



HOWARD BRAIN SCIENCES FOUNDATION

ANNUAL REPORT



Acknowledgements

We are eternally grateful for our partnership with Georgetown University, ni2o, amazing Board members, small staff and Fellows who have been instrumental to our continued development.

A special thank you to Anis Hilal, Erik Cambria and Lijuan Su for their time and contributions to this report.

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This report was designed
by José R. Menéndez.



Rebecca F. Howard.
Cairo, Egypt 2019.

Letter From the President & CEO

Looking back on this previous year, I wonder how we were able to get so much done with such a small team; it's been a busy year. I am always in awe at what our team at the Howard Brain Sciences Foundation is able to accomplish and this year is no different. I feel so lucky to be able to come in to work everyday and work alongside people who truly love what they do.

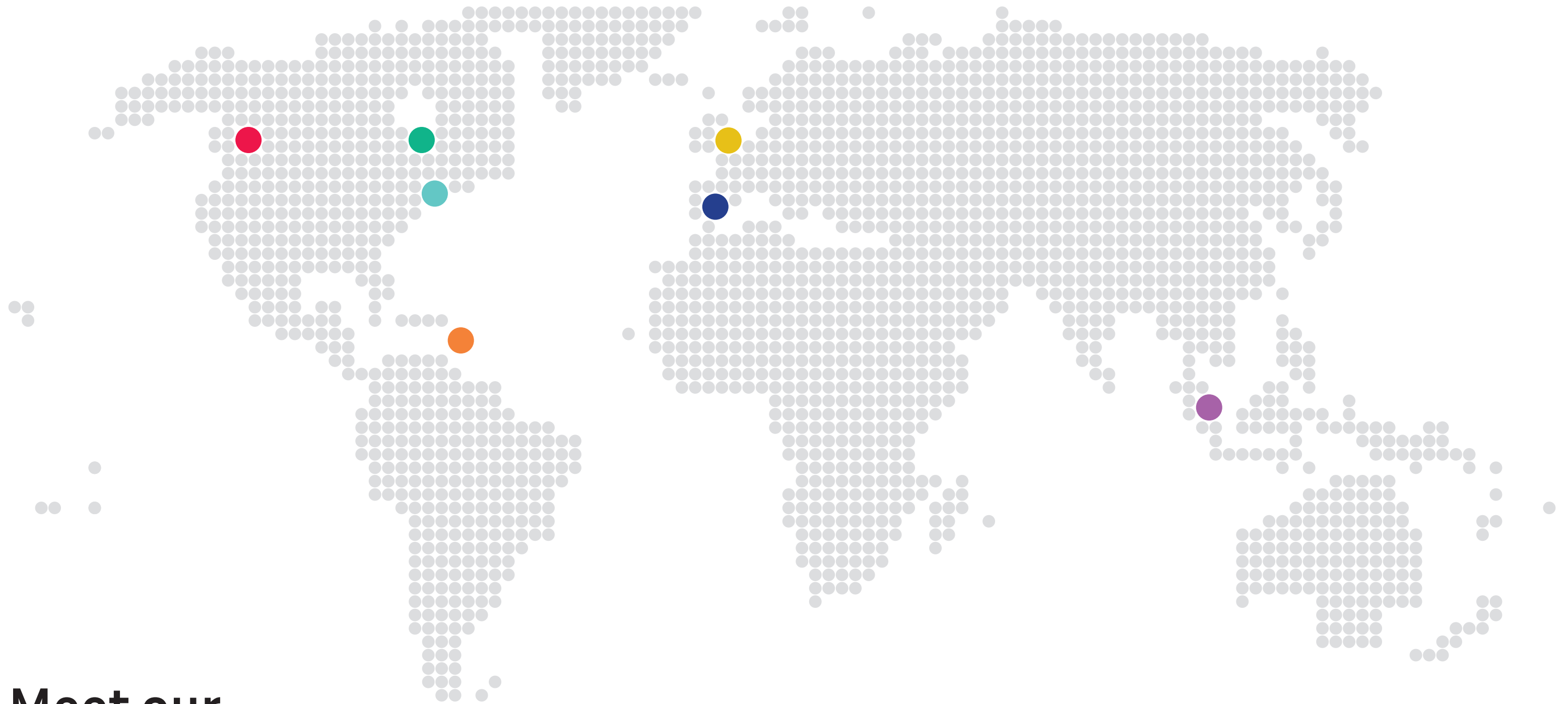
In many ways, this year was a new beginning for us; a sort of “re-birth”. We worked on restructuring our programs, our internal structure, launched a rebranding campaign, creating a new logo and website, hiring an Associate Director, two new members of the Board, restructuring our programs, and honing in on our mission. When we say it's been a busy year for us, we mean it.

