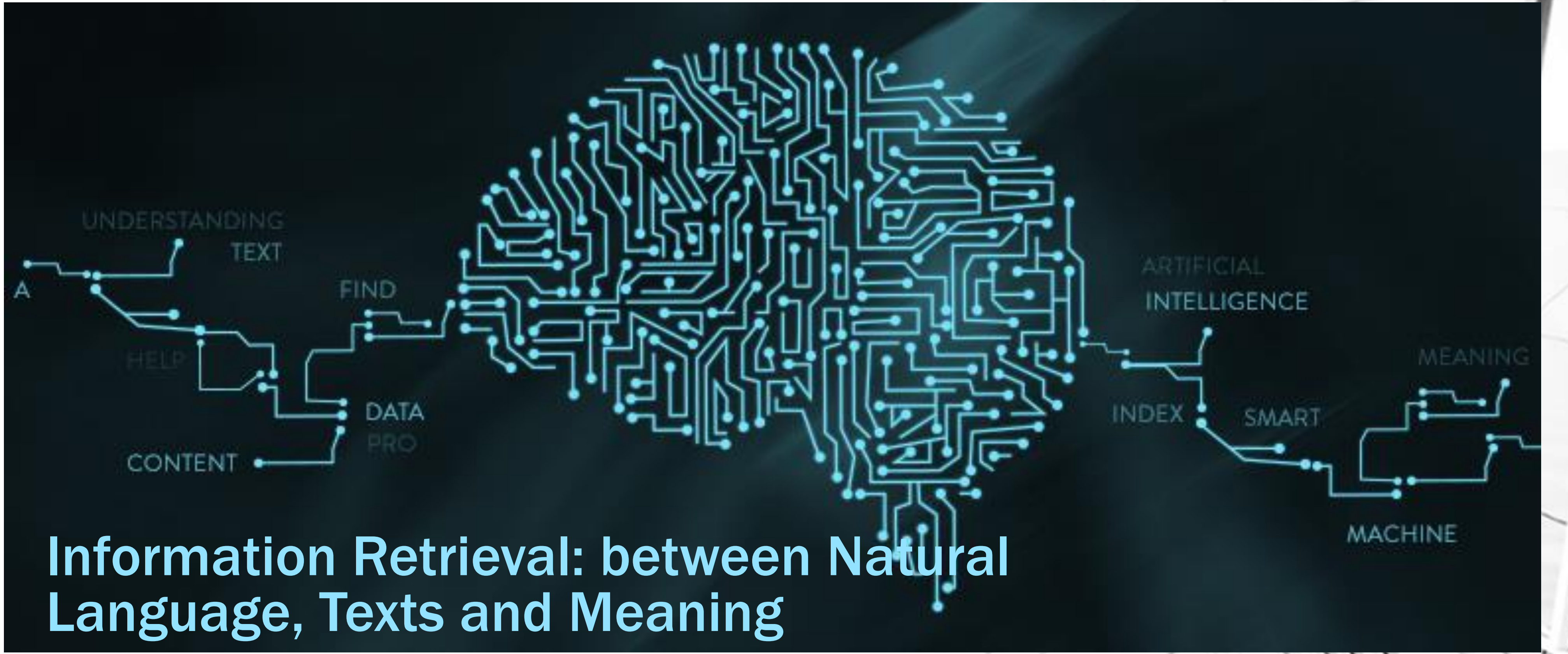

Information Retrieval: between Natural Language, Texts and Meaning

Roberto Basili

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Some slider borrowed from the tutorial «Natural Language Understanding: Foundations and State-of-the-Art", by Percy Liang (Stanford University).

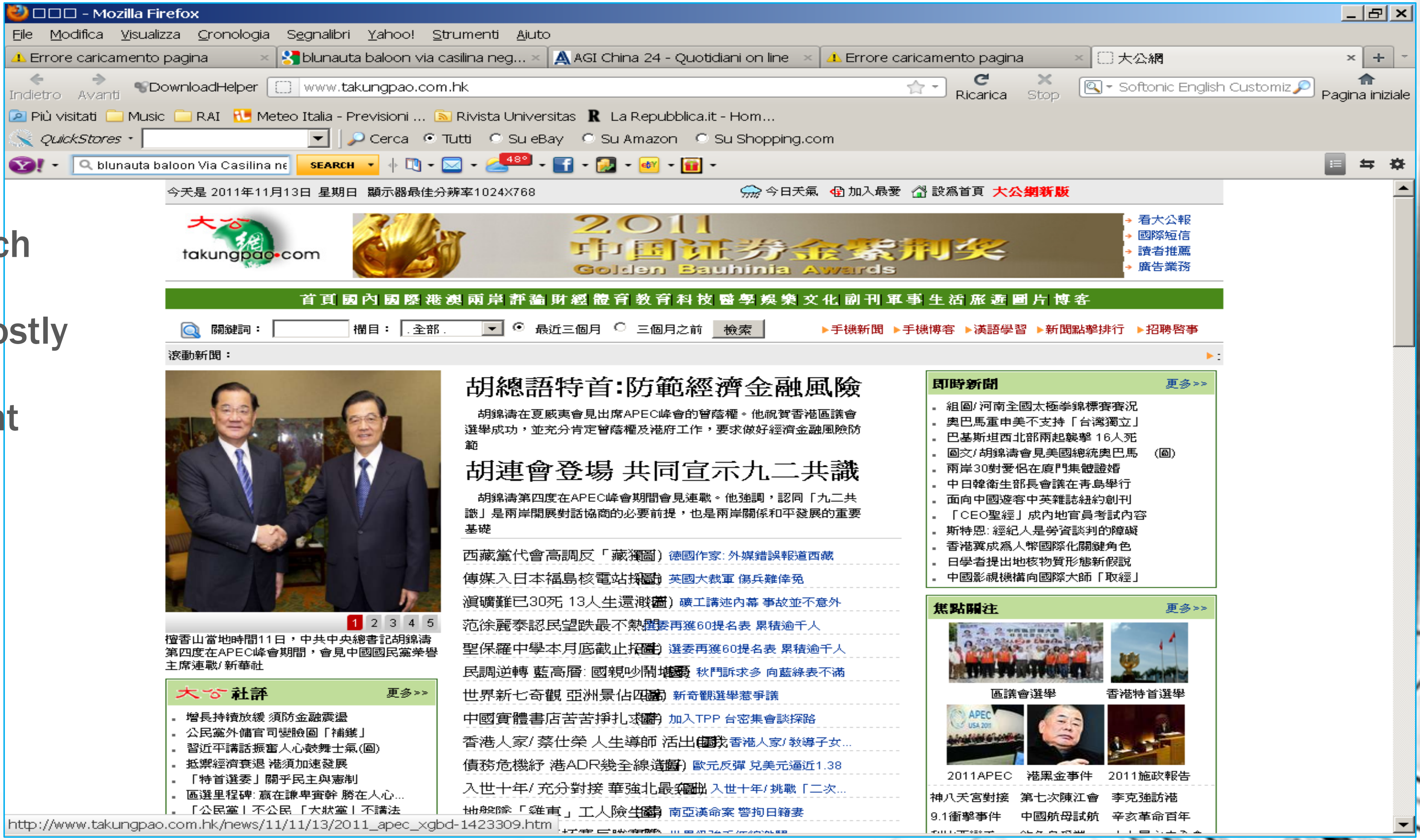
Web Mining & Retrieval, a.a. 2020-21

Overview

- Documents in Information Retrieval
  - Information, Representation, (re)current challenges, success(and unsuccess)ful stories
- Information and Content
  - Natural Language Processing: introduction to the linguistic background
    - Natural Language and Content
    - NL Syntax
    - NL Semantics
  - Document Representation and IR models
- Summary

Semantics, Open Data and Natural Language

- Web contents, characterized by rich multimedia information, are mostly opaque from a semantic standpoint



今天是 2011年11月13日 星期日 顯示器最佳分辨率1024X768

胡總語特首:防範經濟金融風險

胡錦濤在夏威夷會見出席APEC峰會的曾蔭權。他祝賀香港區議會選舉成功，並充分肯定曾蔭權及港府工作，要求做好經濟金融風險防範

胡連會登場 共同宣示九二共識

胡錦濤第四度在APEC峰會期間會見連戰。他強調，認同「九二共識」是兩岸開展對話協商的必要前提，也是兩岸關係和平發展的重要基礎

西藏黨代會高調反「藏獨(圖) 德國作家: 外媒錯誤報道西藏

傳媒入日本福島核電站採(圖) 英國大裁軍 傷兵難倖免

滇礦難已30死 13人生還(圖) 礦工講述內幕 事故並不意外

范徐麗泰認民望跌最不熱(圖) 選委再獲60提名表 累積逾千人

聖保羅中學本月底截止招(圖) 選委再獲60提名表 累積逾千人

民調逆轉 藍高層: 國親吵鬧(圖) 秋鬥訴求多 向藍綠表不滿

世界新七奇觀 亞洲景佔四(圖) 新奇觀選舉惹爭議

中國實體書店苦苦掙扎求(圖) 加入TPP 台密集會談探路

香港人家/ 蔡仕榮 人生導師 活出(圖)我 香港人家/ 教導子女...

