EDAN20
Language Technology
http://cs.lth.se/edan20/
Chapter 1: An Overview of Language Processing

Pierre Nugues

Lund University
Pierre.Nugues@cs.lth.se
http://cs.lth.se/pierre_nugues/

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Applications of Language Processing

- Spelling and grammatical checkers: *MS Word*, e-mail programs, etc.
- Text indexing and information retrieval on the Internet: *Google*, *Microsoft Bing*, *Yahoo*, or software like *Apache Lucene*
- Translation: *Google Translate*, *DeepL*, *Bing translator*, etc.
- Spoken interaction: Apple Siri, Google Assistant, Amazon Echo
- Speech dictation of letters or reports: *Windows 10*, *macOS*

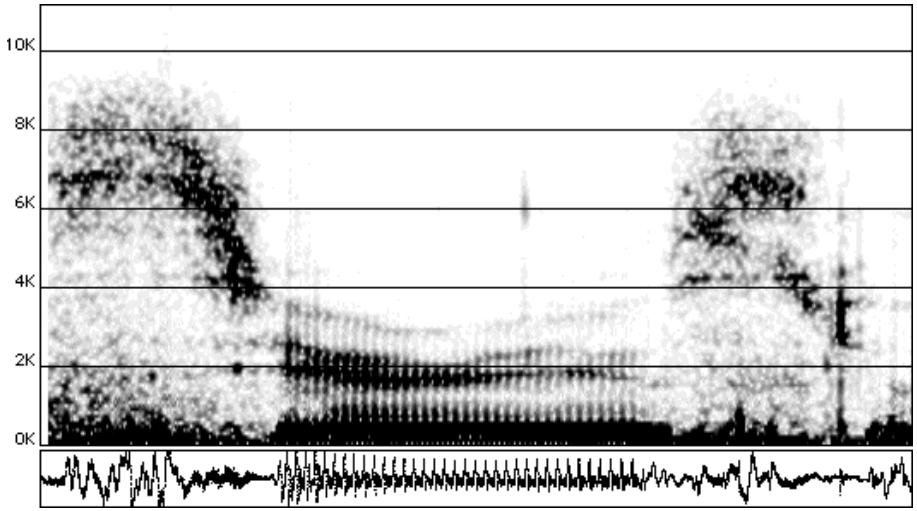
Applications of Language Processing (ctn'd)

- Direct translation from spoken English to spoken Swedish in a restricted domain: *SRI* and *SICS*
- Voice control of domestic devices such as tape recorders: *Philips* or disc changers: *MS Persona*
- Conversational agents able to dialogue and to plan: *TRAINS*
- Spoken navigation in virtual worlds: *Ulysse*, *Higgins*
- Generation of 3D scenes from text: *Carsim*
- Question answering: *IBM Watson* and *Jeopardy!*

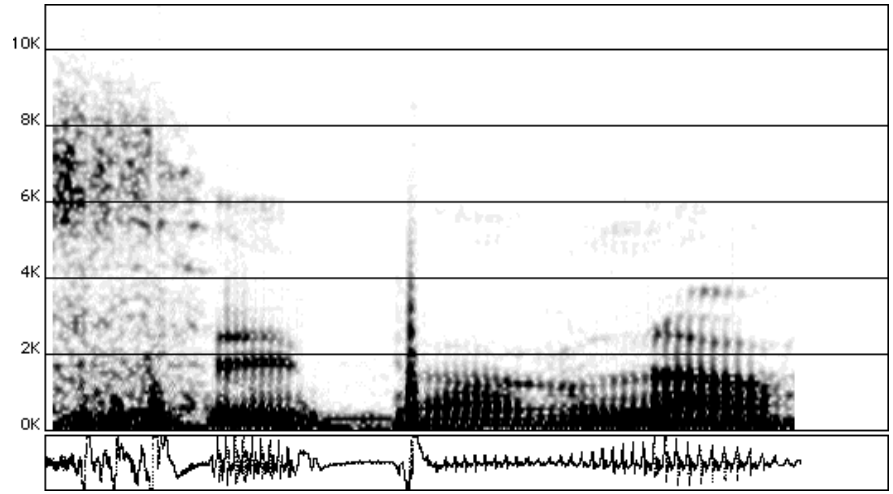
Linguistics Layers

- Sounds
- Phonemes
- Words and morphology
- Syntax and functions
- Semantics
- Dialogue

