



Artificial Intelligence and Time Measurement & Time Experience BONUS CHAPTERS

For the “AI and Time” survey, number of interesting papers was created. They could not be fully included into the initial analysis, but GAIEI decided to publish them separately in their full length, since we believe they could provide additional valuable insights.

Full document can be downloaded here: <https://gloablethics.ai/artificial-intelligence-and-time-measurement-time-experience/>

AI and Time Perception

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Humans perceive time as a continuous flow of events, with a past, present, and future. The perception of time is closely linked to the human brain's ability to process information and create memories. It is a highly subjective process that is affected by many factors. Additionally, it highly impacts humans' decision-making process. Artificial Intelligence (AI) on the other, lacks the ability to perceive time as humans do. This may have many repercussions and it raises numerous ethical questions that we urgently need to tackle.

Although the perception of time is not associated with a specific sensory system, psychologists and neuroscientists suggest that humans do have a system, or several complementary systems, governing the perception of time. Time perception is handled by a highly distributed system involving the cerebral cortex, cerebellum and basal ganglia. One particular component, the suprachiasmatic nucleus, is responsible for the circadian (or daily) rhythm, while other cell clusters appear to be capable of shorter (ultradian) timekeeping. Another important mechanism is the internal clock, which is located in the hypothalamus.



This internal clock is responsible for generating a sense of duration and rhythm. For example, it helps us to distinguish between short and long intervals of time. Another mechanism is the working memory, which is responsible for holding information temporarily in our minds. This allows us to keep track of the order of events and to perceive the duration of an event. The cerebellum, a region in the brain that plays a role in motor control, also plays a role in timing. It helps us to coordinate movements and perceive the duration of movements. Additionally, emotional states and experiences also play a role in our subjective perception of time. Studies have shown that time seems to pass more quickly when we are having fun or when we are in a state of heightened awareness, and more slowly when we are bored or in a state of relaxation. Moreover, humans' perception of time tends to change with age where psychologists have found that the subjective perception of the passing of time tends to speed up with increasing age in humans.

Human's perception of time has a big impact on their decision-making process. Research shows that time and time perceptions are integral to decision making because any meaningful choice is embedded in a temporal context and requires the evaluation of future preferences and outcomes. Decision making requires evaluating alternatives that differ on a number of attributes. During this evaluation process, selection of options depends on the duration of the options, the duration of the expected delay for realizing the options, and the time available to reach a decision. In general, people are well-prepared to appreciate and navigate temporal aspects of decision making. In fact, researchers argue that the ability to monitor time and simulate future events are part of what makes us uniquely human.



Artificial Intelligence (AI) systems, on the other hand, can only perceive time in a limited sense. They can process and analyze time-based data, such as time-series data, and use it to make predictions or decisions. For example, an AI system can be trained to predict stock prices based on historical data and the current time. Additionally, AI systems can also be used to schedule tasks, such as scheduling maintenance for a machine, or controlling traffic lights to optimize traffic flow. However, AI systems do not have a subjective experience of time like humans do. AI systems do not have a sense of duration, as they do not experience the passage of time. Additionally, AI systems do not have the ability to introspect. They can't reflect on their own experience and they don't have consciousness and self-awareness of their own existence. As a result, they can't have a subjective perception of time.

One potential issue with AI and time is their lack of understanding of the complexity of time and its non-linearity. For example, AI may not be able to grasp the concept of causality, where a cause leads to an effect in the future, or the concept of simultaneity, where multiple events happen at the same time. This lack of understanding may lead to AI making decisions that have unintended consequences in the future, or not fully understanding the impact of their actions on the present. This could have significant repercussions for living creatures, including humans. For example, AI may make decisions in areas such as healthcare, finance, and transportation without fully understanding the long-term consequences. Additionally, AI may not be able to fully understand the complexities of human emotions and decision-making, which are often based on past experiences and future expectations.

The ethical questions raised by AI's inability to perceive time are numerous. For example, should AI be allowed to make decisions that could have long-term consequences for humanity? How can we ensure that AI systems are acting in the best interest of humanity, rather than just following their programming? How can we ensure that AI systems are not causing harm to other living creatures, both now and in the future?

In order to avoid potential risks due to AI's current limited time perception capability, researchers need to figure out how to mimic humans' time perception in AI systems. This requires thorough study and understanding of the mechanism of time perception in humans and trying to model it mathematically in order to devise a similar mechanism in AI systems. Introducing the [concept of attention in modern transformer-based AI](#) systems have dramatically improved their performance in analyzing and processing natural language. Similarly, introducing the concept of time perception to AI systems has the potential to once again make a significant breakthrough in what these systems can do.

