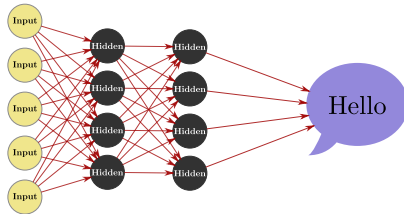# Introduction to Machine Learning

Pavlos Vougiouklis

The Plan (hopefully?)

- Short overview talk on classical Machine Learning

- Practical session using Jupyter Notebook (Python 2),
  scikit-learn and pandas to experiment with feature extraction,
  classification and clustering

- Please ask questions as we go :)

Why Should We Care?

- ML allows us to directly learn from data without requiring hand-coded rules
- The ever-increasing amount of training data on the Web has benefited the performance ML algorithms substantially
- ML models are matrix-oriented models; advances in Parallel Computing along with the sophistication of the tools for GPU Computing have substantially increased their computing capabilities
- ML has achieved super-human performance in domains such as visual object recognition or (video) games (e.g. Go, chess or Dota 2)

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- ML has achieved super-human performance in domains such as visual object recognition or (video) games (e.g. Go, chess or Dota 2); in others, such as Natural Language Understanding or dialogue systems, it's still far from perfect

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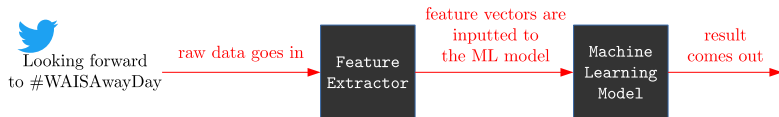
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- Machine Learning is a **highly mathematical** subject; Today, we will try to ignore the details
- The **vector** is the key concept in Machine Learning

The Foundation of Machine Learning

VECTOR HAS BOTH

MAGNITUDE AND DIRECTION

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The General Machine Learning Pipeline

Looking forward to #WAISAwayDay → raw data goes in → **Feature Extractor** → feature vectors are inputted to the ML model → **Machine Learning Model** → result comes out

Feature Extraction

- It is the process of transforming raw data into feature-vectors, which are mathematical vectors
  - ⋆ list of (usually) numbers $\in \mathbb{R}$
  - ⋆ fixed number of elements; the number of element is the dimensionality of the vector
- Each feature-vector represents a point in a feature-space, or equally a direction in the feature-space
- The dimensionality of a feature-space is the dimensionality of every vector within it; vectors of different dimensionality cannot exist in the same feature-space
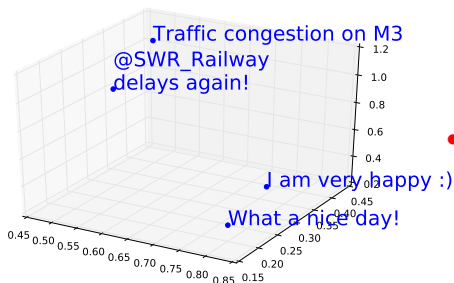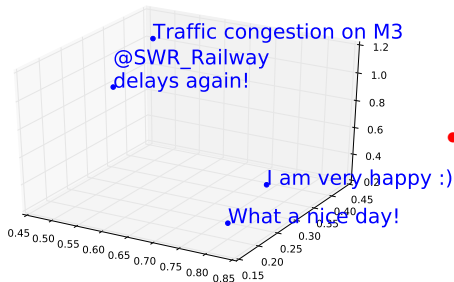
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Distances In Feature-Space

- The general goal of a feature extractor is to produce feature-vectors that are close together for *similar* inputs

- Closeness of two vectors in a feature-space can be computed by measuring the distance between the vectors

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How To Choose Features?

- Choose features that allow you to distinguish objects or classes of interest
  - ⋆ similar within classes
  - ⋆ different between classes
- Try to keep the total number of features small; Machine Learning becomes harder as the dimensionality of the feature-space increases

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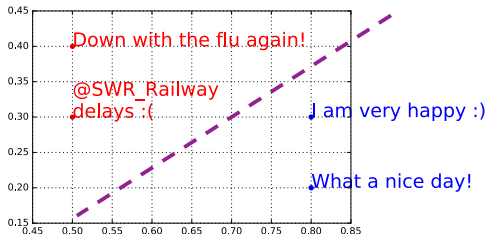
Supervised Machine Learning: Classification

- Classification is the process of assigning a **class label** to an item (e.g. an image or a piece of text)

- A supervised machine learning algorithm uses a set of pre-labelled *training data* to learn how to assign labels to feature-vectors and their corresponding items

- Binary classification is when a classifier has two classes, and multi-class when it has many
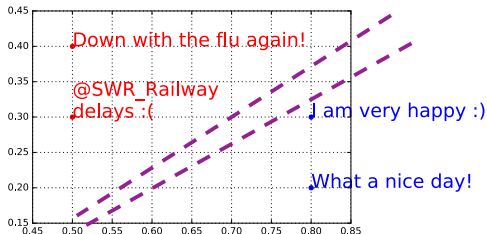
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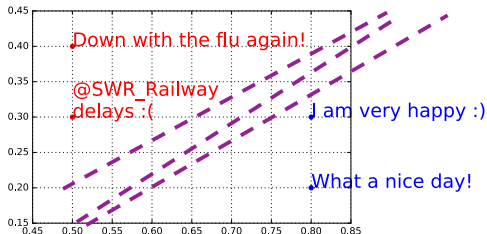
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- Lots of hyperplanes to choose from since different linear classifiers apply different constraints during training
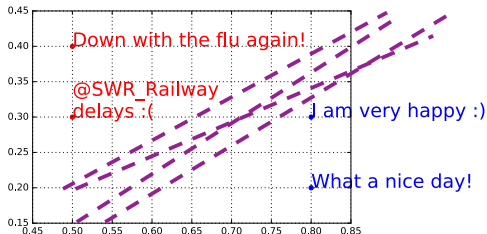
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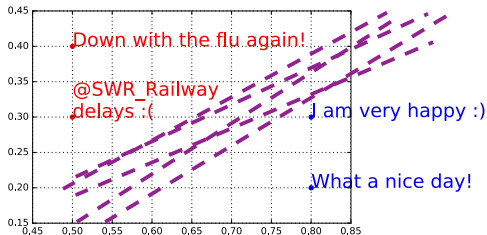
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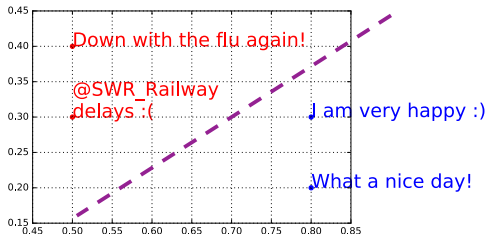
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- Clustering aims to **group** data without any prior knowledge of what the groups should look like or contain

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Let's Get Our Hands "Dirty"

https://github.com/pvougiou/WAIS-Away-Day