# 7: Catchup Session & very short intro to other classifiers

Machine Learning and Real-world Data (MLRD)

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Lent 2019

# What happens in a catchup session?

- Lecture and practical session as normal.
- New material is non-examinable.
- Time for you to catch-up or attempt some starred ticks.
- Demonstrators help as per usual.

# Naive Bayes is a probabilistic classifier

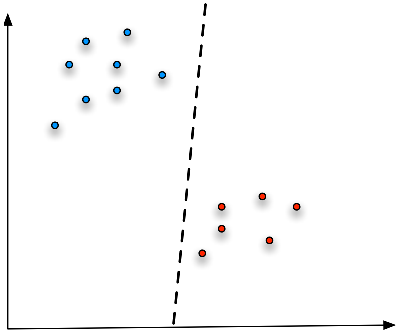
- Given a set of input features a probabilistic classifier provide a distribution over classess.
- That is, for a set of observed features $O$ and classes $c_1...c_n \in C$ gives $P(c_i|O)$ for all $c_i \in C$
- For us $O$ was the set all the words in a review $\{w_1, w_2, ..., w_n\}$ where $w_i$ is the $i$th word in a review, $C = \{\text{POS}, \text{NEG}\}$
- We decided on a single class by choosing the one with the highest probability given the features:

$$\hat{c} = \operatorname*{argmax}_{c \in C} P(c|O)$$

# An SVM is a popular non-probabilistic classifier

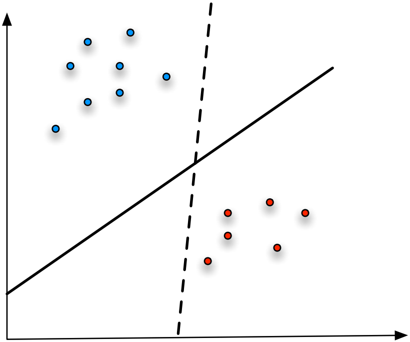
- A Support Vector Machine (SVM) is a non-probabilistic binary linear classifier
- SVMs assign new examples to one category or the other
- SVMs can reduce the amount of labeled data required to gain good accuracy
- A linear-SVM can be considered to be a base-line for non-probabilistic approaches
- SVMs can be efficiently adapted to perform a non-linear classification

# SVMs find hyper-planes that separate classes



- Our classes exist in a multidimensional feature space
- A linear classifier will separate the points with a hyper-plane

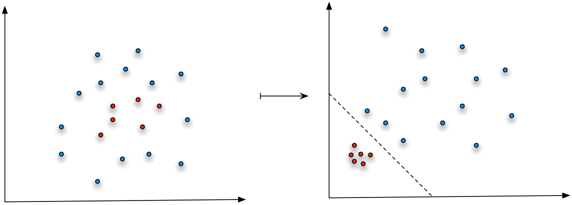
# SVMs find a maximum-margin hyperplane in noisy data



- There are many possible hyperplanes
- SVMs find the best hyperplane such that the distance from it to the nearest data point from each class is maximised
- i.e. the hyperplane that passes through the widest possible gap (hopefully helps to avoid over-fitting)

# SVMs can be very efficient and effective

- Efficient when learning from a large number of features (good for text)
- Effective even with relatively small amounts of labelled data (we only need points close to the plane to calculate it)
- We can choose how many points to involve (size of margin) when calculating the plane (tuning vs. over-fitting)
- Can separate non-linear boundaries by increasing the feature space (using a kernal function)



# Choice of classifier will depend on the task

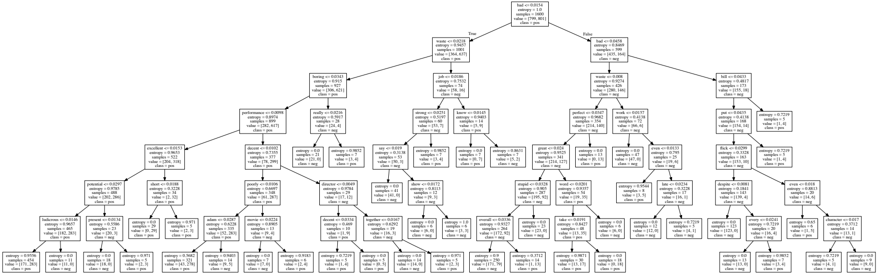
Comparison of a SVM and Naive Bayes on the same task:

