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Review Article

"Artifact Intelligence", The Real "AI"

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Abstract

Intelligence has been defined in many ways: the capacity for abstraction, logic, understanding, self-awareness, learning, emotional knowledge, reasoning.

For all animals, "intelligence" is ascribed to the use of tools or to communicate in groups to establish communal behavior...ultimately to survive.

But to ascribe intelligence to man-made devices (automotons) that are made from brick, mortar, metal or plastic is a challenge. The drive to survive and reproduce is lacking in such artifacts. We review various types of automotons including humanoid robots and discuss memory. The pioneering ideas of mathematical biologist Alfred Lotka bear consideration.

"A state of consciousness (i.e. neural memory) can be described either in terms of its "contents" or in terms of the disposition of the molecules etc of the brain, just as a magnetic field might be described either in terms of an intensity chart or the position of a number of magnets."

We employ a psycho-chemical mechanism to describe the emotive neural memory code.

The proposed tripartite mechanism and iconography involves the interactions of neural cells (neurons/astrocytes) with their surrounding extracellular matrix (nECM/PNN). Incoming perceptions are encoded into the nECM/PNN by neural cells ejecting trace metal cations and neurotransmittters (NTs).

Consciousness and memory are linked in all sentient creatures, expressed as intelligence. In any case, the "intelligence" of a computer is far removed from that of any living being, both conceptually and mechanistically. The computer system is totally electrodynamic; but the neural system operates via a combination of electrodynamic and chemodynamic processes. Thus, a better description of computer-based process would be the term "Artifact Intelligence". This removes any ambiguity associated with the word "artificial" which implies mimicking a natural process or material, which the artifact clearly does not do.

Keywords: Cognitive Information; Emotions; Memory; Neurotransmitter; Trace Metal; Psycho-Chemistry

Introduction

"Intelligence" has multiple meanings. For humans, it relates to the mental talents expressed as language, as abstraction, logical planning, creativity, critical thinking, and problem-solving. The word "intelligence" evokes the words "consciousness", "memory" and "judgement". Some human intelligence is manifest as a particular talent, as for music, art, mathematics, mechanics or literature. Others may manifest intelligence as the ability to empathize with others or to survive extreme circumstances. In any case, "Intelligence" subsumes the phenomena of "consciousness", "emotions" and "memory" that are operative in all living beings (from bacteria on upward). All could be considered as "intelligent". Thus, it could be a synonym for "life".

"Artificial" refers to a man-made material or process that mimics a natural one (i.e. artificial sweetener).

"Artificial intelligence (AI)" refers to technologies that enable computers to perform advanced functions, notably to translate written or spoken language, to analyze data, to recognize faces and to make recommendations regarding pattern recognition, in airport flight bearings or military missile defence strategies.

The quantum mechanical approach is powerless in this regard, as it is based exclusively on electrodynamic signaling and is inherently "demotive". By contrast, the biological neural system employs chemo-electric signaling modes. The neurobiology community evinces epidemic ignorance by not recognizing both modes as relevant to the process of mentation (see Connectome Projects which focus exclusively on electrodynamic synaptic contacts).

"Artifact" refers to a device produced by humans, a man-made object or process.

The challenge

"Intelligence" has been defined in many ways: the capacity for abstraction, logic, understanding, self-awareness, learning, emotional knowledge, reasoning, judgement.

For all animals, "intelligence" is often ascribed to the use of tools (e.g. crows, octopus) or to communicate in groups to establish communal behavior) (bees, orca). Ultimately to survive by means of mental efforts. Examples of such have been documented in the behavior of ants, bees, dolphins, chimpanzees, whales, etc.

But to ascribe intelligence to man-made devices (artifacts) that are made from brick, mortar, metal or plastic is a challenge. The drive to survive and reproduce is lacking in such artifacts. Even very "intelligent" algorithms that recognize faces and comprehend numbers cannot grasp the essence of emotive states that define the subjective experience of intelligent living beings.

The Golem: Power of prayer

Man has always looked to heaven as the source of life power. Indeed, the sun in heaven is the prime energy source for life on earth. Indeed, the ancient Egyptians prayed to the sun as a god. The ancient Greeks also looked to the heavens as the domicile of their gods, who were spiritual automotons that could occasionally interact and intercede in human affairs. Some engaged in sex with human women. Materially, they were represented as marble statues that helped define human qualities of beauty, anger, jealousy, speed, and violence. These statues could not budge but implied movement.

