Language Technology I

Introduction

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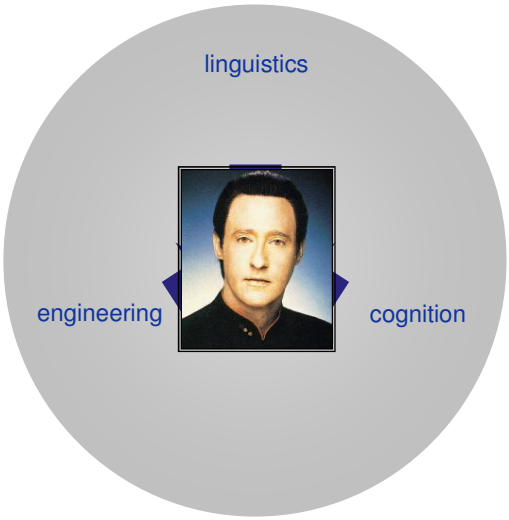
Overview

- What is Language Technology?
- Some Selected Technologies
- Methods
- State of the Art
- Maturity of Technologies
- Megatrends

Motivations



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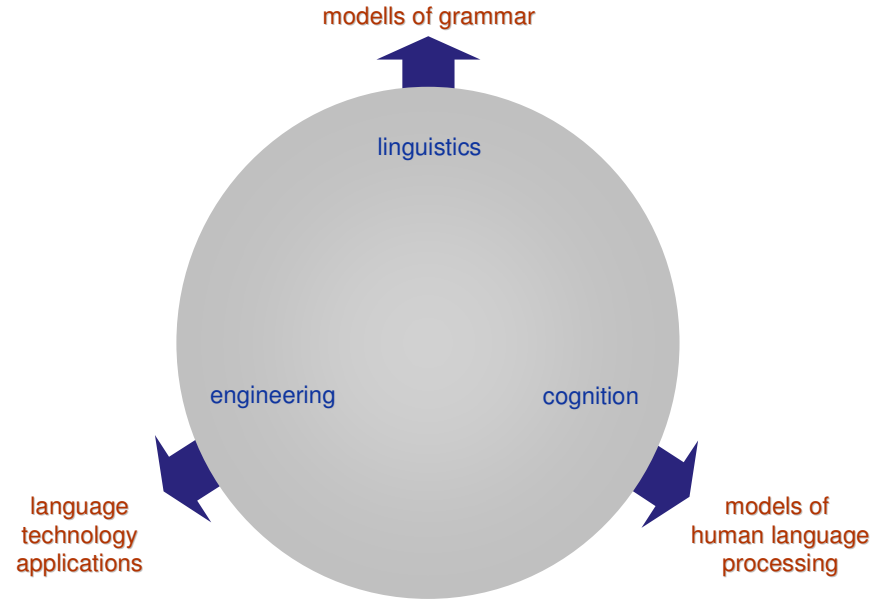


What is a Technology

Technology: methods and techniques that together enable some application.

In real life usage of the word there is a continuum between methods and applications.

method/technique	finite state transduction
component technology	tokenizer
technology	named entity recognition
	high precision text indexing
application	concept based search engine

Types of Technologies

Communication partners: humans and machines (technology),
humans and humans
humans and infostructure

