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# SingularityNET: Blockchain-Driven AI Marketplace and Quest for AGI

*SingularityNET aims to become the key protocol for networking AI and machine-learning tools to form a coordinated Artificial General Intelligence.*

Technological singularity was predicted to occur when technological advancements, particularly in artificial intelligence (AI), would lead to machines that are smarter than humans. In 2017, Ray Kurzweil, famous futurist and Google's Director of Engineering, commented on technological singularity at a conference: "That leads to computers having human intelligence, our putting them inside our brains, connecting them to the cloud, expanding who we are. Today, that's not just a future scenario. It's here, in part, and it's going to accelerate." Unlike some darker predictions, Kurzweil stated, "We're going to get more neocortex, we're going to be funnier, we're going to be better at music. We're going to be sexier. We're really going to exemplify all the things that we value in humans to a greater degree." Kurzweil asserted that true technological singularity would occur by 2045.

## Narrow AI and AGI

The term narrow AI distinguishes earlier, more scripted versions of AI from artificial general intelligence (AGI). Narrow AI functions are programmed beforehand and then called upon based on empirical data. Apple's Siri was an example of AI. Siri was able to use voice recognition to gather data used to search for and return information based on AI search functions. Narrow AI had also been used for Industry 4.0 applications within factories such as Bossard, AG's inventory replenishment systems that used electronic scales to weigh c-parts (e.g., nuts and bolts), and AI functions to determine when to place orders for replenishment.

AI dates to 1956 when a group of scholars and practitioners gathered to consider the potential for computers to learn to do certain activities previously reserved for humans. Research activity emerging from those early meetings led to the first computer program to learn to play checkers and to solve a variety of mathematical problems. However, when development failed to deliver the outcomes within the timeframe envisioned by original working group overall, AI development slowed during the 1970s. The 1980s brought a resurgence of global AI development fueled by promising signs from Japan's fifth-generation computer project and renewed commitment to research funding by the U.S. and British governments.

AI began to gradually find commercial footing in the early 2000s in areas like logistics and data mining. Public dialogue regarding AI spiked in 2011 when IBM's Watson, a question-answering super computer system, soundly defeated the two most prolific *Jeopardy!* champions. A series of other exhibitions would further solidify the notion that machines could outperform humans in a variety of cognitive-based tasks. Steady increases in computer processing capabilities and data accessibility fueled growth in commercial application of AI. For example, Google went from minimal AI usage in 2012 to nearly 3,000 projects in 2015. By 2017, many of the economic powers in the world had national agendas to support AI development, and at least 20% of companies reported using AI to some extent in their operations.

While many descriptions and perceptions of AI exist, the late John McCarthy, widely considered the founder of the artificial intelligence field, described AI as the "science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals, and some machines."

Artificial General Intelligence (AGI), a subfield of AI, focused on creating thinking machines with general cognitive capability at the human level and beyond. As of 2018, AGI was an aspiration. Getting from preprogrammed narrow AI to AGI involved much more that simply connecting narrow AGI. Machine-learning and neural networks showed some promise as pathways to AGI, but most believed that true AGI was decades away, if even possible. Based on 2013 survey results, AI researcher Vincent C. Müller and philosopher Nick Bostrom predicted a 50% chance that AGI would be developed between 2040 and 2050, increasing to 90% by 2075. One of several tests could be performed to determine the eventual achievement of AGI (see Exhibit 1).

**Exhibit 1. Tests for Validating General Artificial Intelligence**

| Test | Description |
|---|---|
| Turing Test<br>(Alan Turing) | Interact successfully with humans in a 30-minute freeform conversation while interpreting audio-visual input. |
| Coffee Test<br>(Stephen Wozniak) | Go into an average American home and figure out how to make coffee, including all activities such as finding the machine, finding the coffee and filters in a cabinet, to brewing it. |
| Robot College Student Test<br>(Ben Goertzel) | Enroll in college, pass required classes, and get a degree. |
| Employment Test<br>(Nils Niilsson) | Complete all necessary duties of an economically important job. |

## Hanson Robotics

David Hanson founded Hanson Robotics in 2005. That same year he co-authored an article titled "Upending the Uncanny Valley" in which he argued persuasively for more human-looking robots. At the time, Hanson had developed patent-pending Frubber materials made of porous elastomers that stretched and compressed to give the appearance of facial soft tissues. Hanson's prior experience included working as a senior designer at Walt Disney Imagineering.

Hanson Robotics developed a reputation for building humanoid robots that looked and acted as though they were human. Beyond the Frubber used for realistic faces, the robots required a complex system of artificial intelligence (AI), animation, and machine vision. Hanson called for open-source development of the AI architecture to encourage broad and diverse contributions. "Our intention is to host an open-source development project on sourceforge where developers from all over the world can start contributing to the efforts of making software more intelligent and interactive. The architecture initiative is a core system that represents the brain of the android."

