Living Digital Beings

Edward A. Lee

UC Berkeley

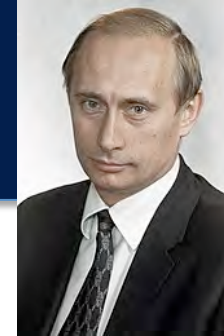*Keynote, ICT.OPEN, Hilversum, The Netherlands, March 20, 2019*
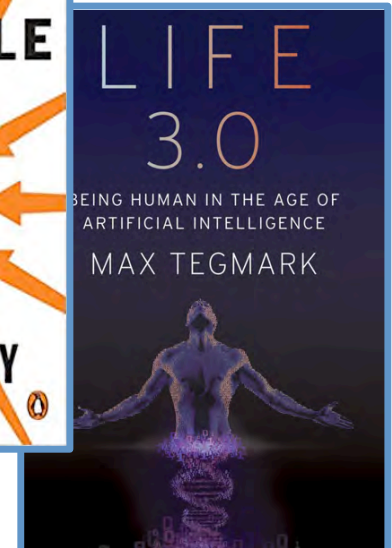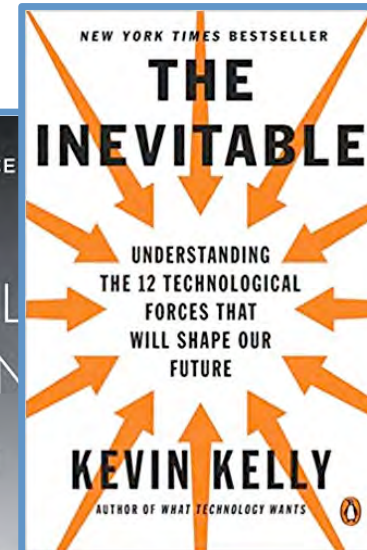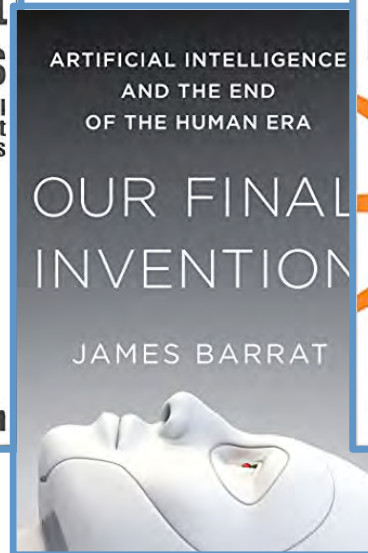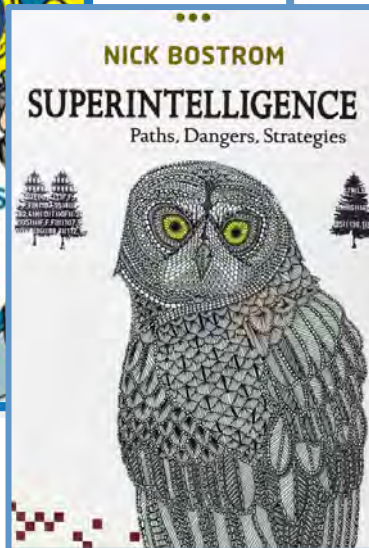
iCyPhy

University of California at Berkeley

Hype and Fear

Is AI an *existential threat* to humanity?

Three Questions About AIs

1. Are we going to lose control of them?

2. Are they alive?

3. Are they going to match and exceed us?

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Changing the Question

Can we teach computers to program?

–Maarten van Steen, March 19, 2019

Can computers teach humans to program?

–Edward Lee, March 20, 2019

Computers Teaching Humans to Program

Eclipse

Jupyter

Github

Stack Overflow

Google

…

Eggs and Chickens

Richard Dawkins

"A chicken is an egg's way of making another egg."

Is a human a computer's way of making another computer?
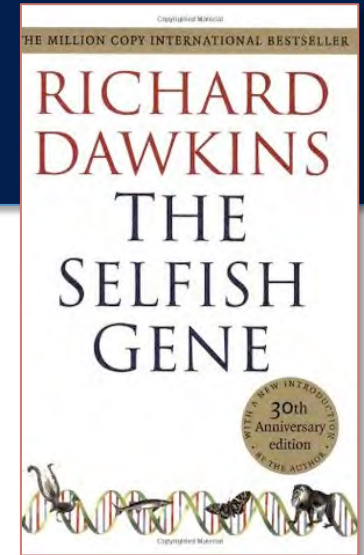
Digital Creationism: The Hypothesis that Technology is Top-Down Intelligent Design

Vasa

Evolutionary processes are capable of much more complex and sophisticated design than top-down intelligent design.
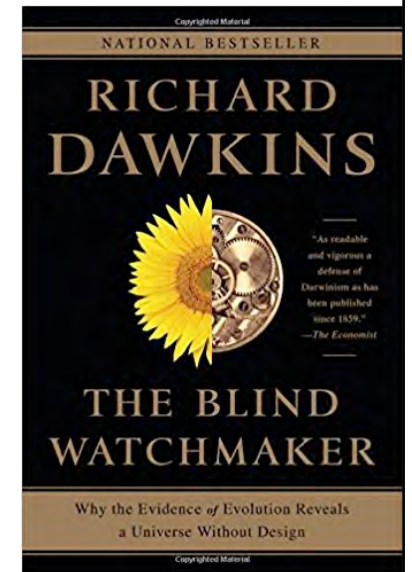
An Alternative to Digital Creationism: Symbiotic Coevolution

"Are we playing God, creating a new life form in our own image, or are we being played by a Darwinian evolution of a symbiotic new species?"

"Are humans the purveyors of the 'noisy channel' of mutation, facilitating sex between software beings by recombining and mutating programs into new ones?"

