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

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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*

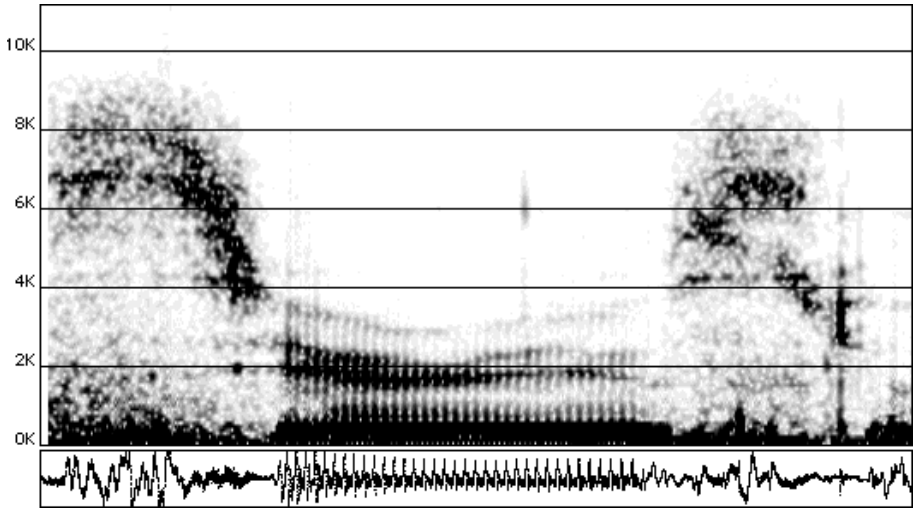
Applications of Language Processing (ctn'd)