- 2000 imdb movie reviews, 400 kept for testing
- preprocess with improved tokeniser (lowercased, removed uninformative words, dealt with punctuation, lemmatised words)

| | **SVM** | **Naive Bayes** |
|---|---|---|
| Accuracy on train | 0.98 | 0.96 |
| Accuracy on test | 0.84 | 0.80 |

- But from Naive Bayes I know that *character*, *good*, *story*, *great*, ... are informative features
- SVMs are more difficult to interpret

# Decision tree can be used to visually represent classifications




- Simple to interpret
- Can mix numerical and categorical data
- You specify the parameters of the tree (maximum depth, number of items at leaf nodes—both change accuracy)
- But finding the optimal decision tree can be np-complete

# Information gain can be used to decide how to split

- Information gain is defined in terms of entropy $H$

Entropy of tree node:

$$H(n) = -\sum_p p_i \log_2 p_i$$

where $p$'s are the fraction of each class at node $n$

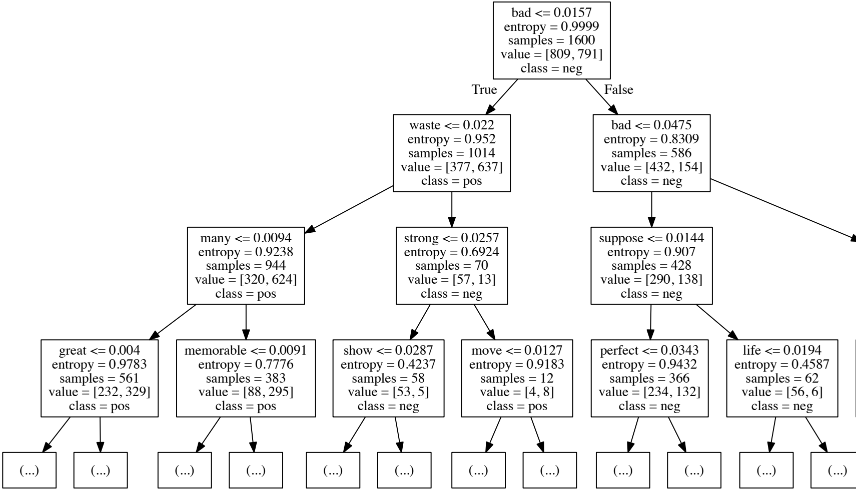
- Information gain $I$ is used to decide which feature to split on at each step in building the tree

Information gain:

$$I(n, D) = H(n) - H(n|D)$$

where $H(n|D)$ is the weighted entropy of the daughter nodes.

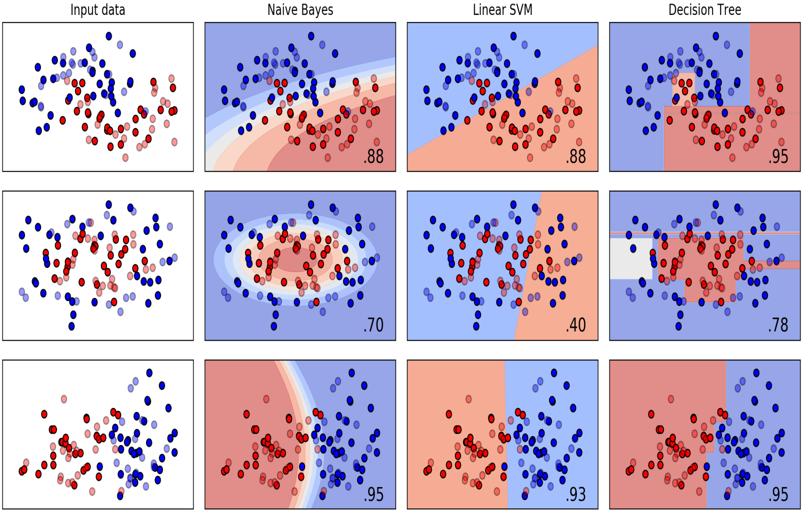
# Information gain can be used to decide how to split



Results on the 2000 movie reviews:

| | **SVM** | **Naive Bayes** | **DTree** (max depth 7) |
|---|---|---|---|
| Accuracy on train | 0.98 | 0.96 | 0.80 |
| Accuracy on test | 0.84 | 0.8 | 0.69 |

# Classifier comparison on sample data




Modified from SciKit Learn Classifier Comparison

# Today

- Come to see lecturers if you are behind
- New topic starts on Monday—try to have ticks 1–6 by end of today