Throughout the process of rebranding and revising our mission, we had to really think about what our larger purpose is. What is important to us? What impact do we want to make in the world? It may seem like an incredible feat, and some may say we are in over our heads, but what we want is to explain how the brain functions in health and disease, while finding a permanent solution to restore parts of the brain that have been debilitated by neurodegenerative diseases. We want to democratize these solutions and make them accessible to all people, globally. This feels like an insurmountable goal but we are taking all the small steps we need to get there. Baby steps I say. Just as I did when I watched my one year old try to take his first steps this year, launching into the open space only to fall and be discouraged; baby steps Noah, baby steps.

Now, I watch as he bolts around the house, unstoppable and on his way to doing incredible things, just as I know we will be years from now. We of course cannot get there without the help of the larger community in which we work. One of the tenets of our mission is the importance of collaboration in science and I believe our Fellowship program is a true representation of that. The Fellowship is a cohort of scientists and researchers from all disciplines who are dedicated to our mission. This report is a celebration of our Fellows, our extended family, who have been with us from the start. I am overjoyed that this year, we were able to offer unique grant opportunities to our Fellows to fund their own projects and research, many of which you will hear about next year.

As you read this report, I hope that you can feel our excitement and passion for the work we do, our unwavering determination, and that you continue to follow our growth in the years to come.

Rebecca F. Howard
President & Chief Executive Officer



Meet our extended family.

IN 2018, TWO NEW FELLOWS JOINED OUR GLOBAL TEAM.

