


NATURAL LANGUAGE PROCESSING

LESSON 10 : DIALOGUE SYSTEMS AND QUESTION ANSWERING


OUTLINE

- **Dialogue Systems**
 - Overview of Dialogue Systems
 - Types of Dialogue Systems
 - Dialogue System Components
 - Example Systems
- **Question Answering**
 - Overview of Question Answering
 - Types of Question Answering
 - Question Answering Components
 - Question Answering in TREC

OVERVIEW OF DIALOGUE SYSTEMS


- Interview between a person or something else (e.g. computer).
 - Dialog systems are computer-based systems that are able to converse with human beings in a similar manner to how one human speaks with another.
 - These programs communicate with users in natural language (text, speech, or even both)
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APPLICATIONS OF DIALOGUE SYSTEMS

- Responding to customers' questions
 - Customer service agent knowledge base
 - Guided selling
 - Help desk
 - Website navigation
 - Technical support
 - Personalized service
 - Training or education
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TYPES OF DIALOGUE SYSTEMS

These programs generally fall into two classes.

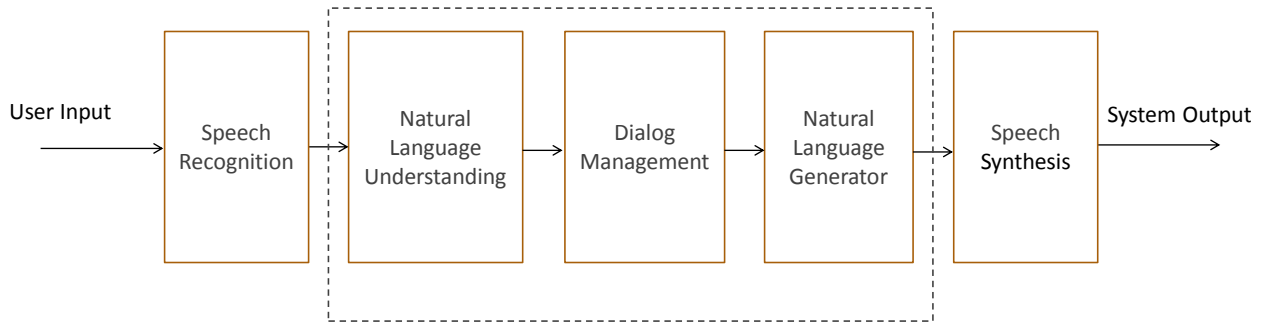
- **Task-oriented dialogue agents:** are designed for a particular task and set up to have short conversations .
 - **Chatbots:** are systems designed for extended conversations.
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TYPES OF DIALOGUE SYSTEMS

Dialog systems can be classified as follows:

- **text-based system:**
Input and output based on the text
 - **spoken-based system:**
A computer system that can speak with a voice
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DIALOGUE SYSTEM COMPONENTS



SPEECH RECOGNITION

- Involves the conversion of **Spoken Sounds** (user utterances) to **Text** (a string of words)
- Requires knowledge of **Phonetics** and **Phonology**
- Challenges:
 - Variability in speech signal due to the language, speaker and channel.
 - Handling continuous spontaneous speech.

NATURAL LANGUAGE UNDERSTANDING

- Converts a sequence of words into a **Semantic Representation** that can be used by the Dialogue Manager.
- NLU is used to obtain the semantic content of the sequence of words provided by the ASR module.
- NLU is applied in several fields
 - text processing and stylistic correction,
 - intelligent writing assistance (detection of writing errors),
 - database interfaces
 - information extraction etc.
- Using syntactic and semantic Analysis.

NATURAL LANGUAGE UNDERSTANDING

Dialogue acts is what the user tries to reach by saying their words.

«Telefon numarasını istiyorum.»

«Telefon numarası nedir?»

Consisting of 4 major classes:

- Constatives
- Directives
- Commissive
- Acknowledgments



COMMISSIVES

- Committing the speaker to some future course of action

«I will have dinner at a restaurant tomorrow.» (plan)



CONSTATIVES

- Committing the speaker to something's being the case

«S: So, you are looking for a restaurant. What type of food do you like? »

«U: I'd like an Italian somewhere near the museum.» (inform)




DIRECTIVES

- Attempts by the speaker to get the addressee to do something

«S: 'Roma' is a nice Italian restaurant near the museum.»

