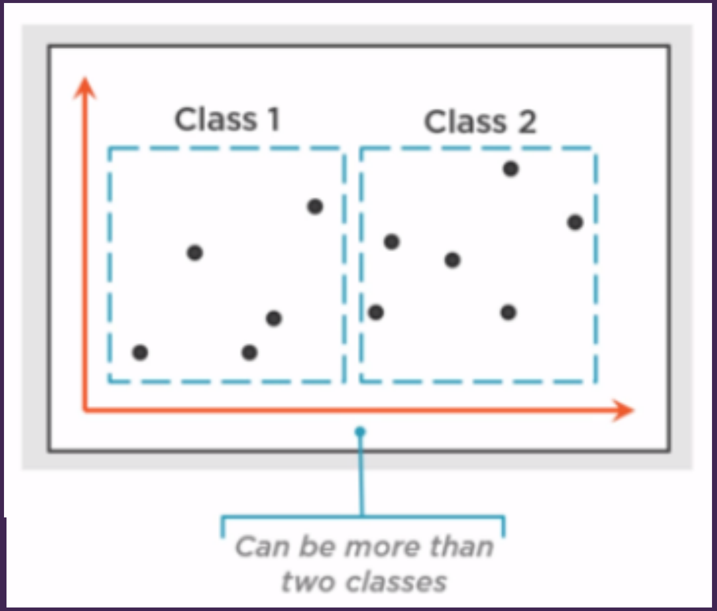
https://www.vox.com/future-perfect/2018/11/2/18053418/elon-musk-artificial-intelligence-google-deepmind-openai

- Dig into Data Science & Machine Learning
  - Types of Machine Learning
    - Regression
      - work out a continuous relationship between inputs and outputs



- Like standard regression, but for multiple dimensions
- E.g.:
  - Based on other examples, what is the value of something (house, car, watches, staff etc)
  - How much is a player likely to spend on my game through IAPs
  - When should I replace server equipment
- Typically, complex data is not ‘linear’, regression is generally split into buckets (short segments of linearity)

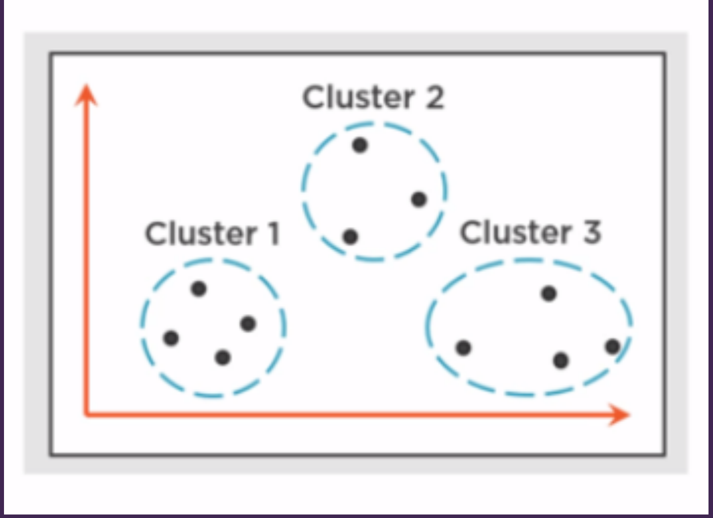
- Dig into Data Science & Machine Learning
  - Types of Machine Learning
    - Classification
      - Group inputs in to a single classification



- Data sorting
- E.g.
  - Mario example (classifications are which buttons should be pressed)
  - Is player behaviour normal?
  - Is a credit card transaction fraudulent?

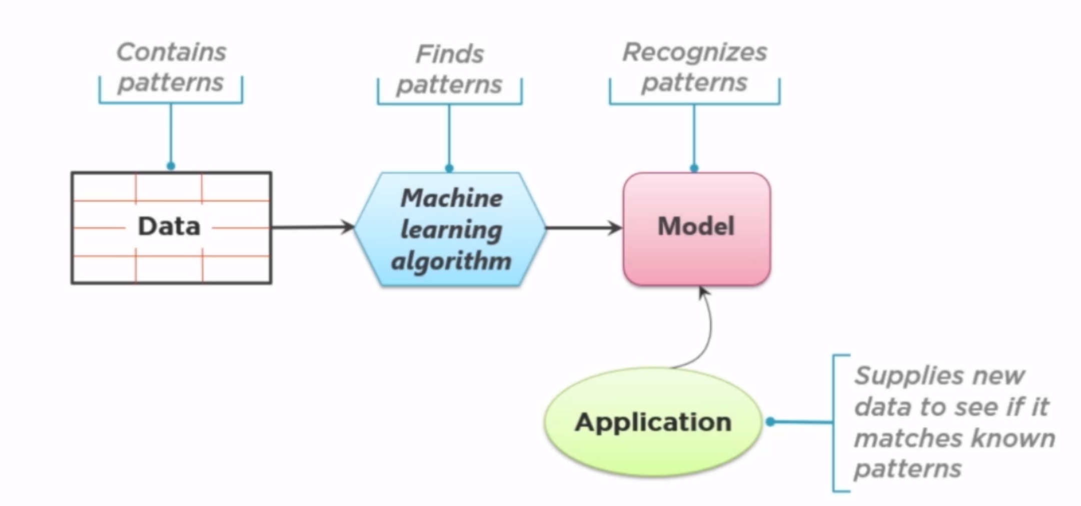
- This is typically 'classical machine learning'
  - Uses neural networks (back prop)
  - Or Marflow-style networks