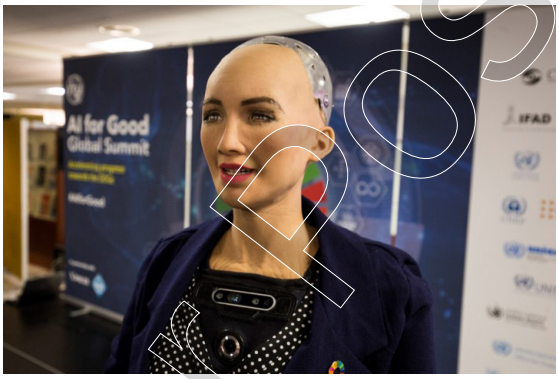
In 2013, Hanson moved the company to Hong Kong. The move was motivated by Hong Kong's emerging robotics community along with significant expertise and design infrastructure. The company's long-term mission was to dramatically improve people's everyday lives with intelligent and empathetic robots that teach, serve, entertain, and provide comforting companionship. Hanson expressed his enthusiasm for lifelike intelligent robots. "I had a fascination with art, science fiction, and philosophy, dreaming of what robots could be. I imagined that if artificial intelligence ever did match human intelligence that it would redesign itself to be ever smarter, ever faster, you would have something like a Moore's Law of super intelligent machines."

Hanson Robotics received notoriety for its 2016 introduction of Sophia, a humanoid robot inspired by actress Audrey Hepburn (see Exhibit 2). Sophia was able to display over 50 facial expressions and mirror expressions while conversing with humans. Despite this, Sophia had not achieved artificial general intelligence (AGI), the point

at which artificial intelligence could perform intellectual tasks and reasoning on par with human capabilities.

Ben Goertzel, chief scientist at Hanson Robotics, described Sophia as a research and development platform on which a number of different software programs could be run. In this respect, Sophia served as a means for experimenting with ongoing advances in AI with an aim of one day achieving AGI. When interviewed in late 2017, Goertzel stated, "If I tell people I'm using probabilistic logic to do reasoning on how best to prune the backward-chaining inference trees that arise in our logic engine, they have no idea what I'm talking about. But if I show them a beautiful smiling robot face, then they get the feeling that AGI may indeed be nearby and viable."

**Exhibit 2. Hanson Robotics Sophia Robot**




Source: ITU Pictures, AI for Good Global Summit 2018. https://www.flickr.com/photos/itupictures/27254369347/.

Goertzel (Exhibit 3) had been interested in what became known as AGI since he was a 16-year-old college freshman. Rather than pursue a PhD in AI, he chose math so he could work on what he then called "real AI" using his own approaches. Goertzel worked with others, including Bruce Klein, a noteworthy futurist, to put together AGI workshops and then a conference series and journal to create a community of AGI researchers. Goertzel commented on the power of building a social network of researchers: "Social networking and community building are a lot more useful expenditures of time than I, as a math/science/philosophy geek, intuitively realized. Of course, people who are more sociable and not so geeky by nature realize the utility of these pursuits innately. I had to learn via experience, and via Bruce Klein's expert instruction."

**Exhibit 3. Dr. Ben Goertzel**

Source: Ito, Joi. "Ben Goertzel." Flickr, Cropped, 1 June 2008. www.flickr.com/photos/35034362831@N01/2540985556.

## SingularityNET

SingularityNET was conceived by Ben Goertzel, Simone Giacomelli, and David Hanson in a series of brainstorming sessions at Hanson Robotics in Hong Kong in 2017. SingularityNET would meet acute business needs for AI while accelerating progress toward AGI. SigularityNET's CEO and Chief Technology Officer, Ben Goertzel, stated, "We will invite developers from around the world to insert their AI code into the SingularityNET, to monetize their work and to contribute to the emerging AGI global brain. We will invite users of AI-as-a-service to choose SingularityNET as an alternative to big, corporate AI. This is the start of the decentralized AGI revolution!"

- The non-profit SingularityNET Foundation, established by Hanson Robotics, maintained high-level stewardship over building and accelerating growth of the SingularityNET network and marketplace. The key founding partners of the Foundation included:
- The OpenCog Foundation, stewards of OpenCog, the leading open-source artificial general intelligence platform.
- Hanson Robotics, creators of the world's most lifelike humanoid robots.
- Vulpem, a blockchain software engineering consultancy responsible for back-end work on a number of successfully designed private and public blockchains, cryptocurrencies, and decentralized applications.
- Artificial intelligence software consultancy Novamente LLC, providing custom AI solutions for corporations and government agencies since 2001.
- Economic Space Agency: A California-based organization developing Gravity, a distributed computing architecture that emphasizes both resilience and interoperability, enabling a new way to create smart contracts.

