

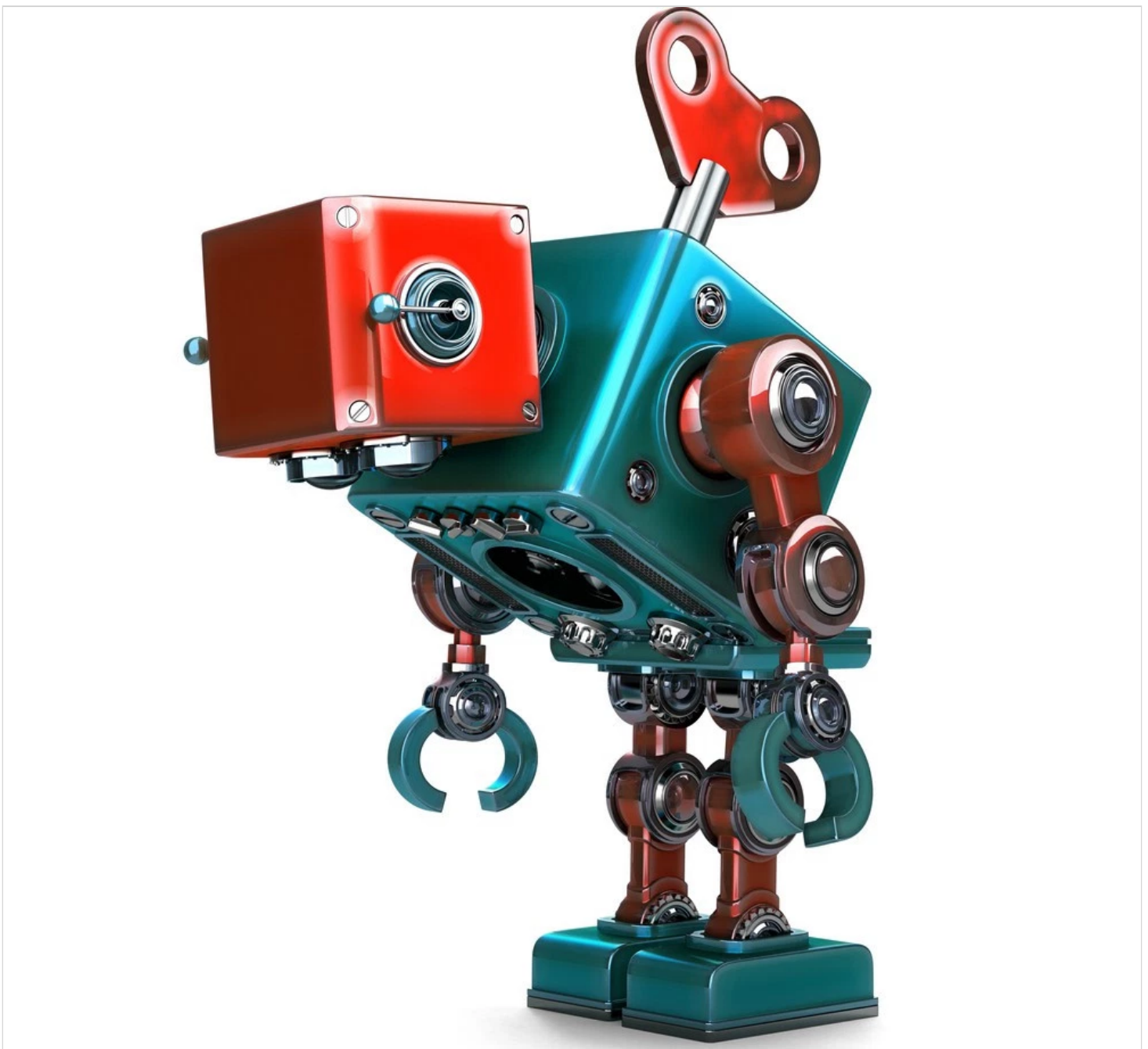


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When Will The Machines Wake Up?