Anis Hilal, M.D.
Sweden
Skane University Hospital
Ophthalmology & Neuroscience

Mohamed Elgendi, M.D.
Canada
University of British Columbia
Postdoctoral Fellow

FELLOW HIGHLIGHT

Erik Cambria, Ph.D.
Singapore
Nanyang Technological University
Founder SenticNet

FELLOW HIGHLIGHT

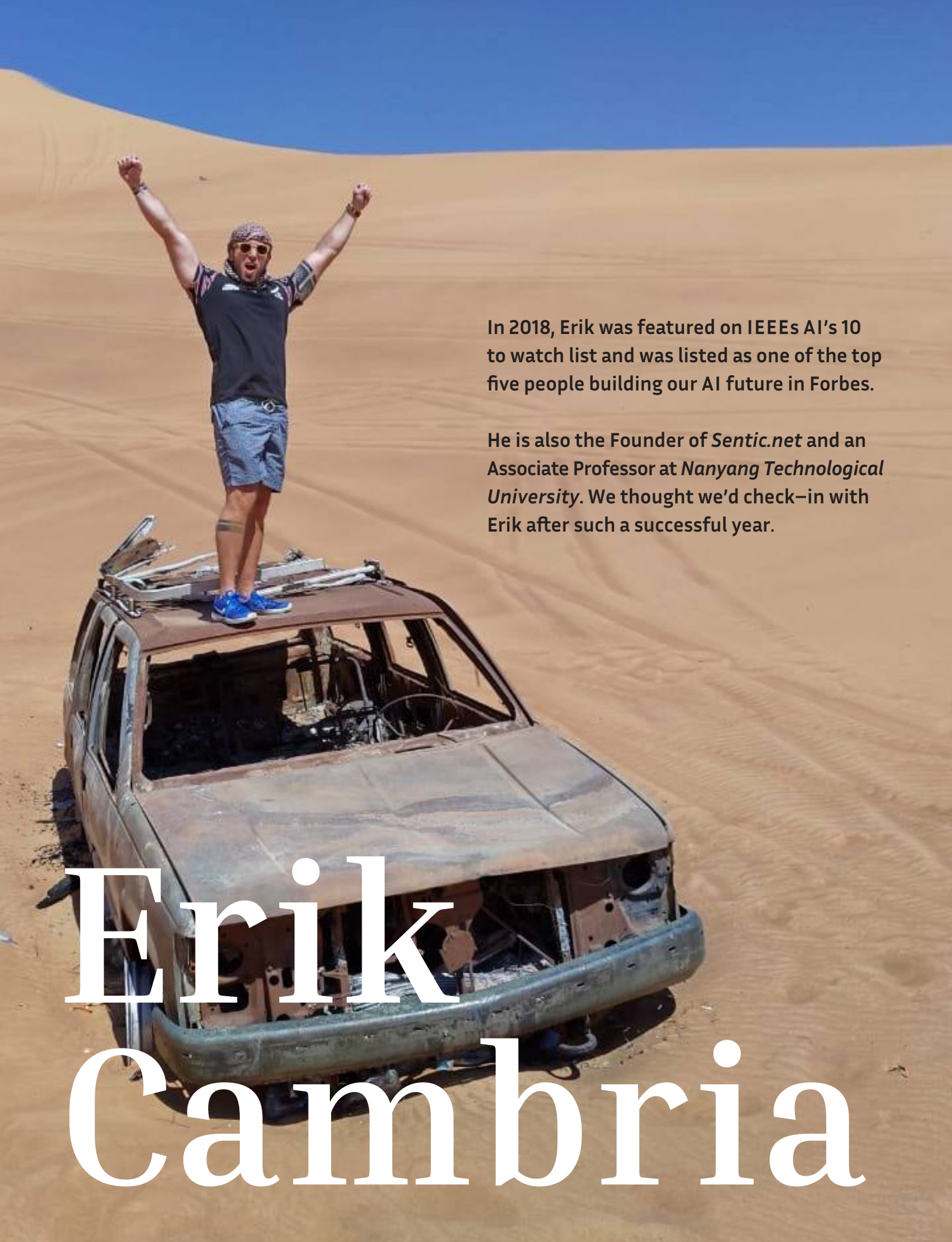
Lijuan Su
China
Harvard Medical School
AI Scientist

EXISTING FELLOWS

Louis Jehel, Ph.D.
Martinique
Universite des Antilles
Head of Psychiatry
& Psychotraumatology

Tipu Aziz
United Kingdom
Oxford University
Professor of Neurosurgery

John Violanti, Ph.D.
United States
University at Buffalo
Research Professor



In 2018, Erik was featured on IEEE's AI's 10 to watch list and was listed as one of the top five people building our AI future in Forbes.

He is also the Founder of *Sentic.net* and an Associate Professor at *Nanyang Technological University*. We thought we'd check-in with Erik after such a successful year.

Erik Cambria

Standing on the shoulders of giants.

Photo © Erik Cambria.



On the Panamericana

Photo © Erik Cambria.

What schools have you attended and what degrees have you earned?

BEng and MEng from the *University of Genoa*, joint industrial PhD from the *University of Stirling* (Advisor: Amir Hussain) and *MIT Media Lab* (Advisor: Catherine Havasi).

Tell us a bit about your background, you've been living in Singapore for some time now.

I am now Singaporean but my genes are 100% Italian.

Did you also spend your childhood obsessing over computers, or is this a fairly new interest?

I have always been a geek. Sadly enough, I spent most of my childhood in front of a computer screen!

At what age did you become interested in computing & mathematics?

I became interested in math as soon as I was able to write. I became interested in computing at the age of 12, I guess... back then I was playing with a *Commodore 64*.

Was your family supportive of your decision to enter into this field?

Yes, definitely. Luckily, my family has always been very supportive of my electronic obsessions.

What about NLP & Sentiment Analysis is fascinating to you?

