Welcome To

Information Retrieval & Text Mining

Introduction

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MS Data Science: Structure

Semester 1

- Tools and Techniques for Data Science
- Statistical and Mathematical Methods for Data Science
- Information Retrieval and Text Mining

Semester 2

- Deep Learning
- Machine Learning
- Big Data Analytics
- Research Methods

Semester 3

- Elective 1
- Thesis 1

Semester 4

- Elective 2
- Thesis 2

Google Classroom code

oe0jour

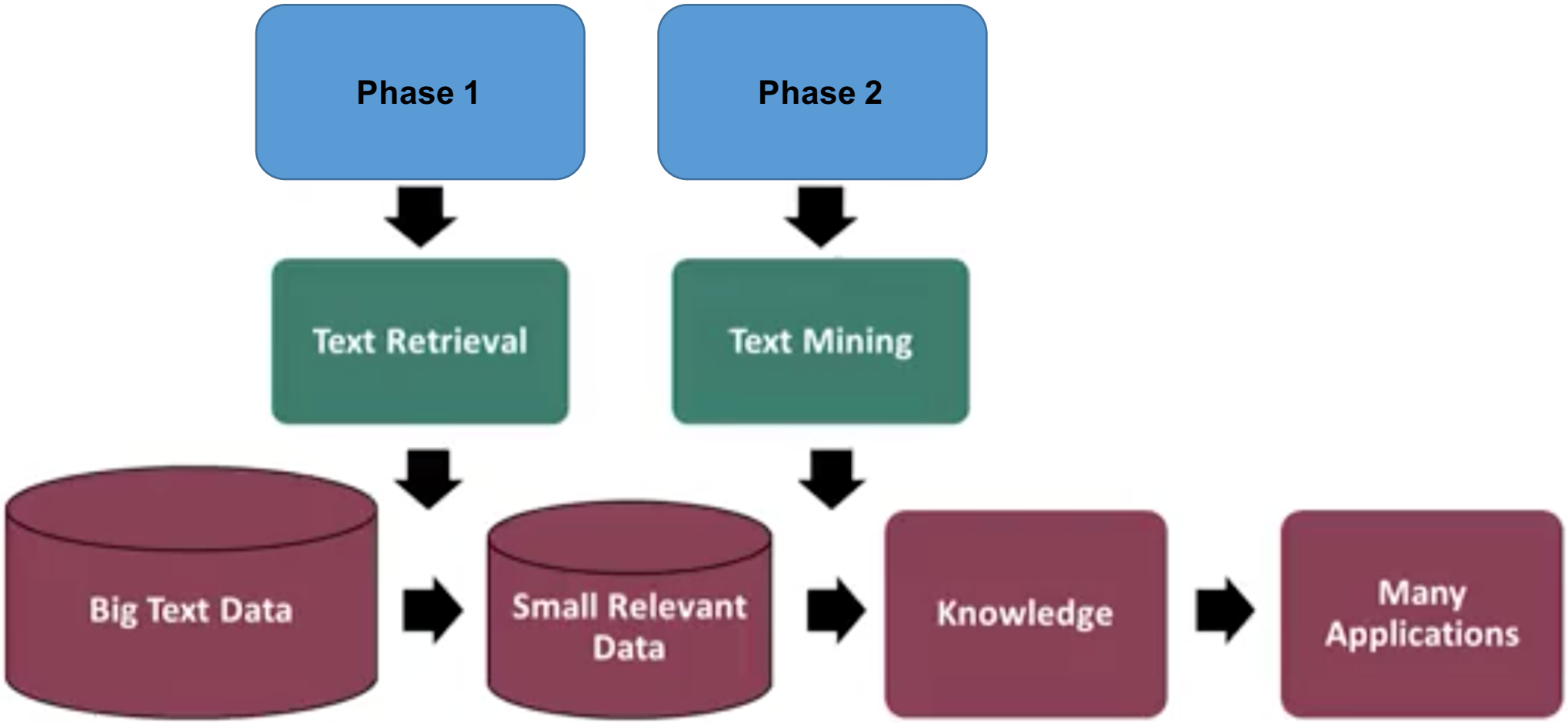
Motivation: Harnessing Big Data Text Data

