# Cognitive Architectures: Cognition and MHP

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## 1 Cognition

### 1.1 In your own words, describe the concepts "cognition" and "cognitive architecture".

Cognition is the conscious mental activities which allow us to respond rationally to environments which have parts which we don't previous faced. Cognition allows us to use tangential knowledge to reason to a appropriate response.

Cognitive architecture is the theory of structures in intelligent agents from which intelligent behaviour stems from. A cognitive architecture is a framework from which a agent develops intelligent behaviour.

### 1.2 Explain Marr and Kelso's three levels.

Marr's hierarchy of abstraction is divided into the computational, the algorithmic and the implementation.

- The computational handles the goal, logic and the accompanying strategy to achieve the goal.
- The representation and algorithm handles the implementation of the computational level. Specifically it handles the representation of input and output as well as the algorithmic transformation between these two.
- The implementation level handles the hardware implementation of the algorithmic level. It ensures the algorithm can be realized physically.

Kelso's hierarchy of abstraction is divided into the boundary constraints, the collective variables and the components.

- The boundary constraints handles the goals and the tasks of the system.
- The collective variables handles the behaviour of the system and is strongly connected to the the tasks and goals, and therefore the boundary constraint level.

- The components level is the physical implementation and realization of the system and is strongly connected to the systems behaviour, as it is what is realized in this level.

## 1.3 What are the differences between the two models?

A significant difference is the strenght of the coupling between the levels. Kelso's has a strong coupling between the adjacent levels, whilst Marr's has a weak one.

In the building of Marr's model, we first create the computational level as it is the most important, so as to leave the design and implementation for later. After this we consider the design(algorithm and representation), which is less important. And finally we consider the implementation which Marr set out as the least important aspect. Kelso's model is built on the basis that the instantiation of the system has a direct role to play in the model itself. His model's levels are considered equally important for the model.

## 1.4 Explain how these differences can be explained by different paradigms for cognitive architectures/systems

## 2 MHP (Model Human Processor)

### 2.1 A brake pedal should be pressed as soon as the red brake light of the front car lights up. Calculate the response time until the pedal is pressed using MHP (that is, the time before you actually press the pedal).

We break the scenario down into the three basic components:
Perceive the brake light: $t_p$
Generate motor command: $t_c$
execute motor command: $t_m$

Total:

$$t_p + t_c + t_m = 100ms + 70ms + 70ms = \underline{\underline{240ms}}$$

### 2.2 Assume a user sees the Danish flag on a screen. Calculate the response time until the user knows the flag is Scandinavian using MHP (assume the flag's semantic name must be fetched from LTM etc.)

We break the scenario down into the three basic components:
Perceive the image and load into VIS in the WM: $t_p$
Recognize flag in LTM : $t_c$
Get LTM semantic name for flag: $t_c$
Match sematic name against region name: $t_c$

Total:

$$t_p + 3 * t_c = 100ms + 3 * 70ms = \underline{\underline{310ms}}$$

### 2.3 What is the Index of Difficulty (ID)?

Index of difficulty is a part of Fitts Law which generally describes how difficult a task is based on the distance to the object and the objects size.

### 2.4 How long time does it take to reach the menu bar on respectively Macintosh and Windows?

**Windows:**

$$\begin{aligned}
&S = 5mm \\
&D = 80mm \\
&a = 50 \\
&b = 150 \\
&T = 50 + 150 * \log_2(80/5 + 1) = \underline{\underline{663ms}}
\end{aligned}$$

**Macintosh:**

$$
\begin{aligned}
&S = 50mm \\
&D = 80mm \\
&a = 50 \\
&b = 150 \\
&T = 50 + 150 * \log_2(80/50 + 1) = \underline{\underline{257ms}}
\end{aligned}
$$

### 2.5 How many images per second must be shown to create an illusion of continuity in time?

To appear continuous we need to show images at a speed faster than the lower bound of the time taken to perceive it.

This gives us:

$$\frac{1}{t_p} = 20fps$$

So we need to display the images at a speed faster than 20 frames per second.