Sounds and Phonemes



Serious



C'est par là 'It is that way'

Lexicon and Parts of Speech

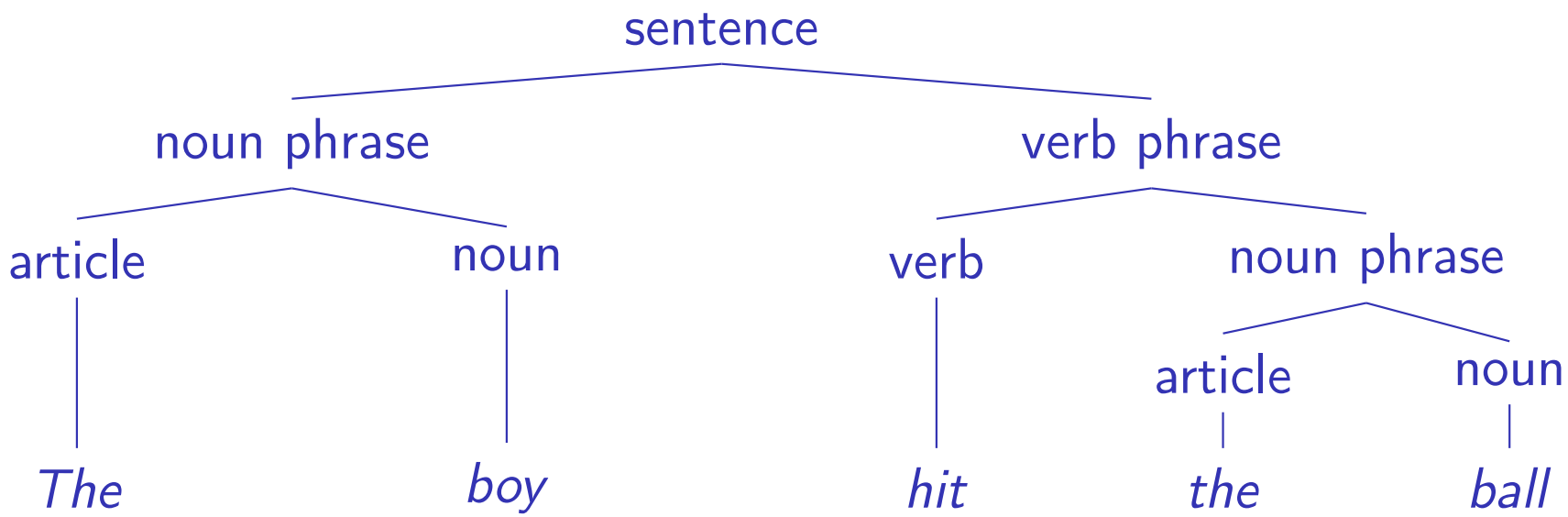
The big cat ate the gray mouse

The/article *big*/adjective *cat*/noun *ate*/verb *the*/article *gray*/adjective *mouse*/noun
Le/article *gros*/adjectif *chat*/nom *mange*/verbe *la*/article *souris*/nom *grise*/adjectif
Die/Artikel *große*/Adjektiv *Katze*/Substantiv *ißt*/Verb *die*/Artikel *graue*/Adjektiv *Maus*/Substantiv

Morphology

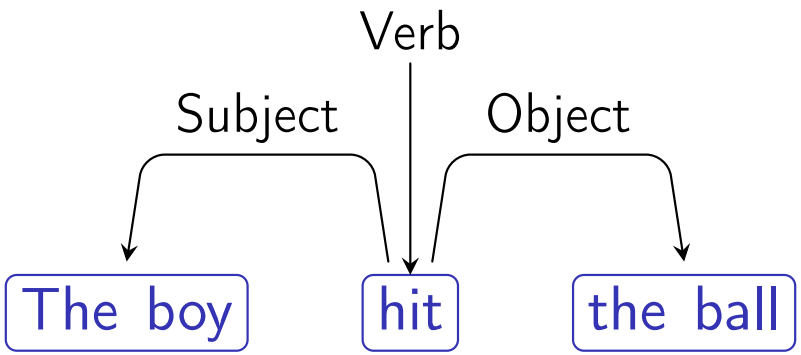
Word	Root form
worked	*to work* + verb + preterit
travaillé	*travailler* + verb + past participle
gearbeitet	*arbeiten* + verb + past participle

