Text and Web Mining

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Knowledge Discovery and Data Mining Course
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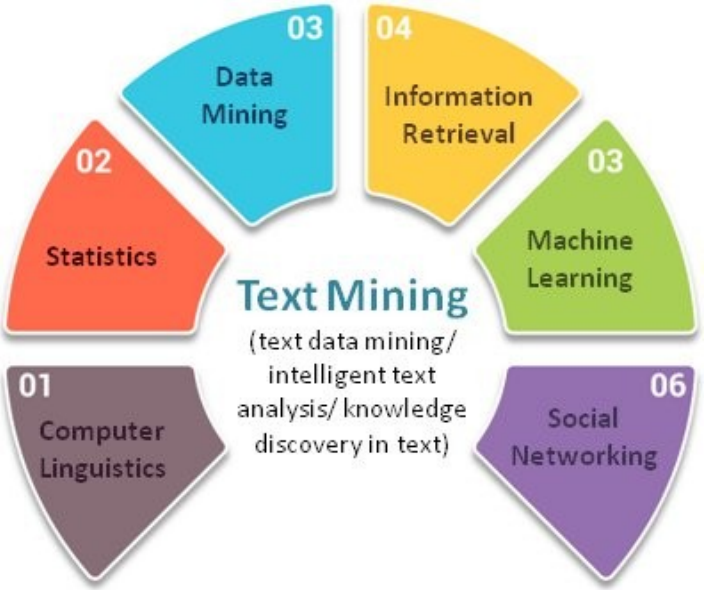
Text Mining

- Finding non-trivial, hidden, unknown and useful patterns in large textual datasets
- Intersection of many areas
- Easy:
  - There are simple and good algorithms for simple tasks
  - Highly redundant data
- Hard:
  - Abstract concepts difficult to represent / visualize
  - High dimensionality



Levels of Processing

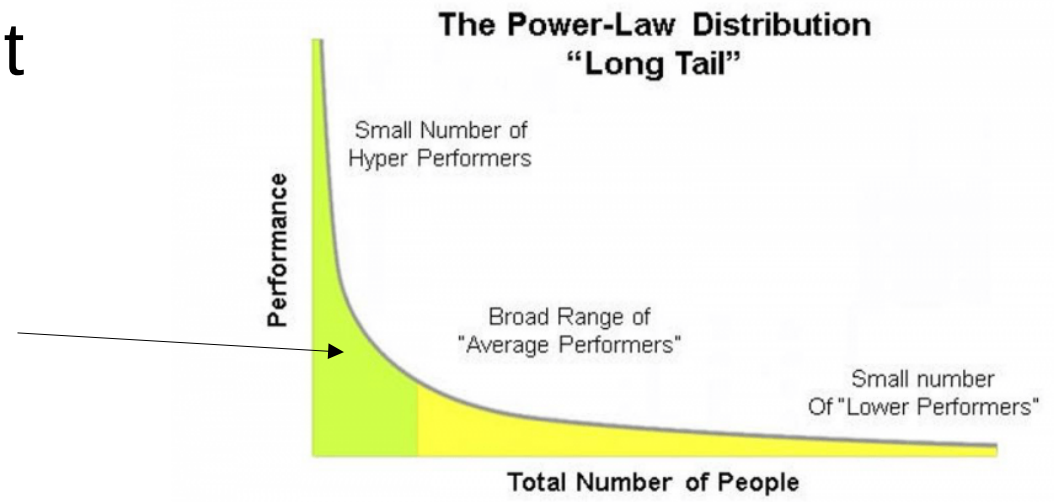
- Character Level
- Word Level
- Sentence Level
- Document Level
- Document – Collection Level
- Linked – Document – Collection Level

Character Level Processing

- Much slower than word level processing for natural language
- Much less accurate than word level processing for natural language
- Used in DNA / RNA analysis
- Similar analysis are used as in word level processing, but longer sequences are required to achieve accuracy for natural language

Word Level Processing (1)

- **Words properties**
  - **Homonomy**: same form, different meaning (bank: river bank, financial institution)
  - **Polysemy**: same form, related meaning (bank: blood bank, financial institution)
  - **Synonymy**: different form, same meaning (singer, vocalist)
  - **Hyponymy**: word denotes subclass of other (breakfast, meal)
  - Frequencies in text have power law distribution
- **Stop-words removal**
  - Language dependent
  - Removes green part