- Dig into Data Science & Machine Learning
  - Types of Machine Learning
    - Clustering
      - Group *related* inputs in to distinct clusters / groups

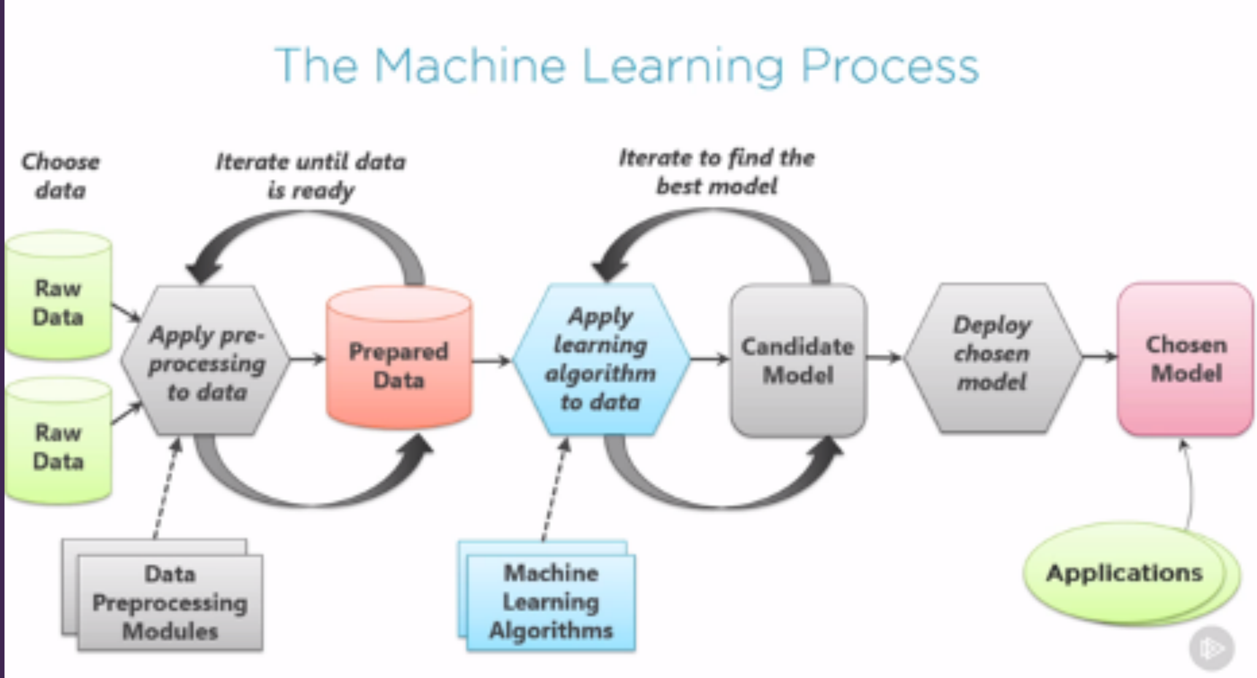


- (More) Data sorting
  - But the algorithms look to determine clusters without being told what they should be
  - Ideal for emergent clusters
    - Cooccurrence
    - Causality
- E.g.
  - What play styles do our players have (Bartle’s Player Types)

