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Week 12

Human-Robot Interaction

Exam Revision

**UWE
Bristol**

University
of the
West of
England

Main topics for written exam

- Human factors
- HRI System design
- User study design
- Social signal processing
- Natural language processing
- Dialogue systems
- Symbolic reasoning and decision making

Human Factors

Human Factors

- Example questions
 - Discuss the human factors issues that could be related to using a robot as a support for a therapist.
 - Name two examples of human characteristics that could be impaired and how these impairments could be improved by a multimodal human-robot interaction.

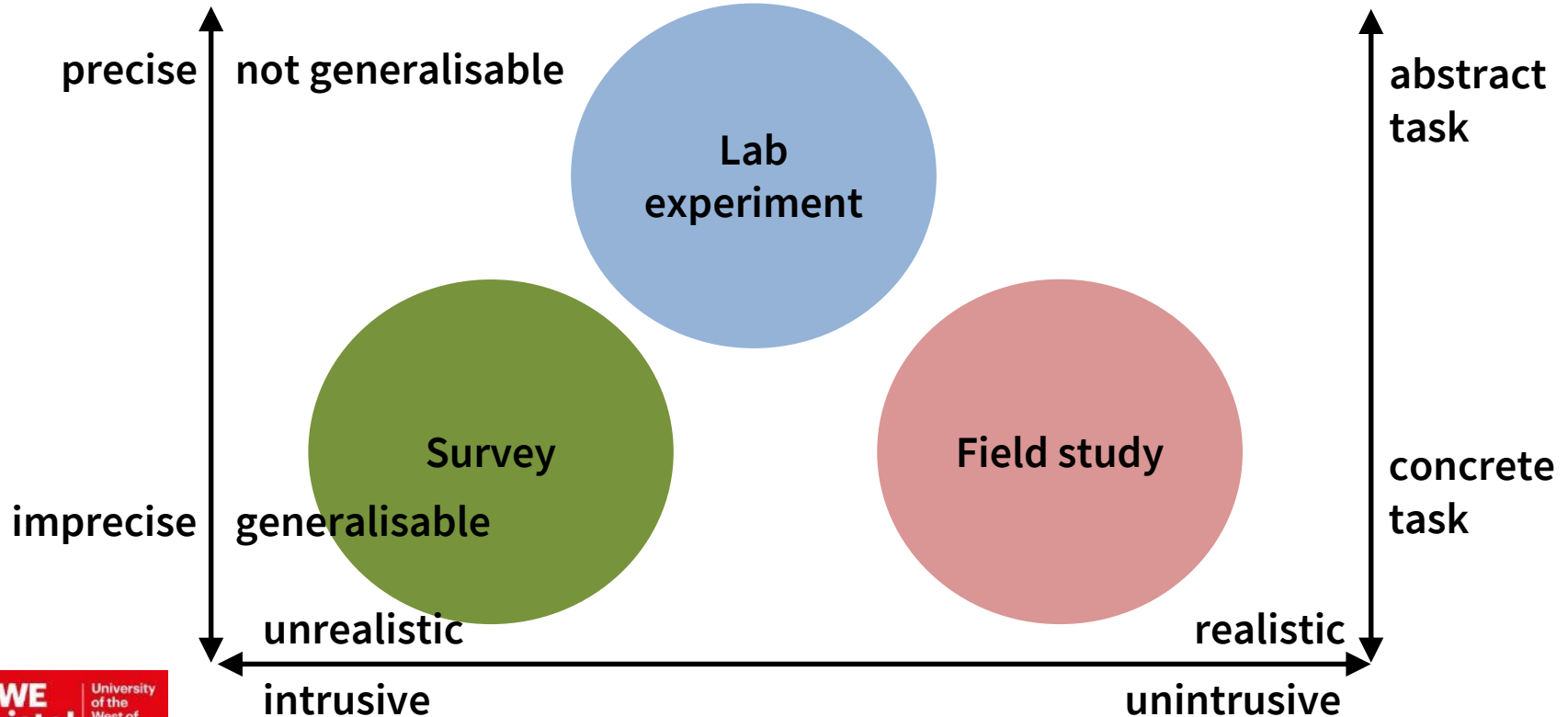
HRI System Design

HRI System Design

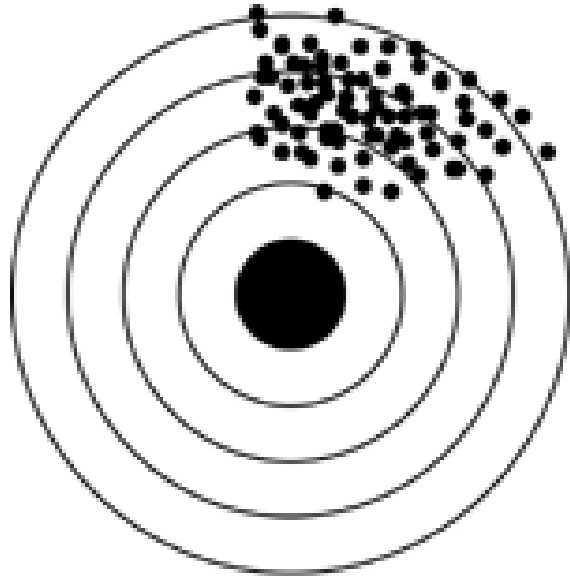
- Example questions
