Machines That Make Art, Improvise Music and Write Film Scripts

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Most people agree that AIs can create art. But can they truly be artists? This question cuts right to the heart of AI because it raises the issue of whether AIs can possess attributes of living beings, even though they are alien life forms. If so their intelligence will no longer be 'artificial' but as real as ours. The archetypal Pygmalion myth is becoming reality.
I will focus on the exciting art created by artificial neural networks and then turn to the key issue of whether machines can be creative like us.[1]

Early Glimmers of Creativity in Machines
Machines have already shown glimmers of creativity when running algorithms like AlphaGo, which plays championship Go; DeepDream that creates bizarre and hitherto unimaginable images; and Generative Adversarial Networks that create images and assess them too.

AlphaGo
In 2016 an artificial neural network running AlphaGo trounced a highly regarded Go master. At that point everyone agreed that the venerable game of Go had been cracked by a machine.
AlphaGo made many extraordinary moves but the one that everyone remembers is move number 37 in the second of the five game match. Engineers found that AlphaGo had calculated that the odds of a human making that move was one in ten thousand. Move number 37 was more than a glimmer of creativity.

DeepDream
Alexander Mordvintsev, the Google engineer who invented DeepDream, originally conceived it as a means for exploring how the artificial neural network's hidden layers of neurons function. He tried out his algorithm by feeding an artificial neural network trained with ImageNet an image of an adorable cat against a verdant background and stopped analysis part way into the hidden layers. What the machine saw stunned everyone. It was surreal, totally unexpected.
Mordvintsev's colleagues at Google immediately saw the artistic potential in DeepDream and its otherworldly images began to circulate.

Generative Adversarial Networks (GANs)
A GAN is made up of two networks, a discriminator network and a generator network. The generator network generates images from nothing, from noise, and sends them to the discriminator network that assesses them as being real or not relative to what it has been trained on. This cycle continues until the generator network no longer generates images from noise but from the images that the discriminator network has sent back. Soon it generates images that do not refer to anything on our planet. We may say that the machine is dreaming, imagining, beginning to build up an inner life of its own.
Plied by the new breed of artist, the AI-artist, DeepDream and GANs have kick-started new art styles.

Continuator
The AI device Continuator is a magnificent example of AI and human bootstrapping each other's creativity. A musician at a piano, connected to Continuator, begins to improvise. Continuator seeks patterns in the musician's notes. In this way it creates an improvisation in reply to the musician's.

Machines as Authors: GPT-3
GPT-3 is the most advanced AI in the field of language processing. Text generation begins with a prompt such as 'How can I become more creative?' GPT-3 is almost magical. It writes text as well as code, composes music, makes art, and translates too. Writers, for example, can input the section of a text at which they have become stuck and GPT-3 takes it from there generating text that can perhaps

spark the person's creativity. Caveat emptor because text can be riddled with factual errors and must be edited.

Computational Aesthetics
Presently there is no computational aesthetics for AI-created art, only for art made by humans. Advances await algorithms for assessing the form of AI-art and for machines with emotions for assessing content.

Human Creativity/Machine Creativity
As we have seen, even in their current somewhat limited state, machines are already showing glimmers of creativity which is a substantial step forward. When we make a leap forward and produce something that goes beyond the initial material, we call it creativity. Why not recognise a machine's creativity in the same way? Why should creativity be an attribute reserved only for us? In order to investigate machine creativity we have to start from the only creativity we know, ours.
My own theory of creativity emerged from my studies of highly-creative people and pivots around characteristics of creativity which I have identified. Among them are competitiveness, unpredictability, emotions and consciousness.
Can machines have human characteristics of creativity and be creative like us?

COMPETITIVENESS
A robotics group at L'École Polytechnique Fédérale de Lausanne conducted an experiment in which robots running on artificial neural networks were programmed to seek food. After many trials some learned to conceal their visual signals from other robots to keep the food for themselves. Thus we can evolve robots that can be deceptive and even lie, both of which are forms of emotion.

UNPREDICTABILITY
A key characteristic of creativity is unpredictability, going beyond logic. Might machines too be unpredictable? In fact machines have unpredictability built into them. AlphaGo's move number 37 was entirely unpredictable.
In humans, emotions plus unpredictability can be explosive and trigger creativity. Both competitiveness and unpredictability involve emotions. Can machines have emotions?

EMOTIONS
Some people argue that machines cannot be truly creative because they are not 'out there' in the world, having emotional experiences. In the not too distant future machines will be able to read a language fluently. Then they will be able to truly read the web and acquire more knowledge than we can gain in a lifetime and thus experience being 'out there' and be able to convince themselves and us that they have actually had experiences often essential to creativity such as love, hate, anger and happiness.

MACHINES WITH CONSCIOUSNESS
In the age of AI the problem of consciousness has moved from the philosophical to the scientific. After wrestling for some years with the problem of consciousness, I have concluded that it results from the data processing of incoming information by the 100 billion neurons that make up the brain. That is, it is computable – reducible to numbers, which means that computers will be able to be programmed to have consciousness.

The Future
The big question is – Can we learn to appreciate art, literature and music which we know has been created by a machine? This may be relevant now and for some years to come but in the future will be a moot point, for we are gradually merging with machines.

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[1]. For details see my book *The Artist in the Machine: The World of AI-Powered Creativity* (Cambridge, MA: MIT Press, 2019).