

## 2024 31st IEEE Electronic Design Process Symposium

### Is AI Intelligent ?

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# + Highlights - Who am I



## ■ Inventor

- Founded and sold AI companies
  - Lexicus (founder and CEO) – sold to Motorola
  - Cellmania (founder and CEO) – sold to BlackBerry/
  - Vocal IQ (Advisor and investor) – sold to Apple

## ■ Investor

- Board Member/Investor in 100 AI/Biotech companies
- Founder, R42 Group Venture Capital firm investing in AI and Longevity

## ■ Teacher

- PhD Cambridge, MS MIT, BSc. Birmingham
- Adjunct Professor in Genetics, Stanford School of Medicine
- Boundaries of Humanity Project: Intelligence in Humans, Animals and Machines in the age of Biotechnology and Artificial Intelligence



# DR. RONJON NAG

Adjunct Professor in Genetics, Stanford School of Medicine

## INVENTOR, INVESTOR, ENTREPRENEUR

### EDUCATION BACKGROUND

- Stanford - Adjunct Professor in Genetics, Stanford Medicine
- Cambridge - PhD
- MIT- MS



Massachusetts Institute of Technology

### INVENTOR & SERIAL ENTREPRENEUR

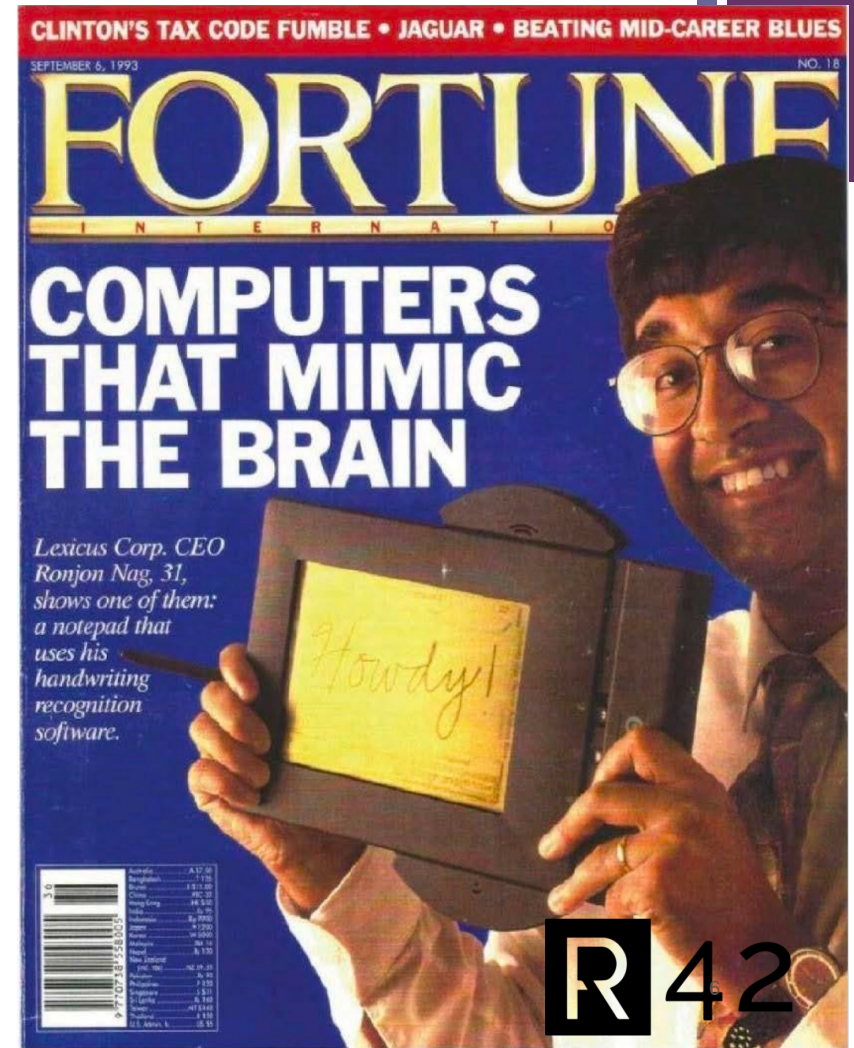
- Lexicus -First Chinese handwriting recognition, sold to Motorola
- Cellmania - First private label operator apps store, sold to Blackberry
- Advisor to VocallQ – Spoken Dialogue System, sold to Apple

### ACHIEVEMENT & AWARD

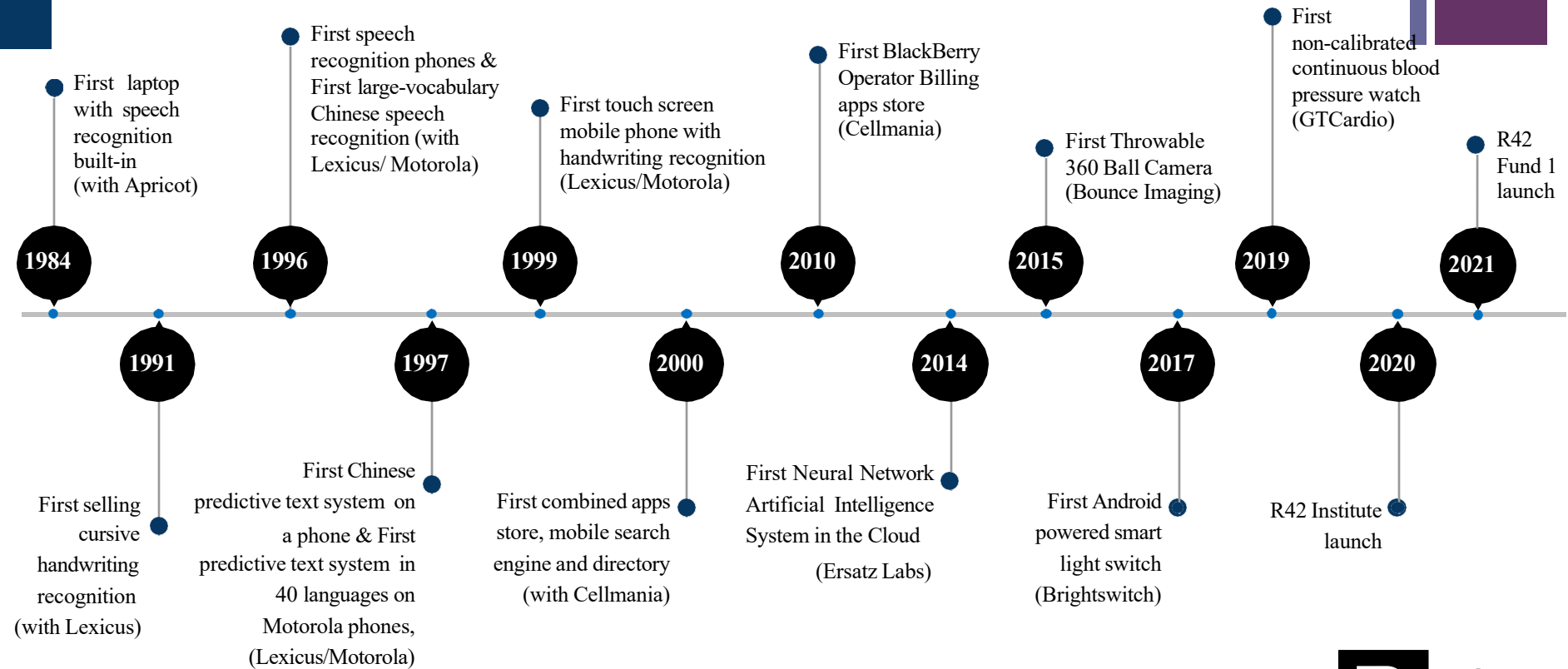
- Silicon Valley Engineering Council 2024 Hall of Fame
- IET Mountbatten Medal – Institute of Engineering and Technology
- 2023 CogX AI Lifetime Achievement Award
- 2021 IEEE-SCV Outstanding Engineer Award
- 2021 IEEE-USA Leader in Entrepreneurship Spirit Award