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Machines matter to people. But, they “matter” only because they affect people. It’s widely

Daniel Faggella is founder of [TechEmergence](#), a news and advice website for entrepreneurs and investors interested in the intersection of technology and the mind.

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supposed that today's machines themselves cannot be "affected" — because they have no feelings, no conscious thought, no sentience.

Interestingly enough, it might not always be that way.

While biology has held a relatively firm monopoly on "consciousness" over the last few hundreds of millions of years, many researchers in the domain of machine learning are of the belief that, eventually, humans may replicate

self-awareness and inner experience (rough terminology that we'll use as representative of the broad term "consciousness" for the sake of this article) in our machines. And some of their guesses are sooner than one might expect.

Over the last three months I've interviewed more than 30 artificial intelligence researchers (essentially all of whom hold PhDs). I asked them why they believe or don't believe that consciousness can be replicated in machines.

One of the most common contentions as to why conscious *will* eventually be replicated is based on the fact that nature bumbled its way to human-level conscious experience, and with a deeper understanding of the neurological and computational underpinnings of what is "happening" to create a conscious experience, we should be able to do the same.

Professor Bruce MacLennan sums up the sentiments of many of the researchers in his response: "I think that the issue of machine consciousness (and consciousness in general) can be resolved empirically, but that it has not been to date. That said, I see no scientific reason why artificial systems could not be conscious, if sufficiently complex and appropriately organized."

It might be supposed that attaining conscious experience in machines may require more than just a development in the fields of cognitive and computer science, but also an advancement in how research and inquiry are conducted. Dr. Ben Goertzel, artificial intelligence researcher behind [OpenCog](#), had this to say: "I think that as brain-computer interfacing, neuroscience and AGI develop, we will gradually gain a better understanding of consciousness — but this may require an expansion of the scientific methodology itself."

Some researchers hold even greater optimism, and believe that in some form or another, machines may already be conscious (such as [Dr. Stephen Thaler](#) of Imagitron, LLC), or have a good likelihood of obtaining consciousness within the next five years (like Dr. Pieter Mosterman of McGill University in Canada); others are less hasty with their timelines.

Nature bumbled its way to human-level conscious experience ... we should be able to do the same.

MIT's Dr. Joscha Bach put his rough estimate for machine consciousness at 2101-2200 (along with a few others who guessed that same time frame), and Dr. Sean Holden of Cambridge University believes that despite seeing

no insurmountable obstacle, conscious machines may not exist until the time frame between 2201-3000. Dr. Holden sums up his perspective: "Yes, it's possible. Humans are made from stuff that obeys the laws of physics — they constitute an existence proof. The difficulty is just that of working out how the machine (taken in a very wide sense) works and how to build an equivalent."

Indeed, that is the difficult part.

It could be that many of the "optimistic" researchers are aware of all the "impossible" feats that have been beaten to smithereens by time and focused scientific inquiry within their lifetimes (from the moon landing to mapping the human genome, and beyond). I wanted my inquiry to pry beyond just their inclinations as to *if* machine consciousness could happen; I asked them *when*.

The results from the survey, shown in the graphic below, included 32 responses from different AI/cognitive science researchers. (For the complete collection of interviews, and more information on all of our 40+ respondents, [visit the original interactive infographic here on TechEmergence](#)).

TechEmergence OCT 2015
A.I Expert Poll on Machine Consciousness and AI Risk



Conscious Machines

Time Scale Guesses (90% confidence predictions)

We asked over 30 artificial intelligence researchers

With a 90% confidence, when do you suppose machines would become conscious (subjectively aware) in the same way that humans are? Please choose a date range among the selected (below), or select "probably never" or "not comfortable predicting", and explain your position in 1-2 sentences.