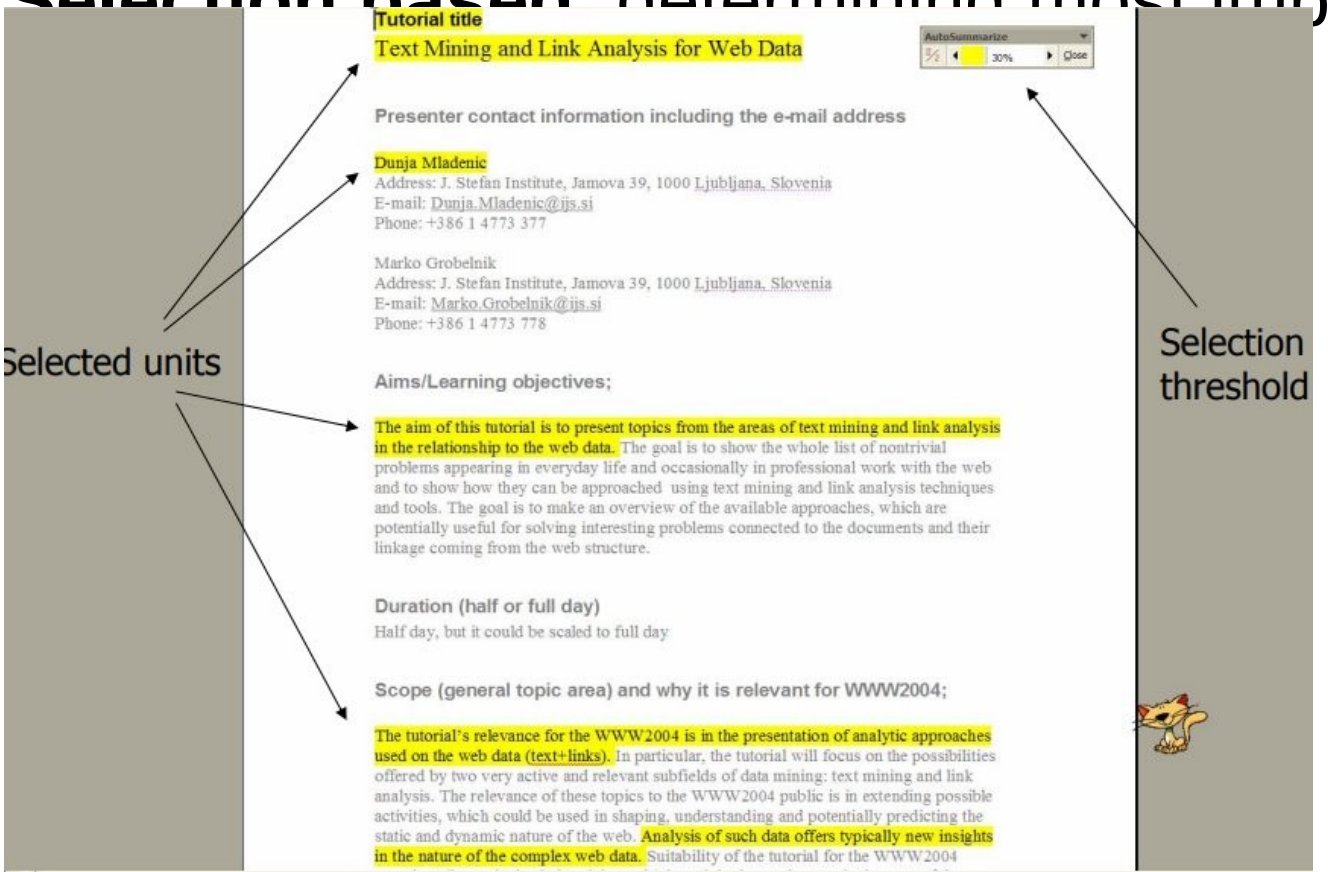
Word Level Processing (2)

- **Stemming**
  - Different forms of the same word are problematic for many algorithms
  - Heuristics and rules for transforming a word into a normalized form (ex. cats → cat, eating, ate → eat)
  - Many stemmers (Porter stemmer mostly used)
- **Tokenization**
  - Splitting by words (can be spli
- **N-grams**
  - Sequence of n consecutive to
- **WordNet**
  - Lexical database for English

Category	Unique Forms	Number of Senses
Noun	94474	116317
Verb	10319	22066
Adjective	20170	29881
Adverb	4546	5677