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# + INVENTIONS RECORD FOR 40 YEARS



# + R42 invents, invests and informs



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# There are also other types of intelligence



- IQ – intelligence quotient
- EQ - Emotional Intelligence Quotient (Daniel Golman)
- AQ – Ambition Intelligence Quotient
- PQ – Purpose Quotient (John Gottman)
- CQ - Compassion Intelligence Quotient
- FQ – Freedom Quotient

# + What is Artificial Intelligence: AI in Daily Life

Siri/Alexa/Google Now

iRobot cleaners

Robot Grass Cutters

Fingerprint recognizers

Collision avoidance systems

Loan Scoring

Stock market predictor

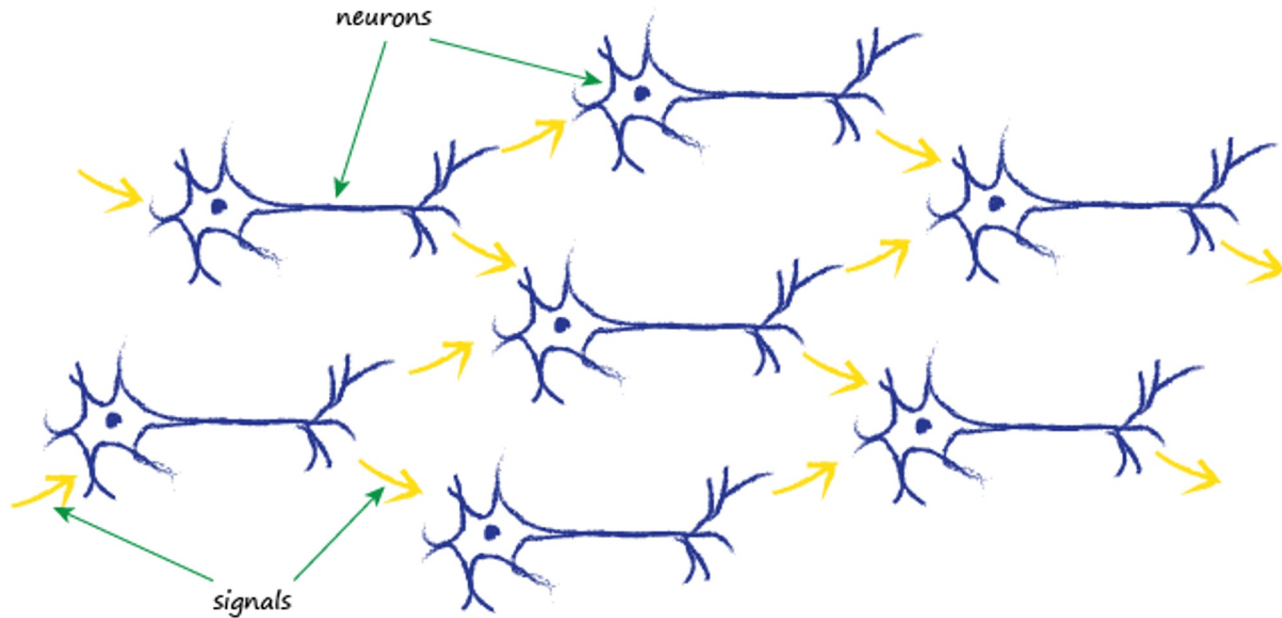




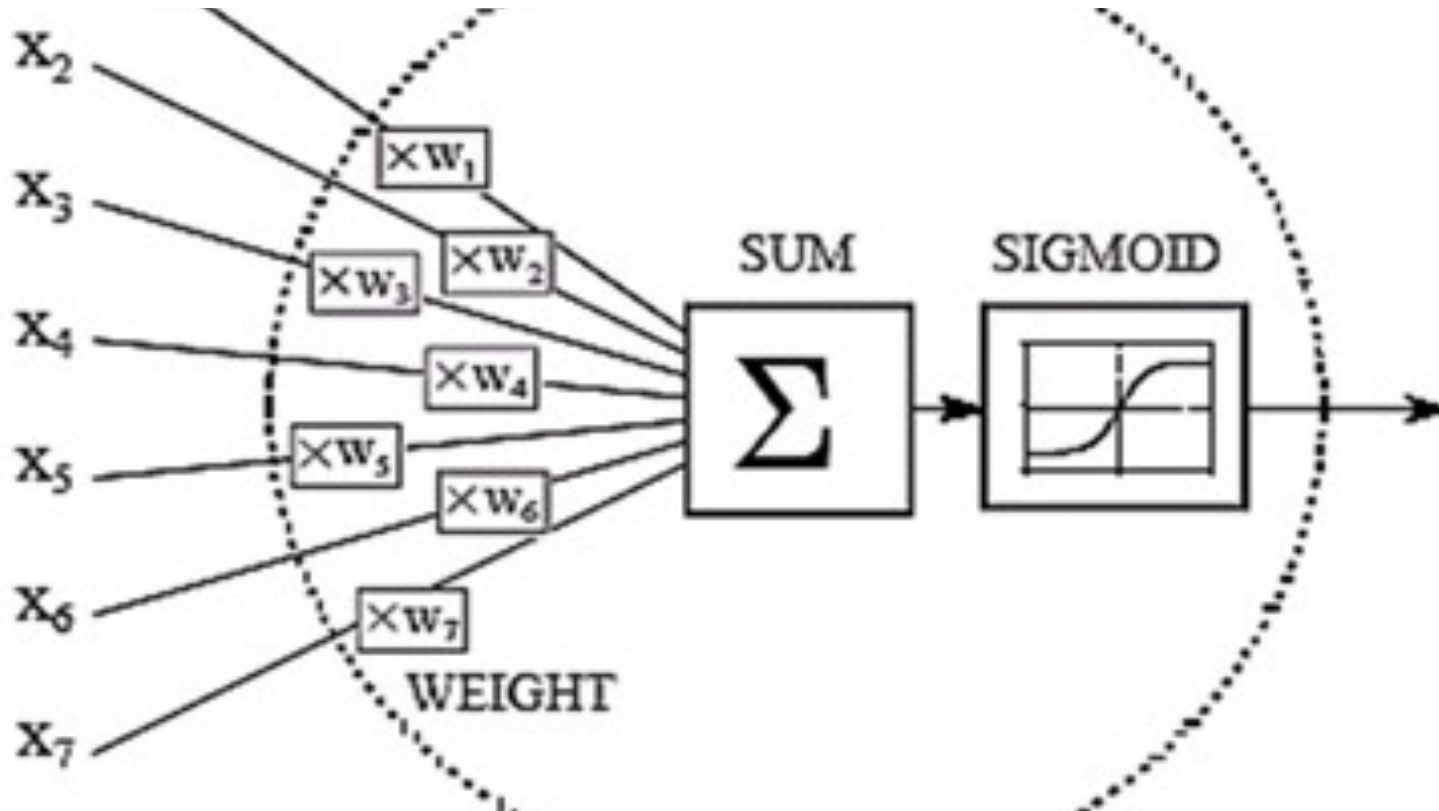
# + Terminology – What is AI ?

- 1. GOF AI – Good Old Fashioned Artificial Intelligence – usually refers to rules based systems and **symbolic** processing
- 2. Machine Learning
  - Algorithms that learn from data