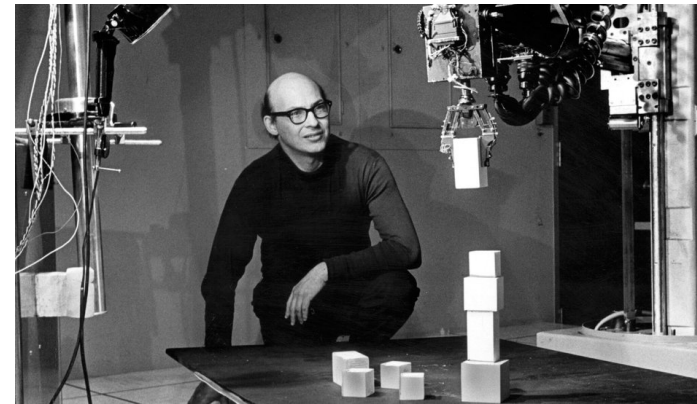
Communication is what characterizes us most as a species and we mostly do it through our EQ and IQ. These are two fascinating facets of human intelligence mostly because we still do not know much about them: there are still many debates on what actually is an emotion and how emotions should be categorized and we still do not actually understand how we understand (encode and decode) language.

You are the Founder of *Sentic.net*, tell me about the work you are involved in currently.

We are working on a new hybrid approach to NLP that is both top-down and bottom-up: top-down for the fact that we leverage symbolic models such as semantic networks and conceptual dependency representations to encode meaning; bottom-up because we use sub-symbolic methods such as deep neural networks and multiple kernel learning to infer syntactic patterns from data. Coupling symbolic and sub-symbolic AI is key for stepping forward in the path from NLP to natural language understanding. Relying solely on machine learning, in fact, is simply useful to make a 'good guess' based on past experience, because sub-symbolic →

“You do not get discoveries in the sciences by taking huge amounts of data, throwing them into a computer and doing statistical analysis of them: that’s not the way you understand things, you have to have theoretical insights”

—Erik Cambria on Noam Chomsky



Marvin Minsky
Photo © New York Times, (2016).

methods only encode correlation and their decision-making process is merely probabilistic. Natural language understanding, however, requires much more than that. To use Noam Chomsky’s words, “you do not get discoveries in the sciences by taking huge amounts of data, throwing them into a computer and doing statistical analysis of them: that’s not the way you understand things, you have to have theoretical insights”.

What are your thoughts on AI in today’s world?

We are living in one of the most exciting times in human history. It is exciting to think that we can change the world for the better through AI. With great powers, however, come great responsibilities. If we don’t engineer it well, AI could be as bad as plastic, which looked like an amazing invention one century ago, but it’s now threatening the sustainability of our species.

What would you say to people who see AI as a threat to society?

They have nothing to worry about: we are still light-years away from creating an AI that is as intelligent as the dumbest human.

Who in the field has greatly influenced you and your work?

Marvin Minsky. I had the honor of meeting him during my PhD studies at MIT Media Lab. I attended a few of his classes and also had a few discussions with him. He was a great man and a great mentor.

What do you like to do when you are not teaching machines to understand natural language?

I like traveling, dancing salsa, and motorbiking.

What movie that features AI is your favorite?

