

Master in Artificial Intelligence

Introduction

Human
Language
Technology
courses in
MAI

Introduction to Human Language Technologies



UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Facultat d'Informàtica de Barcelona



Outline

Introduction

Human
Language
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1 Introduction

- What is Human Language Technology?
- Which is the general strategy for computing Human Language?
- Why is Human Language difficult to be processed?
- Examples of applications

2 Human Language Technology courses in MAI

- HLT branch
- IHL

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Definition

Introduction

What is Human
Language
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- HLT is the technology focused on the study of human language from a computational point of view.
- HLT comprises computational methods, resources and models specifically designed to deal with all kind of text:
 - list of words
 - question in natural language
 - document in electronic format (e.g., plain text, web page, sms, tweet, oral transcriptions)
 - **corpus**: collection of documents in electronic format

Definition

Introduction

What is Human
Language
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- HLT is a multidisciplinary area:
 - **Natural Language Processing (NLP)**
 - Computational Linguistics
 - Artificial Intelligence
 - Speech Processing
 - Cognitive Science, Psychology
 - Logic, Mathematics

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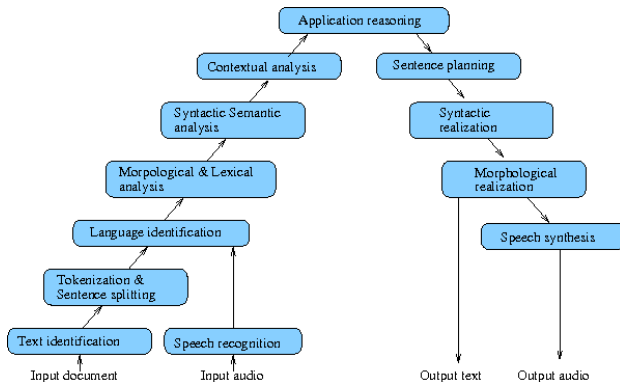
- HLT branch
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Definitions

The general strategy follows the standard subareas of linguistics:

- Phonetics: sounds of human speech.
E.g., *infrequent* → /ɪn'frikwənt/
- Morphology: structural formation of words.
E.g., *in-frequent-ly*.
- Syntax: structural relations between words in sentences.
E.g., *a determiner is followed by a common noun*.
- Semantics: meanings of words and their composition via syntax.
E.g., *the president of USA is Donald Trump* →
president(USA, Donald_Trump)
- Pragmatics: meaning in the context.
E.g., **He** *is very well known in his country* [sarcasm]

General architecture

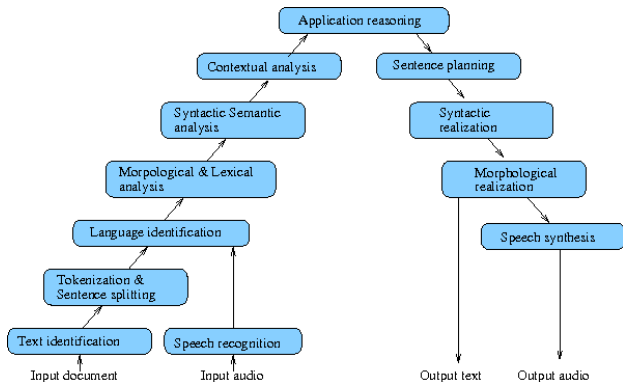


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Which is the general strategy for computing Human Language?

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General architecture



- Branches: NL Understanding and NL Generation.
- Approaches: Knowledge-based vs. Statistical-based.
- Shallow methods (lexical overlap, pattern matching) vs. Deep methods (semantic analysis, logical inference)

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Problems

- World-knowledge
 - Representing world-knowledge is mandatory for understanding NL (AI-completeness)
e.g., Yago - facts, OpenCyc - common sense
- Multilinguality
 - Different languages require different models and resources
 - Use of words from other languages
Estoy a full! (non-standard Spanish text)
- Evaluation
 - Correctness/suitability of a translation/summary
- Variability
 - Different sentences refer to one meaning
Where can I get a map?
I need a map
need map (non-standard text)
- Ambiguity
 - One sentence refers to different meanings
Esther said about Alice: ''I made her duck''