Explore their answers below



BEFORE 2021

Dr. Stephen Thaler



"Both consciousness and sentience have already been implemented within machines beginning with the reductions to practice behind US Patent 5,659,666, "Device for the Autonomous Generation of Useful Information." This 'recipe' for creative, emotional, and self-aggrandizing cognition has formed the basis of military, commercial, and national intelligence applications for decades, and is now being implemented within trillion neuron synthetic brains just a few feet from where I now sit."

Dr. Peter Boltuc



"The engineering argument for first-person machine consciousness: 1. Some day we should learn how the stream of phenomenal consciousness is generated in human brains. 2. TO understand this is to have an engineering blueprint how to engineer first-person consciousness. 3. If we use this blueprint to build first-person machine consciousness we should be able to build it."

Dr. Mehdi Dastani



"It is obvious that computer systems are getting increasingly powerful and will gradually take over complex human activities that we tend to consider as requiring some kind of consciousness. In this sense, computer systems are becoming increasingly conscious and sentient. However, the question whether computer systems will become conscious in the way that human are requires a clear and explicit definition of human consciousness, which would be the subject of continuous change at least as long as human knowledge, challenges, abilities, perceptions, lifestyle, etc. are changing"

Dr. Pieter Mosterman



"The combination of machine classification and reasoning creates a functional semblance of human intelligence. The results of such reasoning may serve as the starting point for a layer of meta classification and meta reasoning, which will appear as consciousness in the same way as humans (but not like humans)."

2021 - 2035

Dr. Helgi Helgason



"Since human intelligence (and consciousness) occurs in nature it must be a process emerging

Dr. Massimiliano Versace



"Machines will be able to have something similar to what we call consciousness in the next 10-20 years, but we will not need that to achieve machines with narrow (task-specific) super-human capabilities. This is

occurs in nature it must be a process emerging from physics and chemistry, I see no theoretical reason that would prevent us from eventually reproducing it in man-made systems if we so desired."



narrow (task-specific) super-human capabilities. This is achieved already today and this is the real use of AI for our society."

Peter Voss



"Machines *will* reach human-level intelligence – which inherently includes the ability to conceptualize abstractly. Consciousness is a direct consequence, or by-product, of this ability."

Dr. Pei Wang



"I think it can be done, and we already have a preliminary design for it in the NARS project."

Dr. Michael (Mishka) Bukatin



"I don't know of any reason which should prevent us from developing machine consciousness, and moreover I hope that smarter-than-human machines would eventually solve the Hard Problem of Consciousness, even if humans keep failing at solving it on their own."

2036 - 2060

Dr. Andras Kornai



"Since we have an existence proof that such things are possible to build from protein, it is evident that no magic will be required."

Dr. Jim Hendler



"I do believe that we are seeing the beginning of an increasing autonomy that will be operationally non-differentiable from awareness some day – but the border between non-aware and aware is not a sharp one, so I don't expect this to be a sudden change."

Dr. Bruce MacLennan



"I'm fairly confident that machines can become self-conscious. As a materialist I consider organic life to be 'meat machines': we are machines and we're conscious. As for reconstructing consciousness in vitro: Selmer Bringsjord of Rensselaer Polytechnic Institute in New York with robots of the Nao model has already demonstrated a rudimentary level of self-awareness."

Dr. Daniel Berleant



"The real question is, 'how can we know for sure if a machine is conscious?' The answer is we can't. We can't even know for sure if another person is conscious or if instead it just seems that way. The Turing test offers a way around that, suggesting that if we can't tell the difference between communications from an AI and communications from a person, then the AI is, for practical purposes, at least as intelligent or conscious as a person."