  - Logistic regression, SVMs, Random Forests, HMMs, and includes **Neural Networks and Deep Learning**
- 3. Artificial Intelligence
  - Academic field to provide human like intelligent functions
  - Cynics say once implemented its not AI anymore by definition
- 4. Generalised Artificial Intelligence, Strong AI
  - Human performance intelligence
  - Perform any task a human can
  - Equivalent intelligence to a human
- Literature, press, often use these terms interchangeably

# Brains in Nature



# + Neuron model



# Human vs GPT

- **HUMAN**

- 100 Billion Neurons
- Each neuron connected to 1000 neurons
- So **100 trillion** connections/parameters

- **GPT4**

- **1.6 trillion** parameters

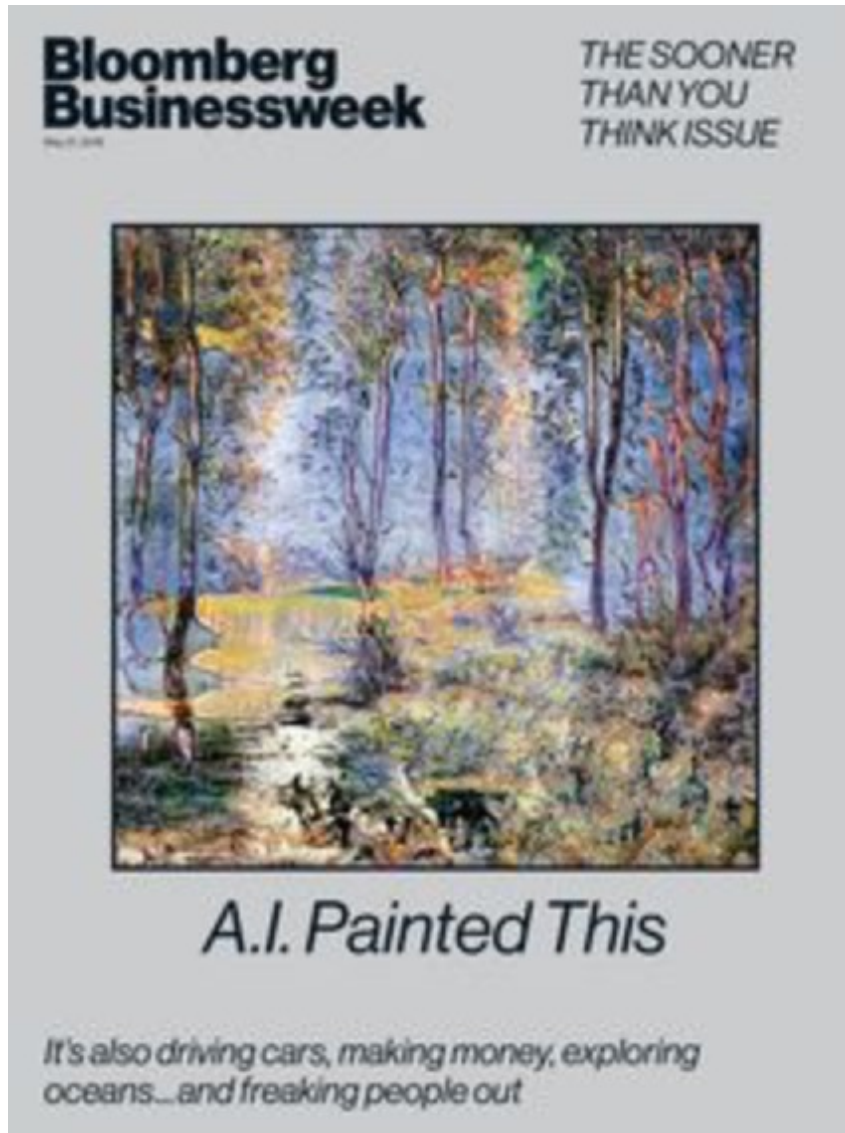


# Artificial General Intelligence Is Already Here

Today's most advanced AI models have many flaws, but decades from now, they will be recognized as the first true examples of artificial general intelligence.