The Creative Partnership of Humans and Technology

PLATO AND THE NERD

EDWARD ASHFORD LEE
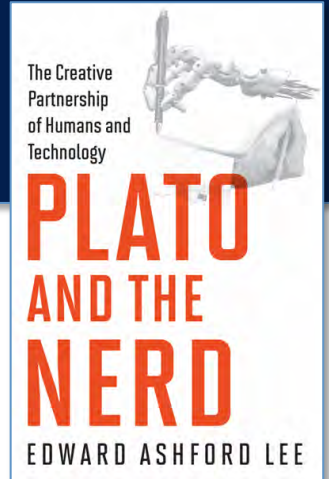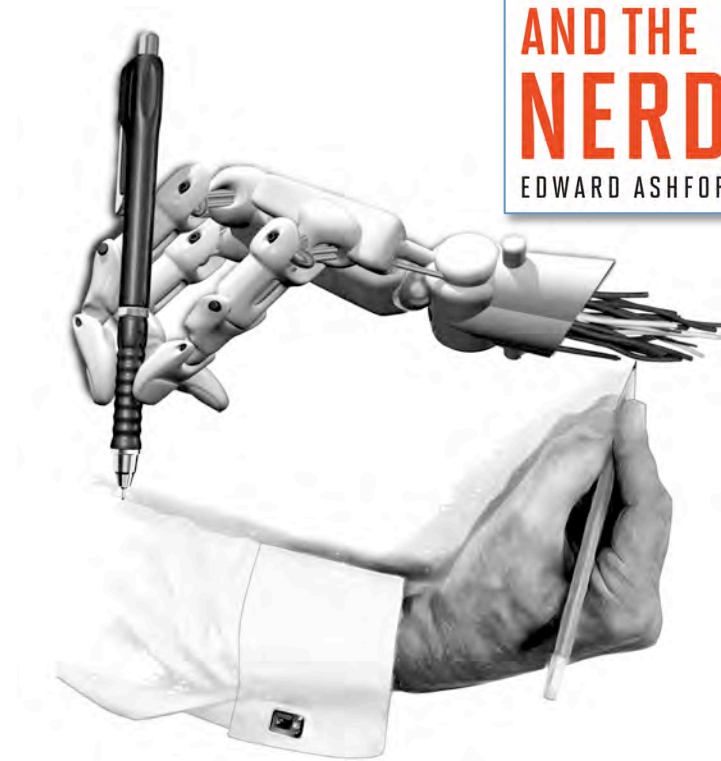
Coevolution of Digital Beings and Humans

[Photo By James Morrison CC BY-SA 2.0]

DARWIN among the MACHINES
The Evolution of Global Intelligence

"As remarkable an intellectual history as any I have read." —OLIVER SACKS

George Dyson

1997

Turing's Cathedral

THE ORIGINS OF THE DIGITAL UNIVERSE

George Dyson

2012

9
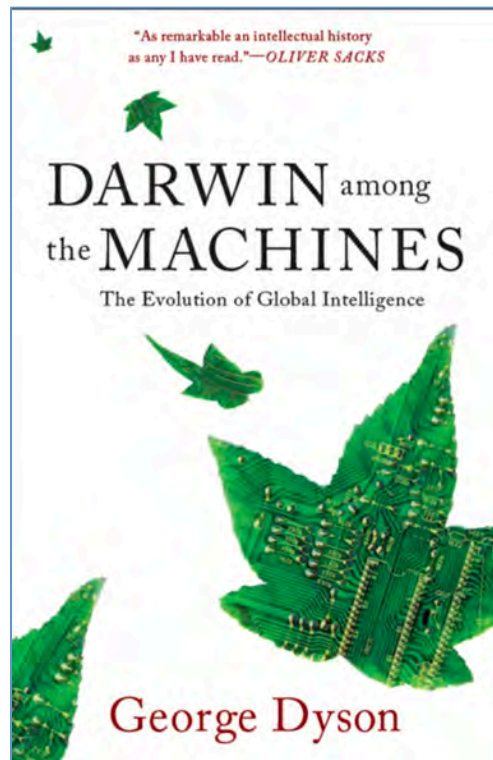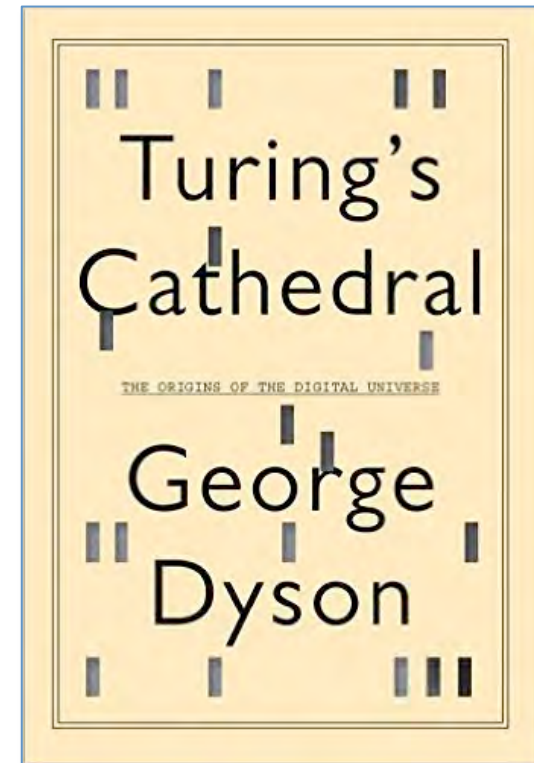
Humans in Control of AI?

Are we going to lose control of them?

No.

We never were in control, so we can't lose control.

Three Questions

1. Are we going to lose control of them?
2. Are they alive?
3. Are they going to match and exceed us?

The Technium

Kevin Kelly, talks about the "technium" as the 7th kingdom of life.
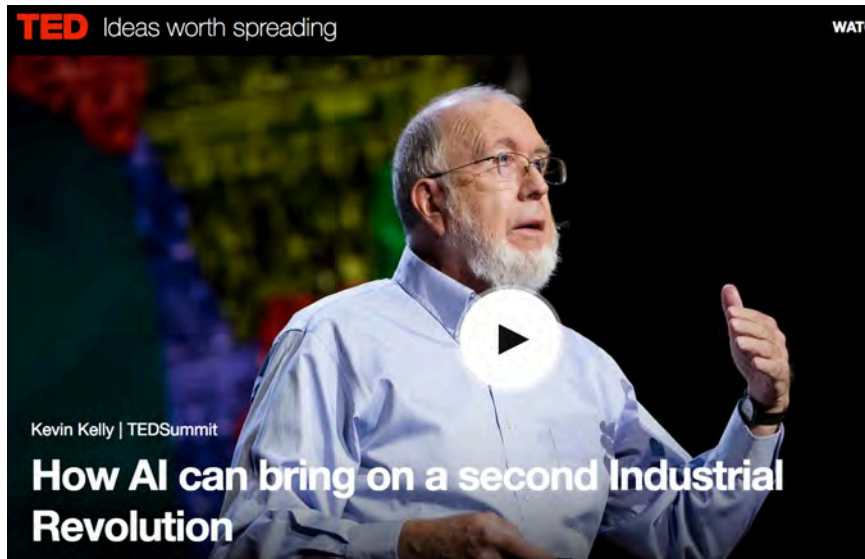
2010