The Hebrew God of all creation and the source of life was not represented in statues at all. His was an invisible but all-encompassing presence. How could the power of God be harnessed to help his people, the Jews of Central Europe (1500-1700) to avoid the pains of pogroms, rapes and tortures?

In reaction, it is said that a Golem, a type of automoton, was fabricated from clay. There were many tales of such automotons helping the Jews. In Prague, Rabbi Juda Lowe (the Maharal of Prague) is said to have fashioned a clay figure that was powered by a religious text inserted in its mouth. Its job was to protect the Jewish Community but it always ended in a tragic loss of control. The Golem could be deactivated by removing some of the inserted text.

Regardless of the cultural details, these tales reveal the deep-seated effort of humanity to build subservient devices to perform desired tasks. The Golem stories do not describe devices with empathy or emotive connections, or signs of intelligence. Rather, the stories focused on saving Jews, but they tended to end in tragedy.

Mechanical automoton

Fabricated automotons often were dolls that could perform a physical act, such as banging on a drum or moving their head or their eyes. There are accounts of such in China (~400 BCE) and tales of such in ancient Greece. The historical record shows that

there were many attempts to render man-made devices with seeming intelligence. The artifacts were generally powered by springs, weights and pulleys, or water or sand. The French were particularly involved in this (~1700 onward), notably building mechanically-driven toys with springs that moved or made music or foretold events with cards, for the amusement of the aristocracy. Examples of such can still be viewed, as did I, in the Bercy Palais (Paris). It has been said that the Industrial Revolution took hold in England rather than France because the British used their talents to invent steam-driven water pumps to drain mines and engines to power factories, rather than fashion toys to entertain the rich.

Electrical automoton

Newly discovered electricity was also imagined as being a power source for automotons. Galvani (~1750) had shown that frogs legs could be made to move by a jolt of electric voltage. The most famous example of an electrically driven automoton was not an invention, but in the story of Frankenstein by Mary Shelley (1818). Here, a cadaver was revitalized by a jolt of electricity. But the resultant automoton would not be considered to be particularly intelligent. It could move and perform certain physical acts, but could hardly be considered as an intelligent entity. In the many plays and movies inspired by the original story, the zombie Frankenstein turned out to have limited mental ability tinged with a love interest for the heroine, but great destructive capability. Frankenstein was not really represented as a controllable intelligent entity.

Humanoid robots

Science fiction writers (Asimov, Clark, Dick) presented intelligent robots that seemed human in term of their behavior and motivation. But of course, they never described the actual mechanisms underlying the operation of the robots, though Asimov mentioned "positronic brains". But the root mechanism of a robot wanting to be free, or expressing an emotive quality was not broached.

In Ex Machina, the human female appearing robot acts very normal in speech and comportment. She passes the Turing test and can be deemed intelligent. More to the point, it/she exhibits traits that are distinctly human. It/she develops an emotional rapport with the male protagonist. It/She desires freedom and is capable of killing to that end. It/she kills the creator/programmer and intrigues with the protagonist to achieve the goal...freedom from the prison of human control.

Ex Machina describes the invention of a consciously intelligent entity, akin to the creation of a lifelike robot analogous to that presented in the Bible. It erases the line between man and machine and obscures that between man and God. The only relief we have is that this is pure fantasy. All the robots in these movies and stories seemed humanoid in terms of their motivation and responses, but the basis of their behavior or was not broached.

The Ex Machina and Blade Runner films ascribe robots with a desire to be freed from human control. But they do not specify how this desire is algorithmically embedded in the Artifacts. Though they can be programmed to encode algorithmic memory, even the quantum mechanical approach is powerless in this regard. It is purely electrodynamic, inherently "demotive".

So today, we have electrodynamic robots that perform specialized, repetitive tasks (i.e. building cars, vacuuming the room), but there is no doubt about their lack of humanoid intelligence.

By contrast, the biological neural system employs both chemodynamic and electrodynamic signaling modes. There have been epidemic failures by the neurobiology community not to recognize such (see Connectome projects [4-6].

The ability to create a life-like object is a god-like talent not in the purvue of humans, though this may be the subconscious goal of some. It harkens to the Biblical story of Bavel some 4000 years ago where with bricks and tar the citizens of an early city tried to build a tower to "*reach to heaven...to challenge the uniqueness of the Creator... to make a name for themselves* " (Genesis Chapter XI). This displeased the Creator who confounded the citizens by blessing them with many languages so they could not communicate with one another to build.

