CS347

Review Slides

(IR Part II)

June 6, 2001

Overview of topics

- Clustering
  - Agglomerative
  - k-means
- Classification
  - Rule based
  - Support Vector Machines
  - Naive Bayes
- Finding communities (aka Trawling)
- Summarization
- Recommendation systems

Supervised vs. unsupervised learning

- Unsupervised learning:
  - Given corpus, infer structure implicit in the docs, without prior training.
- Supervised learning:
  - Train system to recognize docs of a certain type (e.g., docs in Italian, or docs about religion)
  - Decide whether or not new docs belong to the class(es) trained on

Why cluster documents

- Given a corpus, partition it into groups of related docs
  - Recursively, can induce a tree of topics
- Given the set of docs from the results of a search (say *jaguar*), partition into groups of related docs
  - semantic disambiguation

Agglomerative clustering

- Given target number of clusters k.
- Initially, each doc viewed as a cluster
  - start with n clusters;
- Repeat:
  - while there are $> k$ clusters, find the "closest pair" of clusters and merge them.

k-means

- At the start of the iteration, we have k centroids.
  - Need not be docs, just some k points.
  - Axes could be terms, links, etc...
- Loop
  - Each doc assigned to the nearest centroid.
  - All docs assigned to the same centroid are averaged to compute a new centroid;
    - thus have k new centroids.

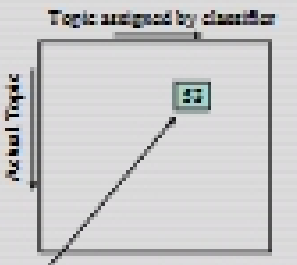
Classification

- Given one or more topics, decide which one(s) a given document belongs to.
- Applications
  - Classification into a topic taxonomy
  - Intelligence analysts
  - Routing email to help desks/customer service

Choice of "topic" must be unique

Accuracy measurement

- Confusion matrix



This (*i*, *j*) entry means 53 of the docs actually in topic *i* were put in topic *j* by the classifier.

Explicit queries

Topic queries can be built up from other topic queries.

Classification by exemplary docs

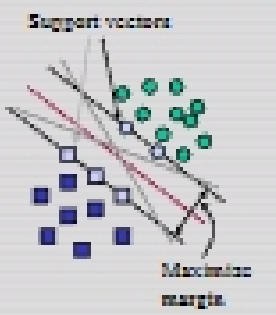
- Feed system exemplary docs on topic (*training*)
- Positive as well as negative examples
- System builds its model of topic
- Subsequent *test* docs evaluated against model
  - decides whether test is a member of the topic

Vector Spaces

- Each training doc a point (vector) labeled by its topic
- Hypothesis: docs of the same topic form a contiguous region of space
- Define surfaces to delineate topics in space

Support Vector Machine (SVM)

- *Quadratic programming* problem
- The decision function is fully specified by training samples which lie on two parallel hyper-planes



Naive Bayes

Training

- Use class frequencies in training data for $\Pr[c_i]$.
- Estimate word frequencies for each word and each class to estimate $\Pr[w \mid c_i]$.

Test doc d

- Use the $\Pr[w \mid c_i]$ values to estimate $\Pr[d \mid c_i]$ for each class c_i .
- Determine class c_j for which $\Pr[c_j \mid d]$ is maximized.

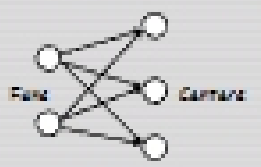
Content + neighbors' classes

- Naive Bayes gives $\Pr[c_j \mid d]$ based on the words in d.
- Now consider $\Pr[c_j \mid N]$ where N is the set of labels of d's neighbors.

  (Can separate N into in- and out-neighbors.)
- Can combine conditional probs for c_j from text- and link-based evidence.

Finding communities on the web

- not easy, since web is huge
- what is a "dense subgraph"?
- define (i,j)-core: complete bipartite subgraph with i nodes all of which point to each of j others



Document Summarization

- Lexical chains: look for terms appearing in consecutive sentences.
- For each sentence S in the doc.

  f(S) = a*h(S) - b*t(S)

  where h(S) = total score of all chains starting at S

  and t(S) = total score of all chains covering S, but not starting at S

Recommendation Systems

Recommend docs to user based on user's context (besides the docs' content).

Other applications:

- Re-rank search results.
- Locate experts.
- Targeted ads.