- **Text data is produced by humans**
  - Contains people's opinions
  - Encodes human knowledge
  - Offers opportunities for discovering knowledge
- **Text is consumed by humans**
  - Need intelligent tools
  - Humans play an essential role in mining
- **What types of data we produce? Take a moment!**

Examples of Text Information System Applications

- **Search**
  - Google, Bing, Search Box on Lap top
- **Filtering/Recommendation**
  - News filters, Spam filters, Movie or Book Recommendations
- **Categorization**
  - Automatic Sorting of Emails, Product reviews, News Categories
- **Mining/Extraction**
  - Customer Complain Messages, Product Reviews, Systems to Read Literature
- **Many others**

Main Techniques for Harnessing Big Data: Text Retrieval + Text Mining



Course Objectives

- **Detailed** concepts and practical techniques in text retrieval
  - How search engines work
  - How to implement a search engine
  - How to evaluate a search engine
  - How to improve and optimize a search engine
  - How to build a recommender system
- **Hands-on experience** on
  - Creating a text collection for evaluating search engines
  - Experimenting with search engine algorithms
  - A term paper project (in group)

Prerequisites and Format

- **Prerequisites:**
  - Basic concepts of computer science (e.g. data structures)
  - Comfortable with programming, particularly with C++
  - (Optional) Knowledge of Python
- **Format**:
  - Lecture + quizzes + term paper project + mid term + final exam

Main Book

Text Data Management and Analysis: *A Practical Introduction to Information Retrieval and Text Mining*