債務危機紓 港ADR幾全線(圖) 歐元反彈 兌美元逼近1.38

入世十年/ 充分對接 華強北最(圖) 入世十年/ 挑戰「二次...

地盤陰「雜東」工人險生(圖) 南亞滅命案 警拘日籍妻

檀香山當地時間11日，中共中央總書記胡錦濤第四度在APEC峰會期間，會見中國國民黨榮譽主席連戰/ 新華社

大公社評

- 增長持續放緩 須防金融震盪
- 公民黨外傭官司變臉圖「補鑊」
- 習近平講話振奮人心鼓舞士氣(圖)
- 抵禦經濟衰退 港須加速發展
- 「特首選委」關乎民主與憲制
- 區選里程碑: 贏在謙卑實幹 勝在人心...
- 「公民黨」不公民 「大狀黨」不講法

即時新聞

- 組圖/ 河南全國太極拳錦標賽賽況
- 奧巴馬重申美不支持「台灣獨立」
- 巴基斯坦西北部兩起襲擊 16人死
- 圖文/ 胡錦濤會見美國總統奧巴馬 (圖)
- 兩岸30對愛侶在廈門集體證婚
- 中日韓衛生部長會議在青島舉行
- 面向中國遊客中英雜誌紐約創刊
- 「CEO聖經」成內地官員考試內容
- 斯特恩: 經紀人是勞資談判的障礙
- 香港冀成爲人幣國際化關鍵角色
- 日學者提出地核物質形態新假說
- 中國影視機構向國際大師「取經」

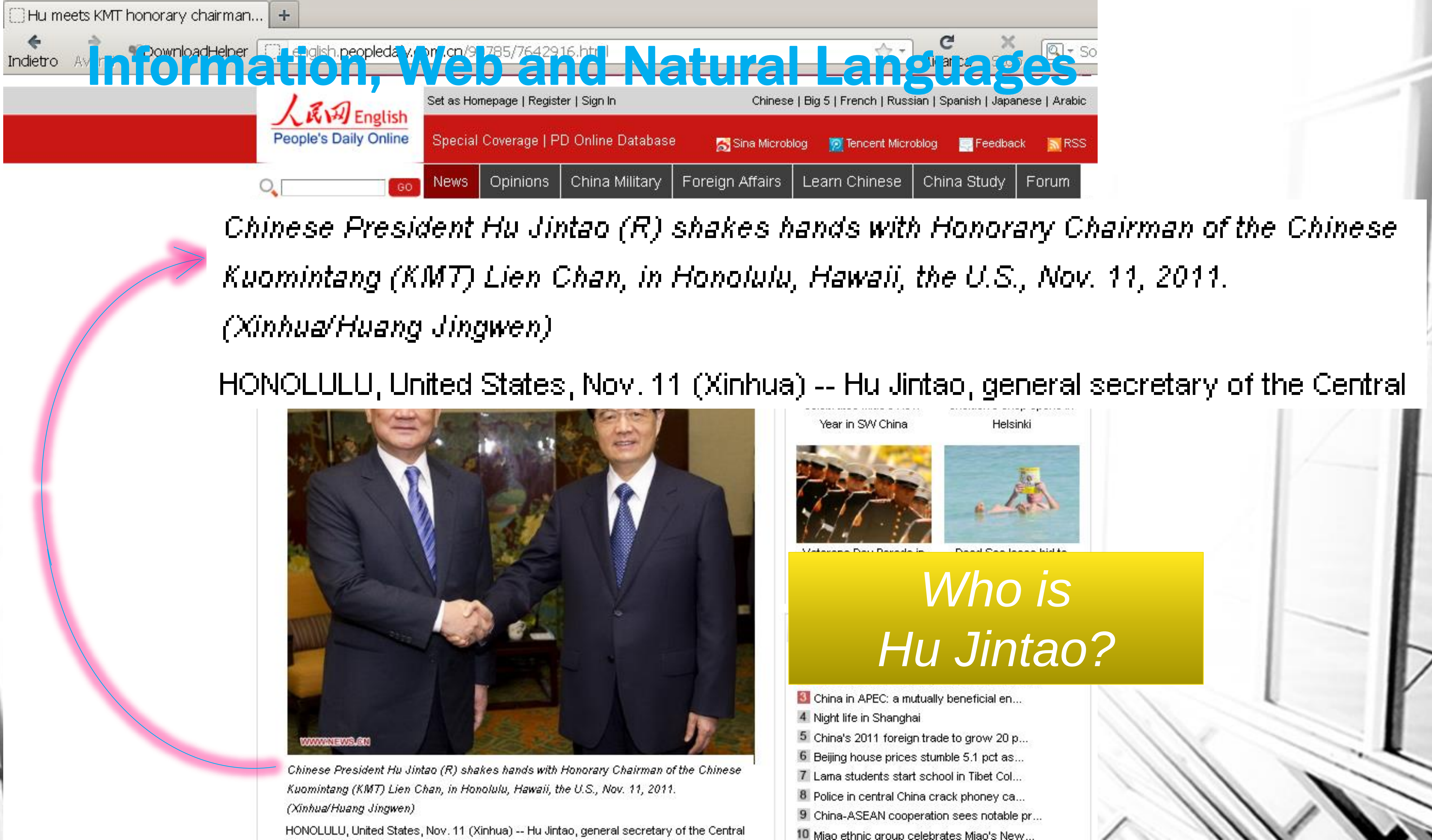
焦點關注

神八天宮對接 第七次陳江會 李克強訪港

9.1衝擊事件 中國航母試航 辛亥革命百年

http://www.takungpao.com.hk/news/11/11/13/2011_apec_xgbd-1423309.htm

Information, Web and Natural Languages


Hu meets KMT honorary chairman...
Indietro
DownloadHelper
english.peopledaily.com.cn/90785/7642916.html
Set as Homepage | Register | Sign In
Chinese | Big 5 | French | Russian | Spanish | Japanese | Arabic
人民网 English
People's Daily Online
Special Coverage | PD Online Database
Sina Microblog
Tencent Microblog
Feedback
RSS
GO
News
Opinions
China Military
Foreign Affairs
Learn Chinese
China Study
Forum
WWW.NEWS.CN

Chinese President Hu Jintao (R) shakes hands with Honorary Chairman of the Chinese Kuomintang (KMT) Lien Chan, in Honolulu, Hawaii, the U.S., Nov. 11, 2011. (Xinhua/Huang Jingwen)

HONOLULU, United States, Nov. 11 (Xinhua) -- Hu Jintao, general secretary of the Central

Chinese President Hu Jintao (R) shakes hands with Honorary Chairman of the Chinese Kuomintang (KMT) Lien Chan, in Honolulu, Hawaii, the U.S., Nov. 11, 2011. (Xinhua/Huang Jingwen)

