

# Master in Artificial Intelligence

Introduction

Human  
Language  
Technology  
courses in  
MAI

## Introduction to Human Language Technologies



UNIVERSITAT POLITÈCNICA DE CATALUNYA  
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# Outline

## Introduction

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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

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What is Human  
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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

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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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Which is the general strategy for computing Human Language?

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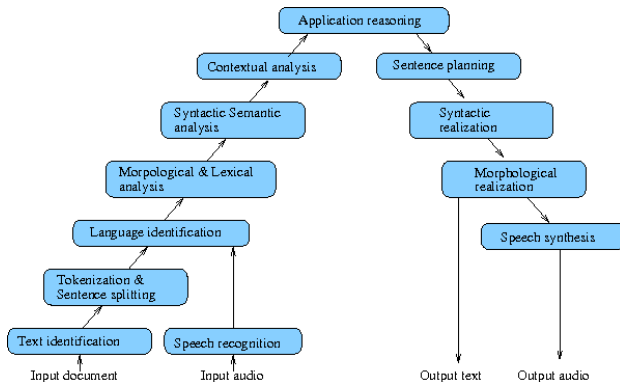
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# Definitions

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



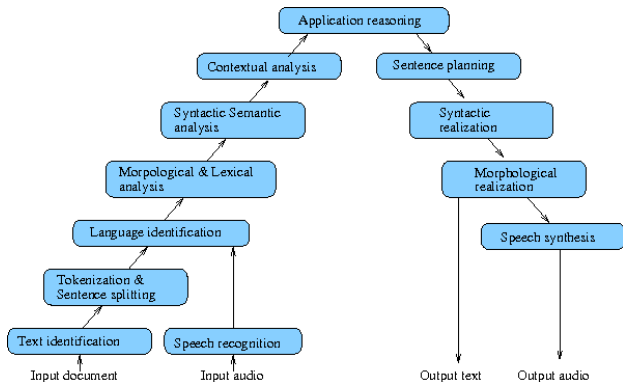
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Which is the general strategy for computing Human Language?

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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                                    |
|-------------|------------------------|---|
| <b>make</b> | semantic               | cook or create                                  |
| <b>her</b>  | syntactic<br>pragmatic | possessive or dative pronoun<br>Esther or Alice |
| <b>duck</b> | synt-sem               | noun or verb                                    |

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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

...

# Information Retrieval (IR)

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Examples of  
applications

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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

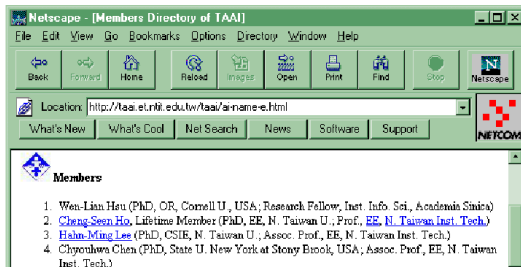
# Information Extraction (IE)

- 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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# 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

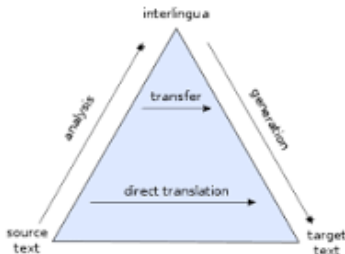
- E.g.: Generate biographies, minutes of a meeting, abstracts or extracts of written documents
- Given a document or a corpus, generate an extract or an abstract consisting of the most relevant content.
- Abstractive methods:
  - Generate new text from the conceptual representation of the important information 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

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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 mark = 50% Exam + 40% Project + 10% Lab deliverables