Modes and media for input and output: text, speech, pictures, gestures

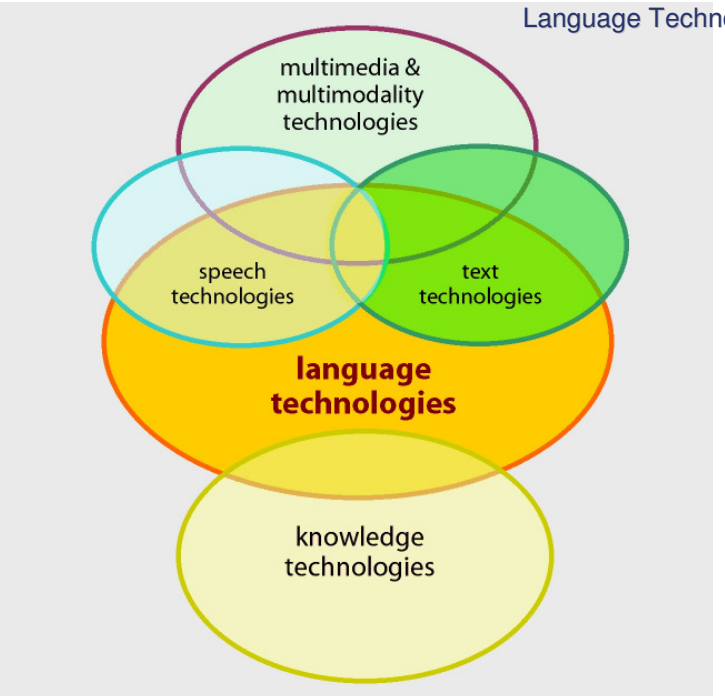
Synchronicity: synchronous vs. asynchronous

Situatedness: sensitivity to context, location, time, plans

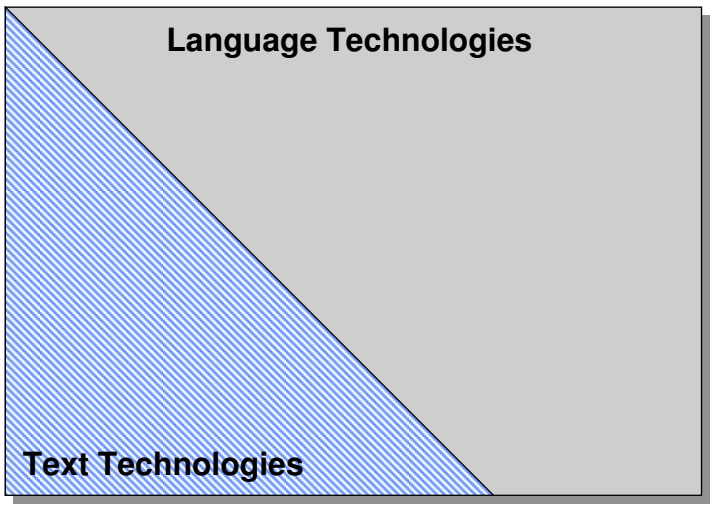
Type of linguality: monolingual, multilingual, translingual

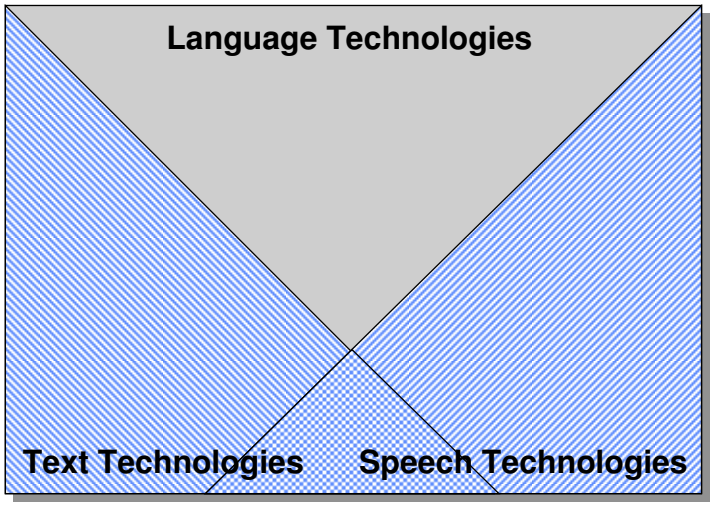
Type of processing: Categorization, summarization, extraction, understanding, translating, responding