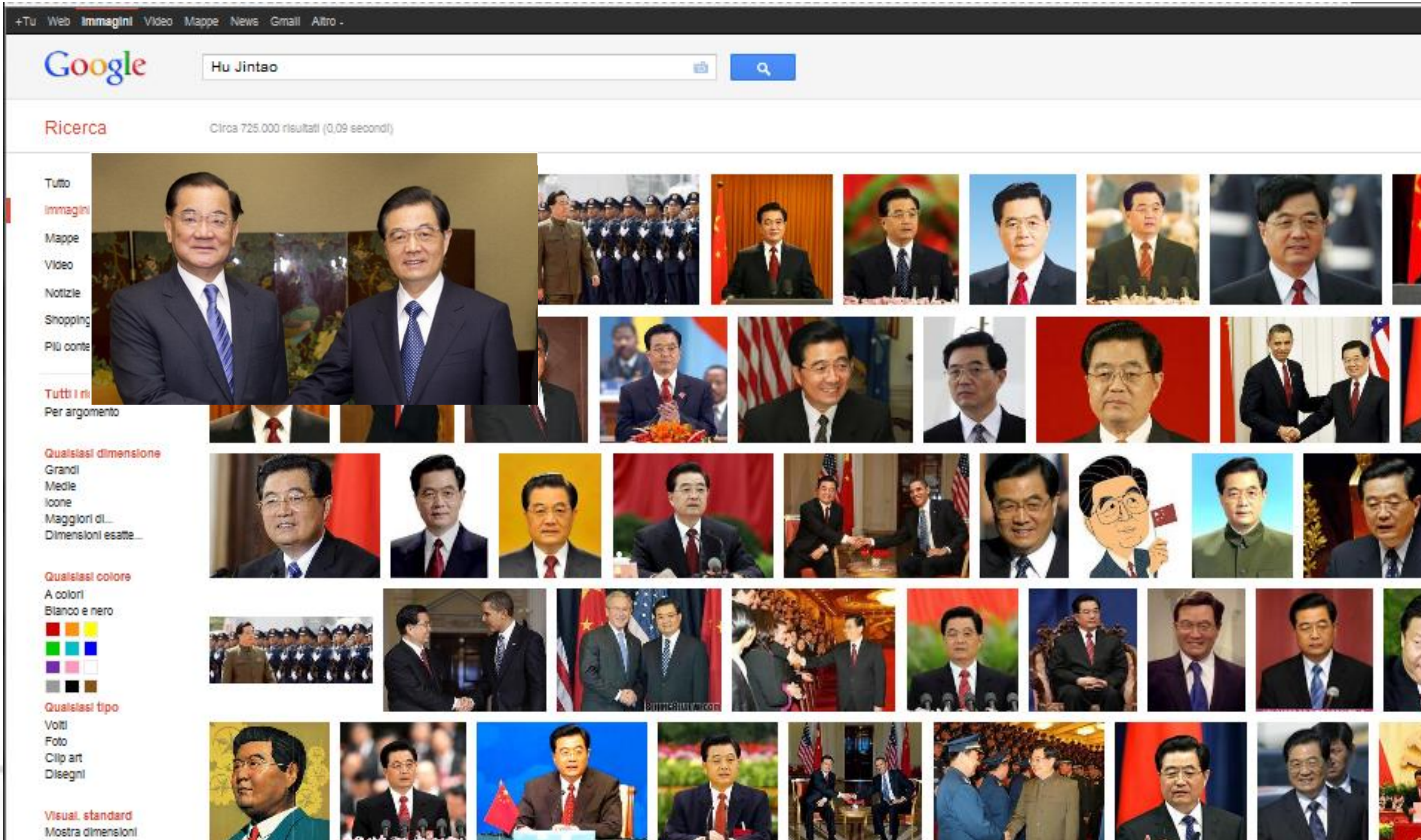
HONOLULU, United States, Nov. 11 (Xinhua) -- Hu Jintao, general secretary of the Central

Year in SW China

Helsinki

3 China in APEC: a mutually beneficial en...
4 Night life in Shanghai
5 China's 2011 foreign trade to grow 20 p...
6 Beijing house prices stumble 5.1 pct as...
7 Lama students start school in Tibet Col...
8 Police in central China crack phoney ca...
9 China-ASEAN cooperation sees notable pr...
10 Miao ethnic group celebrates Miao's New...

Who is Hu Jintao?



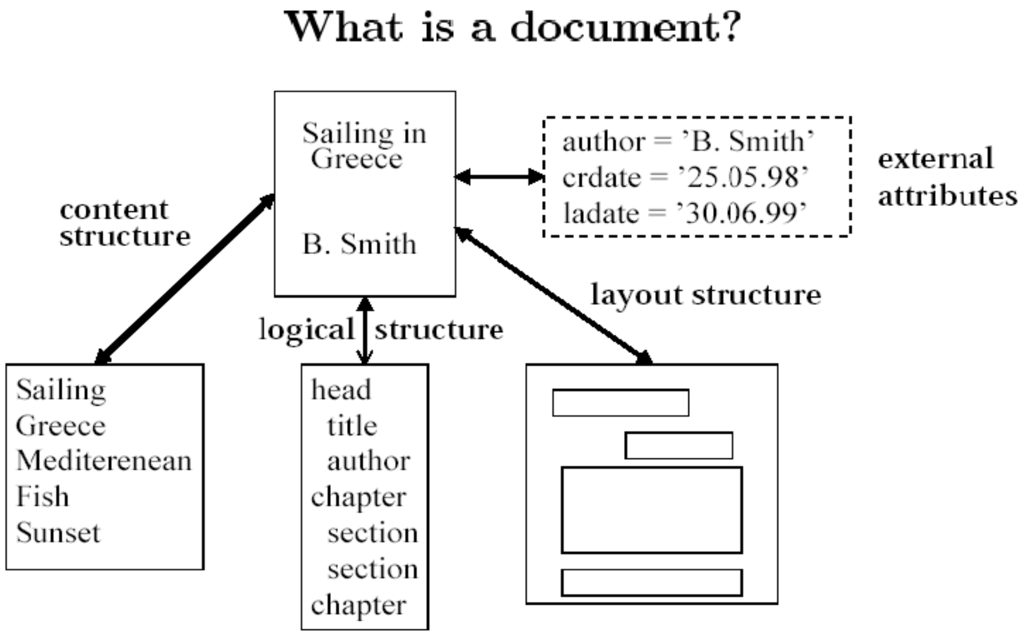
Hu Jintao

Circa 725.000 risultati (0,09 secondi)

Content Semantics and Natural Language

- Human languages are the main carrier of the information involved in processes such as retrieval, publication and exchange of knowledge as it is associated to the open Web contents
- Words and NL syntactic structures express concepts, activities, events, abstractions and conceptual relations we usually share through data
- “Language is parasitic to knowledge representation languages but the viceversa is not true” (Wilks, 2001)
- From Learning to Read to Knowledge Distillation as a(n integrated pool of) Semantic interpretation Task(s)

Texts, Information & Document Structures



What is a document?

Sailing in Greece

B. Smith

author = 'B. Smith'
crdate = '25.05.98'
ladate = '30.06.99'

