

# TDT4137 Solution to Assignment 1

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## 1 Newell and Simon: Symbols and Search

Task 1.1: What is a symbol, from the perspective of Newell and Simon?

A symbol from the perspective of Newell and Simon is a prerequisite for being able to perform intelligent actions. They state that there is no possible way to find any **intelligence principle**, but instead of following a set of rules to find out whether or not something is intelligent, it is possible to analyze the ability to store and manipulate symbols. Symbols, in this case, is some information that communicates a state.

Task 1.2: What is a symbol structure?

A symbol structure defines the arrangement that gives the symbol a meaning by a given context. This structure can be determined by how symbols should be aligned physically.

Task 1.3: What does the word *physical* mean in this context?

The word physical, in this context, addresses two characteristics.

1. It means that it follows the laws of physics. - Furthermore, it is possible to realize them by using systems that consist of engineered components.
2. Even though we use the term "symbol" in a physical setting, it is not given that this symbol is understandable; thus, it is not required to follow the human symbol system.

Task 1.4: Besides symbols, what is the second, equally important component of a symbol system?

Besides having a system of how different symbols should be aligned, it contains a collection of processes that gives instructions on how a system can perform a specific process on a set of symbols in order to create, modify, reproduce and destroy a given set.

Task 1.5: Explain what this second component does

With the first component, one can represent and communicate a given state. This functionality is essential, but in order to communicate different states and thus make sure that a state is updated, a second component is crucial. The second component of a symbol system is the expressions. This addresses how each of the symbols can get modified.

Task 1.6: What is, according to Newell and Simon, the relation between a physical symbol system (PSS) and intelligent behaviour?

(Hint: this relation has two main aspects)NTNU Trondheim, fall term 2020TDT4137-Ex01V1.1, compiled: August 28, 2020

They state in a hypothesis that: **A physical Symbol System has the necessary and sufficient means for general intelligent action.** Later they state that a human has a lot of shared characteristics of a physical symbol system.

Most of the traces of intelligent human behaviour are represented in a physical symbol system. Intelligent behaviour is often defined by looking at a structure and figure out whether a human act. If that is, one can conclude that it was intelligent.

They conclude that physical symbol systems are capable of intelligent actions, and general intelligent action calls for a physical symbol system.

## Symbol grounding

Task 1.7: **optional** What is, according to your own opinion, necessary for being able to say that a regarded symbol, or a symbol structure, has a 'meaning'?

Symbolic vs. non-symbolic processing Hint: here having a look at [Nilsson07] (optional reading) might be helpful.

In order to have a meaning, it should exist a context of which the symbol communicates something.

Task 1.8: **optional** Give at least two different examples of non-symbolic processing (of data)

Task 1.9: If an intelligent system interacts with the world, can all the necessary processing be symbolic? Where would non-symbolic processing be useful (or necessary) in that situation?

Yes and no, if someone were to browse the web, they would be interacting in pure symbols. However, if someone were to record a message by speaking to a mic, it would have to be exposed to non-symbolic processing.

Non-symbolic processing is useful when a computer has to handle analogue signals. Some computers that have to handle radio transmitters or being able to record sound waves.

## 2 The Knowledge Level

See, e.g. [Newell90], excerpt provided in Blackboard

According to Newell if we regard a system (e.g. a human being, an animal, or an 'intelligent machine') on the knowledge level, the system has a (dominant) law of behaviour. This law of behaviour has to do with goals and a collection of possible actions.

Task 1.10: What does it mean if we say that the regarded system behaves in a rational manner?

If a system behaves rational, we can say that *it is doing the right thing*. Stating this can, of course, mean different things. Therefore it is essential to also look at some definitions regarding rationality.

1. One has to create a measurement of the performance in order to determine whether a system is rational or not.
2. We have to look at the systems prior knowledge of the environment.
3. We have to look at what kind of choices the system can make.
4. We have to look at how the system can perceive the environment and what is the input at a given point.

By defining all these things, we can start to understand how the system operates, and also think about what would be a rational decision in some cases.

Task 1.11: **optional** Did Newell forget about perception? How can perception be integrated into this model?

Task 1.12: **optional** According to Newell, if a system uses all of the knowledge that it has, it must be called perfectly intelligent. Still, such a system might be far from human intelligence. If we follow Newell in his claim, there are (at least) two main obstacles that prevented the AI community (so far) from building the machine that approaches general human intelligence. Name these obstacles and comment on this.