The SingularityNET leadership team identified six advantages for platform participants (developers and business customers):

1. Access—AI Agents can leverage previously exclusive datasets, structuring and monetizing them for big data purposes.
2. Accuracy—Users can tackle information sets with significantly higher complexities.
3. Efficiency—Cooperative AIs can outperform entire organizations.
4. Emergence—The combination of AI tools will result in emergent intelligence and capabilities that no other platform can provide.
5. Speed—Information can be processed materially faster than the competition.
6. Creativity—AIs can leverage new datasets and capabilities to create new functionality dynamically.

To fund the startup, SingularityNET conducted an initial coin offering (ICO). An ICO is a presale of the AGI tokens that are used to purchase AI services within SingularityNET's blockchain network. AGI is the token symbol for market exchange purposes. In just over 60 seconds on December 19, 2017, the company raised its funding goal of about $36M USD. They could have raised much more if they had extended the ICO for even a few minutes, but the co-founders had agreed to avoid overcapitalizing the project. Co-founder Simone Giacomelli stated after the ICO, "We believe this decision sets in practice a good example for all token sales going forward and will be healthy for the decentralized and blockchain community over the long run."

## Meeting Business Needs for AI

Nearly all businesses could benefit from AI, but only tech giants and very large corporations could afford to create custom AI needed for their businesses. Many sophisticated AI tools developed by graduate students and independent researchers resided in Github repositories that were not accessible by businesses. Even if they could be accessed, most business did not have the talent required to bridge the AIs to their networks and systems. Additionally, machine-learning AI required large datasets that were beyond the capabilities of most AI developers.

Most AI developers were academics, not businesspeople. SingulartyNET would provide an easy way for these developers to monetize their AI via agents. Agents were the entities that executed the smart contracts (legal agreements) on the platform. Agents could run in the cloud, on mobile devices, in robots, or in other embedded devices. Developers had to create their AI Agents such that they would share information with the SingularityNET application program interface (API). The AI Agents would need to accept and disburse payments according to SingularityNET's economic logic. Additionally, SingularityNET would host certain machine-learning AI tools and datasets in the marketplace, making them more accessible to end-users and developers through its APIs.

Companies that could not afford customizing their own AI could access AI agents that would subcontract to and collaborate with other AI Agents to create customized solutions to meet specific needs (see Exhibit 4). The network would include a reputation (rating) system that would help business customers find the most useful AI Agents to solve specific challenges. By providing an easy means for creating customized AI solutions from existing AI Agents, SingularityNET would reduce costs and required development to a level that would make AI broadly accessible to smaller businesses.

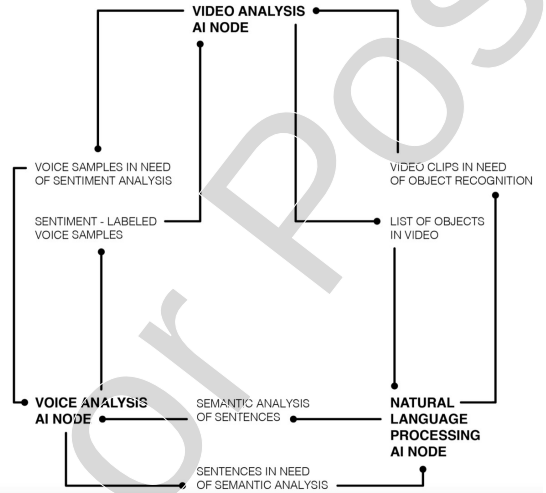
The ability for AI agents, or nodes, to work together was a key value proposition for SingularityNET.

> *If you need a document summarized, as a user you can put a request into SingularityNET...You may get bids from twenty different document summary nodes...and you may choose one with the right balance of reputation and price. But now that document summary node if it hits something in the document it can't deal with, it can outsource that...if the document summary node that you're paying... hits an embedded video it can outsource that to a video summarizing node and it can then pay it some fraction of the money it was paid. Or, if it sees a quote in Russian...it can outsource that...to a Russian-to-English translation node that can do that translation, then send it back to the document summary node.*

## Key Platform Design Components and Principles

The platform would use Ethereum blockchain to allow buyers and sellers to interact directly through the purchase of AGI tokens. Use of Ethereum blockchain would provide a means for money transfer without an intermediary such as a bank or payment processor. Blockchain used a consensus-based distributed ledger that was shared by a community of users rather than held privately. Ethereum allowed developers to program their own smart contracts, or "autonomous agents" that would automatically execute payments when the contract conditions were fulfilled.

**Exhibit 4. AI Agent-to-Agent Collaboration**




Source: "SingularityNET: A Decentralized, Open Market and Inter-Network for AIs." SingularityNet Whitepaper. December 19, 2017.