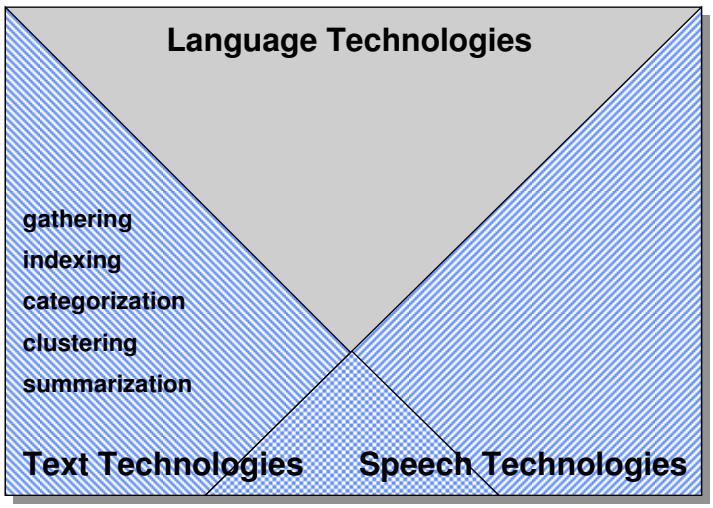
Level of linguistic description: phonology, morphology, syntax, semantics, pragmatics