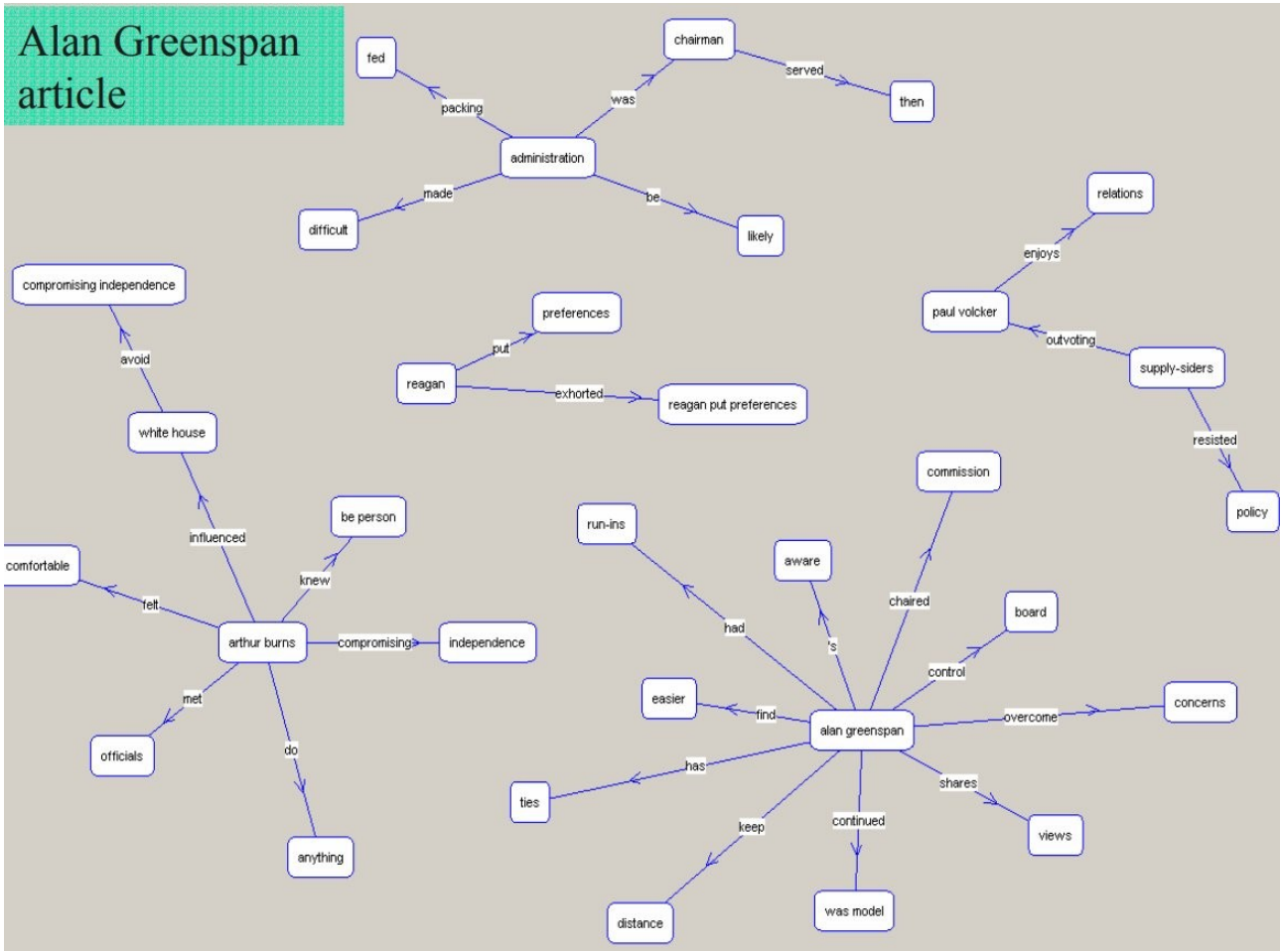
Document Level Processing (1)

- **Summarization**
  - **Knowledge rich**: performing semantic analysis, representing the meaning and generating the text satisfying length restriction
  - **Selection based**: determining most important parts



