Lecture 2

Outline:

1. symbolic vs. sub-symbolic
2. representations
3. perception
4. Attention Auditory perception, a system should be able to filter out what a person says. (At a coctail party.)
5. Memory

> Lecture based on a review paper. "40 years of cognitive architectures: core cognitive abilities and pravtival applications."

Symbolic vs. non-symbolic

What is symbolic?

Examples:

- Labels
- strings of characters
- frames
- productions rules
- *non-probabilistic logical inference* Is also symbolic.

> The most important class of operations is called production rules. Transform someting into naother symbolic structures.

In the *symbolic approach*, AI applications process strings of characthers that represent reeal-woerld entities or concepts.

Symbols can be arranged in structures such as lists, hierarchies, or networks.

These structures shows how symbols relate to each other.

The chinese room thought experiment

`John Searle(1983)` A person is locked in a room. This person is presented with different symbols. The person looks the symbols up in a roolbook, and tells the person what is the output to a given input.

Doeas the person (or the room or the person + book) understand Chinese?

> Want to learn more? Look at wikipedia

What is sub-symbolic?

Lesser clear and evident: what is sub-symbolic?

Example:

1. Distributed representations, in paticular: neural networks.
2. Probablistisc logical inference. (Does not work with sybols, but works with numbers.)
3. 'fuzzy logic' is "soft information". Its an vague representation of this information.

To sum up.

Explicit symbols are atoms of symbolic representations. They can be vombined to fomr meaningful expressions.

> What is meaningful? What is the meaning of the word meaning?

Explicit symbols can be used for inference or syntactical parsing. (You have some input data and make conclutions to create output data.)

> **Eg.** A computer parses the information, and makes inferences about what the user wants the computer to do. (used in text and speach processing.)

Sub-symbolic representations are most often associated with the metaphor of a neuron.

Processing block vs. neuron, processing block means that we are talking about the system.

Two groups of emergent category:

- Implement models of the biological neurons.

  > implement particular neuron models. Aim to accuratley reproduce the low-level brain processes.

- Connectionist logic systems: are most often based on **artificial** neural networks. (Covers one or two aspects of logical neurons, NOT all of them.)

Hybrid architectures

Symoblic architectures is combined with self-contained modules perfoming sub-symbolic computation.

In many cases, the sub-symbolic computations deal with processing of sensory data.

Examples of functional hybrids:

- co-prosessiong
- metaprocessing
- chain processing.

Perception

Sub symbolic systems are typically achieved by perceptions.

- Regardless of design and purpose an intelligent system cannot exist in isolation and requires input for the outside world to produce behaviour.
- System of interest is embedded into an enviroment.

Modalities:

- Vision
- Sound

- Taste

Vision

Dominiating sensor in modality. It is relativley simple to build expiriments with systems.

The investigation of vision

- Early vision
- Intermediate vision
- Late stage of vision

Input image -> Primal sketch

> Primal sketch: Edges, bars, ends, viritual lines.

Input image, edge image, 2 1/2-d sketch, 3D-model.

Visual attention mechanisms, emotion and reward systems also influence all stages of visual processing.

Image understanding model:

1. Detection and grouping of inensity-location-time values.
2. Further grouping of edges, regions, boundaries, depth information.
3. Identificarion of objects and their motion.
4. Building object.senteerd repreeseentation for entities;
5. Assigning labels to objects based on the task. (Example, chair, you know what it does without en)
6. inference of spatiotemporal among entities.

The role of deep learning in this context

implemented imlicity with deep learing methods.

Auditon

Sound or voice commands are tybivally use to guide an intelligent system or to communicate it.

Speech to text software.

Using dedicated software for speech processing and communication helps to achieve som degree of complecity and realism. e.g. having scripted interaction with pepole in a crowded room.

Symbolic input

Input method wich do not fall under physical sensors or simulated sensors. E.g. text commands and data. Input via GUI. Text input is typical for the architectures performin planning and logical inerference tasks. Text commands. (No additional parsing is required.)

Multi sensor input (Multi-Modal perception)

A constant stream of information from different senses. It integretes these streams into a choherent world representation. Most arcitectures uses only two modalities simultaneoutsly.

This is called feature intergration in cognitive science.

Attention

Perceptual attention: important role in human cognition. Filters out irrelevant information. (From invoming sencory data).

We are good at filtering this out, and seperates relevant from irrelevant.

Attention is not a single monolithic struchture. It is not a "switch". It is not only about "what to process next".

> Ample evidence in favor of understanding attention as as a set of mechanisms affecting both perceptual and cognitive processes.

Thre classes of information reduction mechanisms:

- Selection `Focusing`
  - Select gaze and viewpoint.
  - World model
  - Select time/region/features/objects/events of interest.
- Restriction *Prune the search space by*
  - Positive priming
  - Endogenous motivations
  - External stimuli
  - restrict attention to objevts relevant for the task.
  - limited field of view.
- Supression
  - Feature/spatial surrond inhibition.
  - Task-irrelevant stimuli supression.
  - Negative priming
  - Location/object inhibition of return. (Return the attention to something you have looked at before.)

Top down attentional mechanisms A typical example is a Visual search, if someone is looking for a red color.

Action selection

> Action selection is: At any point of time, decide what to do next.

- What(decition making) and how(motor control) part
- When(contiions) partand the what or how part.

Two major approaches. planning vs. dynamic action selection.

Planning:

- Determmine a sequence planning precedes plan execution. **Dynamic action selection**
- Greedy choice. You choose the best alternative based on the knowledge available at the time.
- Important: this knowledge changes over time: Dynamic action selection is adaptive.

Dynamic action selection category:

- winner takes it all.

- Has a criteria for selection. Reactive actions are executed bypassing action selections.

Planning is to prevalent in the symbolic archtectures.

Relevance

- Reflects how well the action corresponst to the current situatuion.

Utility

- Measure of its expected contribution to achieving the current goal.
- Perform a dry run of candidate actions and observe theeir effect to determine their utility.
- Can also take into account the performance of the action in the past and improve the behaciour in the future via reinforcement learning. **Internal factors**
- Motivation, affective states, emotions, moods, drivers, etc.
- Do not determine the next bavior but makes it bias.

Long term vs. Short-term memory

Long term storage: Knowledge base for facts and problems solving rules

Shoty-term storage: Usually represented by a current world model or the contents of the goal stack. Can be split up into **sensory memory**, and **working memory**.

Sensory memory

Cache incoming sensory data and preprocess it before transferring it to other memory structures.

iconic memory It is critical for cognitive capacities such as attention, reasoning and learing.