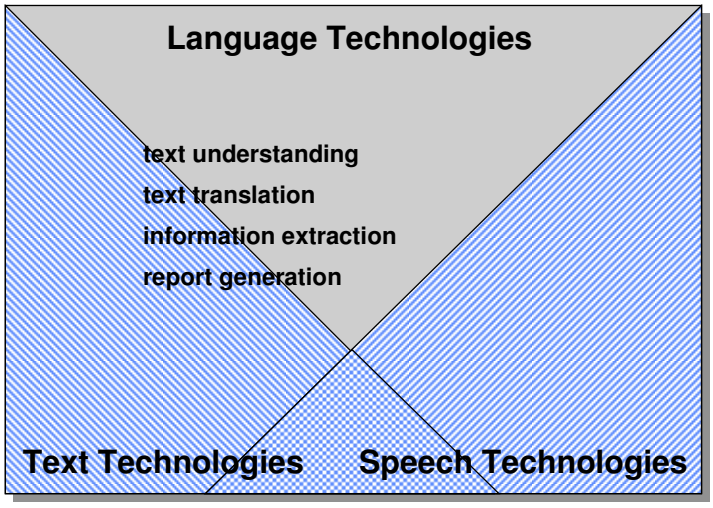


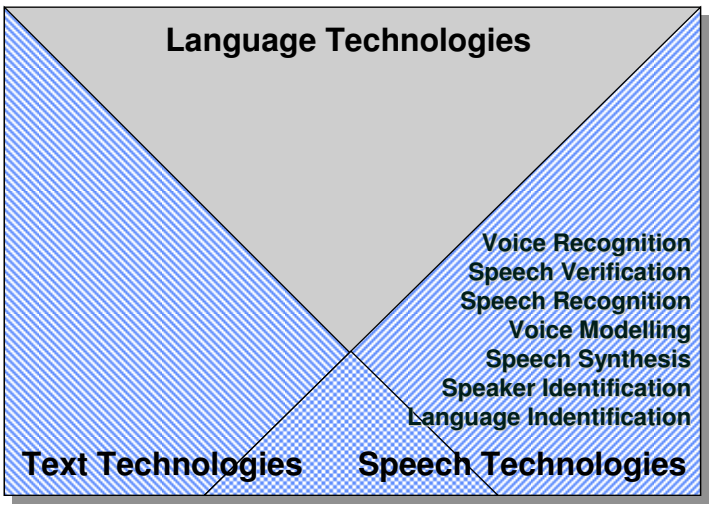
Language Technologies

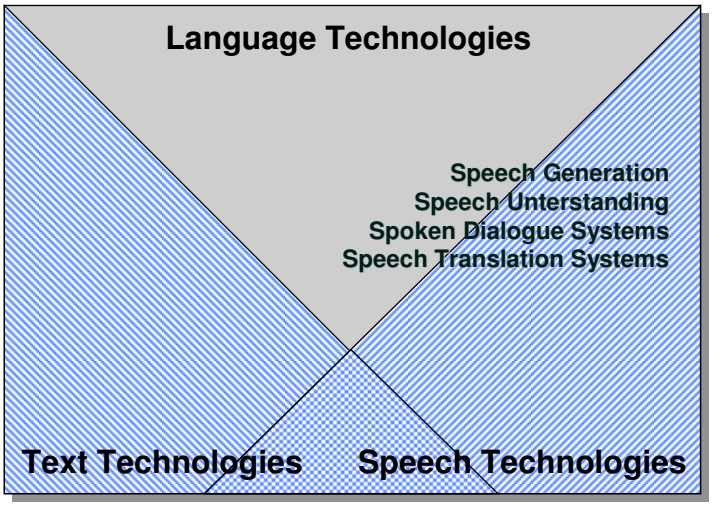


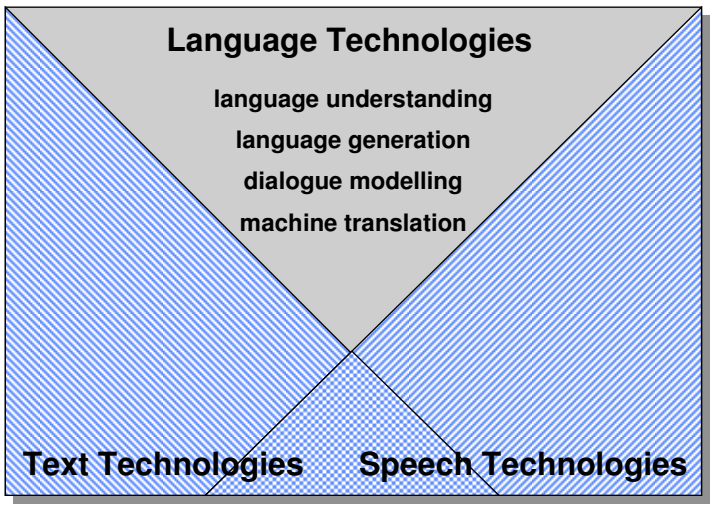






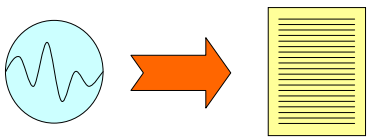






Speech recognition

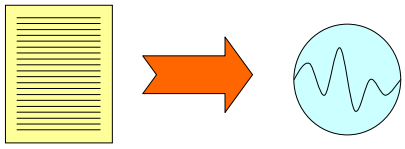
Spoken language is recognized and transformed into text as in dictation systems, into commands as in robot control systems, or into some other internal representation.



Speech Synthesis

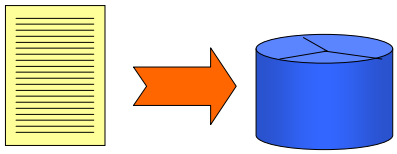
(also Speech Generation)

Utterances in spoken language are produced from text (text-to-speech systems) or from internal representations of words or sentences (concept-to-speech systems)



Text Categorization

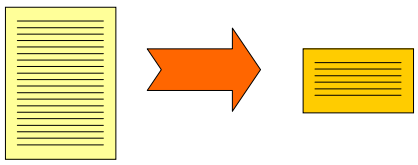
Texts are assigned to given categories. Texts may belong to more than one category, categories may contain other categories. *Filtering* is a special case of categorization with just two categories.



Text Summarization

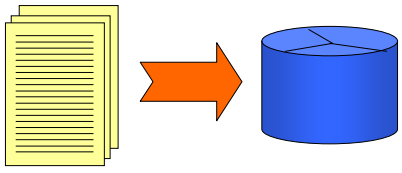
The most relevant portions of a text are extracted as a summary. The task depends on the needed lengths of the summaries. Summarization is harder if the summary has to be specific to a certain query or has to be in a different language.