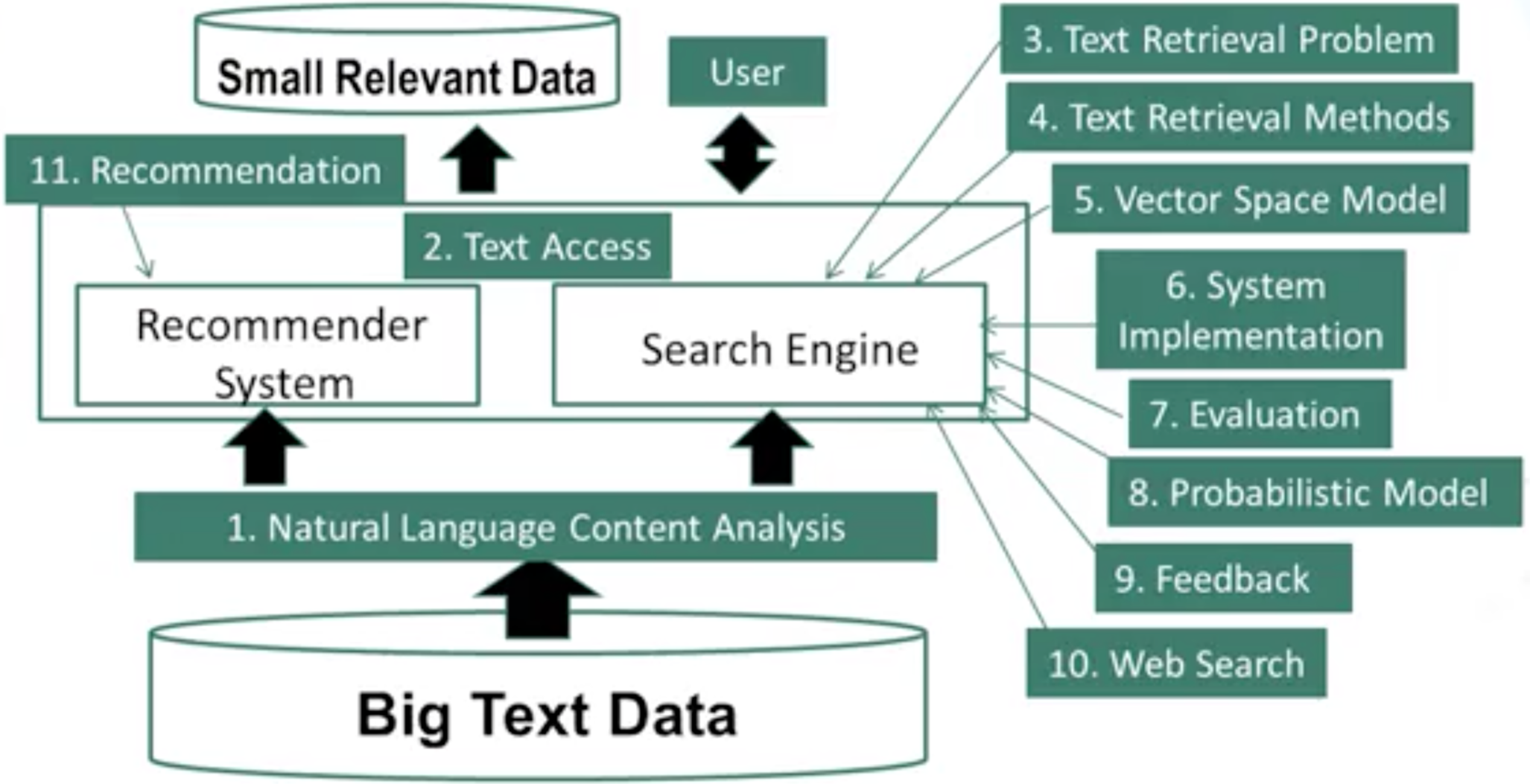
By: ChengXiang Zhai, Sean Massung

ISBN: 9781970001167 | PDF ISBN: 9781970001174

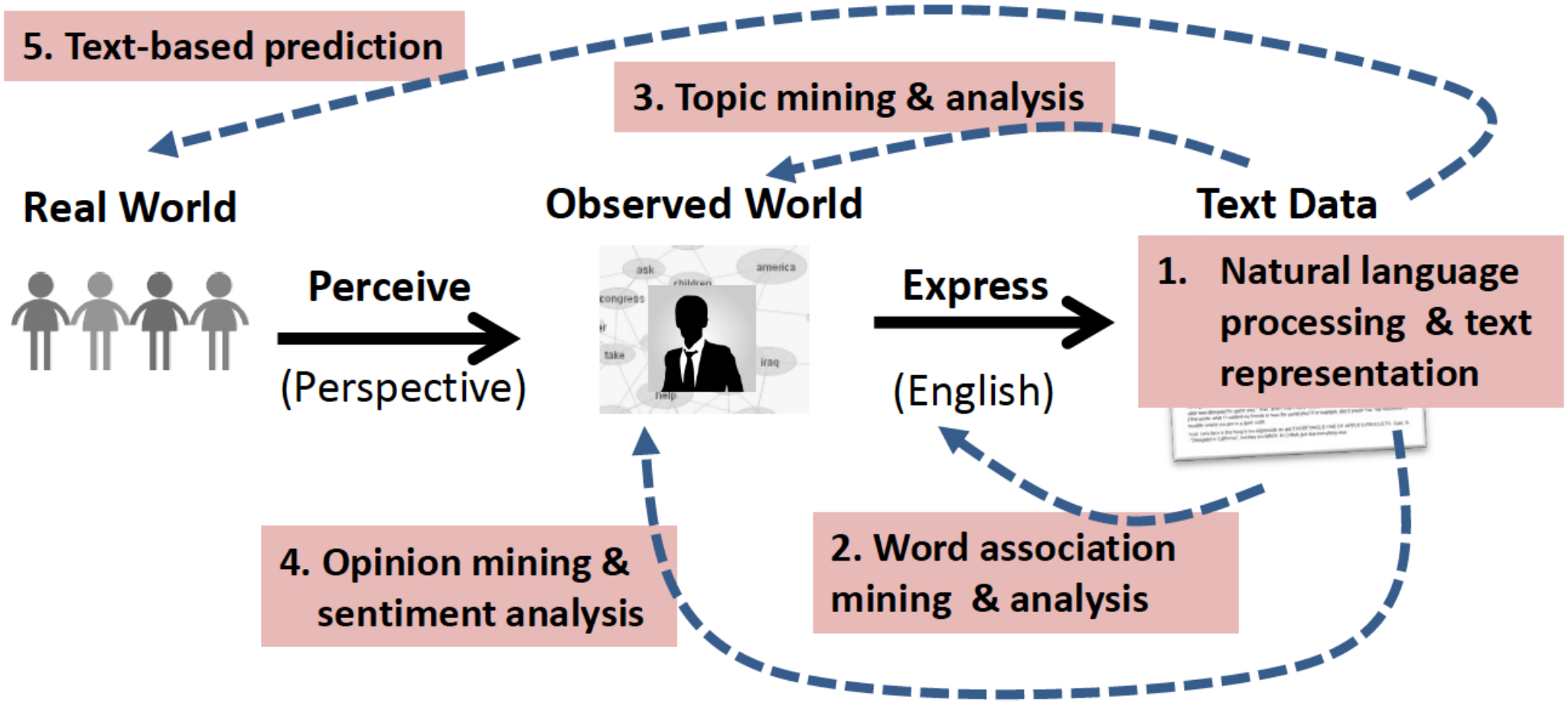
Hardcover ISBN:9781970001198

 | 471 Pages | Publication Date: July, 2016