Syntactic Tree



Syntax: A Classical View

A graph of dependencies and functions



Semantics

As opposed to syntax:

1. Colorless green ideas sleep furiously.
2. *Furiously sleep ideas green colorless.

Determining the logical form:

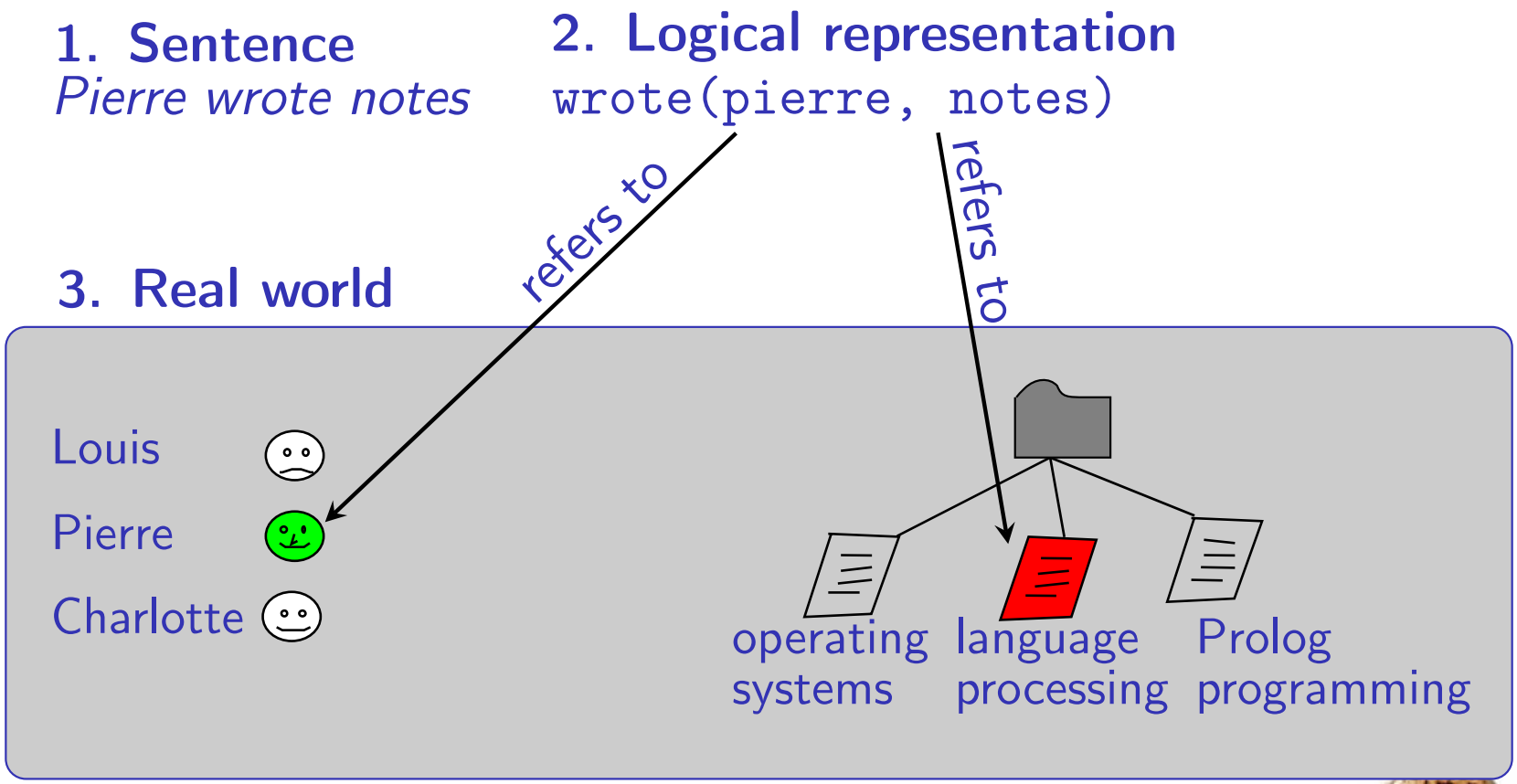
Sentence	Logical representation
Frank is writing notes	`writing(Frank, notes).`
François écrit des notes	`écrit(François, notes).`
Franz schreibt Notizen	`schreibt(Franz, Notizen).`

Lexical Semantics

Word senses:

1. **note** (*noun*) short piece of writing;
2. **note** (*noun*) a single sound at a particular level;
3. **note** (*noun*) a piece of paper money;
4. **note** (*verb*) to take notice of;
5. **note** (*noun*) of note: of importance.