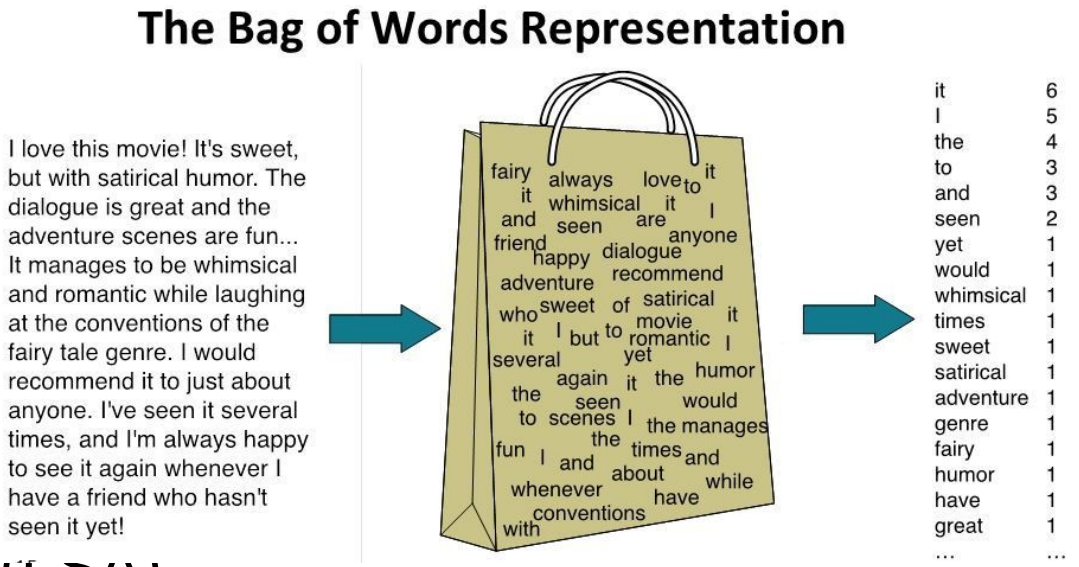
Document Level Processing (2)

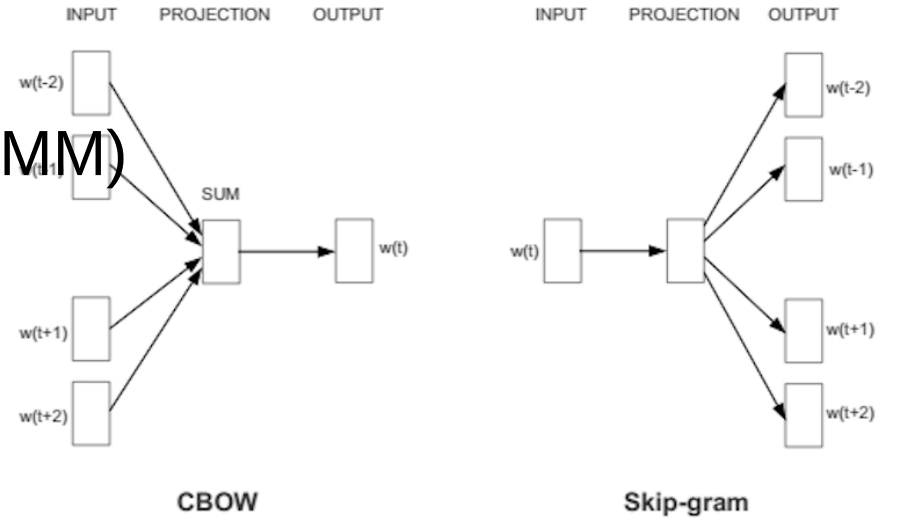
- **Visualization**
  - can’t count on statistical properties (especially for short documents)
  - Use syntactical and logical structure



Document-Collection Level Processing (3)

- **Representation**
  - Bag of words
  - Word weighting
    - Tf-idf $tfidf(w) = tf \cdot \log(\frac{N}{df(w)})$
    - Glove
    - Latent Semantic Analysis (LSA)
  - Statistical representation
    - Latent Dirichlet Analysis (LDA)
    - Dirichlet Multinomial Mixture (DMM)
    - Word-Topic Model (WTM)
  - Word vectors
    - word2vec