(Summarization differs from *abstract generation*, which is subsumed under *language generation*)



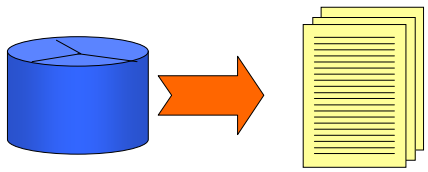
Text Indexing

As a precondition for document retrieval, texts are stored in an indexed database. Usually a text is indexed for all word forms or – after lemmatization – for all lemmas. Sometimes indexing is combined with categorization and summarization.



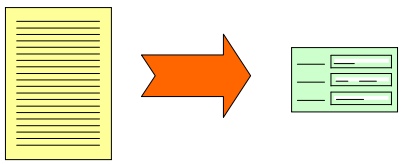
Text Retrieval

Texts are retrieved from a database that best match a given query or document. The candidate documents are ordered with respect to their expected relevance. Indexing, categorization, summarization and retrieval are often subsumed under the term *information retrieval*.



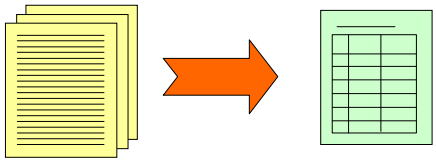
Information Extraction

Relevant pieces of information are discovered and marked for extraction. The extracted pieces can be: the topic, named entities such as company, location or person names, simple relations such as prices, destinations, functions etc. or complex relations describing accidents, company mergers or football matches.



Data Fusion and Text Data Mining

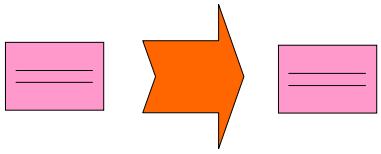
Extracted pieces of information from several sources are combined into one database. Previously undetected relationships may be discovered.



Question Answering

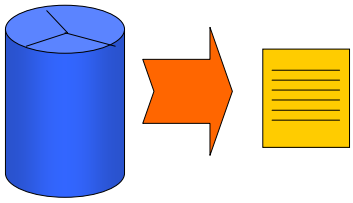
Natural language queries are used to access information in a database. The database may be a base of structured data or a repository of digital texts in which certain parts have been marked as potential answers.

QA on the WWW triggers search engines and exploits their results.



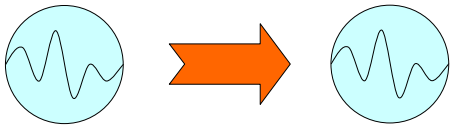
Report Generation

A report in natural language is produced that describes the requested contents or changes of a database. The report can contain accumulated numbers, maxima, minima and the most drastic changes.



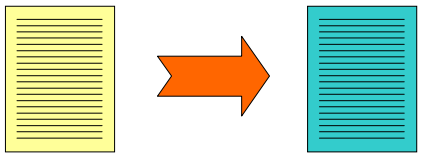
Spoken Dialogue Systems

The system can carry out a dialogue with a human user in which the user can solicit information or conduct purchases, reservations or other transactions.



Translation Technologies

Technologies that translate texts or assist human translators. Automatic translation is called machine translation. Translation memories use large amounts of texts together with existing translations for efficient look-up of possible translations for words, phrases and sentences.



Formal and Computational Methods

Generic CS Methods

Programming languages, algorithms for generic data types, and software engineering methods for structuring and organizing software development and quality assurance.

Specialized Algorithms

Dedicated algorithms have been designed for parsing, generation and translation, for morphological and syntactic processing with finite state automata/transducers and many other tasks.

Non-discrete Mathematical Methods

Statistical techniques have become especially successful in speech processing, information retrieval, and the automatic acquisition of language models. Other methods in this class are neural networks and powerful techniques for optimization and search.

Linguistic Methods and Resources

Logical and Linguistic Formalisms

For deep linguistic processing, constraint-based grammar formalisms are employed. Complex formalisms have been developed for the representation of semantic content and knowledge.

Linguistic Knowledge

Linguistic knowledge resources for many languages are utilized: dictionaries, morphological and syntactic grammars, rules for semantic and pragmatic interpretation, pronunciation and intonation.