Dr. Ben Goertzel



"I think that as brain-computer interfacing, neuroscience and AGI develop, we will gradually gain a better understanding of consciousness – but this may require an expansion of the scientific methodology itself. I wrote a blog post titled 'Second Person Science' considering this issue"

Dr. Tjin van der Zant



"It is absurd to think that humans are the only ones that can have consciousness, since we know apes also have it. Anyone claiming that only biological machines, such as humans, can have consciousness is being a biochauvinist. It might be hard to imagine though, looking at the current technology"

Dr. Danko Nikolic



"Human level of consciousness is possible to gradually approach, but machines will never get quite there. The key limitation will be the lack of a biological body which will make it practically impossible to experience the qualia of hunger, sexual pleasure, fear, having a flu etc. Difficulties will arise also with things like envy or a sudden insight because our bodies play a role in conscious experiences of those too. So, these future machines--albeit conscious--will never quite understand us."

Dr. Lyle Ungar



"Computers won't become conscious "in the same way humans are" -- e.g. using synchronized neural firing or activity in their prefrontal cortex or thalamus."

2061 - 2100

Dr. Blair MacIntyre



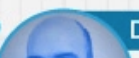
"I believe that we will have conscious machines at some point. I believe our brains are incredibly complex, and our current machines are incredibly simple. Whether through biological or quantum computing, I expect we will dramatically increase the computational capabilities of our machines to exceed that of our brains."