«U: What is the phone number?» (request)



ACKNOWLEDGMENTS

- Express the speaker's attitude regarding the hearer with respect to some social action.

«Ok, thank you goodbye.» (thanking)

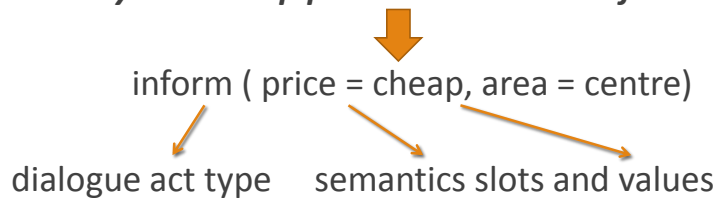


NATURAL LANGUAGE UNDERSTANDING

One simple dialogue act formalism would consist of:

- **dialogue act type** - encodes the system or the user intention in a (part of) dialogue turn
- **semantic slots and values** - further describe entities from the ontology that a dialogue turn refers to

«Is there maybe a cheap place in the centre of town please? »




DIALOGUE MANAGER

- It is a “brain” of an dialogue systems.
- “Manages” all the aspects of the dialogue.
- The dialogue manager can be regarded as the executive controller of the dialogue system, it is this component that holds the current state of the dialogue and makes decisions about the system’s behaviour.


INPUT	OUTPUT
Order (From=X, To=Y, Date=2012-01-01)	TELL (flight-num=123, flight-time=12: 34)

DIALOGUE MANAGER APPROACHES

- **Rule Based Systems:** hand-built rules
 - **Corpus Based Systems:** focus on single responses while ignoring context or larger conversational goals
 - **Frame Based Systems :** central data structure is frame with slots
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DIALOGUE MANAGER

The most common tasks of the dialogue manager can be divided into three groups:

- **Contextual interpretation**
 - **Domain knowledge management**
 - **Action selection**
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CONTEXTUAL INTERPRETATION

S.1: *When do you want to go*



U.2: On Wednesday

S.3: *Where do you want to go?*

U.4: Paris

- U.4 would be transformed into the semantic representation of “**I want to go to Paris**”.
 - Another solution is to open a **semantic slot** when an elliptical utterance is expected. 
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DOMAIN KNOWLEDGE MANAGEMENT

- It includes models and mechanisms for reasoning about the domain and for accessing external information sources. 
 - System must have a semantic representation of the world which can be mapped to natural language.
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ACTION SELECTION

- It is to make decisions about what the dialogue system should do next.
- Dialogue history and contextual play an important role.

INITIATIVE TYPES

User Initiative	<p>User: I want to travel from New York to Chicago by flight.</p> <p>System: There are 10 flights daily.</p> <p>User: I need a non-stop flight in the morning.</p>
System Initiative	<p>System: Please state your origin and destination city.</p> <p>User: I want to travel from New York to Chicago.</p> <p>System: Would you like a non-stop flight?</p> <p>User: Yes.</p>

ERROR HANDLING

Explicit Confirmation	<p>User: I want to travel from New York to Chicago by flight.</p> <p>System: So, you want to go to Chicago from New York? Please answer yes or no.</p> <p>User: Yes.</p>
Implicit Confirmation	<p>User: I want to travel from New York to Chicago by flight.</p> <p>System: Do you want a morning flight from New York to Chicago or an evening flight?</p> <p>User: Morning flight</p>


NATURAL LANGUAGE GENERATION

- Involves constructing the message that is to be spoken to the user.
- The NLG component takes the semantic representation of a communicative act from the system and generates a textual representation,
- Requires the making of decision regarding:
 - Content planning (what to say)
 - Sentence realization (how to say it)




Input	Output
inform(phone=x)	The phone number is x

SPEECH GENERATION

- Translates the message constructed by the response generation component into spoken form.
 - Two approaches may be used:
 - Prerecorded canned speech may be used with spaces to be filled by retrieved or previously recorded samples.
 - Text-to-speech synthesis
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EXAMPLE SYSTEMS - Eliza