 - What are the key stages of a user-centred design process?
 - How does using a user-centred design process influence the design of a novel HRI system?

User Study Design

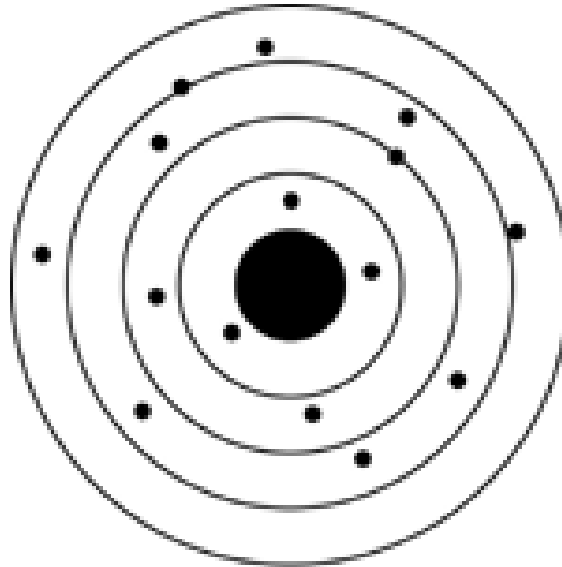
User study methods



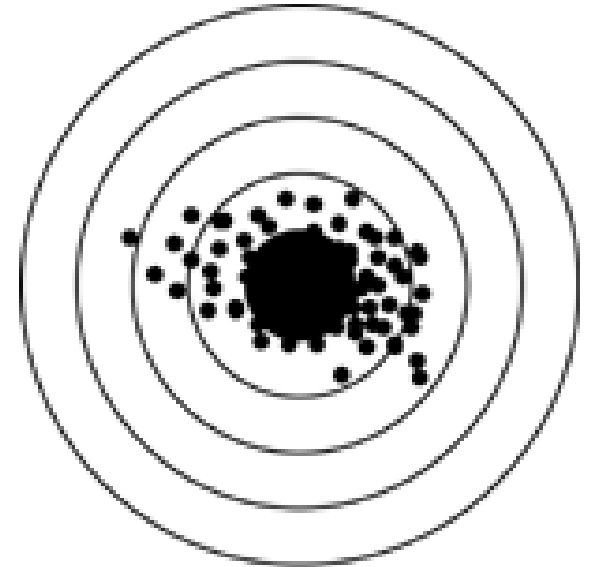
Validity and reliability



Reliable but Not Valid



Valid but Not Reliable



Valid and Reliable

Controlled experiments

- Hypothesis
- Independent variables
- Dependent variables
- Experiment design

User Study Design

- Example questions
 - Name and discuss possible influences on internal and external validity?
 - Imagine you have to design a controlled experiment to test whether a robot with a personality is preferred over a neutral robot. How would the hypotheses, variables and design of this experiment look like?