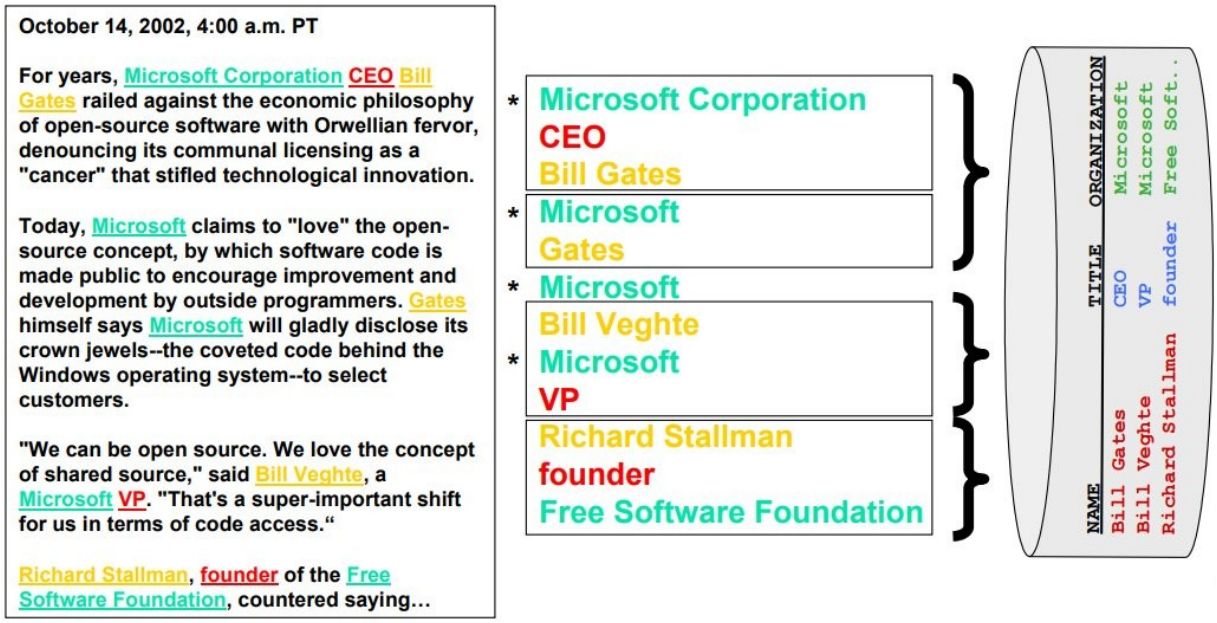


Document-Collection Level Processing (4)

- **Classification**
  - Supervised learning of document labels / topics
  - General classifiers of document vectors
  - RNN/LSTM classification of documents based on their text sequences
  - Statistical classification (LDA, WTM)
- **Clustering**
  - Unsupervised learning of document topics
  - General clustering of document vectors

Document-Collection Level Processing (5)

- **Visualization**
  - Cluster documents by topics and visualize clusters
  - Transform word vectors in 2D and visualize
  - Transform documents vectors in 2D and visualize
- **Information Extraction**
  - Named entity extraction
  - Classification of entities
  - Association extraction
  - Knowledge database creation