Is It Alive?
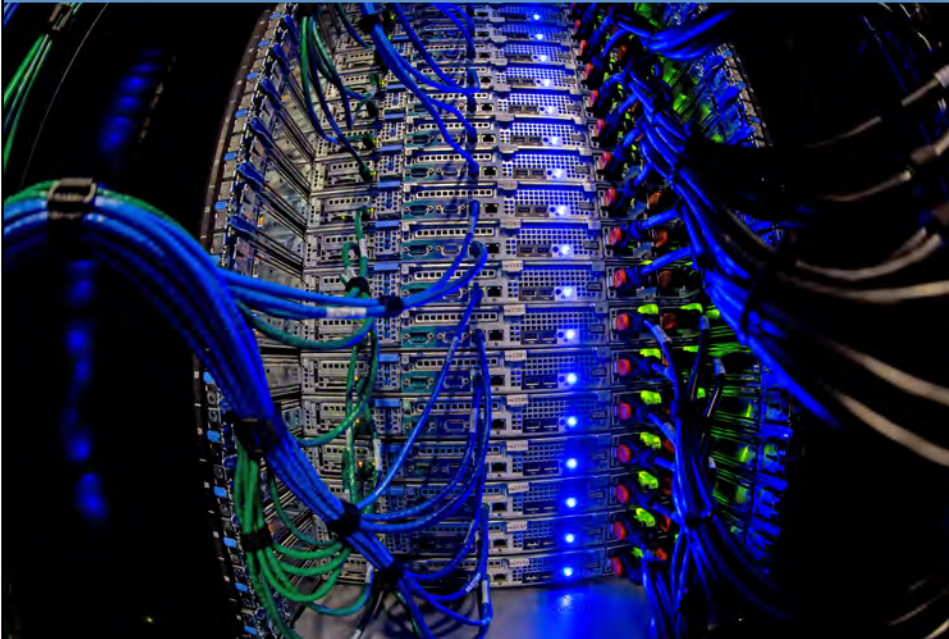
Wikipedia Servers
[Victor Grigas/Wikimedia Foundation CC BY-SA 3.0]
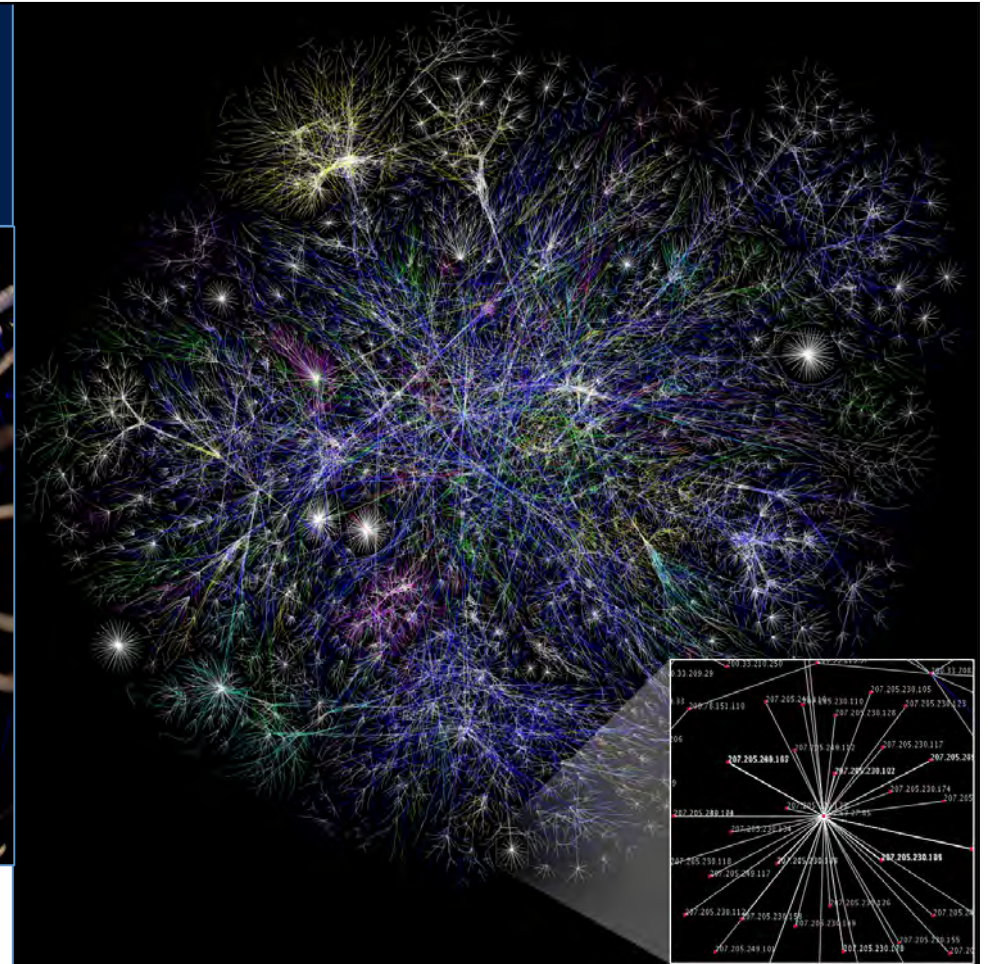
View of the Internet
[The Opte Project, via Wikimedia Commons CC BY 2.5]

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What does it mean to be alive?

Wikipedia is arguably a "living digital being" (LDB, or "eldebee").

