Federal Register Notice 86 FR 46278, https://www.federalregister.gov/documents/2021/08/18/2021-17737/request-for-information-rfi-on-an-implementation-plan-for-a-national-artificial-intelligence, October 1, 2021.

Request for Information (RFI) on an Implementation Plan for a National Artificial Intelligence Research Resource: Responses

RFI Response: National AI Research Resource

Frontier AI Development Based on Bionics or Biologically Inspired Engineering

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The current National Artificial Intelligence Initiative Act of 2020 has general good coverage for National Artificial Intelligence Research Resource. To speed up the AI development in the US and enhance our international competitiveness, new avenue needs to be explored as frontier research. Suggest adding resources on the development of AI driven by bionics or biologically inspired engineering. Here we redefine AI as implementation of algorithm and logics Nature already engineered, into electronics. The intelligence developed from the nature includes decision making, sensing, control and performance like dogs, cats, insects, fishes and even plants, as well as human beings. We can learn not only from human's decision making, but also animals and insects. For example, a toddler learns to tell dogs from cats with only a few examples, while AI would need thousands of pictures to train. Dogs and cats walking elegantly are probably driven at top level by conservation of energy instead of coordination of joints and limbs. A tiny mosquito can sense CO2 from long range, navigate towards potential pray, find the warm blood skin temperature, verify the host with skin chemical (octenol), suck blood, ride with wind back to the pond, and lay eggs to complete a life cycle. The Venus fly trap plant has simple nerves similar to animals. The neural response is verifiable with electrode. A spike is observed if trigger hair is touched, but the trap leaf is not ready to close. It turns out that the Venus fly trap can count one and two. The trap leaf closes if the trigger hairs are stimulated twice within 10 seconds, a simple logic to avoid false alarms from rain drops and dust fall. After about 30 second, the 1st stimulus is reset, and the plant starts over to count one and two. The simplicity and fool-proof decision making are what we could implement in the nowadays AI, and there are vast examples in the nature to copy with. This is a holy grail to be discovered. Nature neural networks have the computational power not in GHz, nor MHz, and likely in the kHz range or slower; however, nature creatures have been able to make correct decisions better than nowadays computers and AI programs in many areas, plus additional tasks on food hunting, reproduction, life cycle, etc. If the decision algorithm is understood and implemented into computers and electronics, it can be augmented by million times faster with GHz speed computer, or by million copies of the electronic devices. The biological neural networks are different from silicon-based gates and electronics. The frontier AI development based on bionics can be derived from the following directions:

- Understand the algorithm and logics nature engineered, based on bionics or biologically inspired engineering. Pay attention on their simplicity and fool-proof decision-making methodology as well as physiology differences from silicon-based electronic chips.
- Development of hybrid analog and digital computers. The biological nerves and signal processing are not entirely digital. They combine digital, analog, and chemical signals as harmonically orchestrate. Electronic analog signal processing is approximate but fast. Analog computer elements can be build based on

operational amplifiers. They perform addition/subtraction, differential, and integration easily. Arrays of analog processing elements can be arranged with digital gates to combine into complex and versatile tasks. The combination of analog signal processing with modern digital computation capability may be superior than digital alone.

- Holographic Modality Perception for Reinforcement Learning. Animals learn from nature's feedbacks with full spectrum of sensors. Example of humas' sensors includes vision, hearing, touching, temperature, moisture, taste, smell, acceleration, vibration, etc. This may be necessity to learn nature's intelligence as in the real world all sensors always agree each other. The modern AI ML (Machine Learning) commonly relies on a single data source, and occasionally combines two (e.g., audio, visual) as cross modality perception. A holographic modality perception may be necessary for advanced learning mimic nature.
- Identify correct feedbacks for the AI ML process. As the nowadays AI ML starts to have breakthroughs on successful tasks such as voice recognition and facial recognition, there are still immense areas to be explored. The job function of a future programmer could be similar to nanny and school teachers, who guide computers with feedbacks of awards and punishments while the computer AI system complete the program language behind the scenes.

In summary, a successful AI will learn and implement into electronics systems the algorithm and logics Nature already engineered. We may be able to avoid big data and HPC and work smart to achieve more advanced intelligence and decision-making by computer and electronics.