Her. ‡

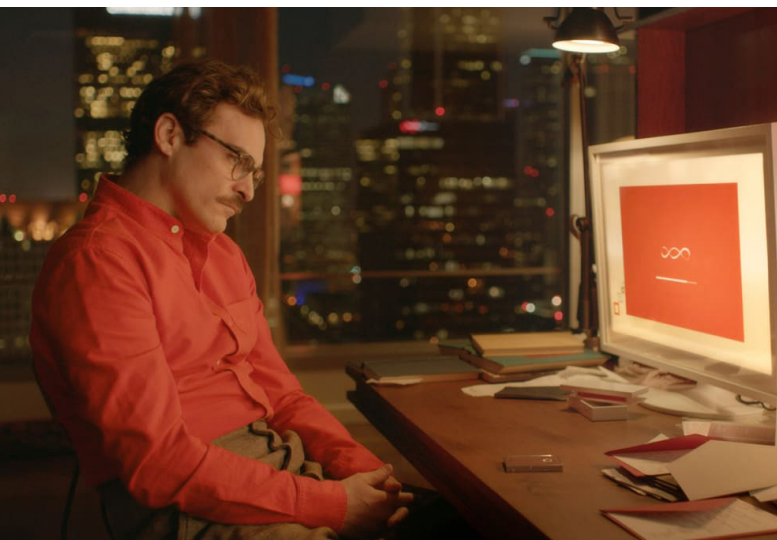


Photo from the movie *Her* (2013).
Photo © Slate Magazine, (2014).



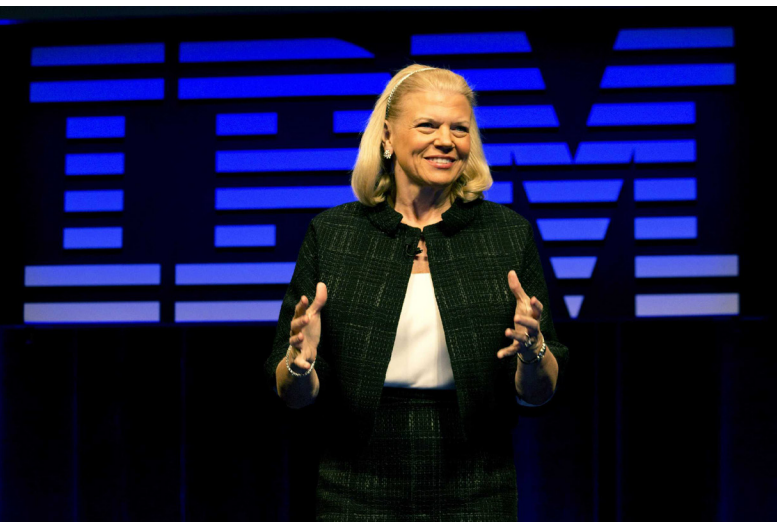
Lijuan Su

Lijuan Su
Photo © Mount Everest, (2014).

Lijuan Su is CIO and Co-Founder of FORYOR HEALTH: healthcare tech startup with offices in Beijing, Silicon Valley and Boston. Aside from managing the stress of running a startup, she is also a Research Assistant with *Harvard Medical School* and an AI Researcher with *Tencent Inc.* Needless to say, Lijuan is very busy these days, but still finds time to get away from the screen and hit the great outdoors. Read our interview with Lijuan. →

“I believe in AI, it must empower our world on many sides. It can meaningfully improve people's lives, especially in healthcare. We need to work hard for this, and make good use of it.”

—Lijuan Su © FORYOR HEALTH INC, (2019)



Ginni Rometty.
Photo © The Software Report, (2017).

What schools have you attended and what degrees have you earned?

Phd, Computer Science in *Zhejiang University & Harvard Medical School*

Were you born in China or in the U.S.?

I was born in Province Anhui, China; I grew up in different provinces in China and USA.

Tell me a little about your childhood.

I was born in a small village in China, the village is very beautiful and peaceful. Meanwhile I adopted a lot of animals, like dogs, cats, dogs, birds, hedgehogs, rabbits and pigeons. As a child, I had a strong curiosity and passion for the unknown world, and enjoyed learning and science very much. To have a better education, I left home for primary school when I was 10 years old and lived on campus since then. This helped me to keep hard-working, independent, confident, openness and responsible.

At what age did you become interested in Neuroscience?

When I was a child, I was very curious about the similarity and difference between the animals I adopted, such as their languages and body

actions. When I was about 15 years old, I learnt that they were controlled by animals' brain, and neuroscience is exactly the study about the structure and function of the nervous system, since then I lost myself in neuroscience. It is amazing to be a neuroscience researcher, I am lucky to do work that I love so much.

Did your family encourage you to study neuroscience?

Yes, my family encouraged me to study anything as long as I loved it. They believed in me and supported me to chase my dreams no matter what it is. Now I combine computer science and neuroscience to help patients to get the best solution for diagnosis and treatment, they are really proud of me.