Information Retrieval



Text Mining


5. Text-based prediction
3. Topic mining & analysis
Real World
Observed World
Text Data
Perceive
(Perspective)
Express
(English)
1. Natural language processing & text representation
4. Opinion mining & sentiment analysis
2. Word association mining & analysis

Information Retrieval & Text Mining

Natural Language Content Analysis

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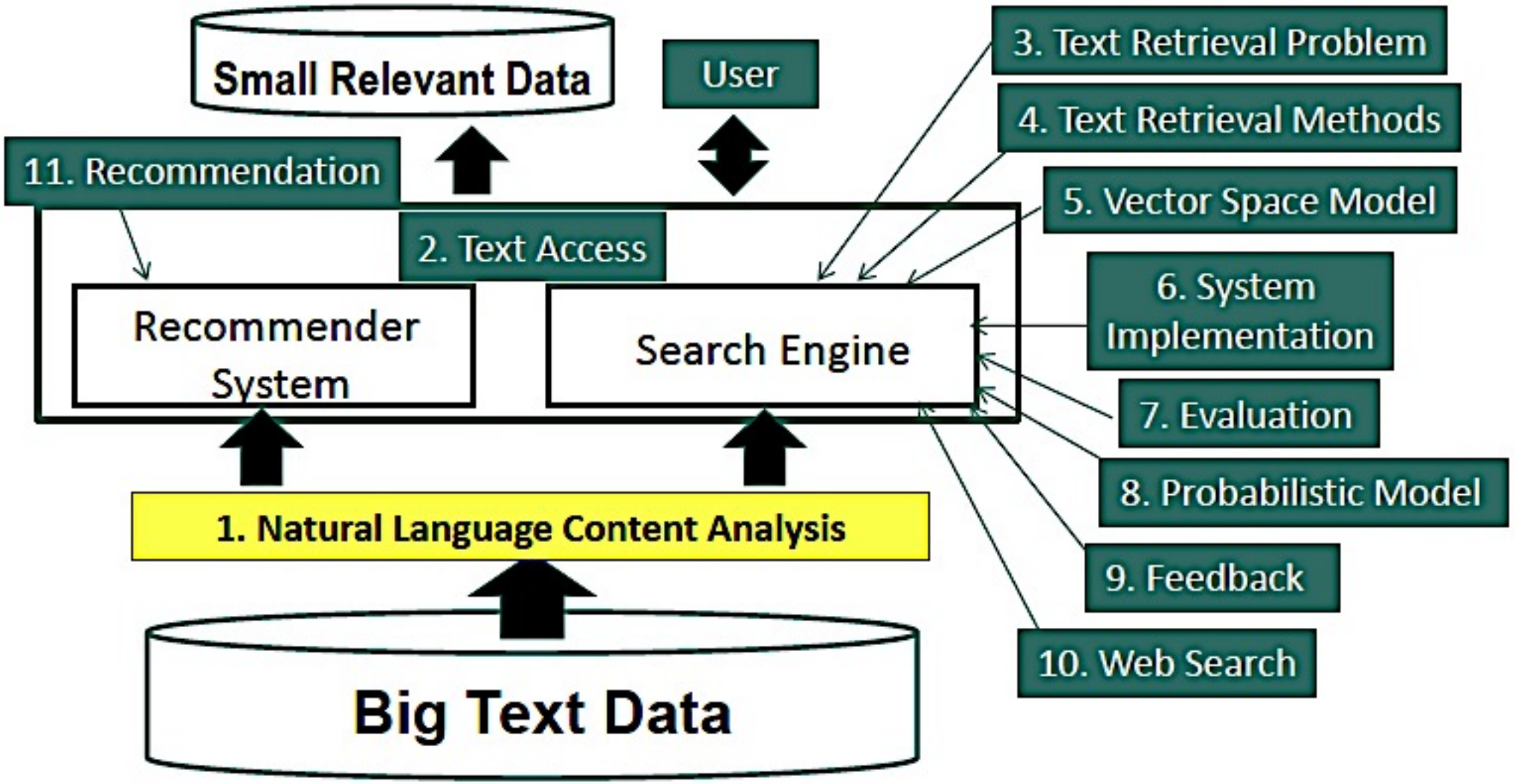
Course Schedule