external attributes

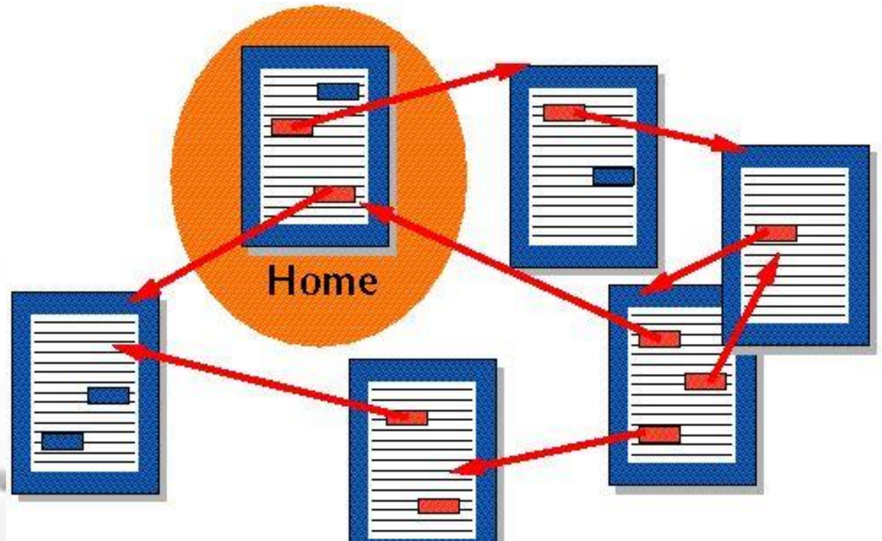
content structure

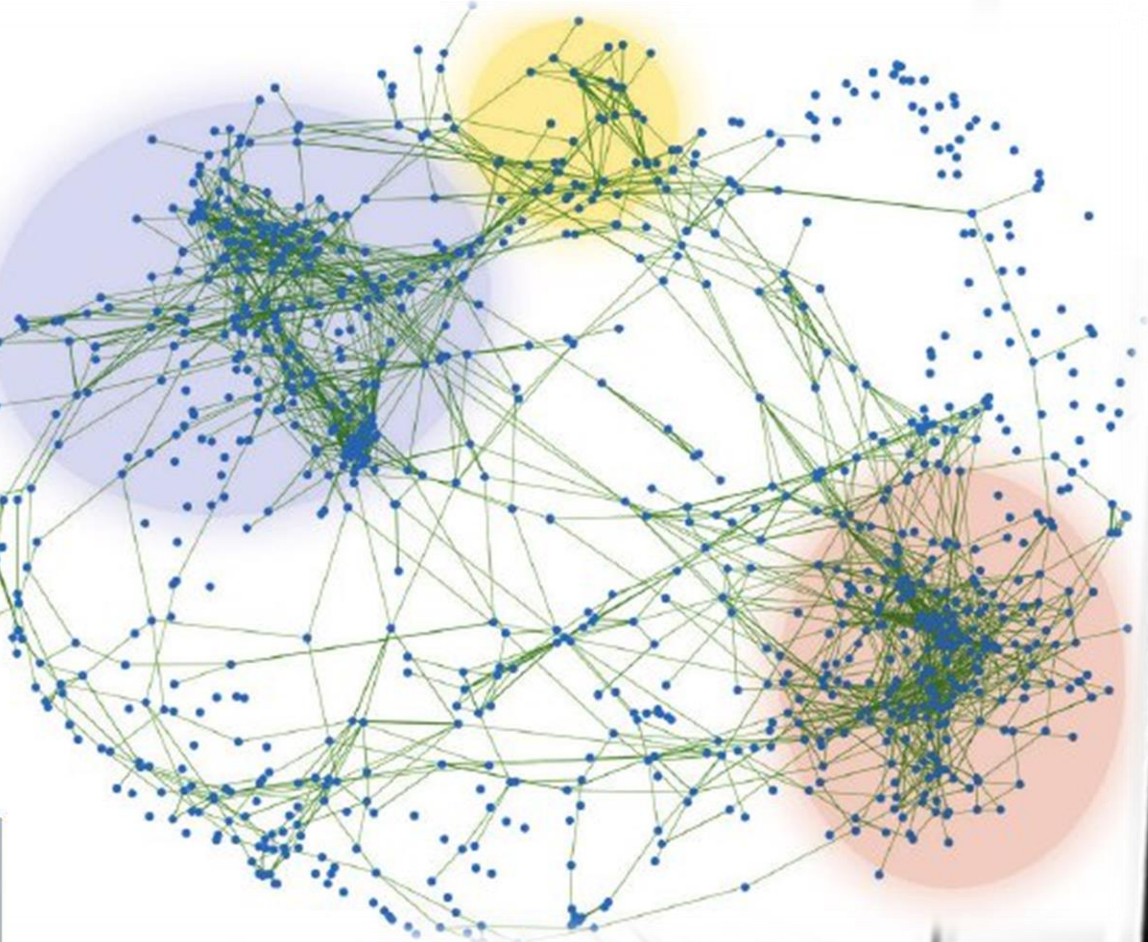
logical structure

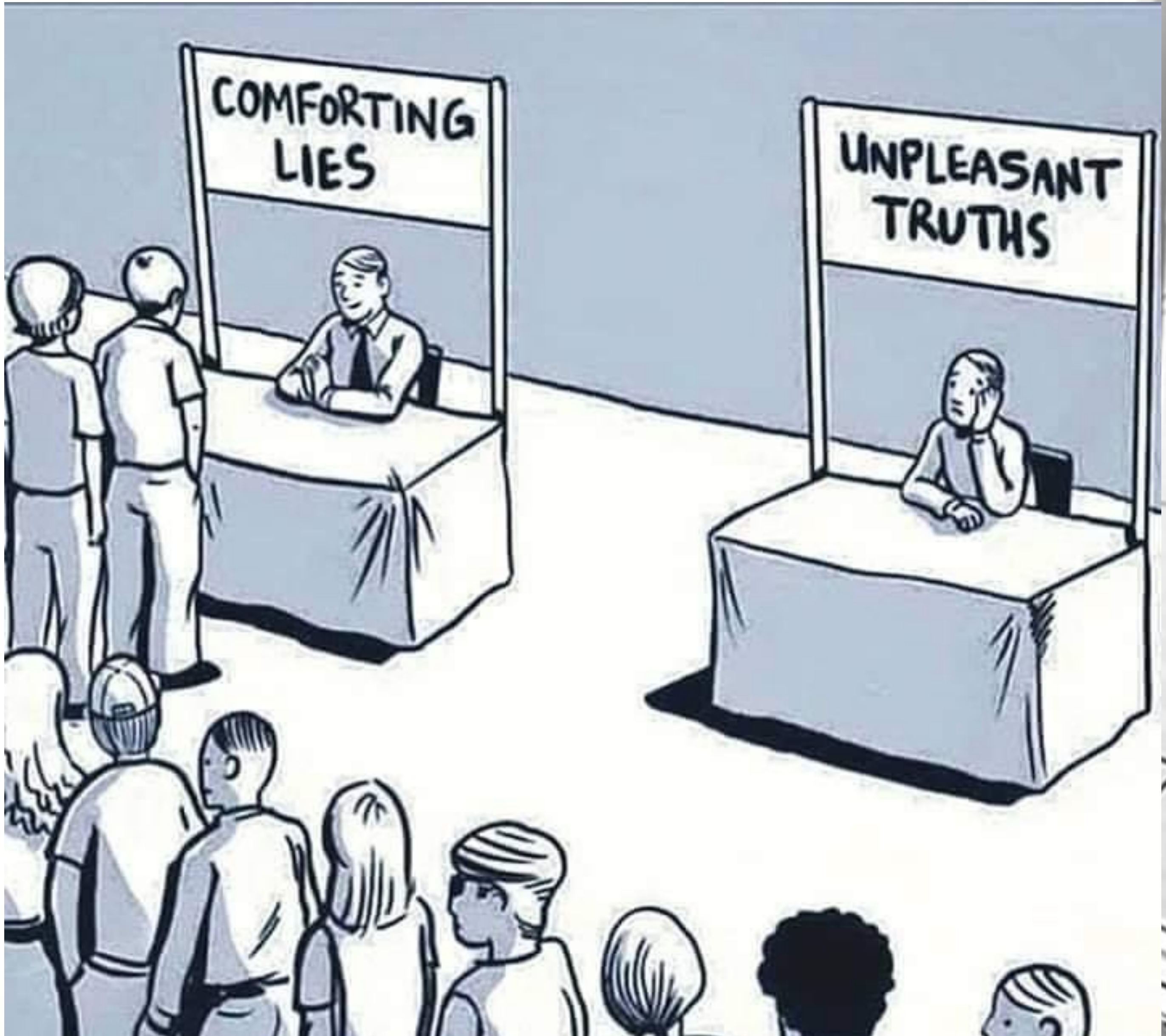
layout structure

Sailing
Greece
Mediterenean
Fish
Sunset

head
title
author
chapter
section
section
chapter





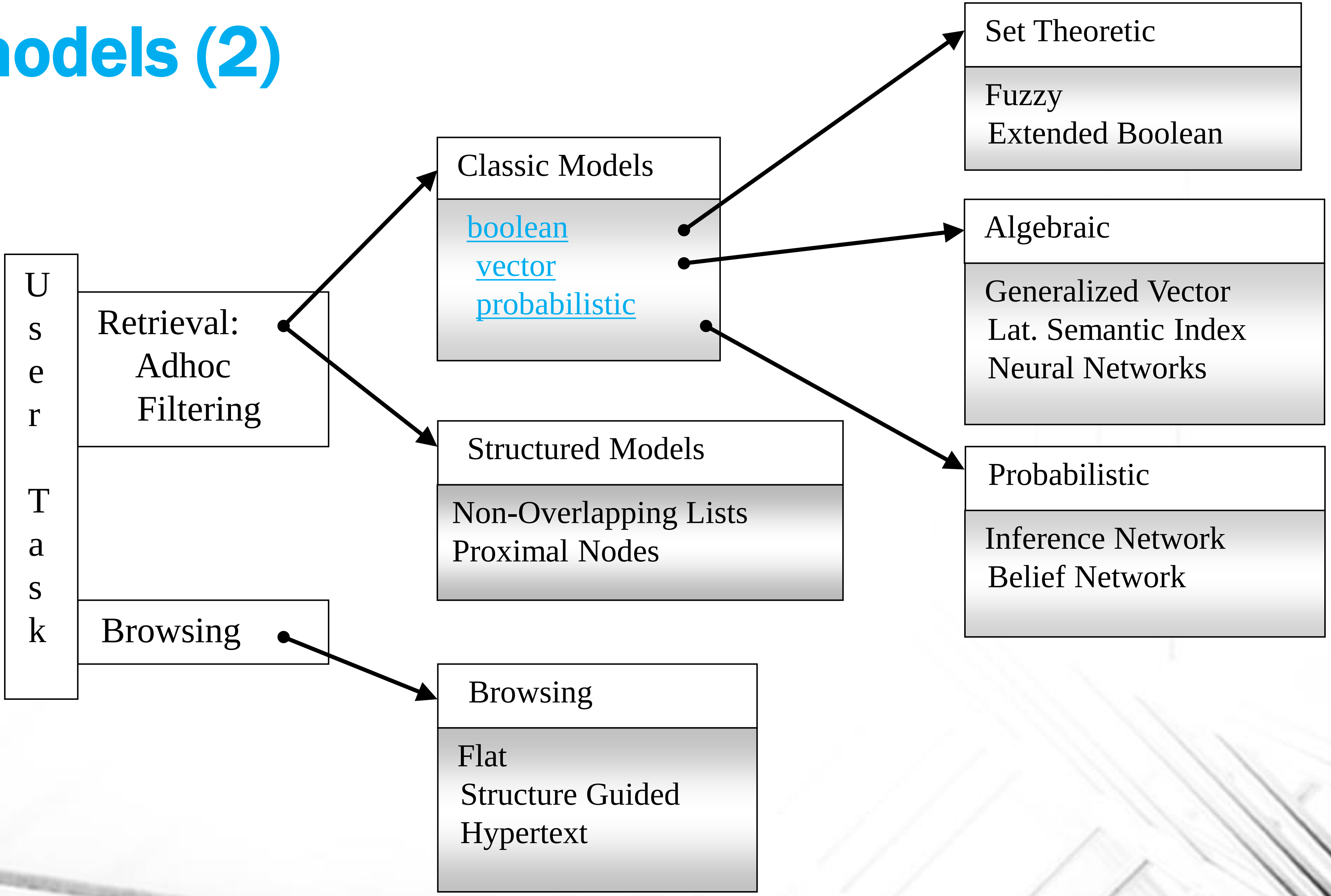


COMFORTING LIES
UNPLEASANT TRUTHS

Information Retrieval Models

- An IR model must specify (at least) :
  - A representation of the document
  - A rapresentation of individual queries
  - The retrieval function
- The model determines a specifici notion of relevance.
- Relevance can be discrete (e.g. binary) or continuous (i.e. rank or relevance order).
- It is a perfect example of learnable function through induction from examples (see Google)

