HUMAN FACTORS

Q1: human factor issues about robot as a support for a therapist

A1: application of human factors design technology:

Safe, comfortable, effective, human use;

As for the aging:

Vision, hearing, mobility, cognition

Q2: 2 examples of human characteristics impaired & how impairments could be improved by multimodal human-robot interaction

A2: Example1： HRI for mediating assistance via Social robot

Medicating assistance:

a. User's mental model
b. Interaction flow error
c. Learnability and adaptability
d. Structure of conversation
e. Memorability
f. Multimodal feedback

Example2: Physical robot assistance dressing support task

HF safety related issues:

a. Attention and potential
b. Situational awareness& proprioception
c. Cognitive load and stress

User study method

集中度：reliable

中心度：valid

Internal validity: are the experimental results influenced only by the experimental variables?

External validity: can the results be generalized beyond the experiment?

Reliability: if repeat the experiment, will get the same result?

Q1: name and discuss possible influences on internal and external validity

A1: **Internal validity**

Order effects： randomizing the order of experiments tasks is important

Selection effects: do not use existing group of study participants; assign participants randomly to experimental conditions

Experimenter bias: based on the hypothesis, experimenter prefer for some conditions.

1. Give instructions on paper or video;
2. provide same instruction for all experiment conditions
3. double-blind experiment: experimenter and participants both do not know which condition the participant is experiencing

External validity
Participants: select participants from target group
Separate existing subgroups
Environmental influences: Make the most realistic environment in laboratory studies
Eliminate disturbing environmental influences that are not part of the experiment
Instructions: imitate human-human interaction

Tasks: tasks based on previous context analysis

Controlled experiments

a. Hypothesis
   Testable; involving assumption
b. Independent variables(自变量)
   Test variables that are changed between experiment condition
c. Dependent variable （因变量）
   1. Be measured to test the hypothesis
   2. Objective variables: time, counting events…
   3. Subjective variables: questionnaires
d. Experiment design
   Between subjects:
   1. Users are split into multiple groups
   2. One group per experiment condition
   3. Comparison of results between groups
   4. Eliminates order effects

   More participants are needed cause users differences are larger than order effects.

   Within subjects:
   1. Each users sees all experimental condition
   2. Results are compared individually for each user
   3. Eliminates variation due to differences between users

   External validity is higher than in between subjects experiment cause in reality users only user 1 of the 2 robot variants

Q2: design a controlled experiment to test whether a robot with personality is preferred over a neutral robot. How would the hypotheses, variables and design of this experiment look like?
A2:

Social signal processing

Social signals are **observable behaviors** that people display during social interactions
Social signals from an individual **produces changes** in others and the changes follow **principles and social norms**

Q1: what are typical social signals that humans are using is everyday communication?
A1: On face: emotions; gaze
The body: gestures; motion; proxemics (body distance); body posture
The voice: prosody(韵律); verbal communication; non-verbal

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Q2: what are typical pre-processing steps for analyzing hand gestures and what algorithms would you use to classify the signal?
A2: we need to build representation by pre-processing based on models.
Social signal processing is typically broken down in smaller, more manageable tasks
People detection; face detection; face recognition; gesture recognition; gaze detection; facial expression reading; detection of social signals; emotion recognition

6 basic emotions: anger, disgust, fear, happiness, sadness, surprise

Classification: decide category a new observation belongs to by training data, which contains data and known categories. (supervised learning algorithm)

Classification methods:

1. k-nearest neighbor(kNN): calculate the distance to the k nearest neighbors. The observation belongs to the class the most frequent amongst neighbors.
2. Summary: does well on a large number of classifications problem, but underperform near the boundary; have large datasets; the neighbors are weighted with the inverse of the distance 1/d to the observation

Support Vector Machines (SVM)

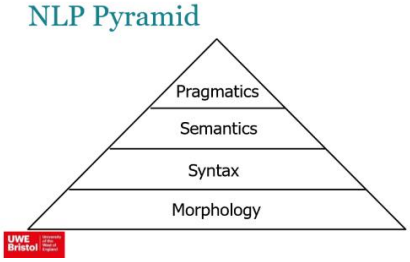
1. The margins should be as large as possible
2. The support vectors(nearest the classifier) are the most useful datapoints

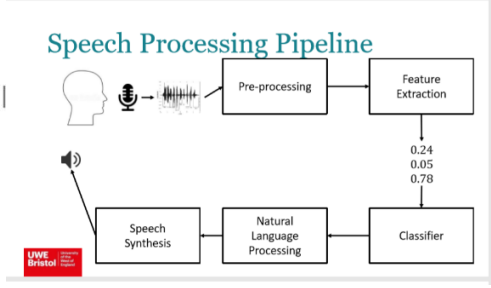
A linear classifier for two categories(binary classifier): f(x)=wx+b, where w is weight vector, x is a data point, b is a bias.