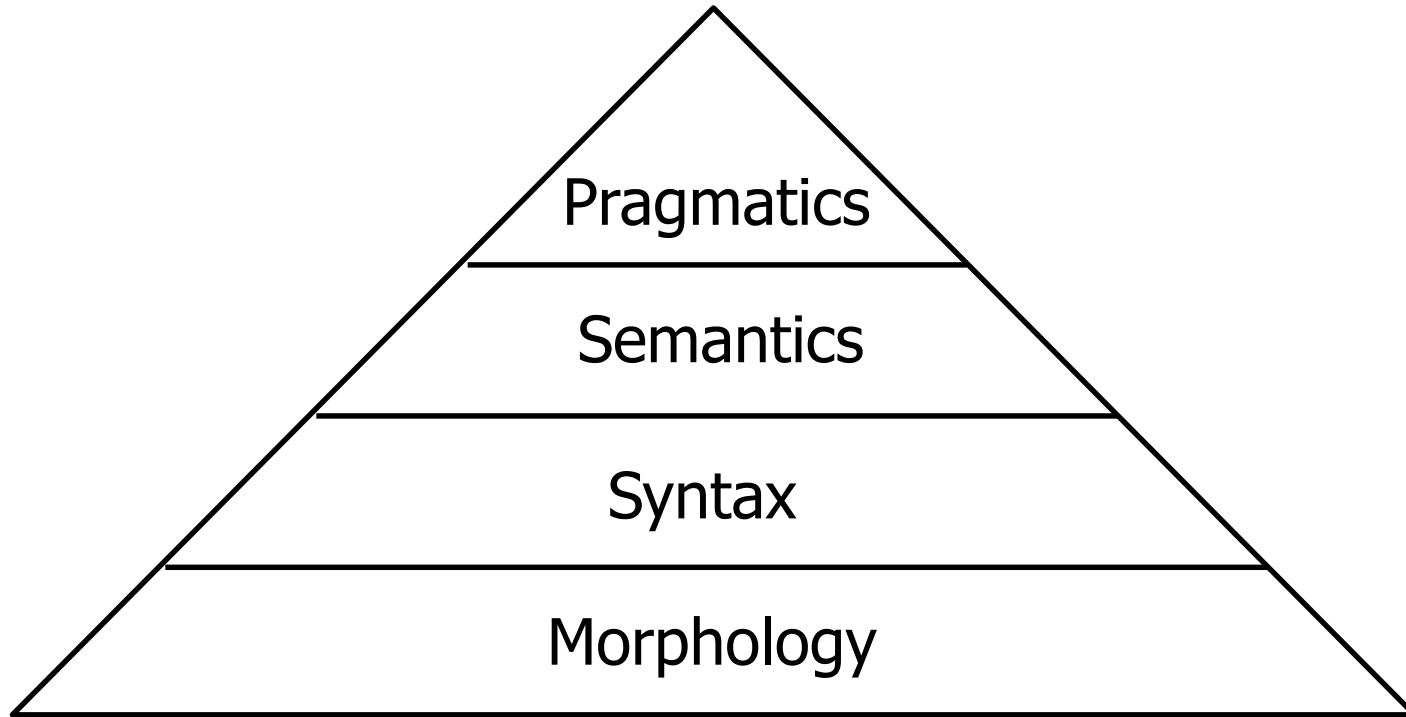
Social Signal Processing

Social Signal Processing

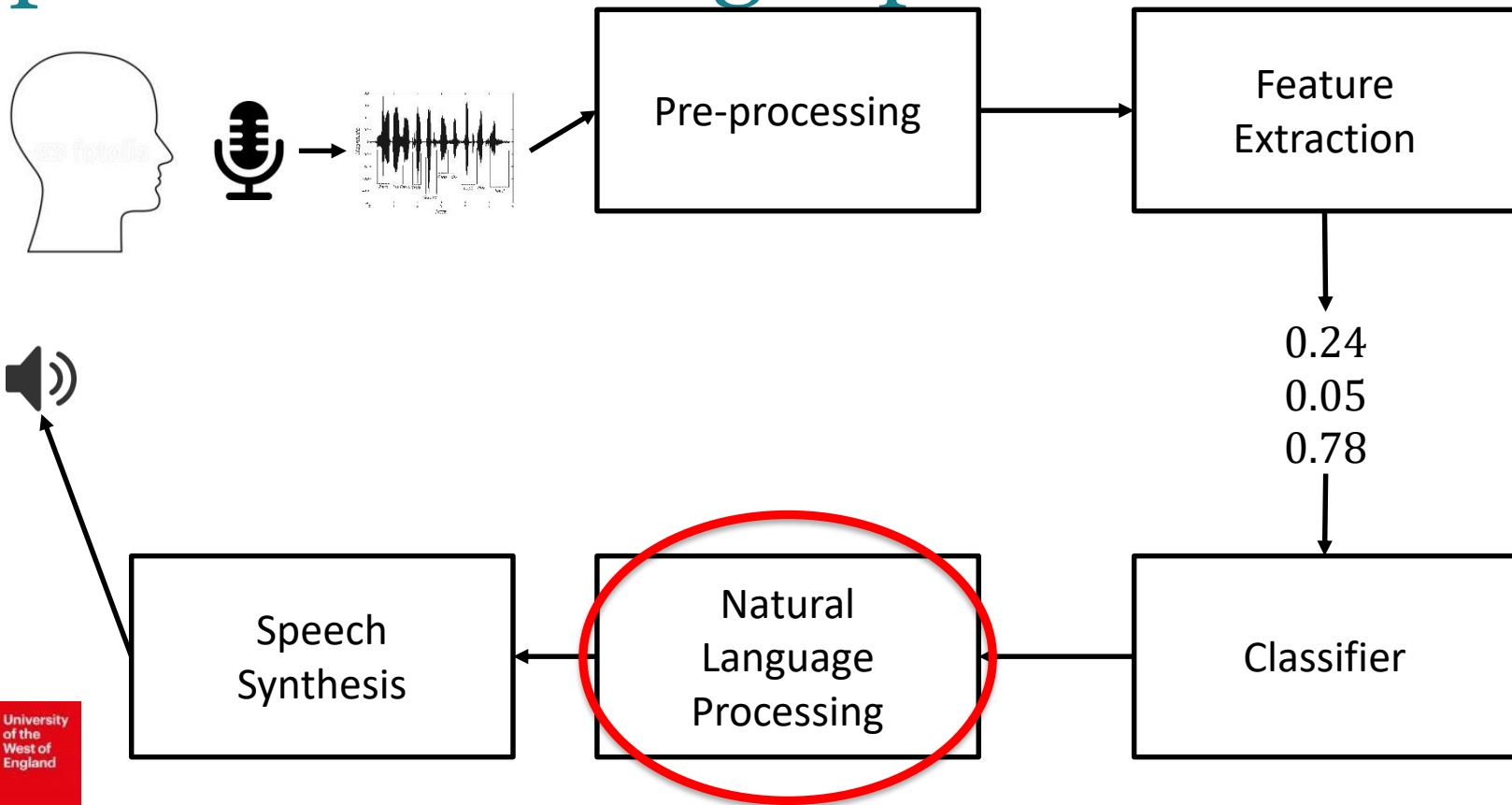
- Example questions
 - What are typical social signals that humans are using in everyday communication?
 - What are the typical pre-processing steps for analysing hand gestures and what algorithms would you use to classify the signal?