IR models (2)



User Task
Retrieval: Adhoc Filtering
Browsing
Classic Models
boolean
vector
probabilistic
Structured Models
Non-Overlapping Lists
Proximal Nodes
Browsing
Flat
Structure Guided
Hypertext
Set Theoretic
Fuzzy
Extended Boolean
Algebraic
Generalized Vector
Lat. Semantic Index
Neural Networks
Probabilistic
Inference Network
Belief Network

Model Families for IR

- Boolean Models (set theoretic)
  - Standard boolean
  - Extended Boolean
- Vector Models (algebraic)
  - Generalized Vector Space
  - Latent Semantic Indexing
  - Neural models
- Probabilistic Models

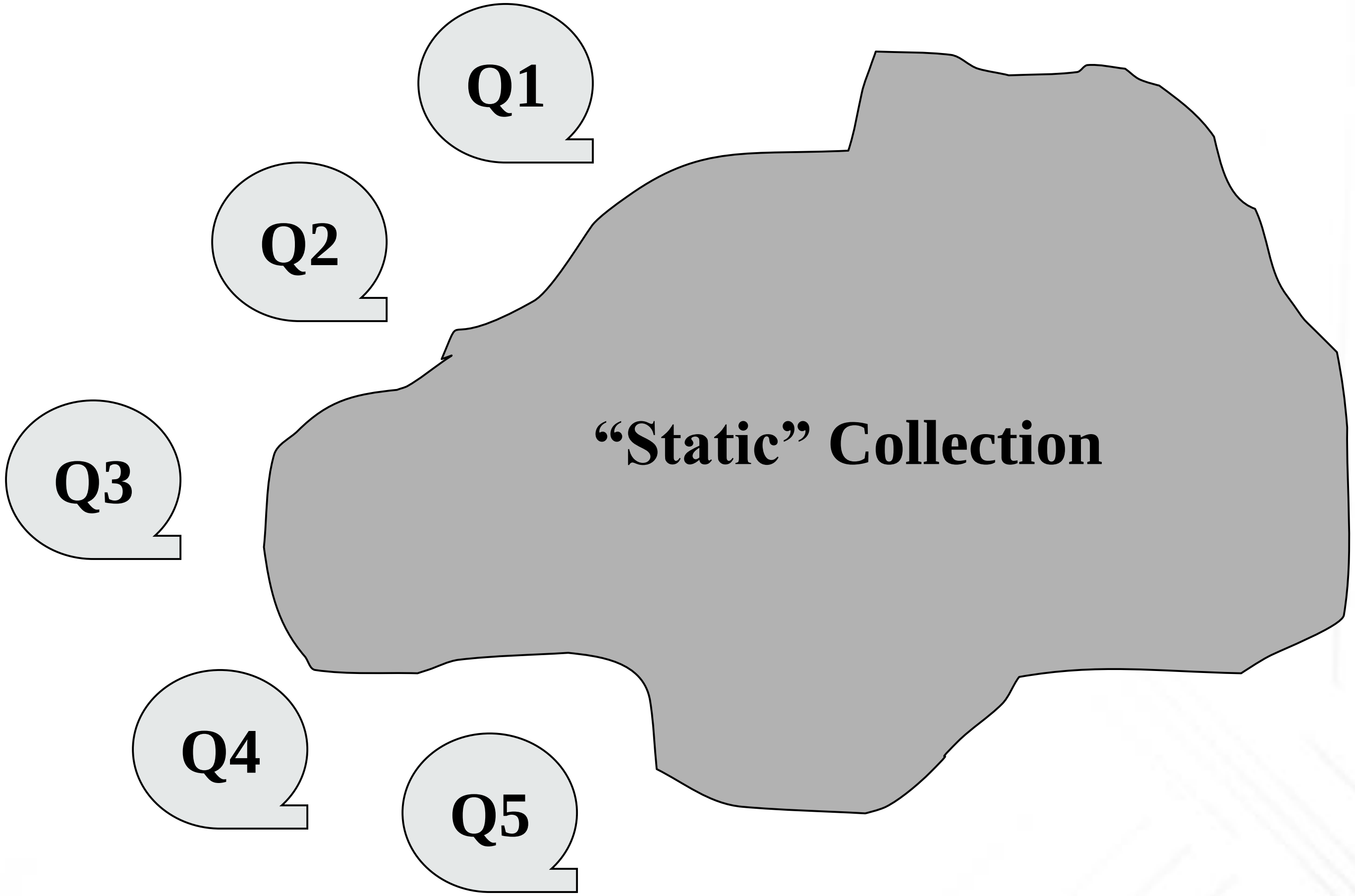
Other classification Dimensions

- Document Logical Model
  - Type of Indexes
    - Structures vs. Content
    - Metadata vs. Content
  - Full text as a model of the content
  - Full text viz. Document (Hypertextual) Structure
    - Declarative vs. operational semantics
- The role of user
  - Subjective vs. Objective forms of relevance
  - Operational environment
    - Search vs. Browsing

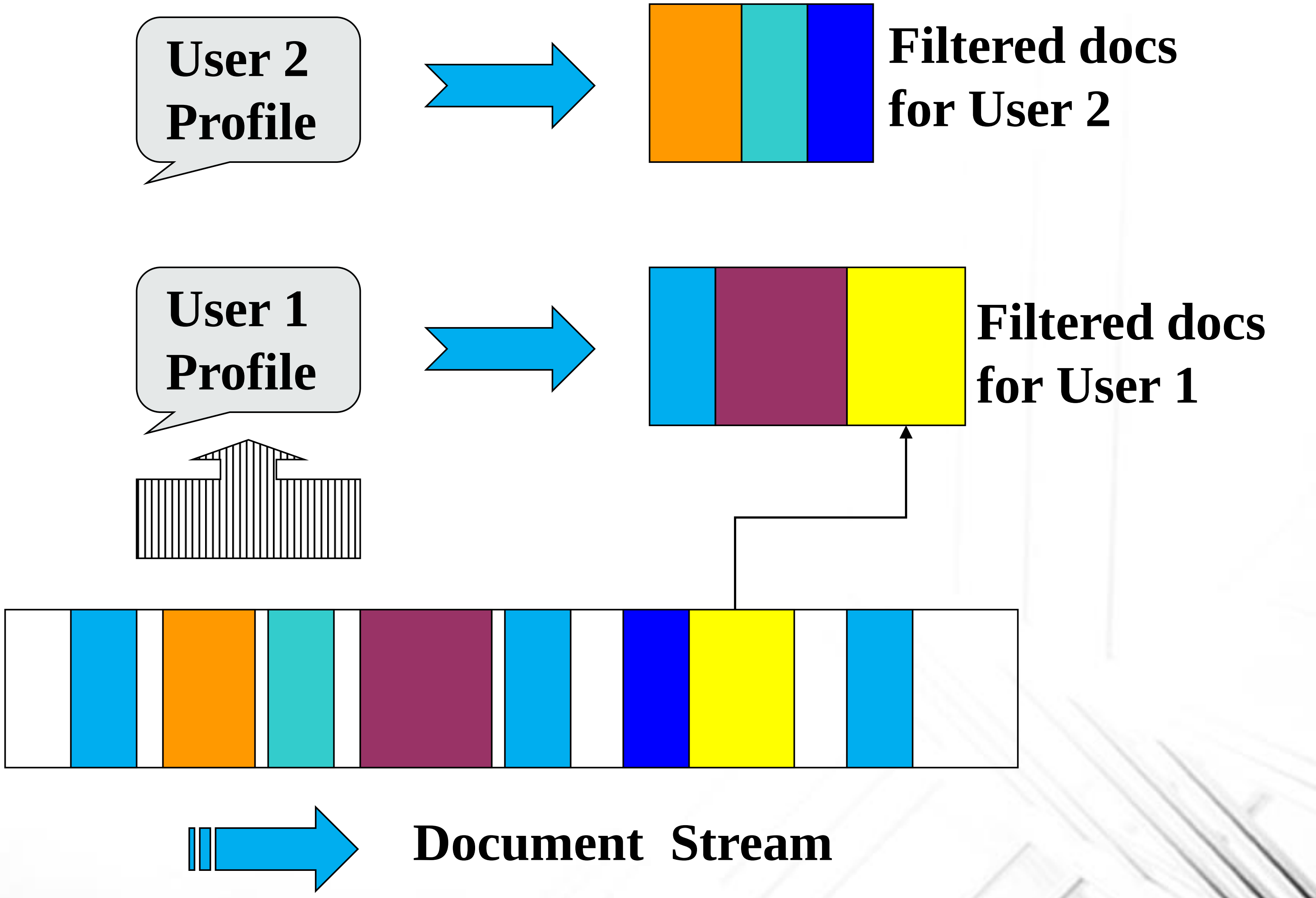
Retrieval Tasks

- **Ad hoc retrieval**
  - DEF. Relatively stable document collection vs. highly variable queries.
- **Information Filtering:**
  - DEF. Fixed Queries and continuous streams of documents
  - Type of Filtering
    - User Filter: static model of the subjective preferences
    - Category based filtering: static model of categories as domain preferences
  - Target Function: binary decision, in general
- **Information Routing:**
  - DEF. When filters define dynamic e non binary models of preference.