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Ambiguity

E.g., Esther said about Alice: ''I made her duck''

- I cooked waterfowl for her
- I cooked the waterfowl she owned
- I created the duck she owns
- I caused her to quickly lower her head or body
- I turned her into waterfowl

| Word | Ambiguity | Alternatives |
|-------------|------------------------|---|
| make | semantic | cook or create |
| her | syntactic pragmatic | possessive or dative pronoun Esther or Alice |
| duck | synt-sem | noun or verb |

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Examples of
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Examples of applications

- Document clustering
- Document classification (e.g. anti-spamming, email routing, sentiment polarity, language identification)
- Information Retrieval
- Text correction
- Plagiarism detection
- Information Extraction
- Automatic Summarization
- Question Answering
- Machine Translation
- Dialog Systems

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Information Retrieval (IR)

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Examples of
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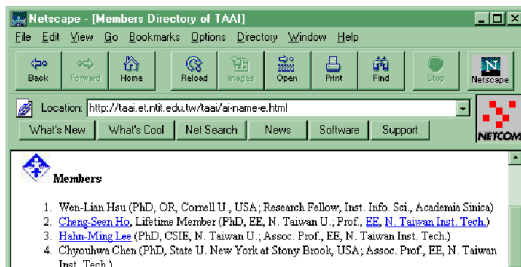
- E.g.: Searchers (Google, Yahoo, ...)
- Given a corpus, $D = \{D_i\}$, and a user query (list of words), Q , provide $\hat{D} \subset D$ that better match Q .
- $\text{sim}(v(Q), v(D_i))$, where $v(X)$ represents X in a vector space
- What vector space seems better?
 - words? $Q = \text{"window"}$, $D_i = \text{"... he closed the windows..."}$
 - lemmas? $Q = \text{"window"}$, $D_i = \text{"... he closed Windows..."}$
 - compounds? $Q = \text{"Energie"}$, $D_i = \text{"... Sonnenenergie..."}$
 - ...
 - In-depth NLP seems not productive

Information Extraction (IE)

- E.g.: Enriching DBs or KBs with new content. Document collection indexing. Sentiment analysis.
- Extract the **relevant information** contained in text (entities, properties, relationships and events).
- Main subtasks:
 - Named Entity Recognition and Classification (NERC)
 - Slot Filling
 - Relationship Extraction
 - Event Extraction
- Depending on the specific task, more in-depth NLP is required (syntax, semantics, pragmatics, world-knowledge), as well as ML techniques.

Information Extraction (IE)

- Example 1: Member Name, Degree, School and Affiliation from WEB pages.



| Name | Degree | Affiliation | School |
|---------------|--------------------------|-----------------|----------------------------------|
| Wen-Lian Hsu | PhD, OR, Cornell U., USA | Research Fellow | Inst. Info. Sci. Academia Sinica |
| Chen-Seen Hu | PhD, EE, N. Taiwan U. | Prof. | EE, N. Taiwan Inst. Tech |
| Hahn-Ming Lee | PhD, CSIE, N. Taiwan U. | Prof. | EE, N. Taiwan Inst. Tech |
| ... | | | |

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Examples of
applications

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Information Extraction (IE)

- Example 2: incidents from free text (type of incident, perpetrator, target, date, location, effects, instrument).

At 5pm on Thursday , a white Fiat van veered off the road and into a crowd outside the Plaça de Catalunya metro station in Barcelona. The van continued down Las Ramblas for more than 500 metres while crashing into pedestrians . 13 people have been killed . 100 people were injured and 15 are in serious condition . Las Ramblas attacker Younes Abouyaaqoub was killed in Subirats.

Information Extraction (IE)

- Example 2: incidents from free text (type of incident, perpetrator, target, date, location, effects, instrument).