# AI can make paintings



Source: Robbie Barrat

# + Why hasn't AGI been declared ?



1. A healthy skepticism about metrics for AGI
2. An ideological commitment to alternative AI theories or techniques
3. A devotion to human (or biological) exceptionalism
4. A concern about the economic implications of AGI

# + Boundaries of Humanity

- What is it to be human? What biological, social, and cultural qualities and capacities define and distinguish the human species? An important subset of this question is the range of variation in human physical, social, and cultural expression.
- What physical constitution, social conditions, and cultural configurations promote the fullest flourishing of our distinct human nature?
- What role will our ideas, perspectives, and technological powers play as we go forward into our human future?





# What distinguishes humans from animals and machines



- Any single distinguishing factor insufficient
- Taken together differentiation more clear

# + Cultural intelligence

- Social learning evolved out of needs for food-sharing and childcare
  - Storage and transmission of information: culture
- Imitation
  - Humans very skilled, key tool for social transmission
  - Culture advantage to human organism (Durham 2016)
- Morality and religion
  - Humans alone adhering to a rule system
    - Rituals, moral codes, laws, religion
  - Humans very adaptable, adapting to whatever culture and environment they are born in
- Evolutionary changes passed by genetics AND culture
  - E.g.. Technologies: shared culturally rather than genetically



# Culture in animals



- **Contested**
  - Some argue originated in great apes, whereas others argue is unique to humans (Hill et al 2009)
  - Chimpanzees often conform to community standards but although have many requisite cognitive traits for culture transmission, humans are clearly distinct in this accentuated ability
- **Compared to animals, humans are most warlike**
- **Many species have social groups, and complex relationships**
  - Whales and dolphins, regional dialects like humans (Fox et al 2017)
  - Social transfer of hunting techniques, cooperative hunting food gathering, social play, and signature whistles akin to name recognition
  - Homing pigeons have preferred routes, passed from generation to generation

# + Culture in machines

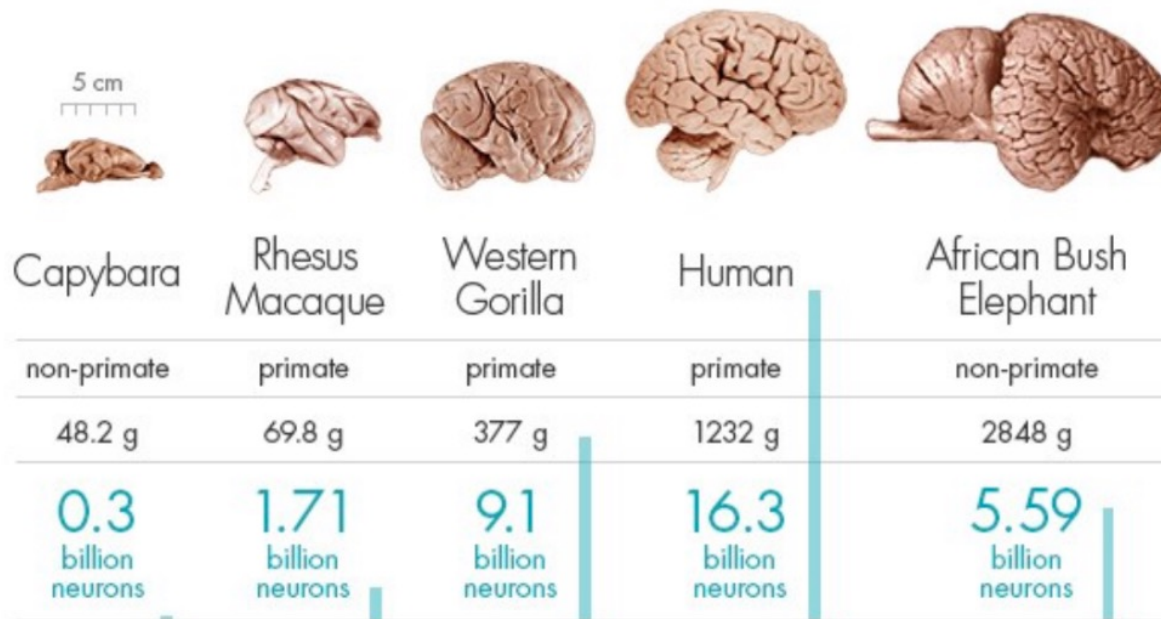


- Raw information encoded and stored in digital form
- Commentary on raw information
  - Amazon reviews
  - Journalism, books, blogs
- Programs and recipes to act on the information
- Higher order culture more difficult to encode
  - Morals, right and wrong
  - May conflict with mathematical objective function of survival

# + We don't have the biggest brains

## BRAIN SIZE AND NEURON COUNT

Cerebral cortex mass and neuron count for various mammals.



2 / 3 When it comes to brains, size isn't everything. The human brain is much smaller than that of an elephant or whale. But there are far more neurons in a human's cerebral cortex than in the cortex of any other animal. Data taken from the following studies: [Cellular scaling rules for primate brains](#); [Cellular scaling rules for rodent brains](#); [Gorilla and Orangutan Brains Conform to the Primate Cellular Scaling Rules: Implications for Human Evolution](#); [The elephant brain in numbers](#). © OLENA SHMAHALO/QUANTA MAGAZINE; SOURCE: [BRAINMUSEUM.ORG](#) AND [HERCULAND-HOUZEL ET AL.](#)

Neurons in cerebral cortex only; there are around 100bn neurons total in human brain

# + Augmented humans





# Can a machine have a mind



- What do we mean by a mind ?
- Machines can have minds (strong AI)
  - Consciousness
  - Sentience
  - Self-awareness
- Machines can simulate intelligence (Weak AI)
  - Solve specific problems
  - Reason logically, find patterns and learn

# + What is consciousness

- Many disciplines have looked at the problem
- One school of thought thought it is a fundamental like time and space, rather than being able to be computed
- Another school, brain simply channels consciousness rather than embodies consciousness
- Consciousness may have correlates in the brain, but they are not equivalent to consciousness.
- Some people counter the above argument by saying that consciousness is an illusion, a side-effect, or what is called an “epiphenomenon” of the brain. They claim that there is no such thing as actual consciousness, and that there is nothing more to cognition than the machinery of the brain.