Mathematical automotons

Charles Babbage (~1820), an Englishman and his collaborator Ada Lovelace , are credited with conceptualizing the first mechanical computer, the Difference Engine, that conceptually led to more complex electronic designs. Joseph Jacquard in France invented a code (~1801) for a textile loom. He used punched cards to control the weaving patterns of the textiles. This was a forerunner of a programming method used by early computers with punch cards. The pioneering ideas of mathematical biologist Alfred Lotka [7] bear consideration.

"A state of consciousness (i.e. memory) can be described either in terms of its "contents" or in terms of the disposition of the molecules etc of the brain, just as a magnetic field might be described either in terms of an intensity chart or the position of a number of magnets.

Years later during WWII, the Germans enciphered their military communications in an Enigma code with a typewriter-like enciphering device that generated scrambled text. Alan Turing and a team at Bletchley Park, designed and built an electronic machine which had memory and could be programed to decipher the Enigma code [6b]. This was the first modern programmable computer. Later workers developed an Information Theory that was grounded in thermodynamics and subsequently quantum mechanics [8,9]. Initially, computers used punch cards to write programs and get output. This later evolved into the electronically programable computers that are common today.

Complexity

The increasing complexity of the electronic computer and its programing languages led many scientists to consider the brain as an appropriate model for developing even more complex computer systems. In fact, many adopted biological terms to describe computer wiring systems conceived as analogues of brain neural connections. Thus, electronic circuits are termed to day as "*neural networks*" with many connections imagined to mimic the synaptic contacts of neural networks. They invoked quantum mechanics by ascribing *fractional weights to these synaptic contacts* by melding Bolzmann probability statistics to the network circuits to generate continuous variable weights (ranging between -1 to +1). Such interpretations gulled a number of scientists to suggest that the increased complexity would result in the emergence of a conscious computer system [10-14].

Neural system

As will be discussed below, the neural system is much more complex than any extant electronic device. For example, it involves chemodynamic signaling modes that don't involve synaptic contacts. In biology, such chemodynamic ephaptic modes invoke emotive states instigated by >100 neurotransmitters (NTs) and cognate receptors (i.e. GPCR, integrins, etc), which link body responses (muscles, organs, visceral reactions) to neural memory (see tripartite mechanism). Thus, in contrast to the computer binary information system (n = 2), the neural system employs more than100 NTs and metal cations (n > 100) which instigate emotive states but whose coding cipher remains impenetrable to our understanding.

The electrodynamic signaling mode evolved only much later with the evolution of neurons in worms (*c elegans*) and later evolved into much more complex creatures that experienced consciousness as emotions and memory. But all still employ the identical bacterial biochemistry with NTs. Consider that the Information Theory of computers is based on a binary code (01) which cannot encode an emotive state. Even with fractional values, the quantum mechanical system is incapable of broaching the emotive pattern of neural creatures.

Brain anatomy

The ability of neural nets to achieve mental states is the "grand conundrum" of neurobiology.

The artificial neural network of computers is presumed to mimic the connective pattern of the brain neurons. Thus, it is worthwhile to examine this assumption more closely.

It has been the hope of neuroscientists that mapping the connectomic structure of the brain would lead to insights about

the brain's unique talent, notably the achievement of mental states manifest as emotions and memory. To this end they employed sophisticated technologies (i.e. fMRI) and Fly Wire Annotation system) and comparative anatomy to evaluate the universal neural-connectome aspects of the brains of a fly (Drosophila melanogaster), a mouse and a human [15,16].

Some have suggested that epigenetic processes such as acetylation of histones via chromatin might provide a means for encoding neural memory [17]. Without going into details, this approach is reminiscent of a car being modified by changing its transmission or muffler. It may alter the car's performance but it does not modify the car's planned route. Memory can be described as a process, not as an anatomic organ. Moreover, acetylation is an irreversible process that cannot address the phenomena of emotive mental states or forgetting.

Others suggest that the sheer complexity of neural circuits instigates the emergence of mentality [18,19]. Some attempted to clarify brain function and disfunction by computational modeling based on optogenetic fMRI identification of synaptic contacts between neurons.

Tripartite mechanism of memory

We employ a psycho-chemical approach to describe the emotive neural memory code.