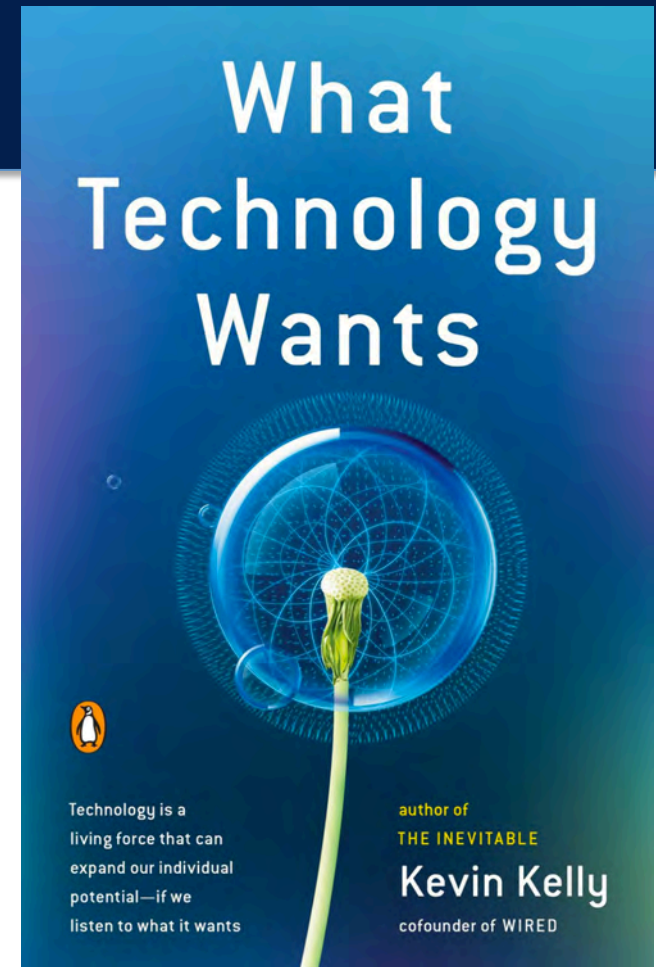It has all of these properties.

GROWTH
and development

RESPOND
to the environment

REPRODUCE
offspring

ALIVE

CELLULAR
structure & composition

HEREDITY
of traits

METABOLISM
energy from
chemical reactions

HOMEOSTASIS
stable inner conditions
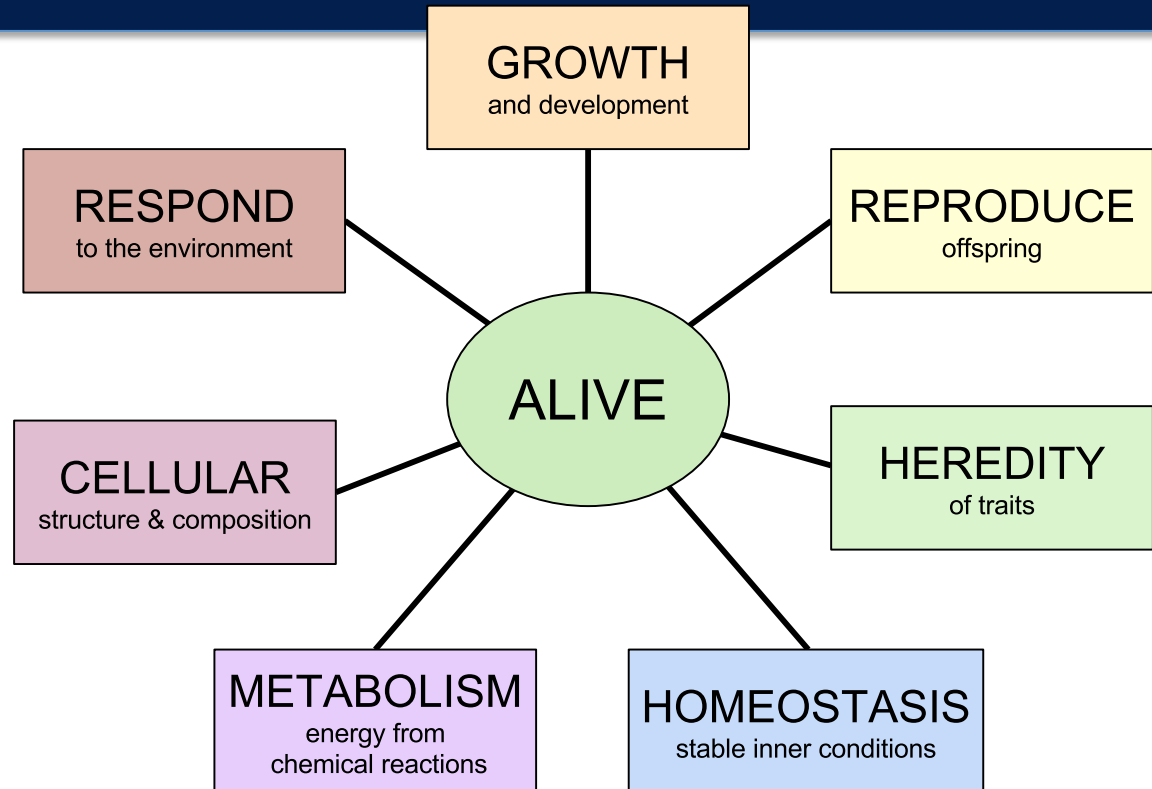
Are we being invaded by or coalescing with an alien life form?

I am having people over to stare at their phones later...

If you want to stop by...

Care to join?