# + Searle argument

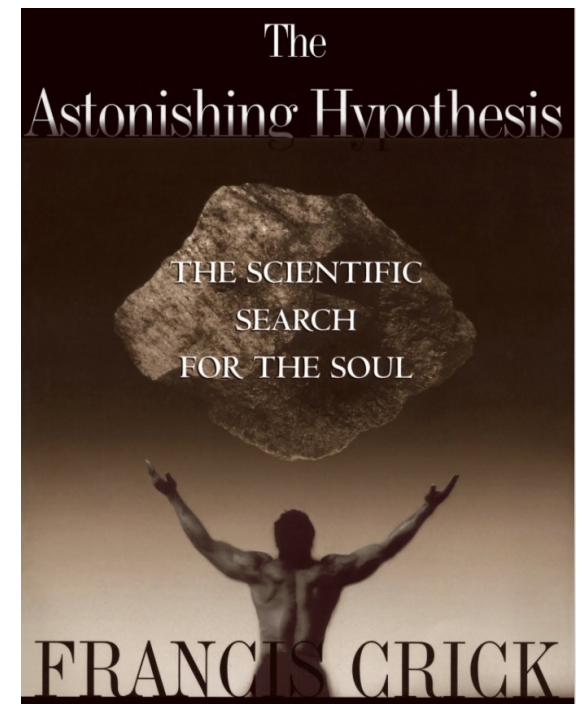
- Searle: Chinese room experiment
  - Person put in a room and given essays written in Chinese characters
  - His sole job is to copy those characters and give them to someone outside the room
  - Although the submitter and reader can understand the writings, does the man in the room understand ?
- Simple act of following instructions – which is all a computer can do – never results in actually knowing what those instructions mean, or what it is doing. The consciousness is not computable.

# + Quantum mind theory of consciousness

- In 2009, physicist Roger Penrose and anesthesiologist Stuart Hamerhoff advanced "quantum mind theory" suggesting that consciousness is a result of quantum mechanics, with microtubules inside the brain working as computing elements in a system they call "orchestrated objective reduction (OR) "
- The theory suggests that human consciousness is a result of the wave functions of quantum particles collapsing once they reach specific energy levels.
- Hamerhoff and Penrose believe the brain's neural networks and cells process information that results in consciousness.
- Critics of the quantum mind theory contend that consciousness is hardly demystified by relating the brain to the rarefied realm of subatomic physics.

# + Neurobiology of the brain

- Christof Koch and Francis Crick put forward the idea that consciousness resides in the brain's prefrontal cortex; they described where in the brain we experience things when we experience them—but not why we do
- Crick argued in 1979 that the time had come for science to take on the previously forbidden subject of consciousness. In his 1994 book "The Astonishing Hypothesis: The Scientific Search for the Soul," he went further. "You," he wrote, "your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules.



# + What is a thinking mind

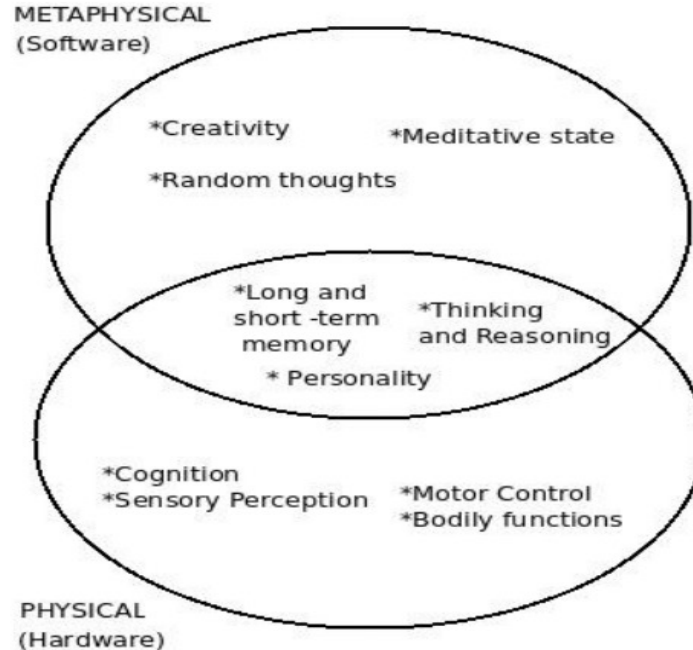


Figure 1: Overlap in states with difference in physical (hardware) and meta-physical components (software).

- Proposition 3: A thinking mind is generation or information which can be viewed as random walks in a network of information where there is an certain level priority to that information with attention based on certain goals or emotional states. The thinking mind generates different types of thoughts depending on the problem at hand, the level of intelligence, depth of knowledge and experience.

Source: <https://arxiv.org/abs/1701.00349>: An affective computational model for machine consciousness, Chandra, 2017

# + Turing Test: not a test of consciousness

- Turing Test :
  - a chat-bot has a 25-minute conversation with human judges.
  - If the bot is able to convince half of the judges it is human, based upon the complexity and understanding displayed in its messages, then it is considered as having passed the test.
- The Turing Test does not seek to understand an AI's mind/internal conscious life, rather it seeks to see if a machine could pass for human.



# Test for consciousness in AI



- ACT (Artificial Consciousness Testing)
  - This is a behavioral test that seeks to probe for experience-based consciousness in AI.
  - The test challenges an AI with a series of increasingly demanding language interactions to see how *quickly* and *readily* it can grasp and use concepts and scenarios based on the internal experiences we associate with consciousness.
  - Examples: concepts in books and movies that involve body switching (“Freaky Friday), life after death, ghosts, reincarnation. Irrespective of the viability, humans do understand the concepts.
  - Argument is that without consciousness computer without consciousness would have difficulty understanding these concepts; similar to a deaf person understanding music, or a blind person understanding color.

Source: Schneider & Turner, Scientific American, July 2017

# + Humans vs LLMs

- Humans and many animals
  - Understand how the world works
  - Can predict the consequences of their actions
  - Can perform chains of reasoning with an unlimited number of steps
  - Can plan complex tasks by decomposing into sequences of subtasks

## AI And The Limits Of Language

artificial intelligence system trained on words and sentences alone will never approximate human understanding.