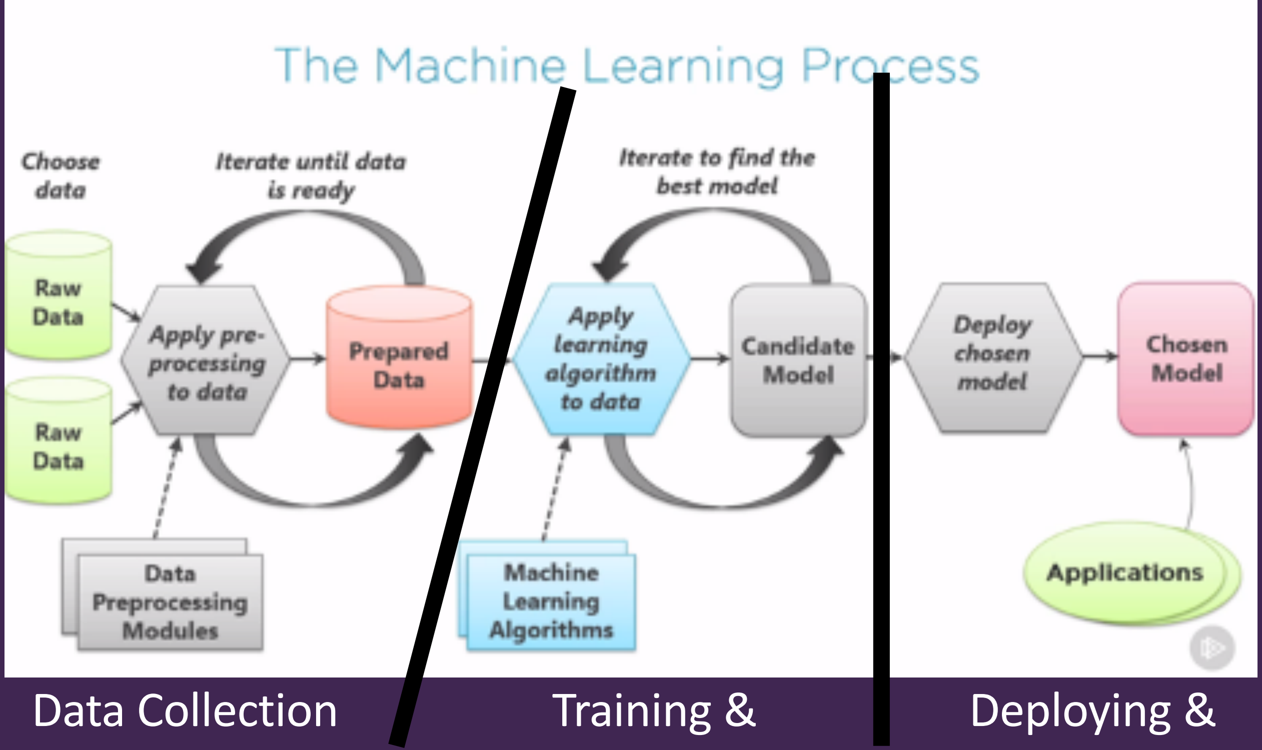
- Dig into Data Science & Machine Learning
  - Process of Machine Learning


Contains patterns
Finds patterns
Recognizes patterns
Data
Machine learning algorithm
Model
Application
Supplies new data to see if it matches known patterns

- Dig into Data Science & Machine Learning
  - Process of Machine Learning


The Machine Learning Process
Choose data
Iterate until data is ready
Iterate to find the best model
Raw Data
Raw Data
Apply pre-processing to data
Prepared Data
Apply learning algorithm to data
Candidate Model
Deploy chosen model
Chosen Model
Data Preprocessing Modules
Machine Learning Algorithms
Applications

- Dig into Data Science & Machine Learning
  - Process of Machine Learning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Deploy chosen model
Chosen Model
Applications

Data Collection & Processing

Training & Learning

Deploying & Using

Note all the scope for iterating

- Dig into Data Science & Machine Learning
  - Process of Machine Learning
    - Data collection & processing
      - Collect enough suitable data for training & testing
      - Typically, this will be ‘live’ data that can come from a multitude of sources
        - Scope to use historic data too
      - Need to process the data into forms that make sense for training
      - This will all depend on type of ML used and algorithms used within that type

- Dig into Data Science & Machine Learning
  - Process of Machine Learning
    - Training & learning
      - ML describes two broad learning paradigms
        - » Supervised
          - Training is done with data + expected outcome (like classroom training)
          - Learning algorithm will look to minimise error between expected outcome and current outcome
          - Typically
            - Regression & classification
        - » Unsupervised
          - Training is done with data but no expected outcomes as algorithm will self-organise representations
          - Typically
            - Clustering