- Written by Joseph Weizenbaum in the mid-1960s
 - Simulation of a psychotherapist.
 - User types questions, and ELIZA responds.
 - Produce response based on analysis of input
 - Transform input to change the point of view (I and you)
 - Perform pattern recognition (pattern matching)
 - Substitute keywords into canned phrases, or submit a general canned phrase
- 


EXAMPLE SYSTEMS - Eliza

User: Men are all like
ELIZA: In what way?
User: They're always bugging us about something
ELIZA: Can you think of a specific example?
User: Well, my boyfriend made me come here.
ELIZA: Your boyfriend made you come here.
User: Yes, he says I'm depressed much of the time.


EXAMPLE SYSTEMS - AutoTutor

- It poses questions or problems that require approximately a paragraph of information to answer. 
- Latent semantic analysis
- It has Curriculum script repository: ideal answer, misconceptions
- Corpus of documents: textbook
- Glossary: technical terms and definitions
- Dialogue management: finite state machine

OVERVIEW OF QUESTION ANSWERING


- Dialog systems are computer-based systems that are able to converse with human.
 - Dialog history is important.
 - Question answering is a system that gives an extract answer to the question asked by the user.
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OVERVIEW OF QUESTION ANSWERING

- Question-Answering (QA) is a technique used to extract information from the web or structured database based on the dialogue system.
 - The main aim of QA is to present the user with a short answer to a question rather than a list of possibly relevant documents.
 - A question answering system should retrieve **a short snippet of text** which exactly answer the question asked.
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OVERVIEW OF QUESTION ANSWERING

QA research attempts to deal with a wide range of question types including: fact, list, definition, how, why, hypothetical, semantically constrained, and cross-lingual questions.

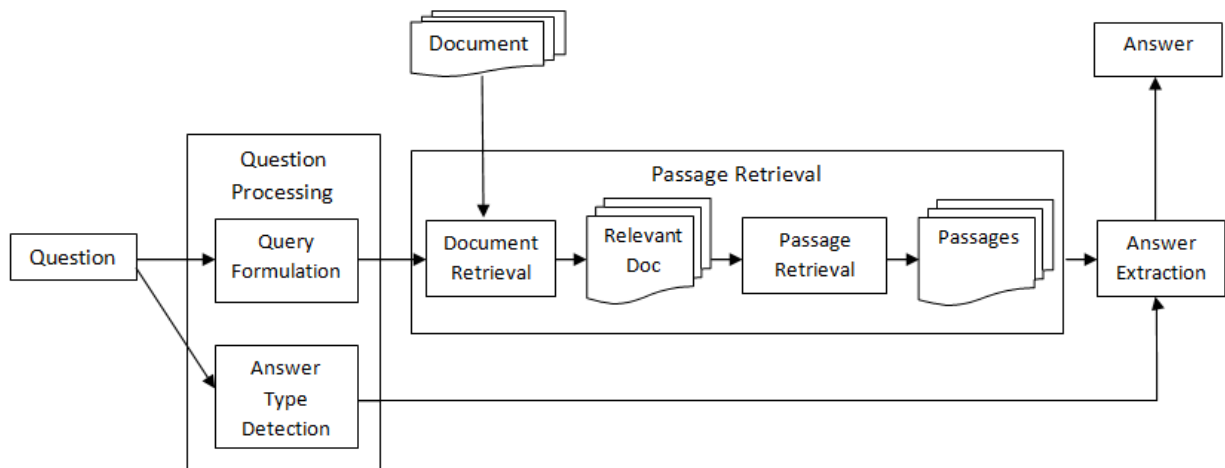
- Closed-domain question answering
 - Open-domain question answering
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OVERVIEW OF QUESTION ANSWERING

The major modern paradigms of question answering:

- **IR-based question answering:** Information retrieval (IR) techniques extract passages directly from documents, guided by the text of the question.
 - **Knowledgebased question answering**
When was Ada Lovelace born? → birth-year (Ada Lovelace, ?x)
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IR-BASED QUESTION ANSWERING



QUESTION PROCESSING

The goal of the question-processing phase is to extract a number of pieces of information from the question.