Corpora and Corpus Tools

Large collections of application-specific or generic spoken and written language sources are exploited for the acquisition, testing and formal evaluation of statistical or rule-based language models.

Methods from Cognitive Science (Psychology)

Models of Cognitive Systems and their Components

The interaction of perception, knowledge, reasoning and action including communication is modeled in cognitive psychology. Such models can be consulted or employed for the design of language processing systems. Formalized models of components such as memory, reasoning and auditive perception are also often utilized for models of language processing.

Empirical methods from Experimental Psychology

Since cognitive psychology investigates the intelligent behavior of human organisms, many methods have been developed for the observation and empirical analysis of language production and comprehension. Such methods can be extremely useful for building computer models of human language processing (Examples: "Wizard of Oz Experiments" and measurements of syntactic and semantic processing complexity).

State of the Art

95%-98%	Correct recognition of word categories (part-of-speech tagging)
85%-98%	Recognition of names of people, companies, places, products (named entity recognition)
95%	Statistical recognition of major phrases (HMM chunk parsing)
91%	Parsing of newspaper texts by statistically trained parsers (probabilistic context-free parsing)
40%-60%	Deep parsing of newspaper texts (HPSG or LFG parsing with large lexicon)

Maturity of Speech Technologies

Voice Control Systems

Dictation Systems

Text-to-Speech Systems

Machine Initiative Spoken Dialogue Systems

Identification and Verification Systems

Spoken Information Access

Mixed Initiative Spoken Dialogue Systems

Speech Translation Systems

Deployed. On the market
Mature or close to maturity
Research prototypes in R&D

Maturity of Text Technologies

Spell Checkers
Machine-Assisted Human Translation
Translation Memories
Indicative Machine Translation

Grammar Checkers
Information Extraction
Human Assisted Machine Translation
Report Generation

High Quality Text Translation
Text Generation Systems

Deployed. On the market
Mature or close to maturity
Research prototypes in R&D

Maturity of IM Technologies

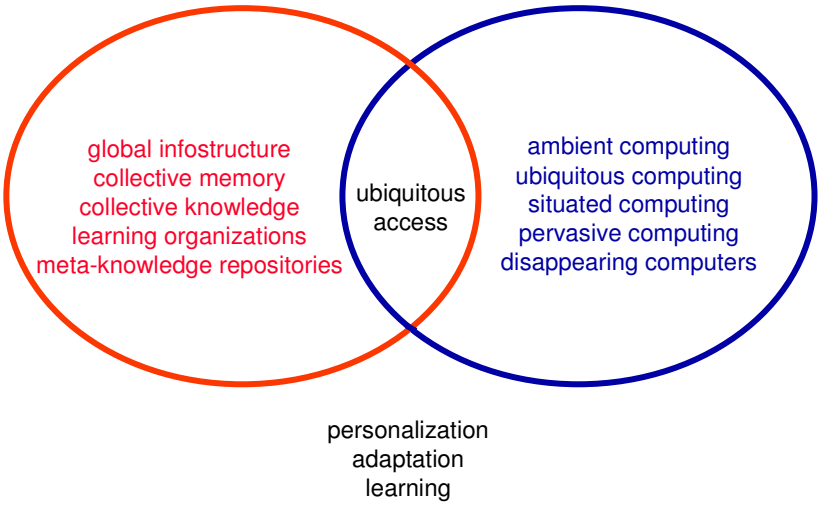
Word-Based Information Retrieval
Summarization by Simple Condensation
Simple Statistical Categorization
Simple Automatic Hyperlinking

Cross-Lingual Information Retrieval
Automatic Hyperlinking With Disambiguation
Simple Information Extraction (Unary, Binary Relations)

Complex Information Extraction (Ternary+ Relations)
Dense Associative Hyperlinking
Concept-Based Information Retrieval
Text Understanding

Deployed. On the market
Mature or close to maturity
Research prototypes in R&D

MEGATRENDS



personalization
adaptation
learning