Natural Language Processing

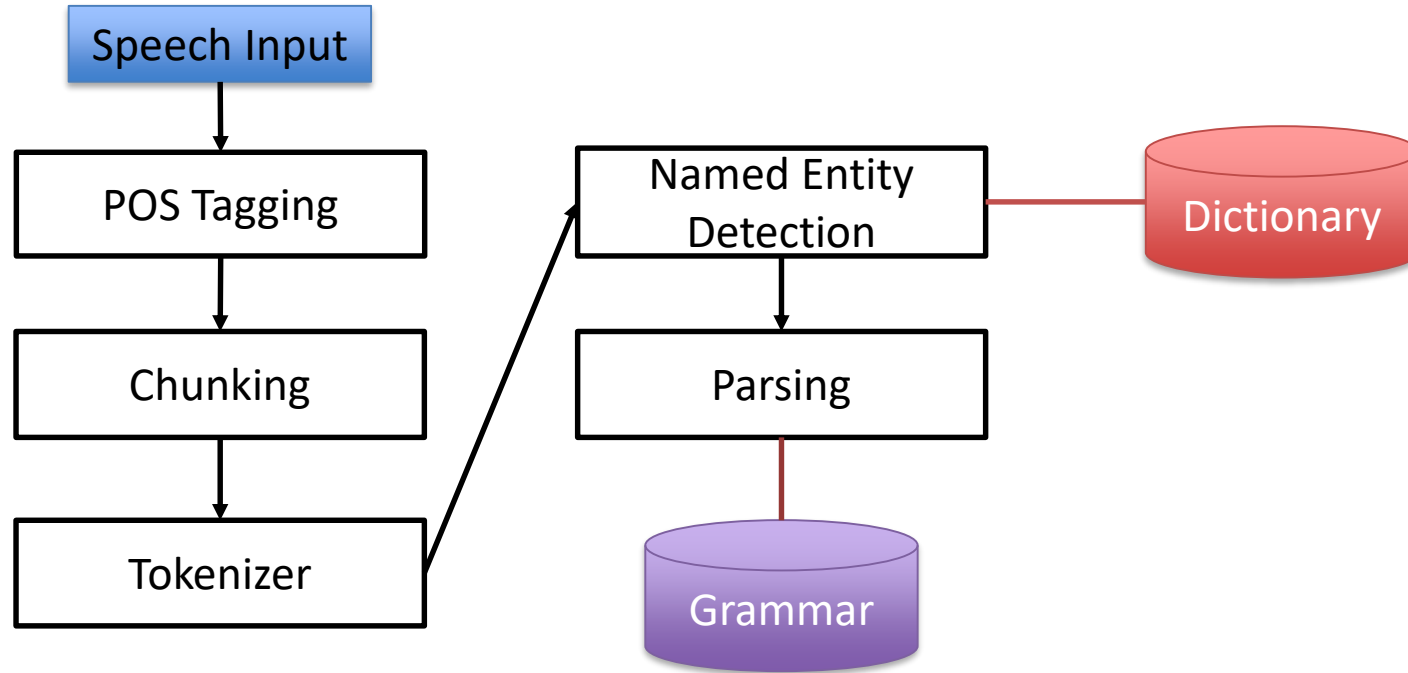
NLP Pyramid



Speech Processing Pipeline



Syntactic NLP



Natural Language Processing

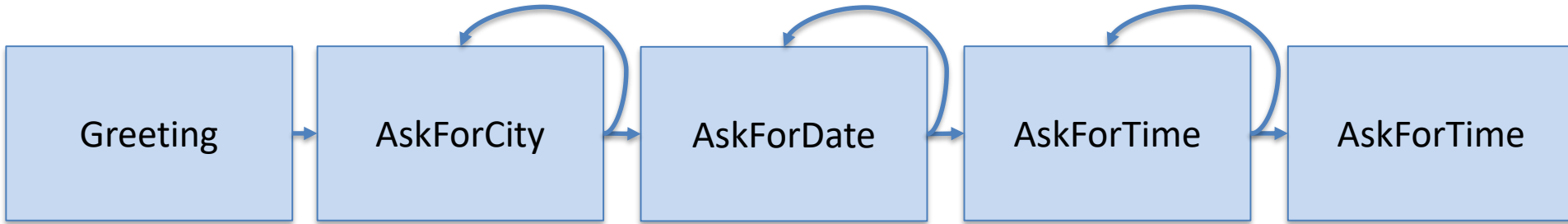
- Example questions
 - Name the basic building blocks of language processing system and describe them.
 - Name three ways to process speech syntactically.
 - What is the difference between semantics and syntax?