This leads to the following steps:

- Classification of Question
- To obtain keywords, tokens etc from the question which will further used to generate Query Frames.

QUESTION PROCESSING

Which US state capital has the largest population?



The query processing should produce results like the following:

Answer Type: city

Query: US state capital, largest, population

QUESTION CLASSIFICATION

- The task of **question classification** or **answer type recognition** is to determine the classification answer type answer type, the named-entity or similar class categorizing the answer.
- If the question starts with Who or Whom, QType is **PERSON**.
- If the question starts with Where, QType is **LOCATION**.

QUERY FORMULATION

- Query formulation is the task of creating from the question a list of keywords that form a query that can be sent to an information retrieval system.

Wh-word did A verb B → . . A verb+ed B

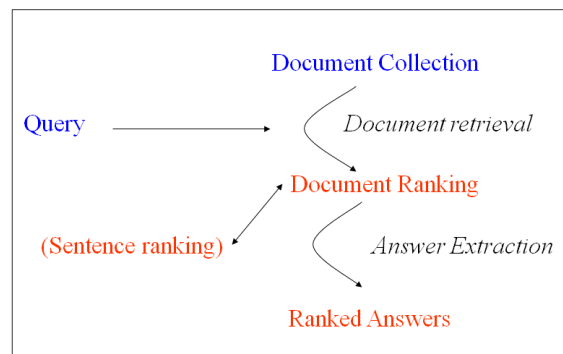
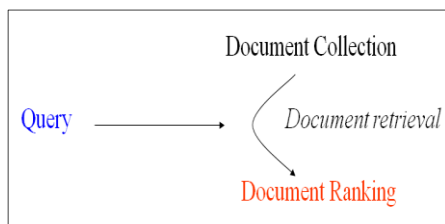
Where is A → A is located in

When was the laser invented? → the laser was invented

Where is the Valley of the Kings? → the Valley of the Kings is located in


PASSAGE RETRIEVAL

- Identify relevant documents, and within relevant documents, identify the passages most likely to contain the answer to the question.



PASSAGE RETRIEVAL

Passage ordering is performed using a sort that involves scores (answer ranking):

- The number of **named entities** of the right type in the passage
 - The number of **question keywords** in the passage
 - The longest exact sequence of question keywords that occurs in the passage
 - The rank of the document from which the passage was extracted
 - The **proximity** of the keywords from the original query to each other
 - The **N-gram overlap** between the passage and the question
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ANSWER EXTRACTION

- The final stage of question answering is to extract a specific answer from the passage.

«How tall is Mt. Everest?»


- Answer-type pattern extraction** has been applied to the answer-extraction task.
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ANSWER EXTRACTION

- Question: Name the first private citizen to fly in space.
 - Answer type: **Person**
 - Text passage: “Among them was **Christa McAuliffe**, the first private citizen to fly in space. Karen Allen, best known for her starring role in “Raiders of the Lost Ark”, plays **McAuliffe**. **Brian Kerwin** is featured as shuttle pilot **Mike Smith**...”
 - Best candidate answer: **Christa McAuliffe**
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ANSWER EXTRACTION

We extract potential answers by a classifier used features like the following:

- Answer type match
 - Pattern match
 - Number of matched question keywords
 - Keyword distance
 - Apposition features
 - Punctuation location:
 - Sequences of question terms
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KNOWLEDGE-BASED QUESTION ANSWERING

- We use the term knowledge-based question answering for the idea of answering a natural language question by mapping it to a query over a structured database.
- Systems for mapping from a text string to any logical form are **called semantic parsers**.

Subject	Predicate	object
Ada Lovelace	birth-year	1815

Question	Logical Form
When was Ada Lovelace born?"	birth-year (Ada Lovelace, ?x)

QUESTION ANSWERING IN TREC

- Text Retrieval Conferences (TREC)
- A common evaluation metric is **mean reciprocal rank (MRR)**.
- Question answering at TREC consists of answering a set of fact based questions
- A competition where subject-independent question-and-answer systems compare to each other
- The aim of it is to have access to answers in large texts.

$$\text{MRR} = \frac{1}{N} \sum_{i=1 \text{ s.t. } \text{rank}_i \neq 0}^N \frac{1}{\text{rank}_i}$$