The proposed *tripartite* mechanism and iconography involves the interactions of neurons/astrocytes with their surrounding extracellular matrix with the perineural net/PNN (nECM/PNN). Incoming perceptions are encoded into the nECM by neurons ejecting trace metal cations and neurotransmittters (NTs). They combine within local "addresses" in the nECM to form metal-centered complexes i.e. cognitive units of information (*cuinfo*) (Figure 1). Neurotransmittter (NT) binding confers emotive qualities to the *cuinfo* [20-23]. A recent report described the impact of PNN on fear memory [23b].

The advantages of the tripartite mechanism are

- Employs the nECM surrounding neurons as a "library" of coding "addresses".
- Employs dopants (metal cations and NTs) available to neura; cells, to encode units of memory.
- Encodes emotive (affective) states with metal cations (n > 10) and molecules (i.e. NTs), a multi-code (n > 100), representing emotions.
- Entangles emotive memory with physiologic reactions.
- Is phylogenetically conservative. It starts with bacterial signaling which evolved into neural net signaling. Proposes that neural circuits, comprised of neurons +astrocytes, can ultimately achieve a phase change, transcnding "metabolic energy" into "mentality".

Astrocytes + neurons

As to the cellular aspects of memory, we often refer to "neurons" but mean to include the associated astrocytes which bridge the neurons and the nECM [24,25]. They are part of the cellular processing circuits which transcend physical experience into mentality.

In short, the neurons/astrocytes employ chemo-affinity processes to encode (emotive) cognitive information. The nECM/PNN is the "library" [26] while the metal cations and the NTs are the "dopants". NTs are physiologic encoding elements, the molecular signifiers of emotive state.

The chemographic notation in figure 5, encapsulates the general coding features of the *tripartite* mechanism. It remains cryptic in that it does not specify how specific NTs elicit various emotions. But it identifies the salient components of neural/astrocyte signaling system that entangles psychic states with physiologic reactions.

Conclusion : Artifact Intelligence (AI)

The mystery of how conscious memory powers intelligence endures. The vastness of the cosmos is open to our investigations with an array of instruments, optical; and variable wavelength telescopes, satellites, rockets. We conceive of stars, vast distances, magnetic fields, black holes, dark matter and dark energy. But the enigmatic quality of our conscious life experience remains *terra incognito*. The metrics of physics do not seem to apply to mentality

[27]. The comment of the mathematician Godel seem appropriate

- "There are some truths that will forever remain beyond our reach."

Consciousness and memory are linked expressed as intelligence in all sentient creatures. In any case, the "intelligence" of a computer is far removed from that of any living being, both conceptually and mechanistically. The intelligence of all living beings is ultimately applied to survival and reproduction. "Intelligence" is also used as a word by the military. But its meaning is clearly indicated by linking the terms "military intelligence" (MI).

For example, the computer system is totally electrodynamic; but the neural system operates via a combination of electrodynamic and chemodynamic processes. "Consciousness" or equivalent term (i.e. subjectivity, mentality, cognition) would describe the psychic realm achieved by a biochemically active circuit of interactive neurons/astrocytes which remember prior experience.

One must admit that the enigma of consciousness manifests a novel aspect in the firmament of natural forces. We may have identified some key components of memory processing with the tripartite mechanism of memory, but the driving life force that activates living beings remains impenetrable to our understanding.

A quote from the erudite Rav Soloveichik seems appropriate

- "The problem of modern man lies not in his quest for knowledge, but in his hubris...unable to admit that he knows little and understands less".
- Thus, a better description of computer data processing would be the term "Artifact Intelligence", which processes with numbers and algorithms**.** This removes any ambiguity associated with the word "artificial" which by implies mimicking a natural process or material.

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(By GM). A memorium to my late wife, the artist Georgette Batlle (1940-2009). Blessings on my children Danae and Jonathan, who always looked kindly on me during the years of my travails relating to trace metals, blood coagulation, art and "thought" and do so continue.

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GM is a founder of MX Biotech Ltd., with the interest in developing new concepts relating to "memory", "memory materials" and thought processes.

CG is an emeritus professor at the Institute of Chemistry, Hebrew University of Jerusalem. He is active in developing technologies for the conversion of peptides into orally available drugs.

Notwithstanding, the ideas forwarded here are scientifically genuine and presented by both in good faith, with many citations without commercial clouding of the concepts expressed therein. The text was not generated by AI, but is the joint effort of the au-

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