Create ontology

Spider

Filter by relevance

IE

Segment
Classify
Associate
Cluster

Load DB

Database

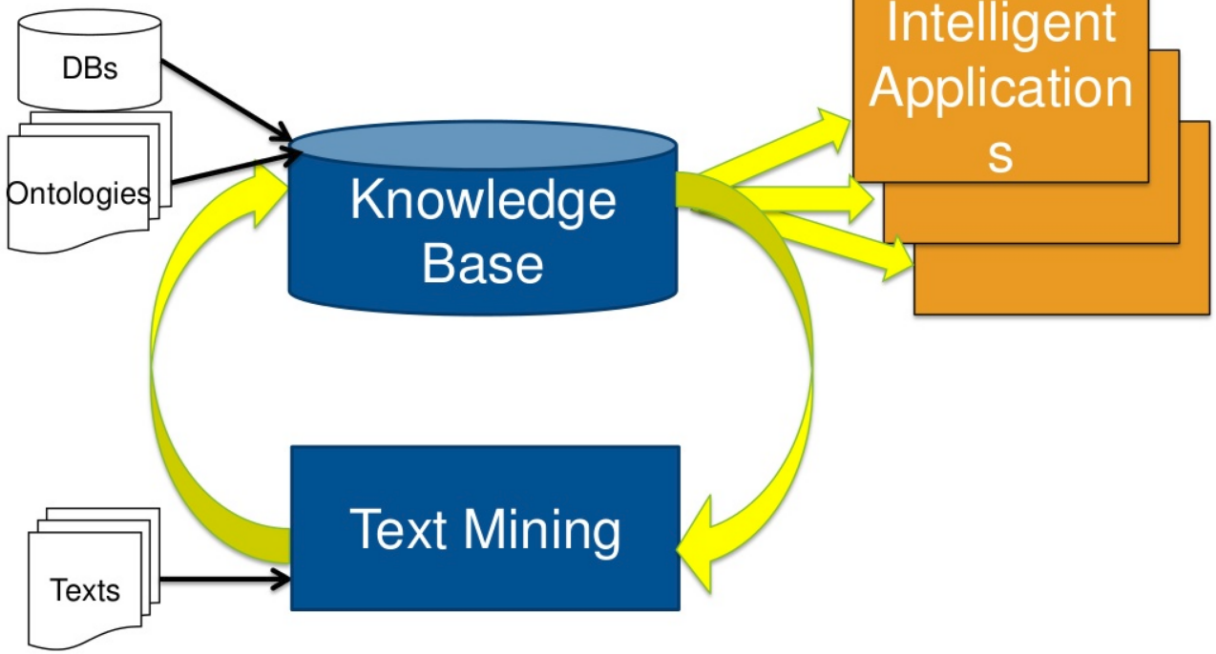
Document collection

Train extraction models