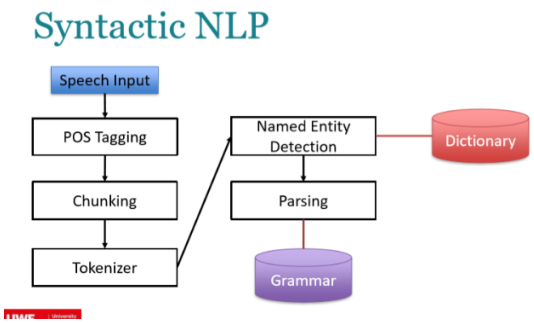
Clustering and classification

Clustering: start from unlabeled data points and find out k clusters in the data(unsupervised learning)

Classification: starts from training data(supervised learning)





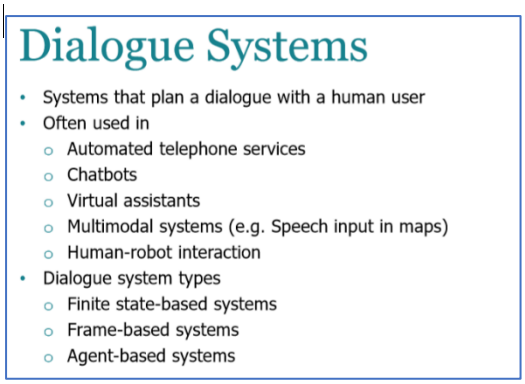


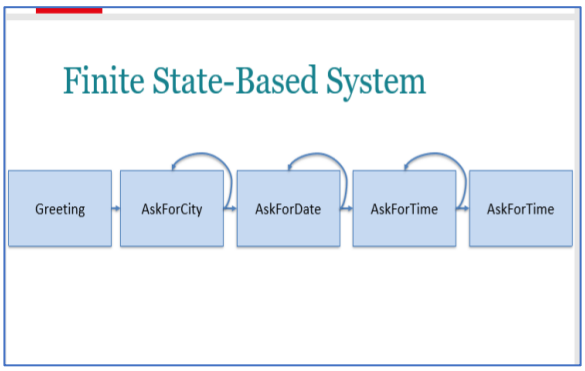
Tagging: detect the part of speech of a word to tag word category (e.g. adjective, noun, verb)
Chunking: find keyword or proper names or to identify phrases
Tokenizer: convert a sequence of characters into a sequence of tokens
Named entity detection: locate and classify named entity mentions in unstructured text into pre-defined categories
Parsing: converts an input into a format suitable for further processing

Q1: Name the basic building blocks of language processing system and describe them.
A1: morphology: processing at word-level
Syntax: processing of relationship of words with a sentence
Semantics: processing of the meaning of a sentence
Pragmatics: understanding of the text as a whole

Q2: What is the difference between semantics and syntax?
A2: Syntax concerns the way words can be combined together to form grammatical sentences; Semantics is about the manner in which lexical meaning is combined morphologically and syntactically to form the meaning of a sentence. Mostly, this is regular, productive and rule-governed

Q3: Name three ways to process speech syntactically.
A3:
Tagging: detect the part of speech of a word to tag word category (e.g. adjective, noun, verb)
Chunking: find keyword or proper names or to identify phrases
Tokenizer: convert a sequence of characters into a sequence of tokens





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 sentencte

Speech Synthesis Technology

- Concatenative synthesis
  - Concatenation of speech units
  - Sentences, words, sillables, 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 prototoypes
  - 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

Q1: Name three typically used kinds of dialogue systems and explain briefly how they work.

Dialogue System Technology

- Finite State-based systems
  - System leads user through dialogue steps
  - Uses a fixed input and output grammar
  - User has less freedom, dialogue steps are fixed
- Frame-based systems
  - System fills missing parts of a frame (i.e. a template for the information the system needs)
  - Dialogue steps are not fixed
  - System needs a more flexible grammare to parse user input
- Agent-based systems
  - System and user work together to solve a dialogue task
  - System uses logical inference to process user answers

A1:

Q2: Name three approaches for speech synthesis and explain on a high level the differences between the approaches.

A2:

Symbolic reasoning and decision making

Q1: for a set of symbolic statements, whether they belong to the robot's belief model or the human belief model.

A1:

Q2: how can common knowledge be presented for a robot?

A2: We usually endow the robot with background knowledge (also known as common-sense knowledge with statements like: Object rdfs: subclassOf PhysicalThing

Location rdfs: subclassOf SpatialThing

Q3: 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.

Why UCD process important?

Ensure user involvement at every stage resulting in:

a. Improve user acceptance
b. Ecological valid testing for safety and reliability and repeatable performance
c. Better understanding of the user and context of use:
   - user mental models, abilities and limitation
   - system operating environment
   - exiting skills and knowledge
   - understanding the constraints of the user in the operational environment
d. Fit for purpose and meet requirement

What are the key stages of UCD (user centered design)?

A: Requirements gathering—conceptual design—prototype co-design—usability and user experience evaluation