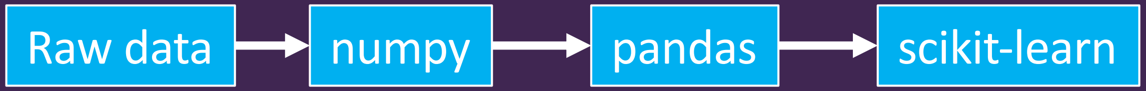
- Dig into Data Science & Machine Learning
  - – Process of Machine Learning
    - Training & learning
      - – Typically, data is split into two sets:
        - » Training data
          - In supervised learning
            - Algorithm is trained with training data to achieve desired / best (minimum) errors
          - In unsupervised learning
            - Algorithm is just presented with training data
        - » Test data
          - Novel test data is presented to the algorithm to assess performance with new cases
          - Performance can be assess quantitatively with a confusion matrix

- Dig into Data Science & Machine Learning
    - Process of Machine Learning
        - Iterating data collection & processing and Training & learning phases
            - Typically, testing an ML solution will result in issues
                - » Over-fitting
                    - training has been so heavily geared to training data, solution doesn’t perform well with novel data
                        - Learning the data and not the trends
                - » Under-fitting
                    - both training data and novel data produce poor results
                        - Algorithm may not be a good fit for data
                        - May not have enough data to train with

- Dig into Data Science & Machine Learning
  - Process of Machine Learning
    - Iterating data collection & processing and Training & learning phases
      - May require iteration in training and learning
        - » Change algorithm parameters
        - » Change algorithm
      - May require iteration in data collection & processing
        - » Process existing data differently
        - » Collect different data

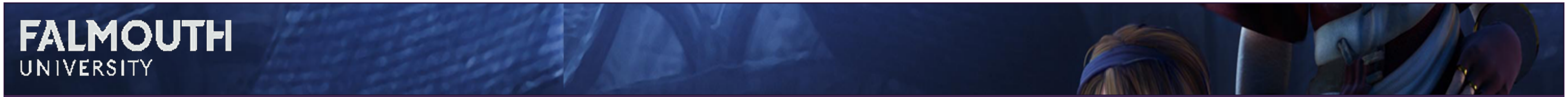
- Dig into Data Science & Machine Learning
  - Process of Machine Learning
    - Deploying and using
      - Once an algorithm has trained the data to acceptable performance (accuracy) it can be packaged and put into use
      - Take algorithm data and package into application
        - » In games and most applications, as a black box AI component

- Dig into Data Science & Machine Learning
  - Machine Learning in Python
    - Python has a lot of support for industrial and academic ML
      - Lots of package support
    - The pipeline we will use



Raw data → numpy → pandas → scikit-learn

- Other pipelines & parts are available
  - TensorFlow
  - ML.net
  - etc



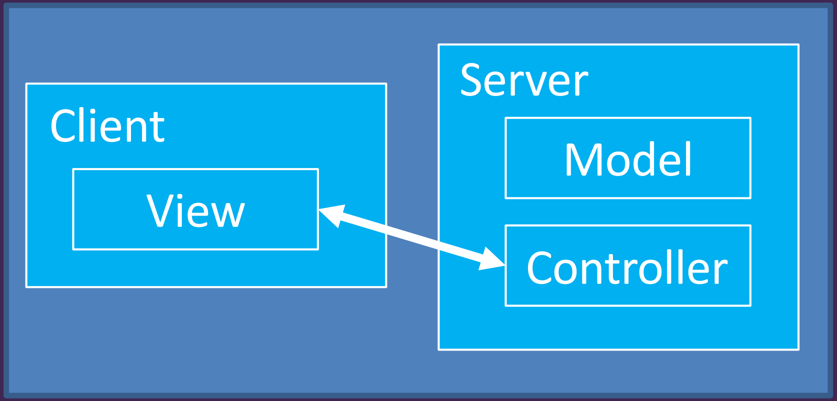
- Dig into Data Science & Machine Learning
  - Machine Learning in Python
    - Numpy
      - A library for ‘array & linear algebra’ for ‘large datasets’
    - Pandas
      - PANel DAta
      - Process data ‘like excel in code’
    - Scikit-learn
      - Library of ML algorithms

- Look at data acquisition

- Look at data acquisition
  - Two broad approaches to data acquisition
    - Live data (take from running services)
    - Historical data (take from offline sources)
  - Both require data processing (dependent on the data & solution requirements)

- Look at data acquisition
  - Live Data (analytics / metrics)
    - This is a common activity for GaaS and is a core part of their business
      - Regression
        - » Customer spend
      - Classification & clustering
        - » Customer behaviours
    - Relatively easy for GaaS, not so for traditional games