Ad Hoc Retrieval



Filtering


User 2 Profile
Filtered docs for User 2
User 1 Profile
Filtered docs for User 1
Document Stream

Learning and IR

- The task in IR and the need of modeling either documents and queries are strongly related to Machine Learning
- First, **no analytical function is available** for every domain, document collection, user and query is available
- Second, **unstructured data** (as much frequently occurring in Web applications) are hard to be modeled without resorting to a reference notion of **content**
- CHALLENGE: How to deal in an **efficient** manner with the tasks of **representing**, **querying**, **matching**, **filtering** and **sorting** the complex contents characterizing the arbitrarily **distributed and unstructured Web data**?
  - In the case of textual document: **how can we learn to formalize the vague notion of content for a document?**

Semantics, Natural Language & Learning: tasks

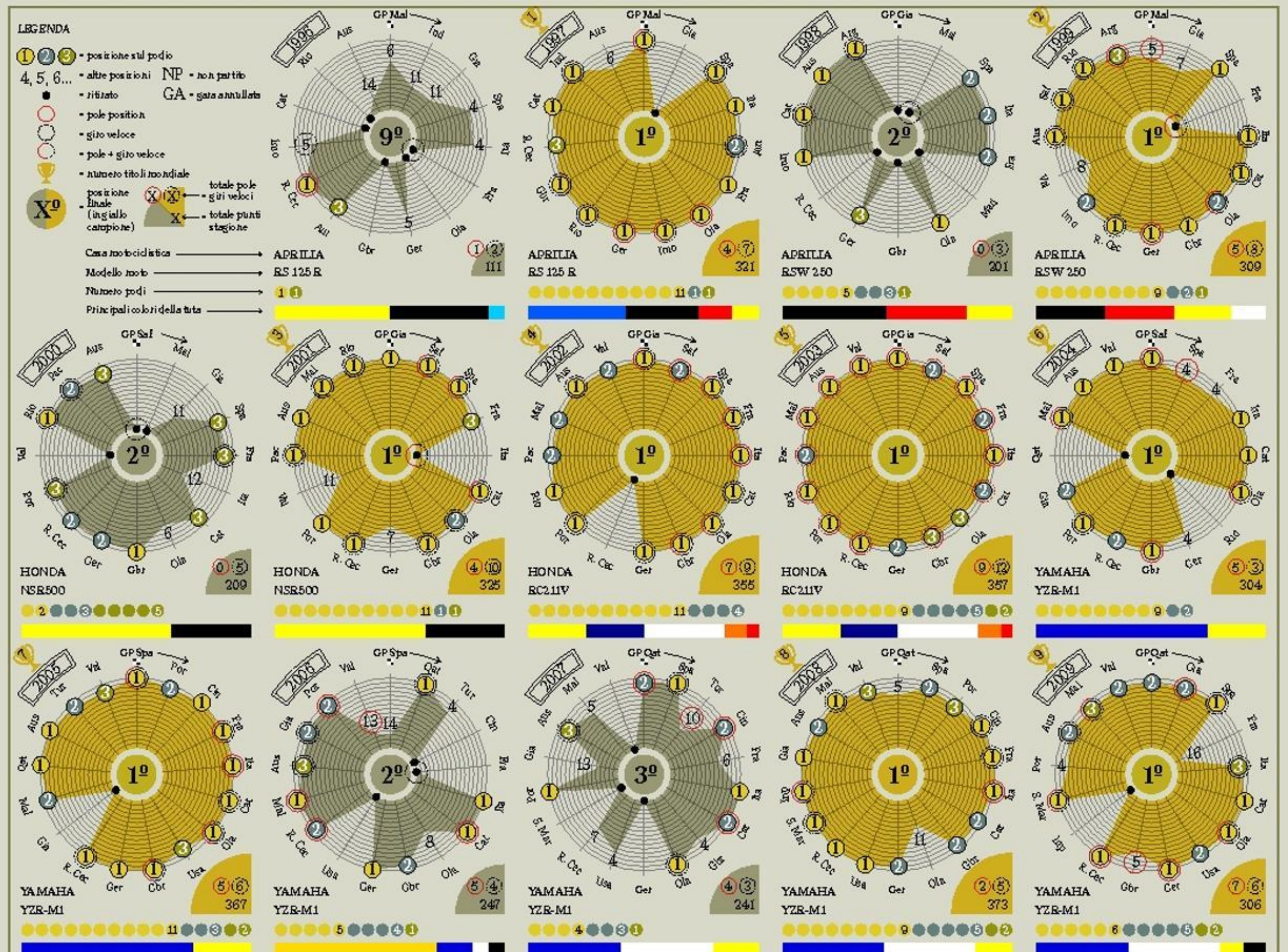
- In order to make contents explicit in an IR process they must be recognized in the contexts of their use
- All these process (also called **Learning to Read** or **Knowledge Distillation**) proceed as a (integrated pool of) **Semantic interpretation Task(s)**
  - **Information Extraction** (from text to machine readable concepts)
    - Entity Recognition and Classification
    - Relation Extraction
    - Semantic Role Labeling (Shallow Semantic Parsing)
  - **Estimation of Text Similarity** (from text to quantitative semantic measures)
    - Structured Text Similarity/Textual Entailment Recognition
    - Sense disambiguation
  - **Semantic Search**, **Question Classification** and **Answer Ranking**
  - **Knowledge Acquisition**, e.g. ontology learning
  - **Social Network Analysis**: Opinion Mining, Recommending

Two major objectives

- Discuss the **nature of content** in unstructured data within a semantic perspective over natural language
  - What constitute a useful notion of content within unstructured data collections (that are largely made of linguistic information, e.g. Web pages or infographics)
  - What is **natural langauge semantics** and how can we model it formally?
  - What is the **meaning of a linguistic expression**?

- What is **the notion of document** that we can use within IR processes
  - Nature and role of document information
  - Relationship between a declarative view on content wrt an operational view of content
  - How this has to do with IR and ML?

Co
lar


LEGENDA
- posizione sul podio
4, 5, 6... - altre posizioni
NP - non partito
GA - gara annullata
- ritirato
- pole position
- giro veloce
- pole + giro veloce
- numero titoli mondiale
Xº
posizione finale (in giallo campione)
totale pole
giri veloci
totale punti stagione
Casa motociclistica
Modello moto
Numero podi
Principali colori della tuta
1996
9º
APRILIA
RS 125 R
1 2
111
1997
1º
APRILIA
RS 125 R
4 7
321
1998
2º
APRILIA
RSW 250
0 3
201
1999
1º
APRILIA
RSW 250
5 8
309
2000
2º
HONDA
NSR500
0 5
209
2001
1º
HONDA
NSR500
4 10
325
2002
1º
HONDA
RC211V
7 9
355
2003
1º
HONDA
RC211V
9 12
357
2004
1º
YAMAHA
YZR-M1
5 3
304
2005
1º
YAMAHA
YZR-M1
5 6
367
2006
2º
YAMAHA
YZR-M1
5 4
247
2007
3º
YAMAHA
YZR-M1
4 3
241
2008
1º
YAMAHA
YZR-M1
2 5
373
2009
1º
YAMAHA
YZR-M1
7 6
306