What about the brain is fascinating to you?

Neuro-oncology, about discovering better treatments and management strategies for cancer patients.

Tell me about the work you are involved in currently.

We develop a Healthcare AI product which helped millions of cancer patients to get accurate diagnosis conveniently and personalized therapy quickly from the world-class doctors.

What are you passionate about?

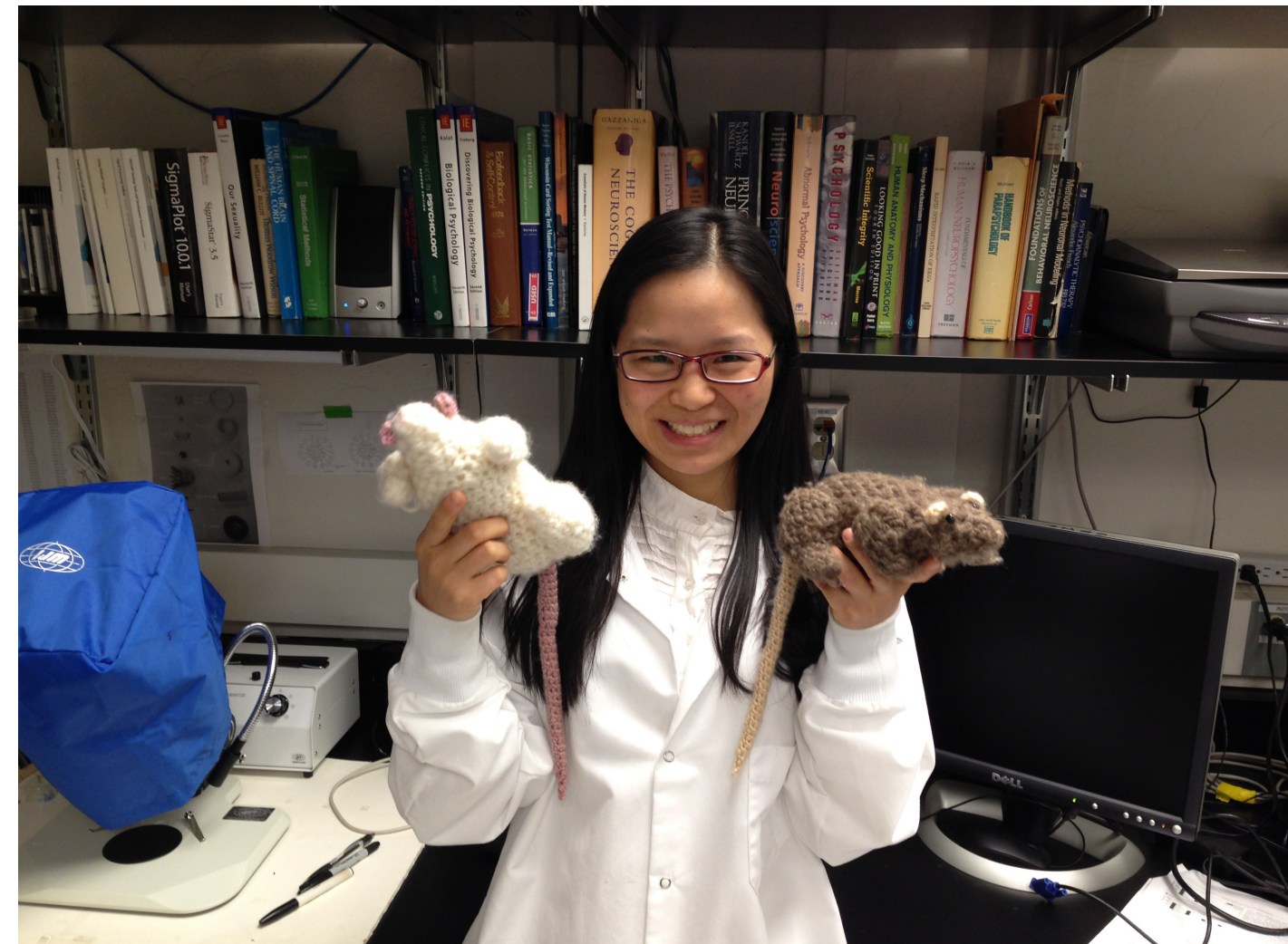
Helping patients and doctors around the world with science, technology, and the internet. Create the real AI doctor.