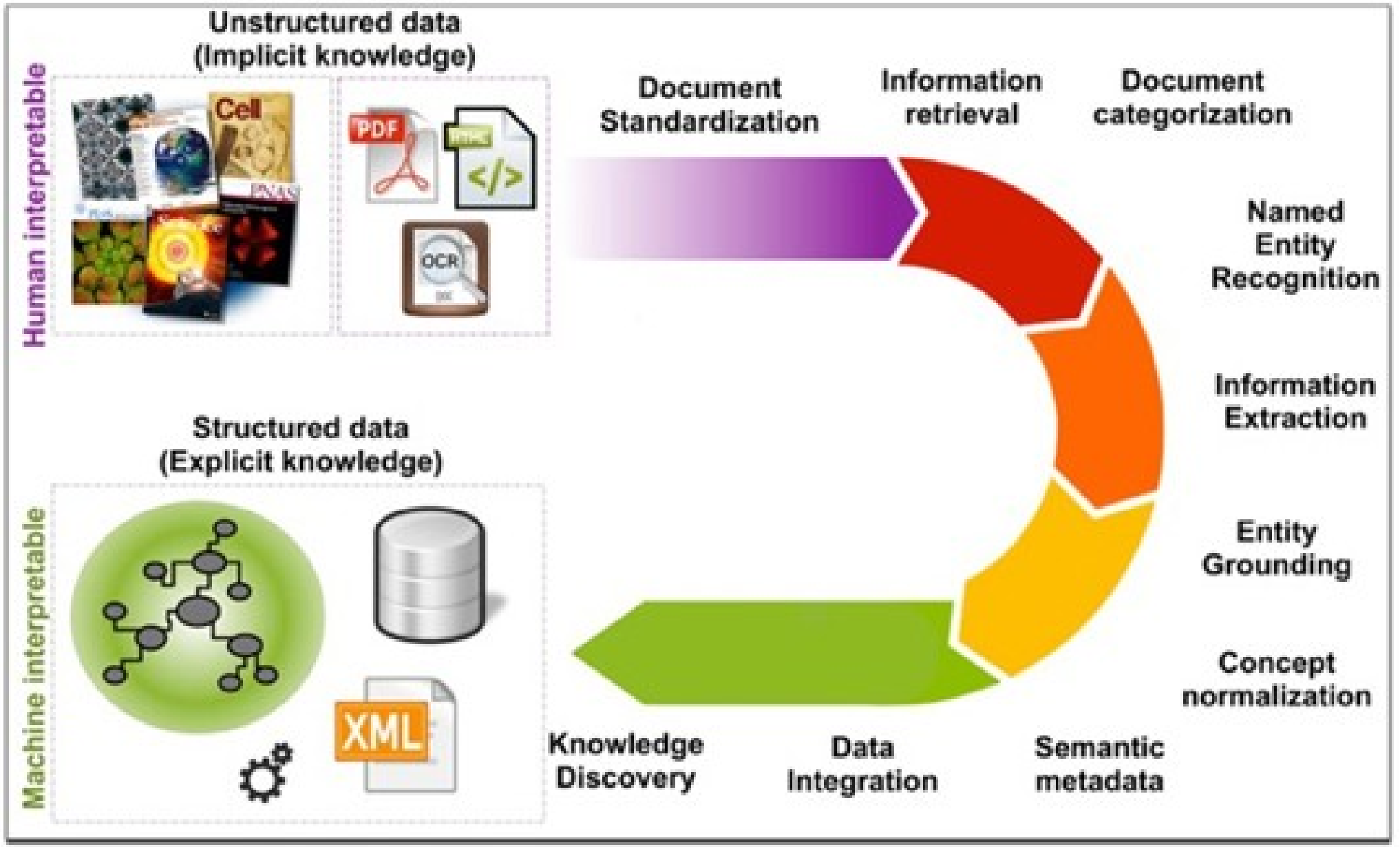
Query, Search

Label training data

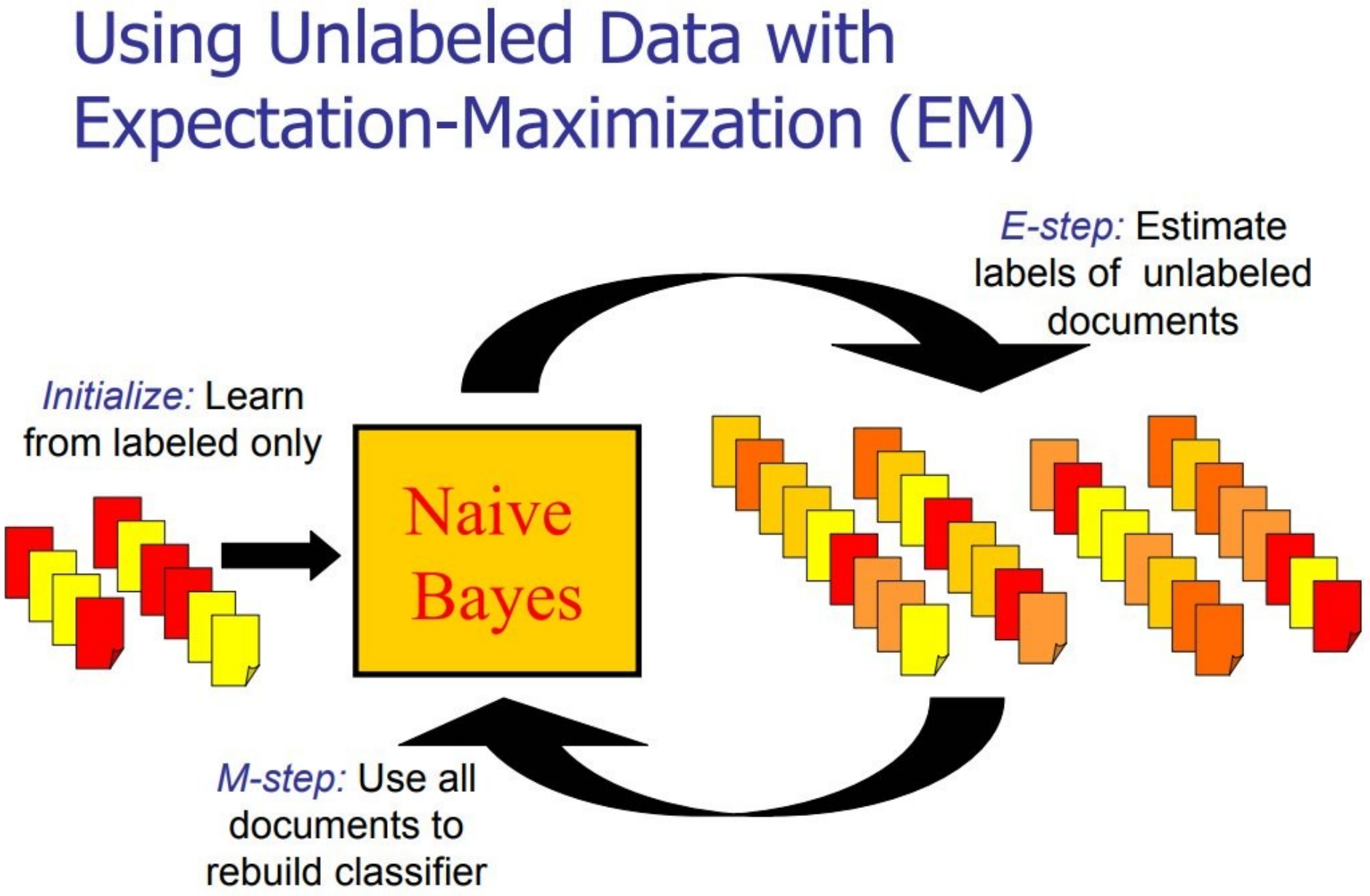
Data mine



Example of knowledge extraction



Linked-Document-Collection Level (1)