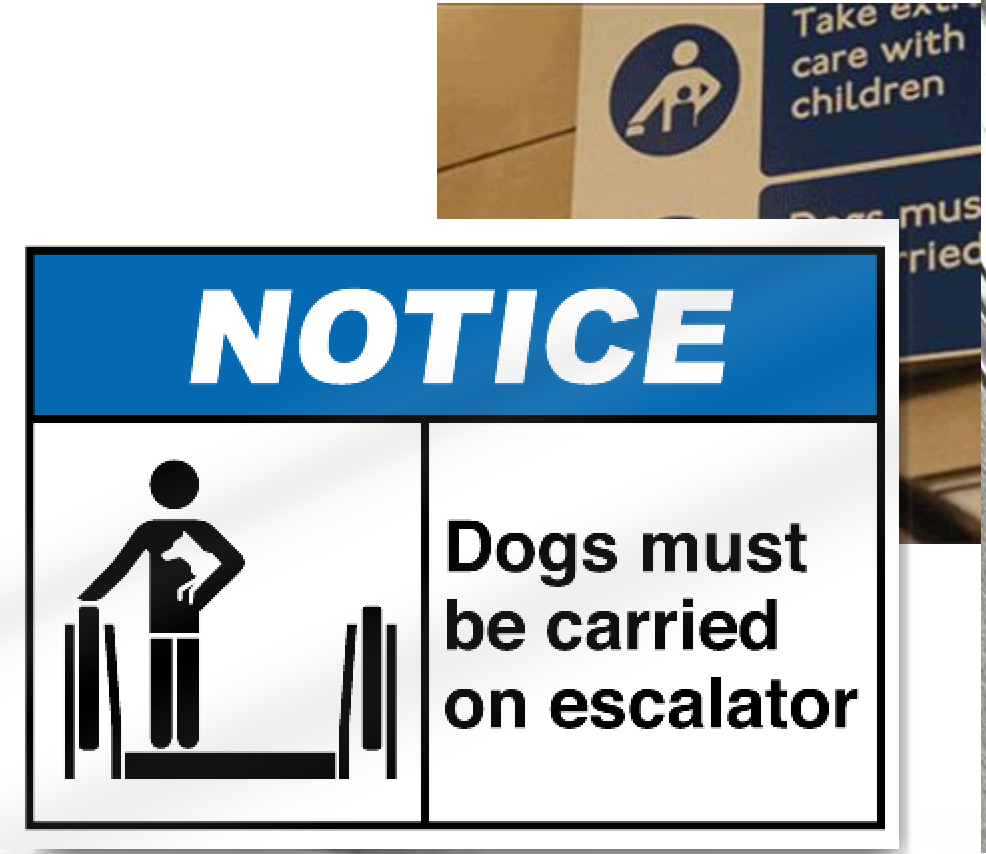
Overview

- Documents in Information Retrieval
    - Information, Representation, (re)current challenges, success(and unsuccess)ful stories
- Information and Content
    - Natural Language Processing: introduction to the linguistic background
        - Natural Language and Content
        - NL Syntax
        - NL Semantics
    - Document Representation and IR models
- Summary

Content in unstructured data

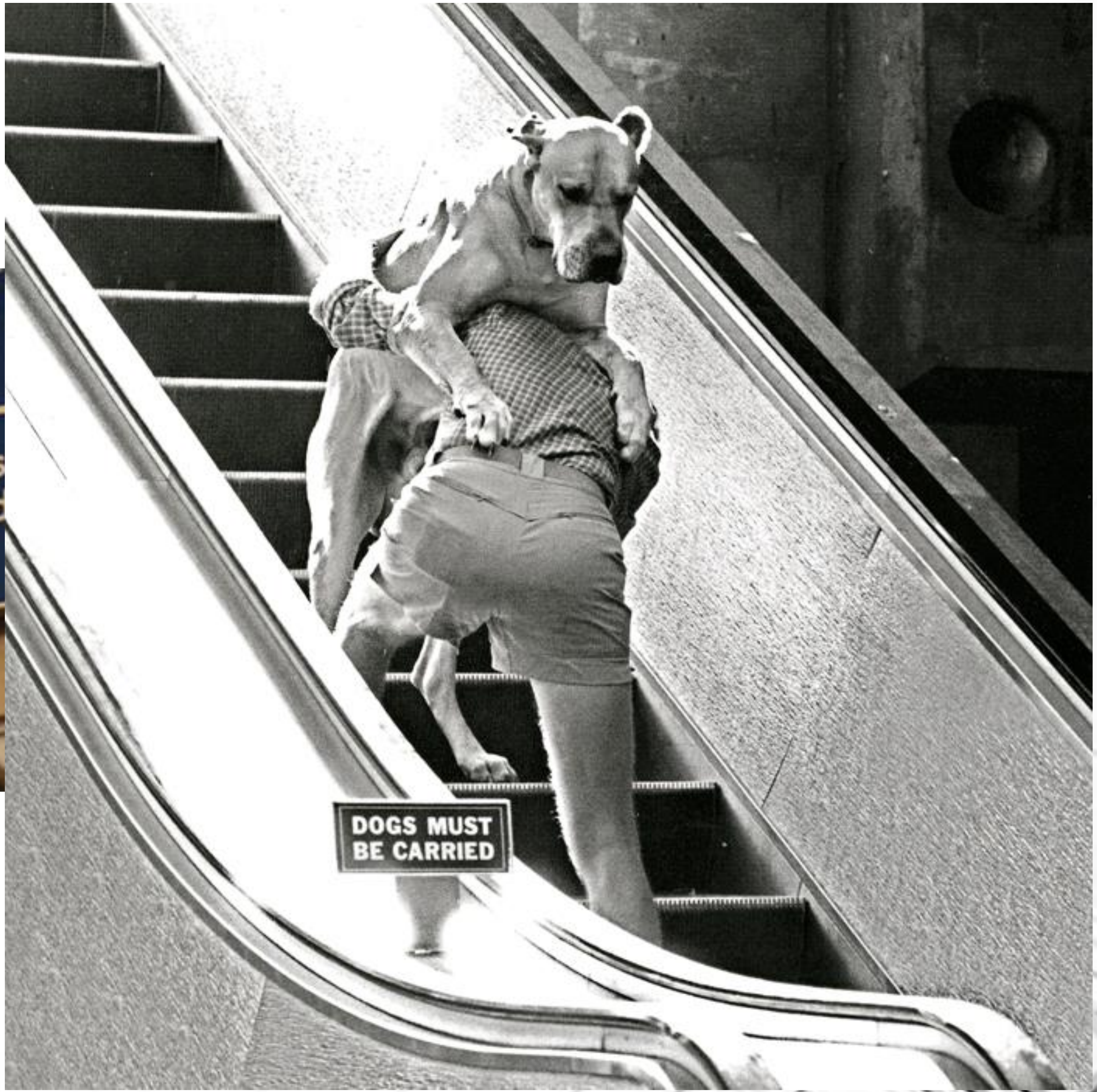
- Natural Language
  - Structure
  - Semantics
  - Types of semantics
  - Relationship with Machine Learning
- Examples:
  - NLU: natural language as a logic language
  - Providing more structure: Frame semantics
    - Logic, Frames and Scripts
    - The relationships between syntax and semantics
  - Semantic role labeling