Reference


1. Sentence
Pierre wrote notes
2. Logical representation
wrote(pierre, notes)
refers to
refers to
3. Real world
Louis
Pierre
Charlotte
operating systems
language processing
Prolog programming

Ambiguity

Many analyses are ambiguous. It makes language processing difficult.
Ambiguity occurs in any layer: speech recognition, part-of-speech tagging, parsing, etc.
Example of an ambiguous phonetic transcription:
The boys eat the sandwiches
That may correspond to:
The boy seat the sandwiches; *the boy seat this and which is*; *the buoys eat the sand which is*

Models and Tools

- Linguistics has produced an impressive set of theories and models;
- Inadequate theories in the beginning and lack of data: corpus, dictionaries, or reference (annotated) data;
- Models and tools have matured. Data has become available;
- Tools involve notably finite-state automata, regular expressions, logic, statistics, and machine learning in many forms;
- In general, language processing requires significant processing power.

The Carsim System: A Text-to-Scene Converter

Texts	XML Templates	3D Animation

Véhicule B venant de ma gauche, je me trouve dans le carrefour, à faible vitesse environ 40 km/h, quand le véhicule B, percute mon véhicule, et me refuse la priorité à droite. Le premier choc atteint mon aile arrière gauche,

```
// Static Objects
STATIC [
ROAD
TREE
]
// Dynamic Objects
DYNAMIC [
VEHICLE [
ID = vehicule_b;
INITDIRECTION = east;
```

Dialogue: The Persona Project from Microsoft Research

A conversation with Peedy

Turn	Utterance
	[Peedy is asleep on his perch]
User:	Good morning, Peedy.
	[Peedy rouses]
Peedy:	Good morning.
User:	Let's do a demo.
	[Peedy stands up, smiles]
Peedy:	Your wish is my command, what would you like to hear?
User:	What have you got by Bonnie Raitt?
	[Peedy waves in a stream of notes, and grabs one as they rush by.]
Peedy:	I have "The Bonnie Raitt Collection" from 1990.
User:	Pick something from that
Peedy:	How about "Angel from Montgomery"?

Dialogue: The Persona Project from Microsoft Research

User: Sounds good.
[Peedy drops note on pile]
Peedy: OK.
User: Play some rock after that.
[Peedy scans the notes again, selects one]
Peedy: How about "Fools in love"?
User: Who wrote that?
[Peedy cups one wing to his 'ear']
Peedy: Huh?
User: Who wrote that?
[Peedy looks up, scrunches his brow]
Peedy: Joe Jackson
User: Fine.
[Drops note on pile]