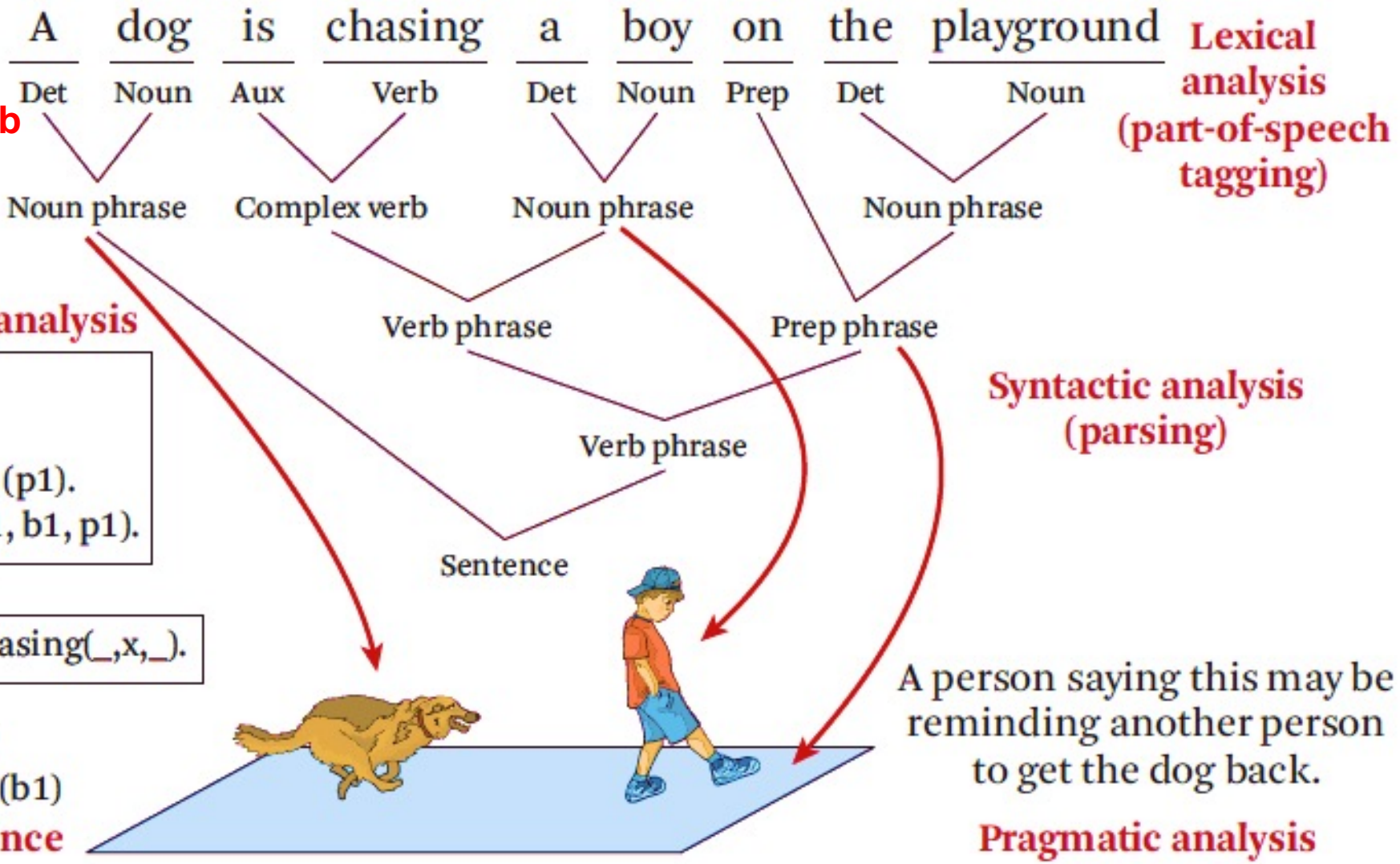


Overview

- What is Natural Language Processing (NLP)?
- State of the Art in NLP
- NLP for Text Retrieval

An Example of NLP

Det: determiner
Aux: auxiliary verb



NLP Is Difficult!

- Natural language is designed to make human communication efficient. As a result,
  - we omit a lot of "common sense" knowledge, which we assume the hearer/reader possesses
  - we keep a lot of ambiguities, which we assume the hearer/reader knows how to resolve
- This makes EVERY step in NLP hard
  - Ambiguity is a "killer"!
  - Common sense reasoning is pre-required