- 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!*

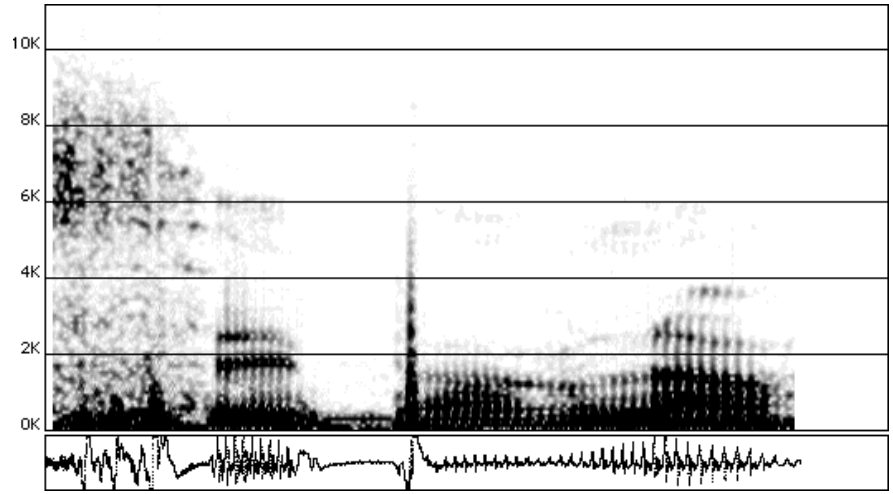
Linguistics Layers

- 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

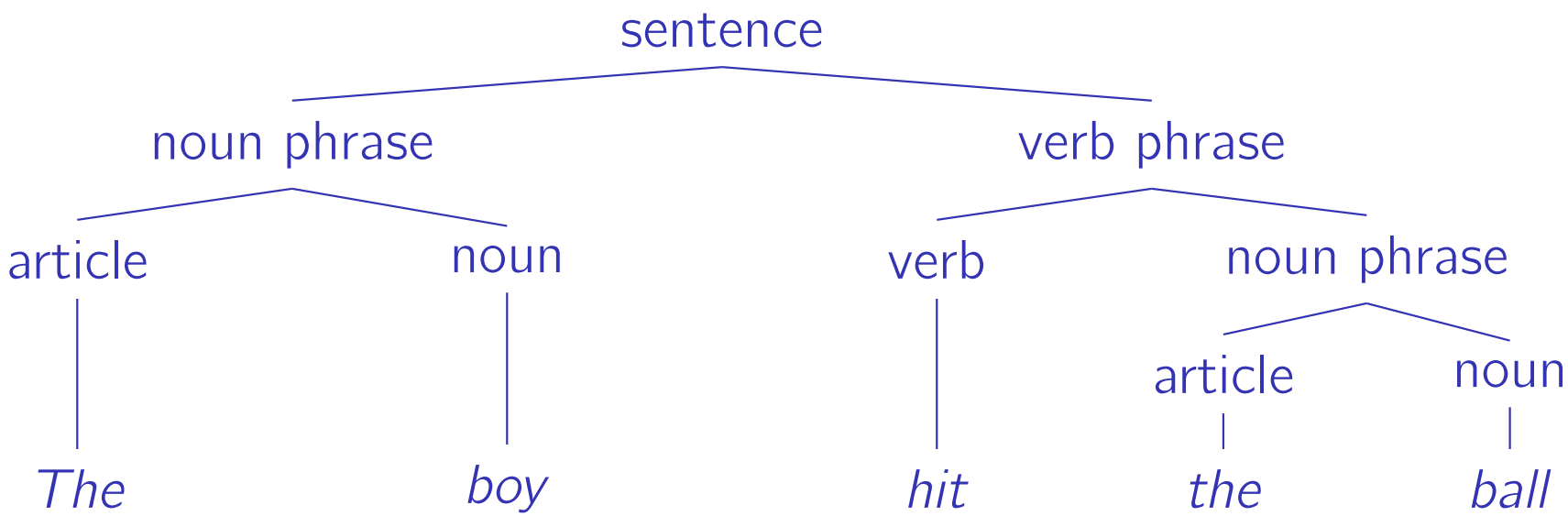
The big cat ate the gray mouse

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

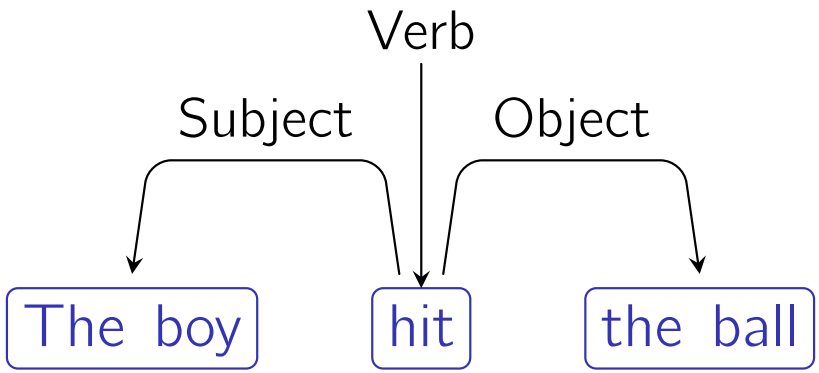
Word	Root form
worked	*to work* + verb + preterit
travaillé	*travailler* + verb + past participle
gearbeitet	*arbeiten* + verb + past participle

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:

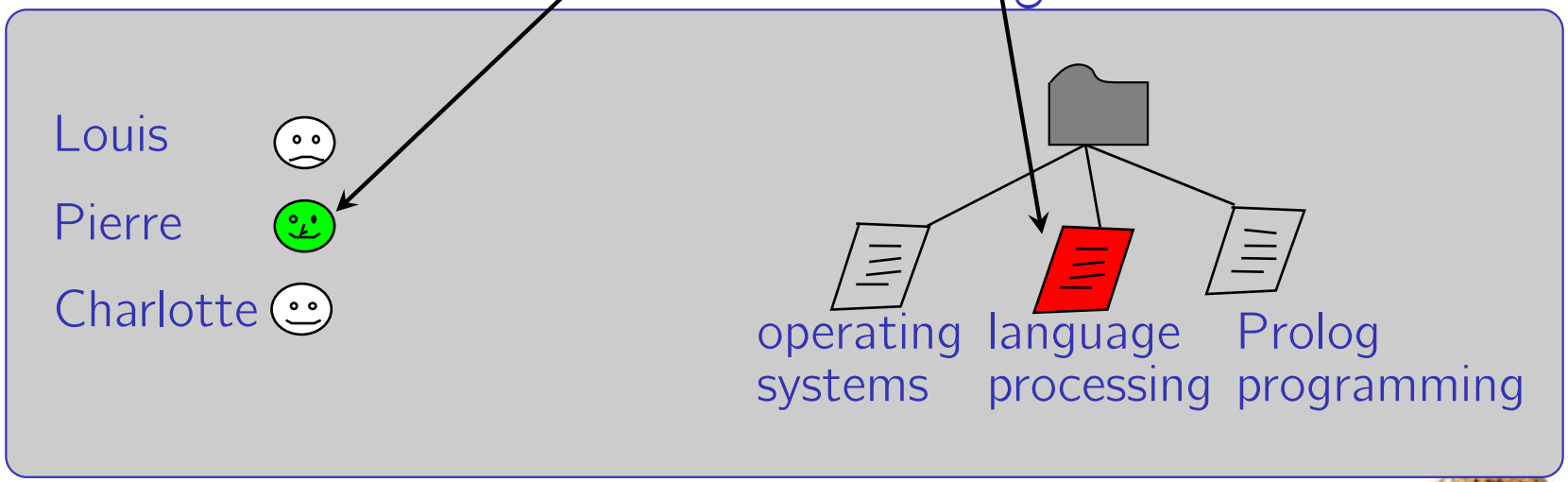
1. **note** (*noun*) short piece of writing;
2. **note** (*noun*) a single sound at a particular level;
3. **note** (*noun*) a piece of paper money;
4. **note** (*verb*) to take notice of;
5. **note** (*noun*) of note: of importance.

