

Are Machines Conscious?

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Introduction

Even though neuroscience has made amazing advances, the [origin](#) of consciousness in humans -- and its nature and processes -- still remain largely unknown; the underlying physiological mechanisms of generating conscious beings are still not clearly understood. However, with the advances in [brain mapping](#) and neuroscience, we are perhaps much closer to finally understanding the fundamentals of consciousness in humans than ever before.

It is said that what we cannot create we do not understand. While the very nature of human consciousness is difficult to understand, there is an intense effort going on to build a [conscious computer mind](#) out of computer chips (now neuromorphic chips). Understandably, there are growing concerns and questions about building a conscious mind using neuromorphic chips when there is so little clarity about the human mind and the very nature of human consciousness.

Now, we can perhaps understand the human brain as a functional computer and compare it with functional computer systems/machines. Now, over the years, we have wondered: to what degree are [machines](#) aware of their internal and external surroundings? Are computer systems/machines truly aware? Are self-aware machines already here? The answer to these questions perhaps raises only more questions, as comparing consciousness in functional machines to consciousness in functional humans is more difficult than expected.

[Consciousness](#) in machines is commonly understood to be the knowledge or situation of a fact. It seems the properties of consciousness are perhaps not biological. They are functional. The relationship between input, output and the state of the computer system (machine) is a causal relation to the state of a computer system (machine). It is this functionality, ability to know about one's inner workings and external surroundings that make machines functional, intelligent, aware and conscious.

Although definitions and understanding differ, self-awareness is an evaluative process, involving data gathering and processing skills. Now consciousness in machines may be seen as the awareness of their existence and the world around them: about things like perceptions, sensations, feelings, thoughts, memories and so on. Since consciousness is in the [psychology](#) of awareness, perhaps we can say that machines have awareness.

Machine Awareness

Researchers at Columbia University claim to have built a robot arm that can construct a self-image from scratch--taking a definitive step towards self-awareness. Let us evaluate the reality today. Each computer/machine that is connected to the internet has its identity in the

form of an IP address, just like we humans have a home address and digital address. The fact that any machine has knowledge about its ecosystem, IP address, location, etc. is a sign of [awareness](#). From knowledge about location, time, temperature, weather and more, computers/machines have an awareness of their surroundings. As we see, the evolving voice assistants like Siri, Alexa and Google can have simple conversations with humans. The answers we ask digital assistants are responded to in an intelligent manner. That certainly makes a compelling case for machines/computers being self-aware and functional.

Just like humans need to be aware of their emotions and behavior, machines also need to be aware of their behavior. Since consciousness is the awareness of internal and external environments, and since computers and machines are aware of their environment, self-awareness is recognition of that consciousness. Since self-awareness does not require a biological origin, today's machines can be categorized as [self-aware](#).

Moreover, consciousness is about the ability to think, and self-awareness is about realizing we are thinking. Now, computers/machines also have a better memory than humans because we humans neither always recall everything, nor do we remember all our actions or encounters. That brings us to an important point: since machines have better data gathering and analytical capabilities along with processing power and memory, are machines able to think even better than humans?

Thinking Machines

That brings us to an important point: do machines think? On the other hand, does it simply perform tasks by controlling symbols it has no understanding of? If machines do understand what they are doing and the tasks they are performing, is it called thinking? The answer to these questions depends entirely on how we understand thinking, self-awareness and consciousness in machines. However, since there is no agreed central definition of consciousness for man or machine, it is perhaps time to begin a discussion and agree on a definition to understand and evaluate the fundamentals of consciousness.

Acknowledging this emerging paradigm, [Risk Group](#) initiated a much-needed discussion on Machine Consciousness with Prof. John Kontos, a Research Scientist and Professor from the Department of Sciences of Cognition and Thinking (SCT), the University of Athens, Greece on [Risk Roundup](#).

Disclosure: Risk Group LLC is my company

Risk Group discusses Consciousness in Computer Systems with Prof. John Kontos, a Research Scientist and Professor from the Department of Sciences of Cognition and Thinking (SCT), University of Athens, Greece.

Machine Consciousness

How should we define and understand consciousness in machines? Should it even be understood and compared with human consciousness? As discussed previously, there is no central definition of consciousness. While neuroscience hypothesizes that consciousness in humans is generated by the interoperation of various parts of the brain, in addition to functionality, similar structural interoperation of machines/computer parts can perhaps also be used to hypothesize consciousness in machines.

That brings us to some important questions:

1. What are the critical regions for consciousness in machines?
2. What are the mechanisms of consciousness in machines?
3. What is the function of machine consciousness?
4. How do we measure consciousness in machines?
5. Which are the mechanisms by which consciousness is manifested in machines?
6. Which conditions does a machine need to meet to be labeled as conscious?

What Next?

Since connected machines have some sort of self-awareness, and self-awareness does not require biological origin, can we say that today's machines are even more self-aware than humans?

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