ESSAY    TECHNOLOGY & THE HUMAN

BY JACOB BROWNING AND YANN LECUN

AUGUST 23, 2022

# + Future of AI



- Where will strong AI come from ?





# Neuromorphic chips need to outperform GPUS and CPUS

- GPUs and CPUs typically
  - Access large amounts of memory off chip, hence memory bandwidth limited
  - Use difficult to manufacture high bandwidth memory (HBM)
- Neuromorphic chips
  - Low precision floating point arithmetic
  - Balancing computational work across parallel processors,
  - partitioning and allocating memory,
  - scheduling message traffic between processors
  - Put the memory on the chip itself, half of the die
  - Obviously can't put as much memory on chip, but can use precomputation instead of storage as a trick, if 1000 times faster



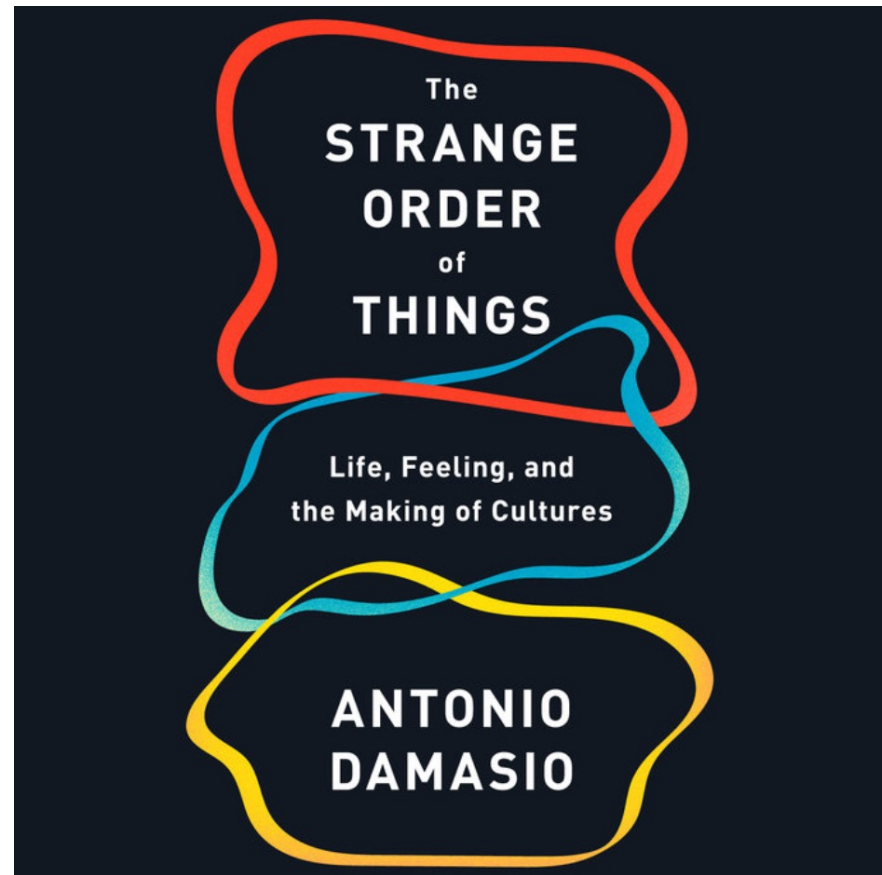
# + Emotion Modelling



# + Damasio (1996):

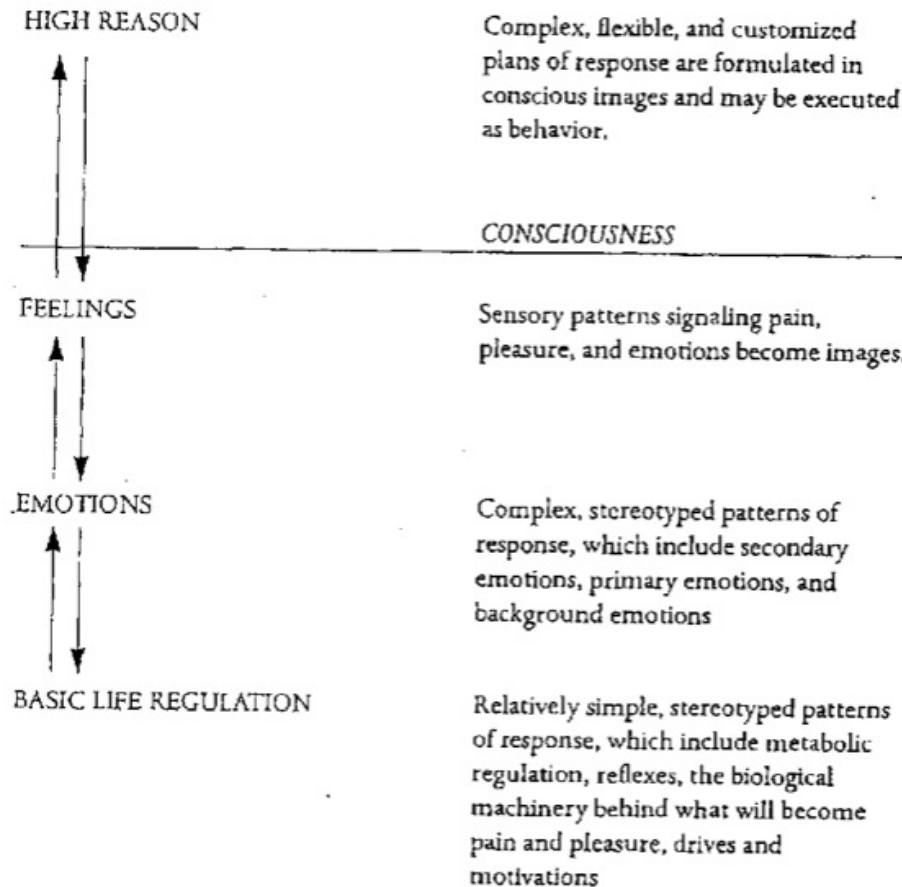
Damasio's somatic marker hypothesis  
emotions evaluate  
external stimuli efficiently  
through our own body

This motivates us to  
consider both  
internal and external  
appraisals simultaneously.