Examples of Challenges

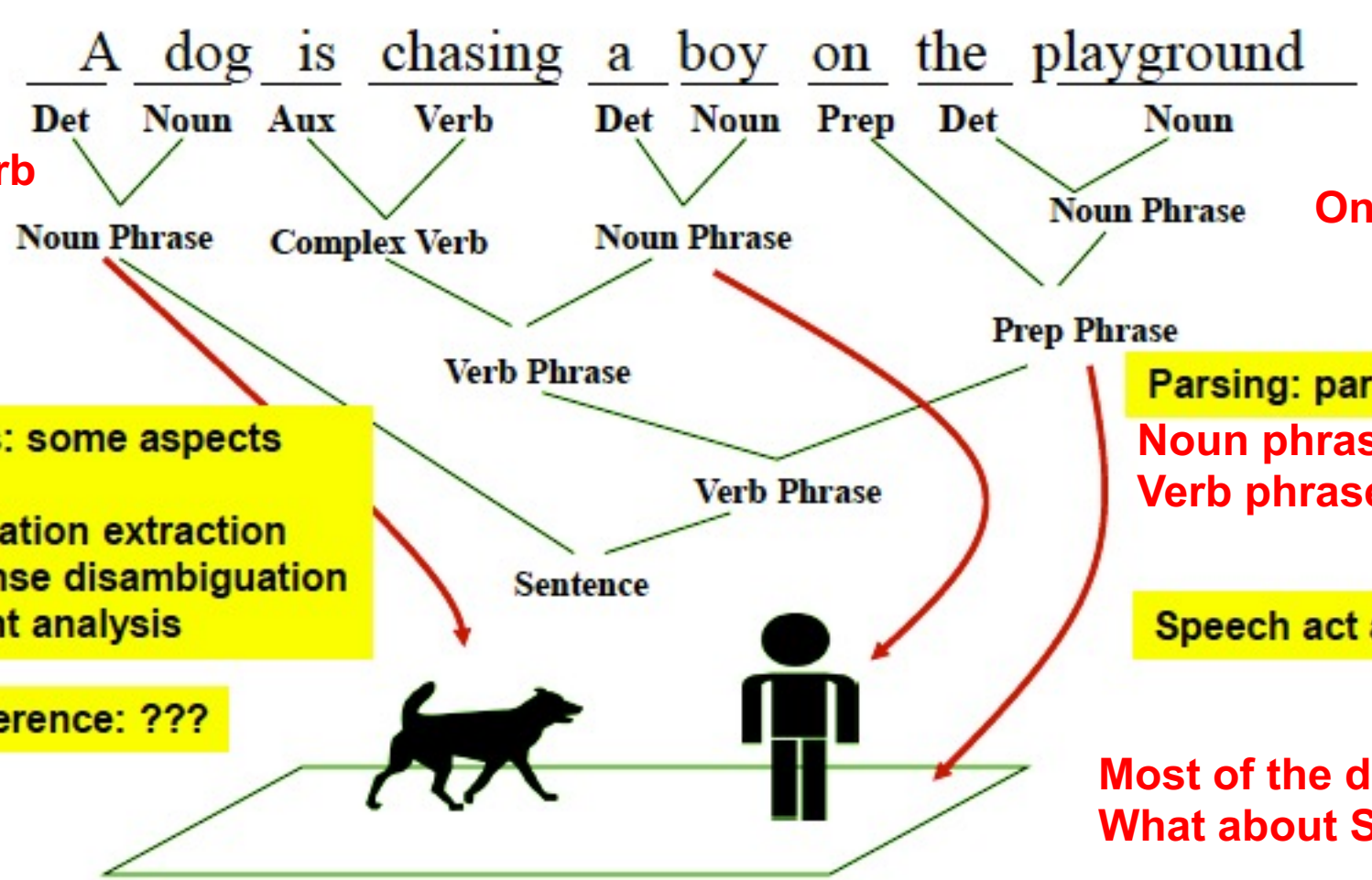
- Word-level ambiguity: E.g.,
  - "design" can be a noun or a verb (Ambiguous POS)
  - "root" has multiple meanings (Ambiguous sense)
- Syntactic ambiguity: E.g.,
  - "natural language processing" (Modification)
  - "A man saw a boy *with a telescope*." (PP Attachment)
- Anaphora resolution: "John persuaded Bill to buy a TV for *himself*." (himself = John or Bill?)
- Presupposition: "He has quit smoking." implies that he smoked before.

Language Processing is Natural?

Who had the telescope?

Prepositional Phrase

The State of the Art



Det: determiner
Aux: auxiliary verb

POS Tagging: 97%

On a given dataset

Semantics: some aspects

- Entity/relation extraction
- Word sense disambiguation
- Sentiment analysis

Parsing: partial >90%(?)

Noun phrase structures
Verb phrase structures

Speech act analysis: ???

Inference: ???

We don't have complete understanding of NLP, in general.

Most of the datasets are News
What about Social Media Data?

What We Can't Do

- 100% POS tagging
  - "He turned off the highway." vs "He turned off the fan."
- General complete parsing
  - "A man saw a boy with a telescope."
- Precise deep semantic analysis
  - Will we ever be able to precisely define the meaning of "own" in "John owns a restaurant."?

Robust & general NLP tends to be "shallow" while "deep" understanding doesn't scale up

NLP for Text Retrieval

- Must be general robust & efficient ➔ Shallow NLP
- **"Bag of words" representation tends to be sufficient** for most search tasks (but not all!)
- Some text retrieval techniques can naturally address NLP problems

Q = java
Q = java applet

- However, deeper NLP is needed for complex search tasks
- **Google Knowledge Graph: Entities and their relations, which goes beyond BOW**

Summary

- What is Natural Language Processing (NLP)?
- State of the Art in NLP
- NLP for Text Retrieval

Additional Reading

Chris Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press. Cambridge, MA: May 1999.