Natural Language & Ambiguity



NOTICE

Dogs must be carried on escalator



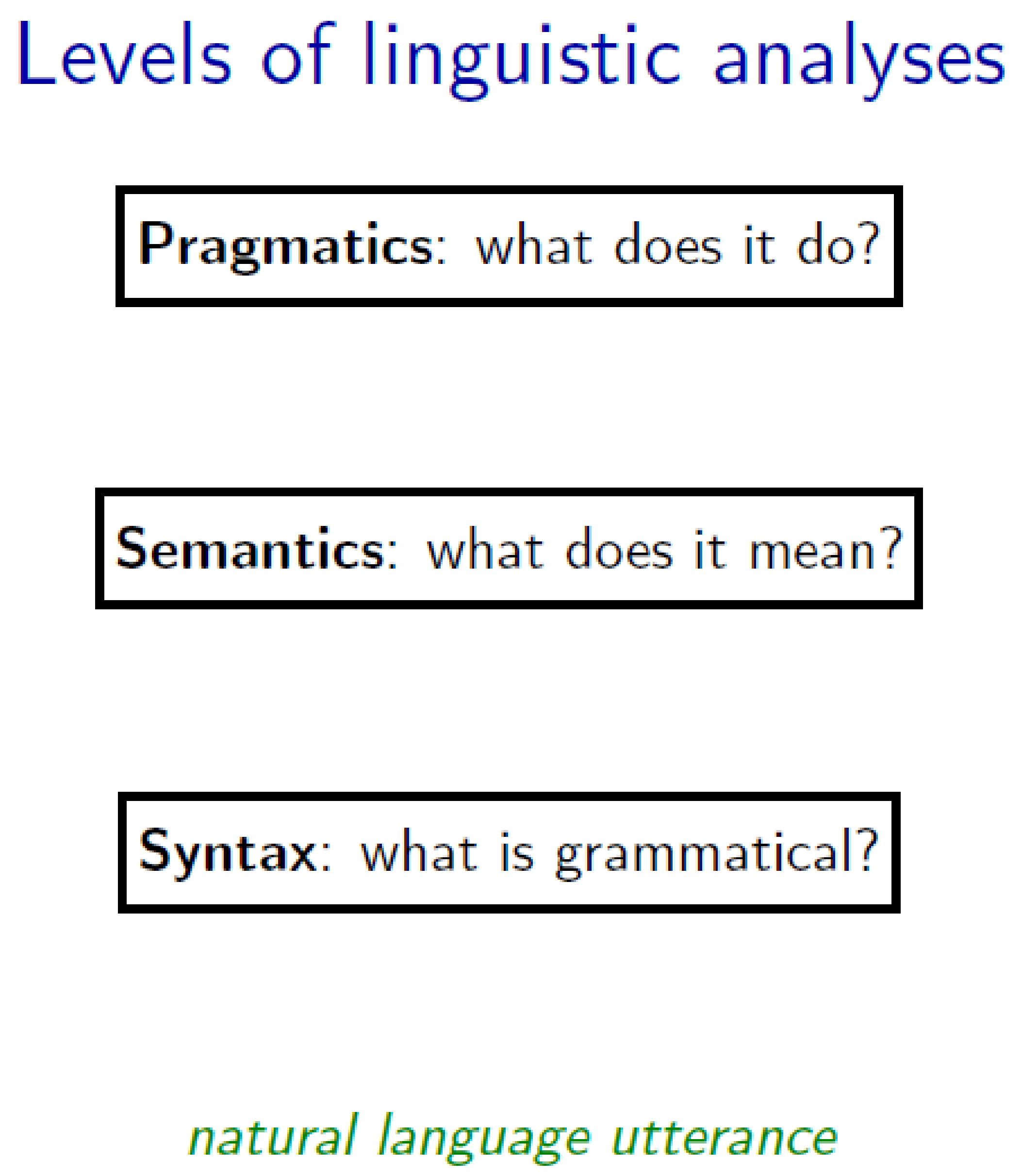
Ambiguità

- "*Dogs must be carried on this escalator*"

can be interpreted in a number of ways:

- *All dogs should have a chance to go on this wonderful escalator ride*
- *This escalator is for dog-holders only*
- *You can't carry your pet on the other escalators*
- *When riding with a pet, carry it*

The NLP chain



Levels of linguistic analyses

Pragmatics: what does it do?

Semantics: what does it mean?

Syntax: what is grammatical?

natural language utterance

Analogy with artificial languages

Syntax: no compiler errors

Semantics: no implementation bugs

Pragmatics: implemented the right algorithm

Different syntax, same semantics (5):

$$2 + 3 \quad \Leftrightarrow \quad 3 + 2$$

Same syntax, different semantics (1 and 1.5):

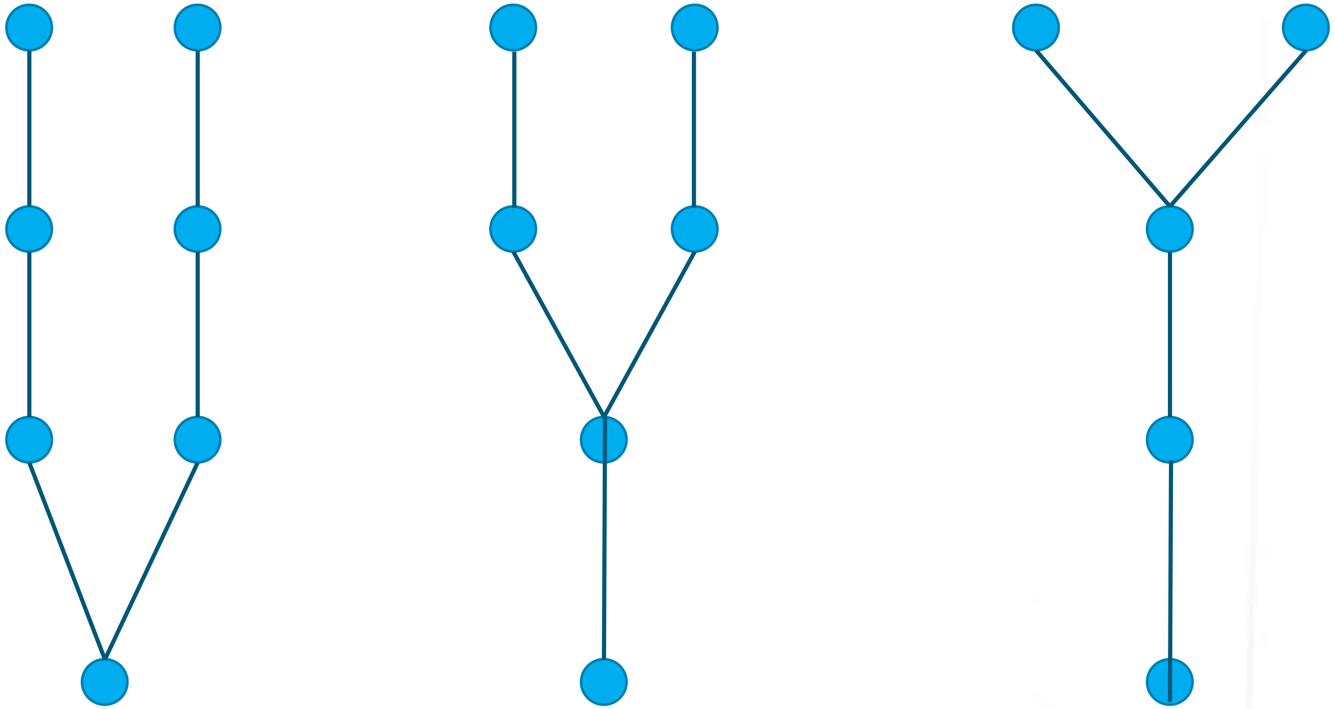
$$3\ /\ 2 \text{ (Python 2.7)} \quad \not\Leftrightarrow \quad 3\ /\ 2 \text{ (Python 3)}$$

Good semantics, bad pragmatics:

correct implementation of deep neural network
for estimating coin flip prob.

Ambiguity and Linguistic Levels

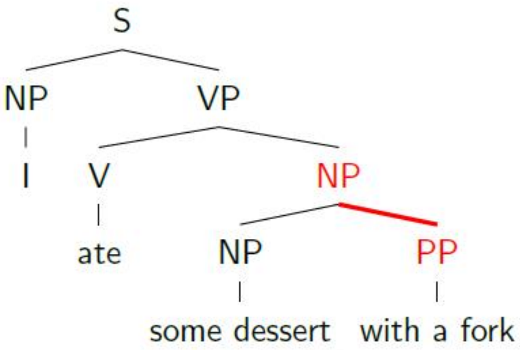
- Semantics
- Syntax
- Morphology
- Phonology

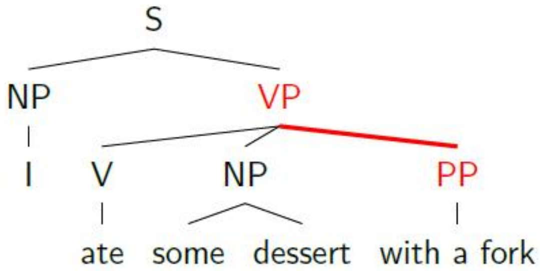


🇬🇧	can/can	eat cake with fork	earth observation satellite Eco’s book
🇮🇹	del (pane) /del (libro)	compro la borsa in pelle	il timore dei manager

Grammars & Ambiguity

I ate some dessert with a fork.





Summary

- IR models necessary in Web mining depend on the ways unstructured data can be made avilable for filtering, classification, retrieval and ranking tasks
- A semantic model for the content of unstructured data is strongly dependent on the linguistic nature of these latter
    - Facts, Entities, Relations, Thematic areas, Subjective information are always rooted in a form of rather free linguistic description
- Studies in Linguistics have provided the basic notion for dealing with the meaning of Natural Language expressions
    - Levels
    - Basic paradigms: lexical description, grammars, logic as a meaning representation language

References

- AI & Robotics. «Robot Futures», Ilah Reza Nourbakhsh, MIT Press, 2013
- NLP & ML:
  - «Statistical Methods for Speech Recognition», F. Jelinek, MIT Press, 1998
  - «Speech and Language Processing", D. Jurafsky and J. H .Martin, Prentice-Hall, 2009.
  - "Foundations of Statistical Natural Language Processing, Manning & Schutze, MIT Press 2001.
- Sitografia:
  - SAG, Univ. Roma Tor Vergata: http://sag.art.uniroma2.it/
  - Reveal s.r.l.: http://www.revealsrl.it/

ROBOT FUTURES
ILLAH REZA NOURBAKHSH
STATISTICAL METHODS FOR SPEECH RECOGNITION
FREDERICK JELINEK
SPEECH and LANGUAGE PROCESSING
An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition
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FOUNDATIONS OF STATISTICAL NATURAL LANGUAGE PROCESSING
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