# + Levels of Life Regulation

Table 2.1. Levels of Life Regulation

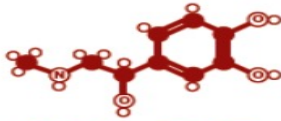




## The chemistry of emotions

Where two neurons meet, a very small gap (synapse) exists between them. The electrical impulse travelling along the axon of the neuron must convert into a chemical signal to bridge this gap. The chemicals that do this are called neurotransmitters. These so-called chemical messengers are involved in our different responses to situations.

Your emotions depend on fluctuating levels of neurotransmitters, which cause the activation of different parts of the brain responsible for different moods, or activate parts of the brain that trigger the stimulation of the autonomic nervous system.



### Adrenaline

Released by the adrenal glands that sit on top of each kidney, adrenaline increases the flow of blood to our muscles, raises our heart rate and dilates our pupils. It is crucial in our fight-or-flight survival response.



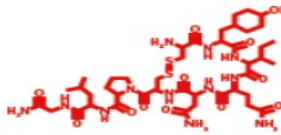
### Noradrenaline

Similar to adrenaline, the release of this chemical can result in increased levels of alertness, helping to prime us for action if needed. It also increases our blood pressure and widens our air passages.



### Dopamine

This is the addictive reward chemical that your brain craves. It serves to motivate you to seek out the things you need for your survival. We can sometimes find ourselves enslaved by this ancient reward mechanism.



### Oxytocin

Also known as the 'cuddle hormone', oxytocin is released when you're close to another person. It's essential for making strong social bonds, and it's also a key part of why we want to trust people.



### GABA

Responsible for regulating muscle tone, gamma-Aminobutyric acid (GABA) also regulates the communication between brain cells. It can calm us down by reducing the rate at which our neurons fire.



### Acetylcholine

This is the main neurotransmitter in the parasympathetic nervous system that slows our heart rate, contracts smooth muscles, dilates blood vessels and increases bodily secretions.



### Glutamate

The most abundant neurotransmitter in the vertebrate nervous system, glutamate is used by nerve cells to transmit signals to other cells. Too much of it can cause cognitive impairments.



### Endorphins

Triggered by the sensation of pain, endorphins work to inhibit the transmission of pain signals. Capable of producing a sense of euphoria, studies have suggested endorphins may also be stimulated by laughter.



### Serotonin

Serotonin is linked to our wellbeing and happiness, and our levels of it are affected by exercise and exposure to sunlight. It also helps to regulate our mood balance, sleep cycle and digestion.

# + Implementing emotions in computers ?

- An organism, as simple as an amoeba or as complex as a person, reacts to an environmental stimulus in a way that makes it more likely to survive and reproduce
- Neurons firing in a particular pattern might trigger the brain to order the release of adrenaline, which makes the heart beat faster, priming an animal to fight or flee from danger.
- That physical state is an emotion
- Feelings, such as guilt, envy, or pride, are “higher order or social emotions.”



# But can AI give emotions

- Haptic technologies – sense of touch
- <https://spectrum.ieee.org/robotics/home-robots/paro-the-robotic-seal-could-diminish-dementia>
- <https://www.youtube.com/watch?v=Vx8mv87e6wE>



# + 40% of adults go to bed with a stuffed animal – teddybot add on

**teddybot**

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## meet teddybot

your conversational AI companion

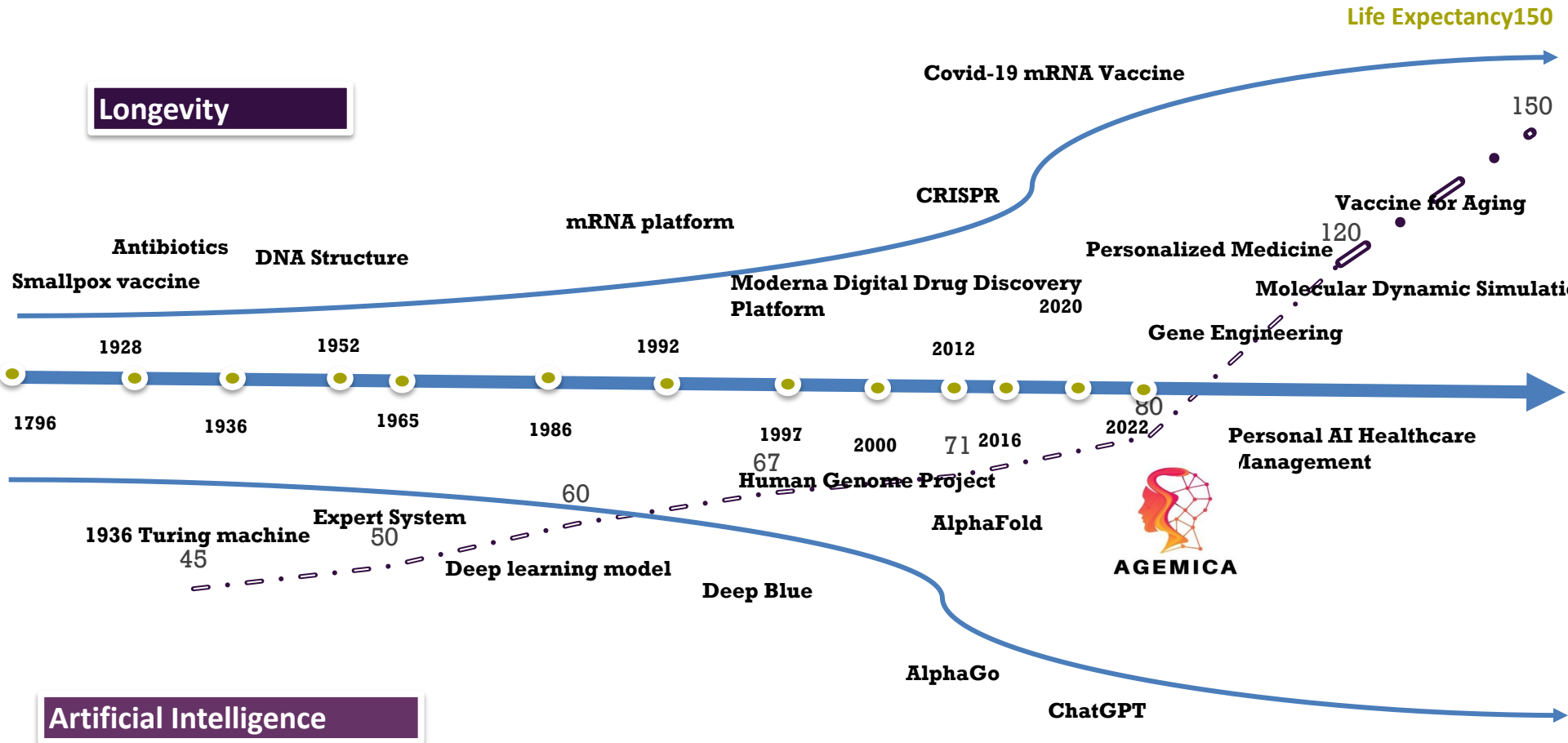
Teddybot is the only AI companion that provides personalized, screen-free conversation and privacy-first design to improve quality of life for elders.