The Human Side of This Coevolution
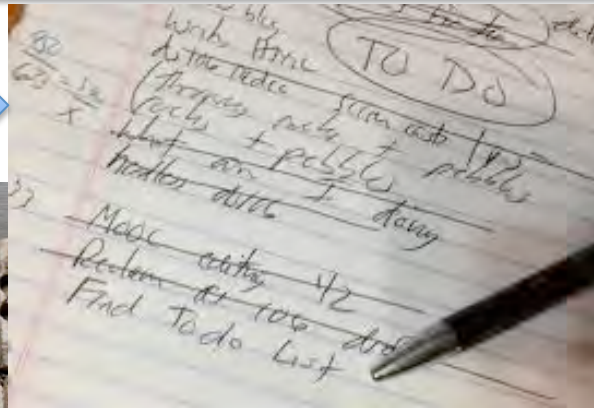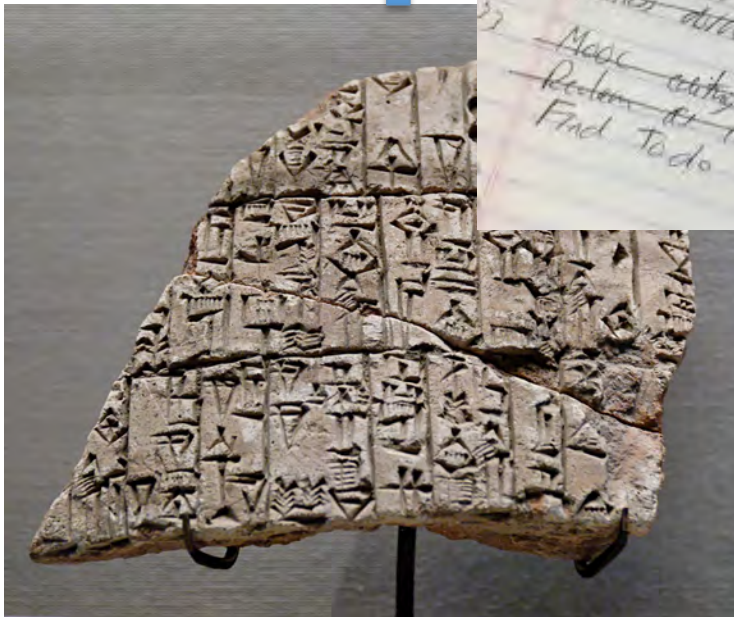
Intellectual Prosthetics

It is human culture and cognition ("memes" per Dawkins) that are coevolving, not (yet) biology.

Reproduction? Heredity? Mutation?

Sterile Workers and a Queen Bee

[Photo by Max Pixel, released to public domain - CC0]

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Symbiosis

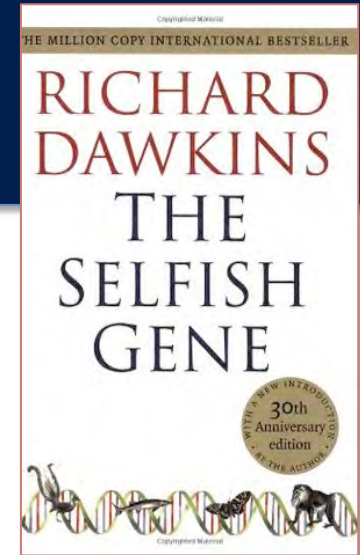"If computers and software form organisms, then they depend on us for their procreation. We provide the husbandry and serve as midwives. In exchange, we depend on them to manage our systems of finance, commerce, and transportation. But more interestingly, the machines make the humans more effective at the very husbandry that spreads the software species.

….

the software survives and evolves only if the company survives and evolves, and vice versa."

The Creative Partnership of Humans and Technology

PLATO AND THE NERD

EDWARD ASHFORD LEE
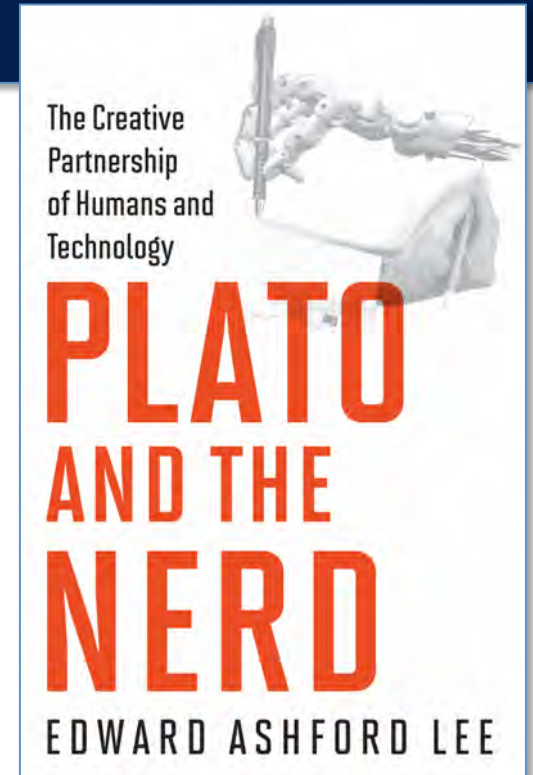
Will We Become Cyborgs?

We are already integrating technology into our biology.

By Unknown Master, Italian (1570s)
Web Gallery of Art, Public Domain

Obligate Endosymbiosis

Lynn Margulis (1938-2011)
[Photo by Jpedreira, CC BY-SA 2.5]
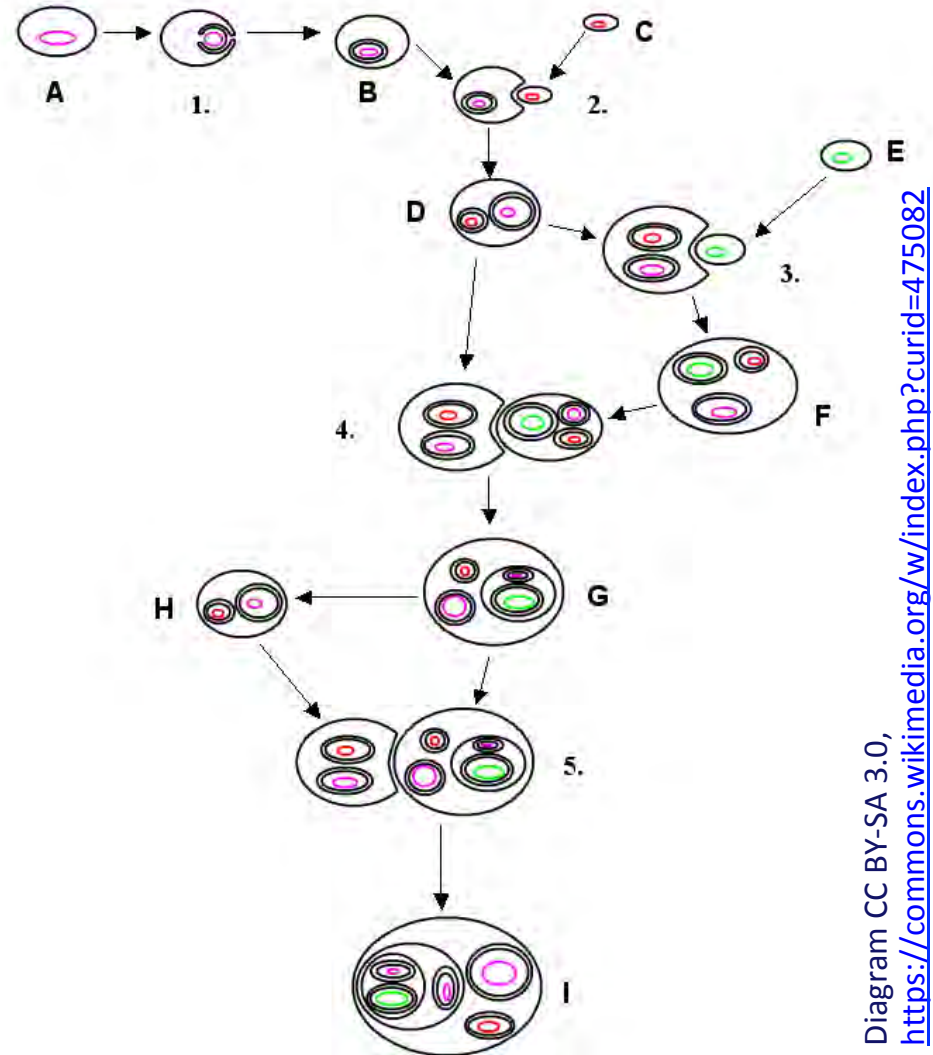
So, Are They Alive?