Reference

1. Sentence
Pierre wrote notes

2. Logical representation
`wrote(pierre, notes)`

3. Real world



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 general, language processing requires significant processing power;
- This overall resulted in massive improvements in most areas of NLP.

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

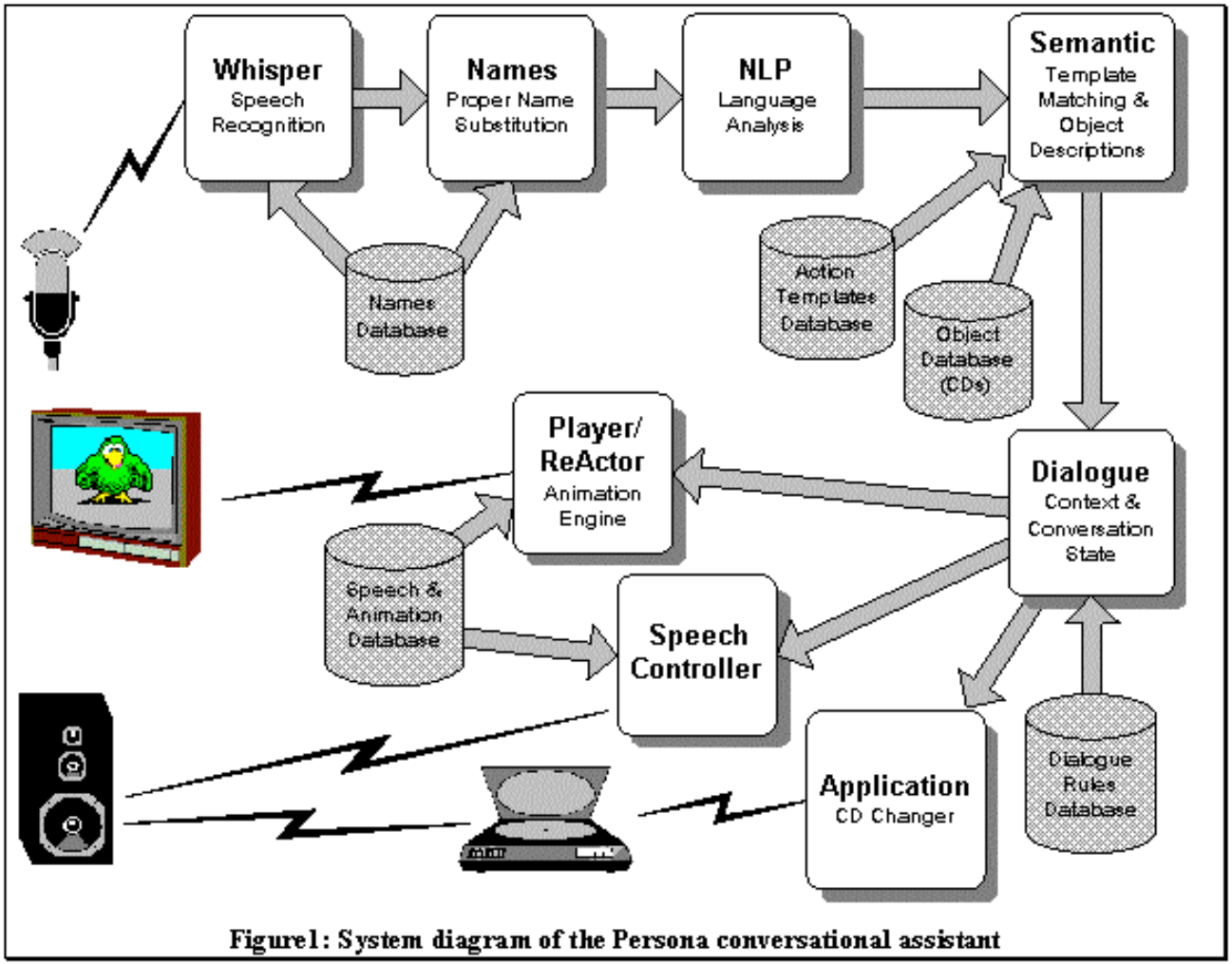


Figure1: System diagram of the Persona conversational assistant

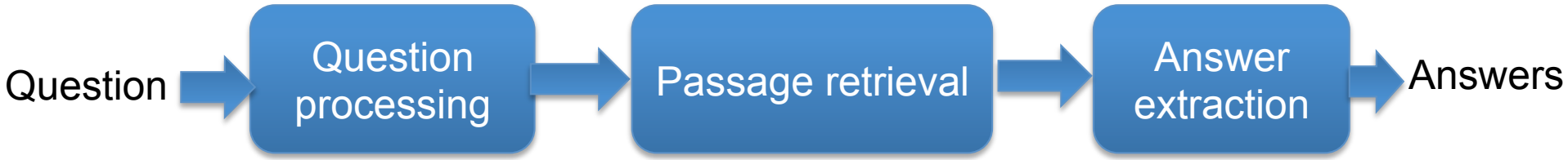
Source: http://research.microsoft.com/research/pubs/view.aspx?pubid=439

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