Persona System Architecture

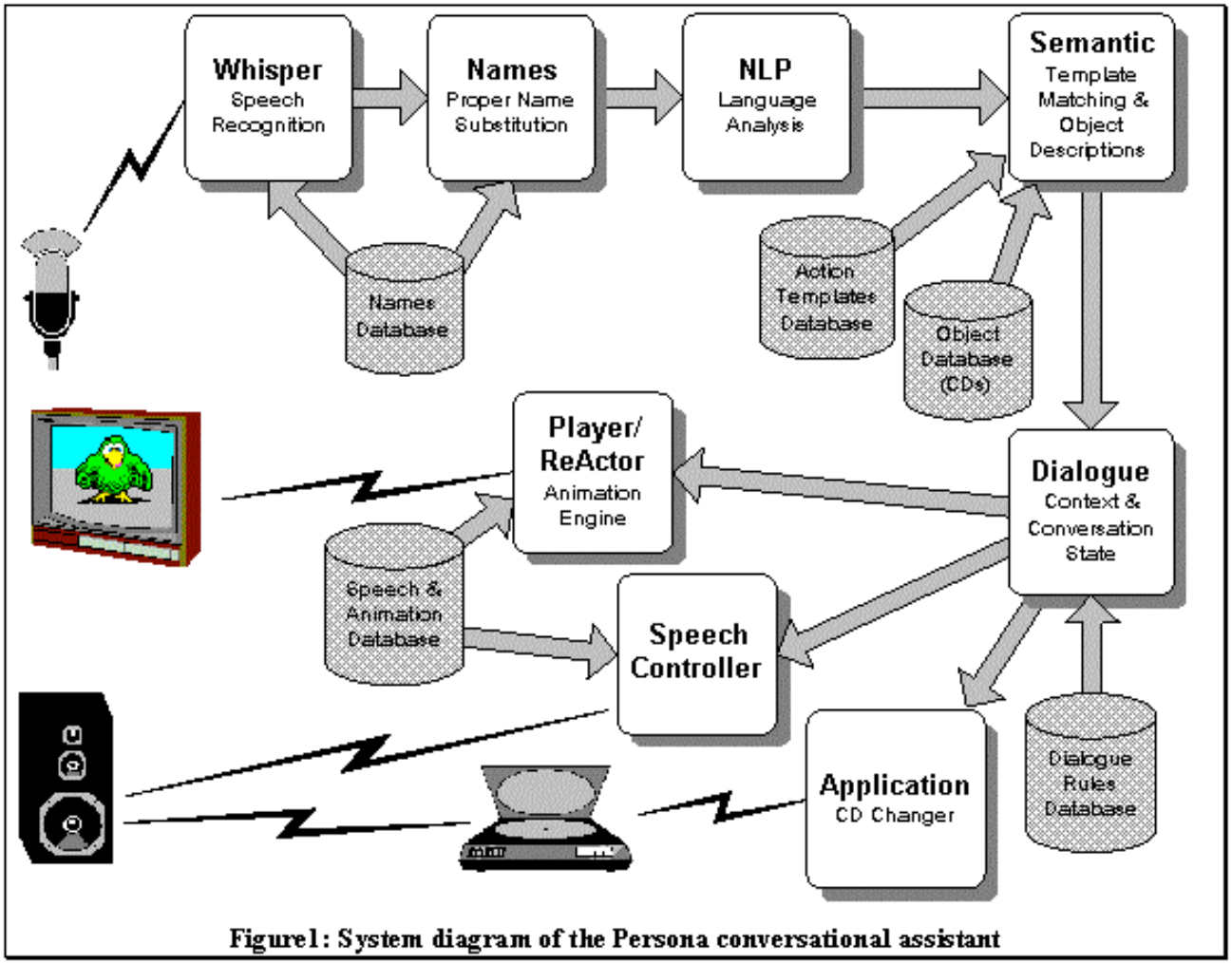


Figure1: System diagram of the Persona conversational assistant

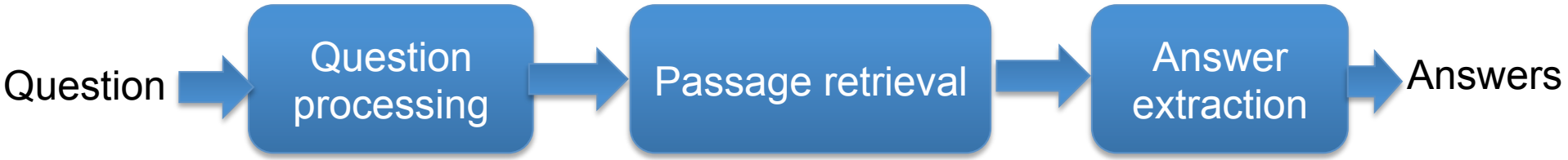
Source: http://research.microsoft.com/research/pubs/view.aspx?pubid=439

IBM Watson

- IBM Watson: A system that can answer questions better than any human
- Video: https://www.youtube.com/watch?v=WFR3lOm_xhE

- IBM Watson builds on the extraction of knowledge from masses of texts: Wikipedia, archive of the New York Times, etc.
- Bottom line: Text is the repository of human knowledge

IBM Watson: Simplified Architecture



Question parsing and classification:
Syntactic parsing, entity recognition, answer classification

Document retrieval. Extraction and ranking of passages:
Indexing, vector space model.

Extraction and ranking of answers:
Answer parsing, entity recognition