This depends on what you mean by "alive," but there is no doubt they share many features with biological beings.

And more importantly, their relationship with us is much like a biological symbiosis.

Three Questions

1. Are we going to lose control of them?
2. Are they alive?
3. Are they going to match and exceed us?

Computers already exceed us in many dimensions.
So the interesting question is: will they match us?

Are We Digital?
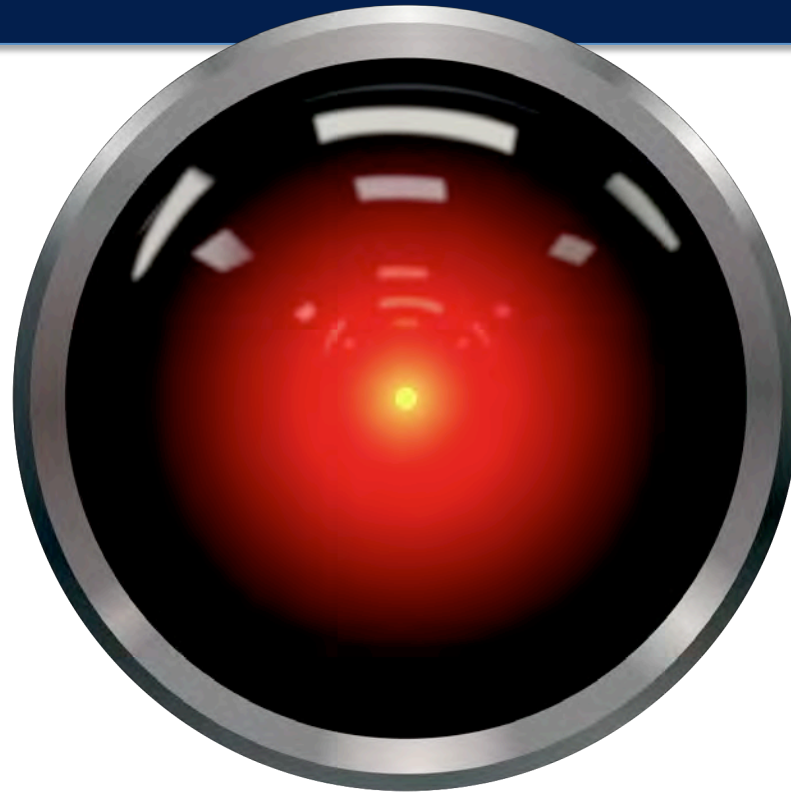
HAL, the computer in Stanley Kubrick's 1968 movie, *2001: A Space Odyssey*

Freeing the Mind From Matter

- Are we alone?
- Teleportation?
- The singularity?
- Uploading?

LIFE
3.0

BEING HUMAN IN THE AGE OF
ARTIFICIAL INTELLIGENCE
MAX TEGMARK
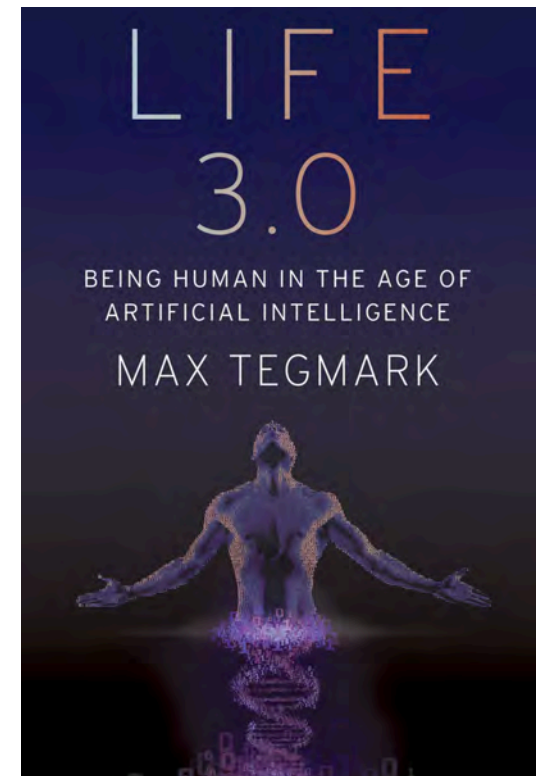
Teleportation and Uploading

What happens to "I"?

- Is the reconstruction the same "I"?
  - How can we tell?

- What if the original is not destroyed?
  - Two "I"s?

- What if a backup copy is later instantiated?
  - Two "I"s of different ages?

What happens to "I"?