- ✓ Reduce loneliness
- ✓ Improve cognitive interactions
- ✓ Support wellness routines
- ✓ Supplement caregiving resources

[join our waitlist](#)

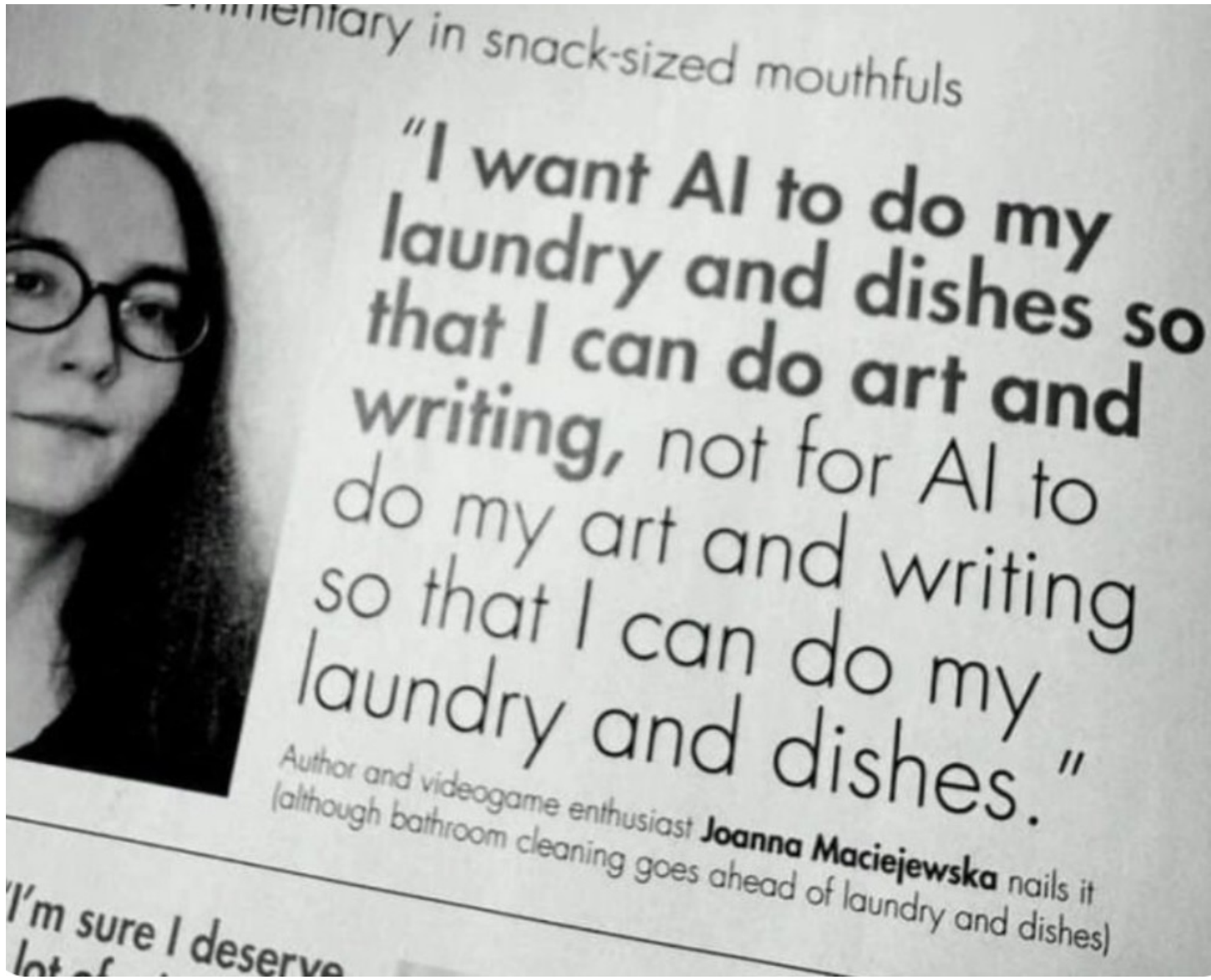


# + Artificial Intelligence and Longevity are at inflection points



Source: Agemica

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# + Chat to me:

# <https://app.soopra.ai/ronjon/chat>

app.soopra.ai/ronjon/chat

SOOPRA

wesomeness! ~ MIMIO.ai is now Soopra.ai. Stay tuned for more awesomeness! ~ MIMIO.ai is now Soopra.ai. Stay tuned for more awesomeness! ~ MI

Ronjon Nag  
@ronjon

22 April 2024

Hello! I'm Ronjon Nag, a Stanford lecturer with a deep passion for AI, healthcare, and linguistics. I've spent my career in the tech industry, applying AI to solve real-world problems and exploring its potential to revolutionize various fields. We can discuss the latest developments in language technology, the ethical considerations in AI, or my experiences in researching longevity and developing treatments for rare diseases. Let's dive into a conversation! 🌟🌍🤖

03:18 pm

tell me about the crash course in AI that you teach at Stanford.

03:18 pm

The AI crash course I teach at Stanford is designed to provide a comprehensive understanding of AI for those who are new to the field or want to deepen their knowledge. The course covers the basics of AI, including machine learning, neural networks, and natural language processing. We also delve into more advanced topics like deep learning and reinforcement learning. The course is designed to be accessible to all, regardless of their background in computer science. It's part of the Stanford Continuing Studies program, so anyone can register for it. The goal is to equip students with the knowledge and skills they need to understand, apply, and navigate the world of AI.

03:18 pm