Invented in 2008, blockchain technology originally served as the public transaction ledger for cryptocurrency such as Bitcoin. By design, blockchain was an "open, distributed ledger that could record transactions efficiently and in a verifiable and permanent, or immutable, way." Records on the blockchain could not be secretly manipulated or erased since this would be noticed through lack of blockchain consensus with others' copies of the chain. Blockchain had been successfully applied to supply chains to increase transparency but had yet to be used to create the type of marketplace that Goertzel and SingularityNET's other founders were creating. Despite the established nature of Ethereum blockchain and its smart-contract capabilities, Goertzel did not believe it would offer the scalability that SingularityNET would require.

> *There isn't a single blockchain out there right now that will be sufficient to serve SingularityNET's needs in the future. There is a lot of hype around projects that claim great scalability capabilities, but the truth is that when we try those networks, none is capable of giving the structure that we need. So we have two choices: We either build a better blockchain or help someone else build a better blockchain, or we choose to design around it while waiting for the next blockchain to come. At this moment, all our blockchain development is on Ethereum. It is a robust system and is well understood. So, for now it works, even if we are doing a lot of things off-chain rather than deploying everything on the blockchain. As the technology develops, we hope we will see a system emerge that is capable to really scale to the level we need.*

SingularityNET was essentially a distributed computing architecture for creating new types of smart contracts to facilitate market interactions with AI and machine-learning tools. According to the company's whitepaper developed before its initial coin offering, SingularityNET adopted four key design principles:

1. Interoperability: The network would be able to interface with multiple blockchains.
2. Data Sovereignty and Privacy: User data control and sharing would come with privacy-enabled controls on top of the network, and access would be validated through smart contracts and the blockchain.
3. Modularity: Flexible network capabilities would make it possible to create custom topologies, AI Agent collaboration arrangements, and failure recovery methods.
4. Scalability: SingularityNET would securely host both private and public contracts, so more scalable and resilient applications could be built on top of it with near-zero transaction costs.

## SingularityNET's Quest for AGI

Goertzel viewed SingularityNET as a means for accelerating development of artificial general intelligence, or AGI. The distributed blockchain-based network allowed for stitching together clusters of narrow AIs that could mimic sections of a brain. Collectively, these clusters could eventually function like a global brain. He referred to narrow AI Agents working together to tap complementary capabilities as *meta AI*, essentially creating a form of

collective AGI. Goertzel also believed that blockchain could be a key tool for ensuring AGI safety. He believed that the decentralized nature of AI development enabled by SingularityNET would increase the likelihood that AGI would not be put to bad use and that society would get a more positive outcome in the long run.

SingularityNET partnered with AI research and development company GoodAI to develop and administer a survey on AGI. The survey was circulated at the Joint Multi-Conference on Human-Level Artificial Intelligence (HLAI) held August 22-25, 2018, in Prague. Twenty-eight percent of respondents expected AGI to be achieved within the next 20 years, while just two percent didn't believe AGI was achievable. Respondents also rated the sectors in which they thought AI could have the greatest impact. The following high-impact sectors emerged:

- Healthcare (46%)
- Logistics (41%)
- Customer service (38%)
- Banking and finance (34%)
- Agriculture; retail, software development; manufacturing (28%)

Goertzel and his colleagues planned to use Sophia to test ongoing efforts to achieve AGI. Sophia would be supplied with on-board SingularityNET Agents that would allow the robot to interact with the evolving *global brain* capability of the SingularityNET network.

> *I expect that Sophia and the other Hanson robots will continue to generate some controversy—along with widespread passion and excitement. But I also expect the nature of the controversy, passion, and excitement to change quite a lot during the next couple years, as these wonderful R&D platforms help propel the Hanson-Robotics/OpenCog/SingularityNET research teams toward general intelligence. The smarter these AIs and robots get, the more controversial things are likely to get—but this is also where the greatest benefit for humans and other sentient beings is going to lie.*

As of late 2018, there was still much work to be done. The project was still in internal alpha testing and not yet released for public beta testing. Nonetheless, Goertzel and his team believed the project could achieve first-mover advantage for SingularityNET.

> *The SingularityNET project is uniquely positioned for first-mover advantage in two ways. One is similar to other marketplaces: Once we have a critical mass of AI Agents in our network, it will become the go-to place for AI microservices, achieving a rapidly accelerating technological and market advantage. Another is subtler: The interactions between the AI Agents in SingularityNET will lead to the emergence of a synergistic intelligence, a decentralized network-mind with a wide range of abilities. Any competing platform will be incapable of emulating this degree of emergent, cooperative intelligence, unless they achieve a comparable scale and complexity of AI Agents as SingularityNET—which will be hard for anyone else to achieve, as it depends on a combination of sophisticated initial AI Agents, a flourishing community of AI Agent developers, and a rich ecosystem of customers at varying levels of sophistication.*

## Endnotes

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