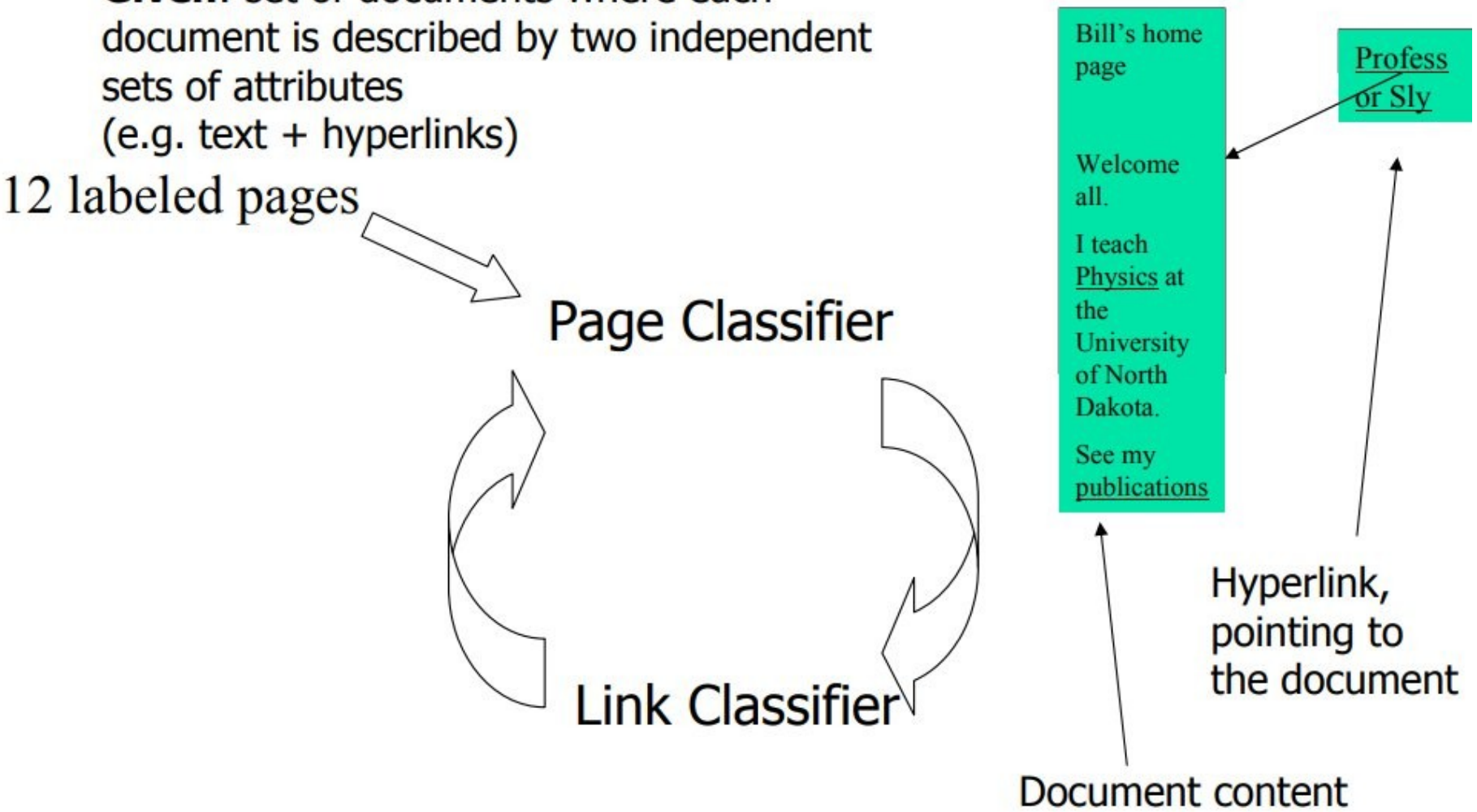


Linked-Document-Collection Level (2)

Bootstrap Learning to Classify Web Pages (co-training)

Given: set of documents where each document is described by two independent sets of attributes
(e.g. text + hyperlinks)

12 labeled pages



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Homework

Document 1: Norway is building a city that is totally powered by renewable energy.
Document 2: Three countries will power two-thirds of global renewable energy growth.
Document 3: New York will invest $1.5 billion in renewable energy projects.

Task:
- Change all text to lower-case, remove punctuation, remove stop-words and do stemming
- Tokenize and create tf-idf for given three documents
- Calculate cosine similarity between each two documents based on tf-idf
- Does the sentences have more similar meaning in your opinion than the score says?

Example:
- **Document**: These two countries are the reason because of which the EU is hitting its ambitious renewable energy targets.
- **Lower case**: these two countries are the reason because of which the eu is hitting its ambitious renewable energy targets
- **Remove stop-words**: two countries are reason eu is hitting its ambitious renewable energy targets
- **After stemming**: two country be reason eu be hit its ambitious renewable energy target
- **After tokenization and tf**: two (1), country (1), be (2), reason (1), hit (1), its (1), ambitious (1), renewable energy (1) target (1)
- **Further details**: https://janav.wordpress.com/2013/10/27/tf-idf-and-cosine-similarity/