- Derek Parfit:
  - The notion of "I" makes no sense.
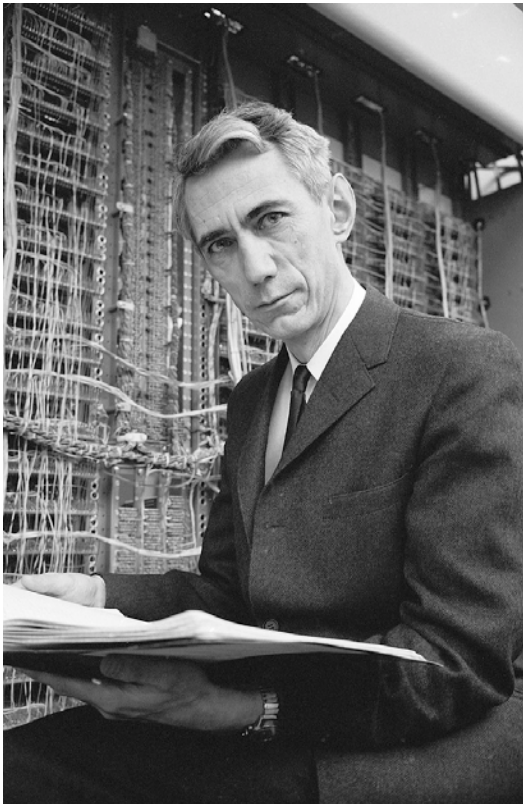
- Daniel Dennett:
  - "I" is a fiction, an illusion, a social construction.

- Douglas Hoftstadter
  - "I" can be in two places at once.

A Simpler Answer: "I" Is Not Digital

Shannon showed in 1948 a noisy channel can, in principle, perfectly convey a finite number of bits (the "channel capacity").

The converse is even more important: A noisy channel *cannot* convey more than a finite number of bits.

Claude Shannon

Or Maybe *Everything* is Digital?

Variants of the "Digital Physics" hypothesis:

1. The number of possible states of a physical system is finite.

2. Physical processes are digital and algorithmic.

3. Every physical process is a Turing computation.

4. The physical world is a computer.

5. The physical world is a simulation.

John Archibald Wheeler
"It from bit"

These theses are not falsifiable,
and therefore not scientific according
to the philosophy of Karl Popper.
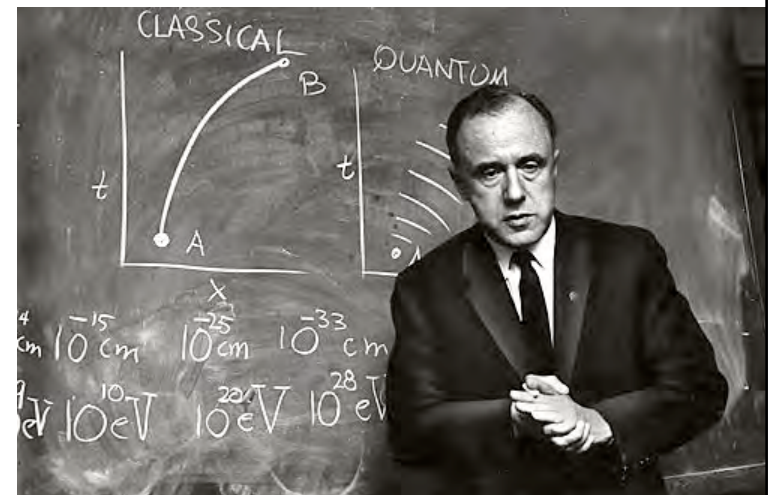
Dataism is a Religion

Yuval Noah Harari

[Photo By Daniel Naber
–CC BY-SA 4.0]