Dialogue Systems and Speech Synthesis

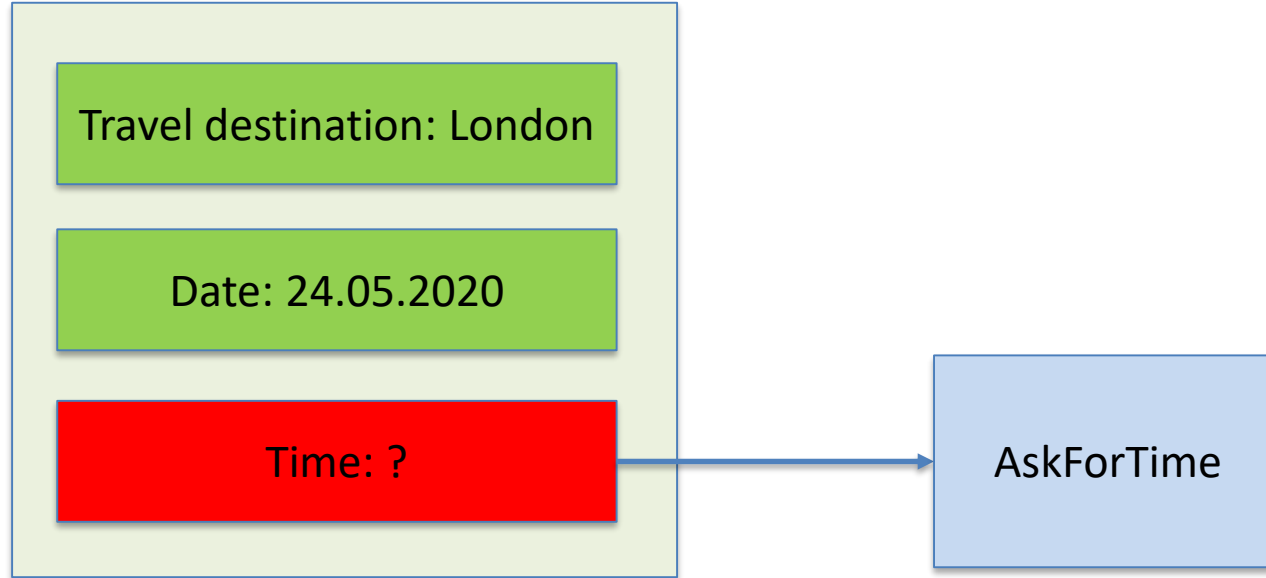
Dialogue Systems

- Systems that plan a dialogue with a human user
- Often used in
 - Automated telephone services
 - Chatbots
 - Virtual assistants
 - Multimodal systems (e.g. Speech input in maps)
 - Human-robot interaction
- Dialogue system types
 - Finite state-based systems
 - Frame-based systems
 - Agent-based systems

Finite State-Based System



Frame-Based System



Agent-Based System

User: *I'm looking for a job in the Calais area. Are there any servers?*

System: *No, there aren't any employment servers for Calais. However, there is an employment server for Pas-de-Calais and an employment server for Lille. Are you interested in one of these?*

Speech Synthesis

- Generation of artificial human-like speech sounds
- Sometimes called text-to-speech (TTS)
- Application areas
 - Reading texts
 - to a person (e.g., for visually impaired persons)
 - from a person (e.g., persons who have lost their voice)
 - Automatic public announcements
 - Human-robot interaction

Speech Synthesis Challenges

- Heteronyms: "A **bass** was painted on the head of the **bass** drum."
- Numbers:
 - '30' vs '30 March 2019' vs '1.30'
 - 'Henry VIII' vs 'Chapter VIII'
- Abbreviations: 'BMW' vs 'NASA' vs 'Mr.'
- Prosody: Speech melody of a sentence

Speech Synthesis Technology

- Concatenative synthesis
 - Concatenation of speech units
 - Sentences, words, syllables, diphones, phones
 - Mostly used technique at the moment
 - https://www.cereproc.com/support/live_demo
- Formant synthesis
 - Uses additive synthesis and an acoustic model to synthesis speech
 - Often creates voices that sound robotic
 - Can be useful for human-robot interaction
 - <https://youtu.be/wQjTgvUEOrY?t=175>

Speech Synthesis Technology

- Articulatory speech synthesis
 - Mechanical model of human vocal tract
 - At the moment, still early research prototypes
 - Could be interesting for human-robot interaction
 - <https://www.youtube.com/watch?v=oIMqxRRvVOw>
 - <https://www.youtube.com/watch?v=HmSYnOvEueo>
- Deep learning-based speech synthesis
 - End-to-end neural speech synthesis
 - Trained DNNs on corpora of human speech
 - DeepMind / Google use WaveNet for speech synthesis:
<https://en.wikipedia.org/wiki/WaveNet>

Dialogue Systems and Speech Synthesis

- Example questions
 - Name three typically used kinds of dialogue systems and explain briefly how they work.
 - Name three approaches for speech synthesis and explain on a high level the differences between the approaches.

Symbolic Reasoning and Decision Making

Symbolic Reasoning and Decision Making

- Example questions
 - For a set of symbolic statements (Subject-predicate-object triplets), specify whether they belong to the robot's belief model or the human's belief model.
 - How can common knowledge be presented for a robot?
 - Describe the process for a robot to process a spoken order from a human and to ground it in its knowledge base and belief state.

That's all, folks!

Good luck for the exam and the coursework!

Please respond to the module survey on UWE Blackboard.