At 5pm on **Thursday**, a **white Fiat van** veered off the road and into a crowd outside the **Plaça de Catalunya metro station in Barcelona**. The **van** continued down **Las Ramblas** for more than 500 metres while **crashing** into **pedestrians**. **13 people have been killed**. **100 people were injured** and **15 are in serious condition**. **Las Ramblas** attacker **Younes Abouyaaqoub** was killed in **Subirats**.

type of incident = crash

location = Las Ramblas (Barcelona)

date = 17/8/2017

perpetrator = Younes Abouyaaqoub

target = pedestrians

instrument = white Fiat van

effects = 13 people killed, 100 people injured, 15 people in serious condition

Automatic Summarization

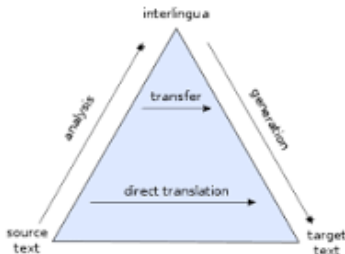
- E.g.: Generate biographies, minutes of a meeting, abstracts or extracts of written documents
- Given a document or a corpus, generate an extract or an abstract consisting of the most relevant content.
- Abstractive methods:
 - Generate new text from the conceptual representation of the important information contained in the input text.
 - Require language understanding and generation
- Extractive methods:
 - Select the most important sentences in the input text and produce a summary.
 - The set of sentences should maximize overall importance and coherency and minimize the redundancy.
- How are *importance* and *redundancy* computed?
- Semantics and ML techniques help

Question Answering (QA)

- E.g.: Questions answered by intelligent cars and rooms.
- Given a corpus, $D = \{D_i\}$, and a question, Q , extract the exact answer for Q from D .
 - Factoid QA: answers are exact facts
E.g.: Who was the president of the USA in 1987?
 - Non-factoid QA: a definition, an explanation of how or why, a biography summary, ...
E.g.: Tell me what has been said so far in the meeting
- Main subtasks:
 - Document indexing
 - Question processing (question type, question focus)
 - Answer extraction
- more in-depth NLP is required as well as ML techniques. Information extraction and Automatic Summarization help.

Machine Translation (MT)

- E.g.: Translation of written documents, help in human-human communication by mobile, online translation of broadcast news.
- Different MT models differ from the level of NLP they use:



- Transfer model is the most frequently used
- In general, the results are not comparable to human translation

Machine Translation (MT)

Examples of drawbacks: (with Google Translate)

- Working sentence by sentence: lack of context

ES: Ana no aprobó el examen. Su amigo sí.

EN: Ana did not pass the exam. **Your** friend **yes**.

ok: Ana did not pass the exam. Her friend did.

- Lack of world-knowledge: Named entities

ES: Disfrutar es el mejor nuevo restaurante de Europa

EN: **Enjoy** is the best new restaurant in Europe

ok: Disfrutar is the best new restaurant in Europe

- Restricted domains: terminology

ES: El níscolo se cría bajo pinos

EN: **The níscolo** grows under pines

ok: Red pine mushroom grows under pines

ES: Los níscolos se crían bajo pinos

EN: **The chanterelles are raised** under pines

ok: Red pine mushrooms grow under pines

Dialog Systems

Introduction

Examples of
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- E.g.: chatbots, dialog-driven QA in smart cars and rooms, health-care assistance
- Help users to achieve specific goals by means of natural language interaction
- Main subtasks:
 - Interpreting user intervention
 - Determining the next system's action considering the user intention (answer a question, ask for more info, suggest alternatives, ...)
 - Generating system's intervention
- High complexity: Natural language understanding and generation is required

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IHLT AHLT HLE

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IHLT branch

- **IHLT**: the foundations of NLP interpretation, focusing on possible simple applications (spelling correction, text classification, paraphrase detection, text anonymization, ...)
- **AHLT**: more in-depth study of ML techniques for NLP interpretation (especially for syntactic and semantic parsing)
- **HLE**: review of complex applications of HLT (MT, IE, QA, Summ, Dialog)

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Content

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Here you can find the schedule of the course. [▶ LINK](#)
You can also find the URL of this schedule in the Racó.

Evaluation procedure

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- Final exam: all the content, exam period
- Lab sessions: groups of 2 students
 - Development of one project
 - Some deliverables of lab exercises
- Final grade = 50% Exam grade + 50% Lab grade