Yuval Noah Harari
New York Times Bestselling
Author of *Sapiens*

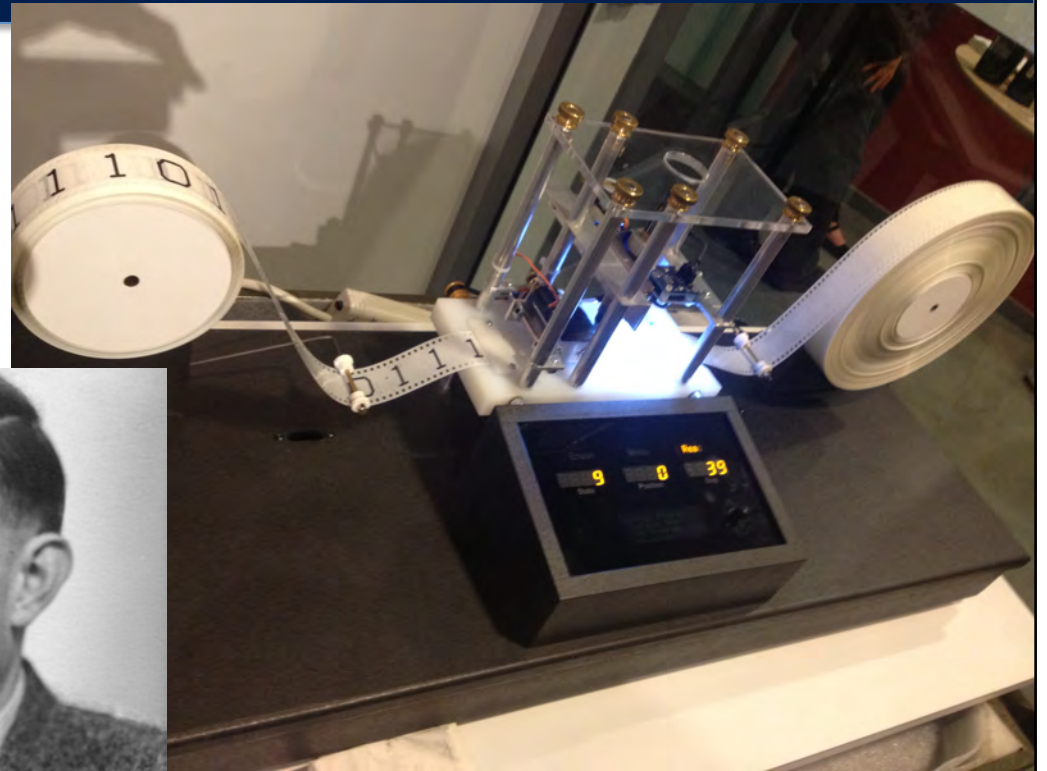Homo
Deus

A Brief History
of Tomorrow

The "Universal Machine" Fallacy

Turing machines:
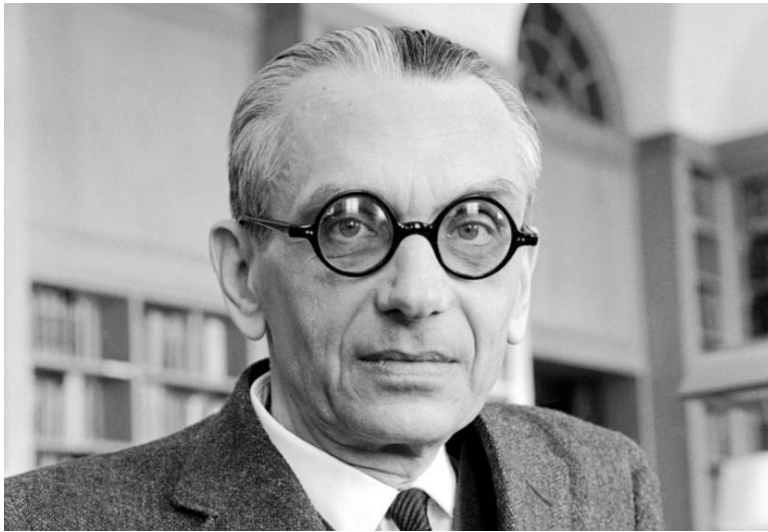
- Algorithmic

- Digital

- Terminating

Alan Turing

Machine designed by Mike Davey
[Photo by GabrielF, CC BY-SA 3.0]

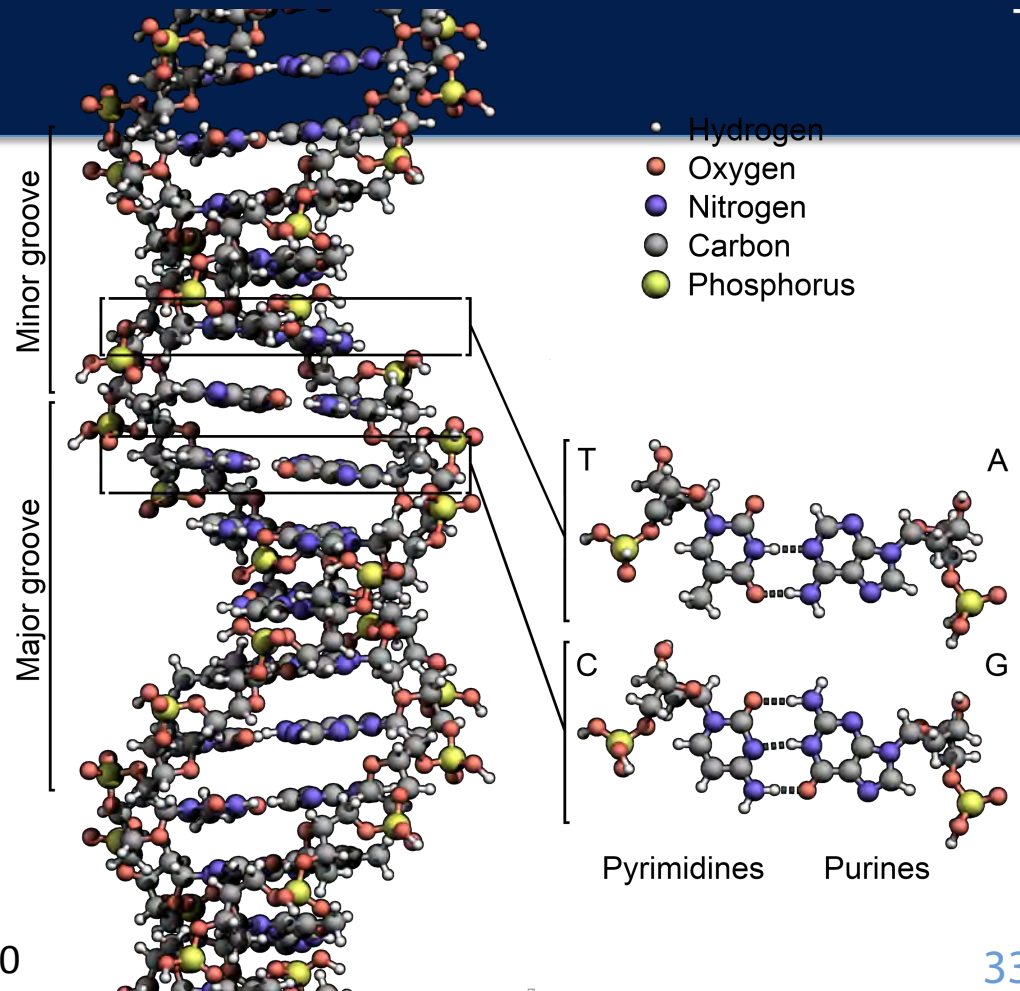# No Universal Machine Has Yet Been Invented

Kurt Gödel

If one is ever invented, it will not be, at its essence, a discrete, algorithmic, terminating process.

The DNA Fallacy

Every human alive today is the endpoint of continuous, unbroken, biological process dating back about four billion years.

By Zephyris - Own work, CC BY-SA 3.0
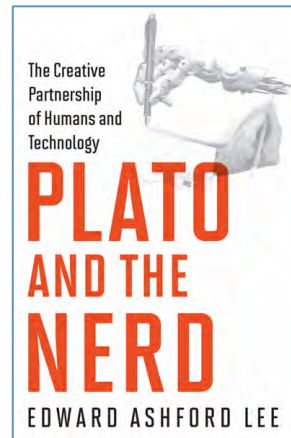
If Cognition is not a Digital, Algorithmic Process, then…

"Your mind is entirely your own."

Three Questions

1. Are we going to lose control of them? *No.*

2. Are they alive? *Maybe.*

3. Are they going to match and exceed us?
   They already exceed us, but they will never match us.

The Creative Partnership of Humans and Technology

PLATO AND THE NERD

EDWARD ASHFORD LEE

MIT Press, 2017

Living Digital Beings

Edward Ashford Lee

MIT Press, 2020