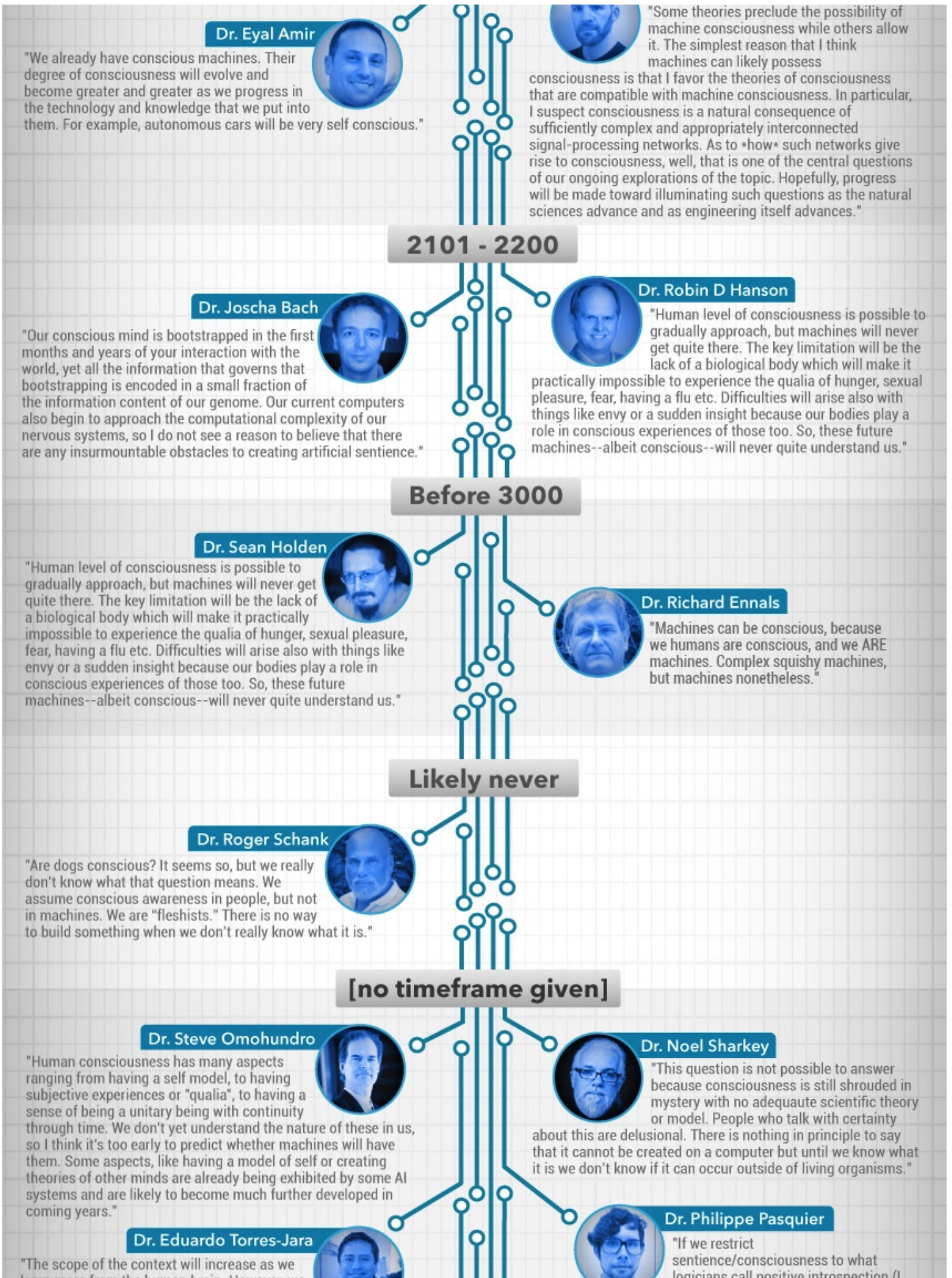
Dr. Nils Nilsson



"I think that, in principle, it will be possible to build machines that are conscious in much the same way that we are. My reasoning for this is that we humans are machines, and we are conscious, or at least claim to be, so we ought to be able to build machines like us (eventually)"

Dr. Keith Wiley





learn more from the human brain. However, we are far away that anything with human capabilities. Just to have some perspective let's consider the visual perception problem. There has been great progress because of the amount of data available to implement machine learning algorithms. Computers can now recognize patterns like a cat with great rate of success. This great success is not close to human visual capabilities yet. Moreover, it helps little to organize the information to make a computer understand the concept of a cat as humans do."

Dr. Yoshua Bengio

"There is heated debate around whether or not machines will be able to ever become conscious or sentient (subjectively aware) in the same way that humans are. If you believe that developing machine consciousness (whether in 1000 years or 20 years), or whether you do NOT believe that such a feat is possible, please explain your position as best you can in 1-2 sentences."

already there with some cognitive agent architectures. If we look to encompass all dimensions of human consciousness, then there are no evidence this is possible and feasible (for example, genuine intrinsic motivations are not present in artificial agents)."

Dr. Roman Yampolskiy

Consciousness is not a scientific concept; it can't be detected or tested for in any way. It also doesn't do anything so no reason exists to invest in research developing artificial consciousness.

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The most popular range across all the respondents was the third time frame, 2036-2060. The second highest response (behind the respondents who chose not to give a date range at all) was the second time frame, 2021-2035.

Though some researchers supposed a longer time frame, and some a shorter time frame, the bulk of the responses (totaling nearly 50 percent of the respondents who were comfortable making a prediction) were in the 2021-2060 time frame.

Some of these time frame estimates seem to couch logically with Dr. Nick Bostrom's poll of artificial intelligence researchers in 2012-2013. Bostrom asked 170 artificial intelligence researchers to estimate with 50 percent confidence when human-level machine intelligence might be developed (i.e., machines that can not only play chess, but write poetry, manage businesses, do all the things that humans do), finding a median response of 2040 (I would encourage you to see the full report [here](#).)

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Predicting the future is notoriously difficult, and hardly any of my own respondents would express anything close to "certainty" about events in the future. However, if legitimately

aware and conscious machines are to exist within our lifetime, we may have new questions on our hands.

If a machine became conscious enough to feel, even at the level of a dog or squirrel, should we not have laws to protect them from types of abuse or neglect?

If machines were in fact able to consciously “feel” physical or emotional sensations, would we be obligated to program them to only experience happiness and bliss?

If machines that were approaching human general intelligence were to be endowed with consciousness, would this potentially make them more willful and less easily controlled by their human creators?

FEATURED IMAGE: [KIRILL_MAKAROV/SHUTTERSTOCK](#)

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