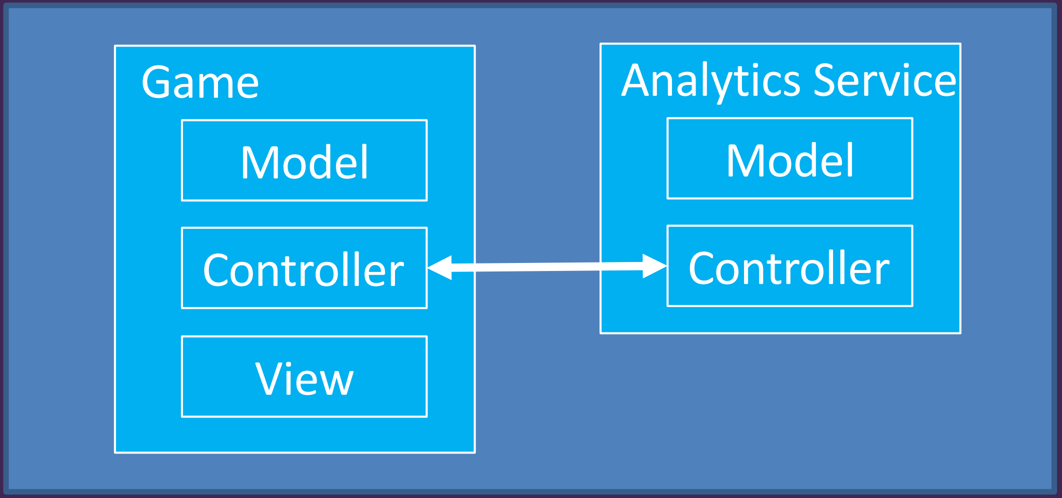
- Look at data acquisition
  - – Live Data (analytics / metrics)
    - Game As a Service (thin client)



– Typically, a thin client GaaS will have all the ‘important processing done on the server and just take user input and drawing on the client

» Easy to collect server-side data & instrument & re-instrument server code to collect different data

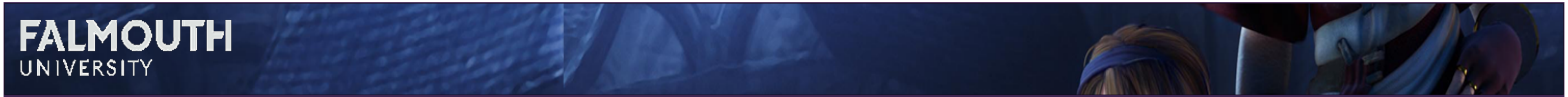
- Look at data acquisition
  - Live Data (analytics / metrics)
    - Standalone Game with analytics support



- Typically, standalone game will be a black box
  - » Only updated through patching
- (Potentially) costly to send data to analytics server
  - » Need to think about data packaging

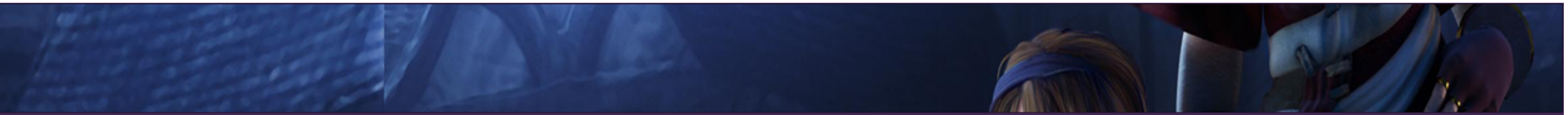
- Look at data acquisition
  - Approaches:
    - Save data to a local text file and process
      - Save data as csv, xls, xml, json etc
    - Send data to a server using HTTP (or other protocols)
    - Manage data as flat files
    - Manage data through xls, sql
      - Remember, ML has a tendency to create large amounts of data, so it needs to be stored carefully.

- Look at data acquisition
  - What to save?
    - All the keystrokes / game events
      - Can generate lots of data that may not process well
    - Do sessional processing locally & send results
      - Treat each play-through of game as a ‘session’ and send key results
      - Can work but relies on you having the correct data
    - Label game events and send
      - Again, relies on you having the correct data



- Look at data acquisition
  - We can see that ML & DS move the burden away from writing algorithms to working with data
    - What to capture
    - How to capture it
    - How to process it
  - Then worry about training

- Prepare for this week’s workshop



- Prepare for this week’s workshop
  - For this weeks’ workshop, we will look at different ways of collecting data from a game
    - Flat files
    - Json
    - Openpyxl
    - HTTP
  - And how we can store data from multiple players & sessions
    - Excel
    - Sql

- Do you have any questions for me