What are your thoughts on AI in today's world?

I believe in AI, it must empower our world on many sides. It can meaningfully improve people's lives, especially in healthcare. We need to work hard for this, and make good use of it.

There is a lot of fear around AI, what would you say to people who see AI as a threat?

It's our human to decide how to use AI, as one of the most promising technologies, AI must help our society a lot. But we need to define the policy and the law for AI to make good use of it.



Lijuan Su
Photo © Nature Scientific Reports, (2016).

Who in the field would you say has influenced your career or your work?

Elon musk, while he is not an AI researcher, he does chair OpenAI and developed very cool products. Ginni Rometty, she has been working on Watson for many years, she turned the core focus of the 105 year company on AI, especially on healthcare AI.

How would you like to make an impact in the world?

Create an AI-powered healthcare system, help doctors diagnose and treat patients conveniently with machine learning, deep learning and natural language processing.

What do you like to do when you are not analyzing mountains of data?

Thinking of who are our customers, what are their needs, and how to implement.

What is your favorite movie that features AI?

Robot & Frank. ‡

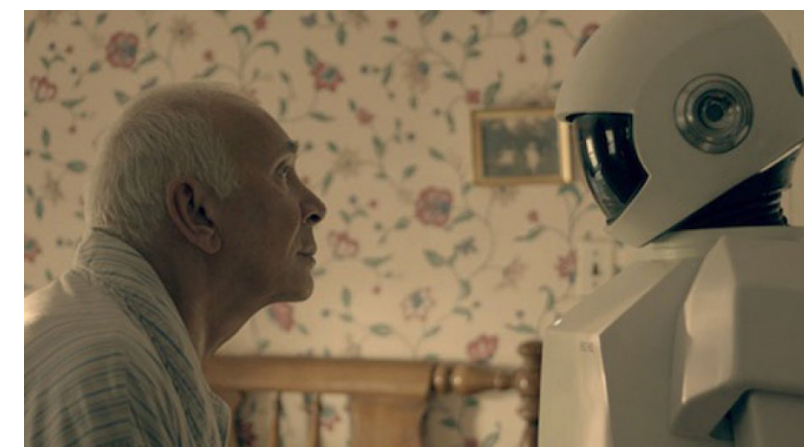


Photo from the movie Robot & Frank (2012).
Photo © Vulture, (2012).

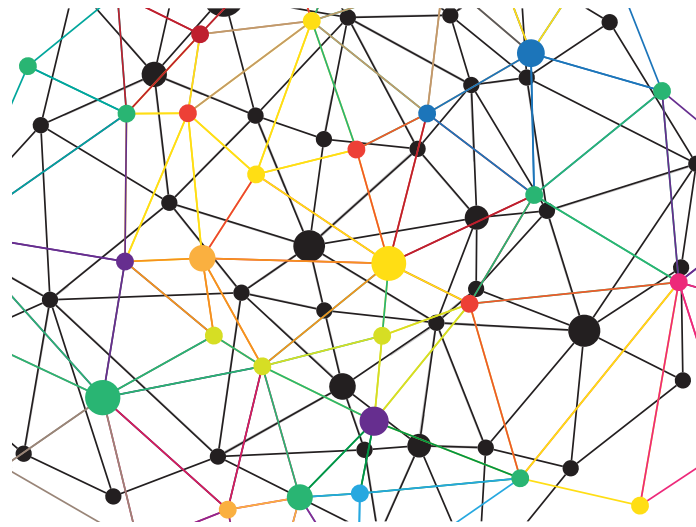


NUMBER OF CONFERENCES PRESENTED

NUMBER OF PAPERS PUBLISHED



The Fundamental Code Unit of the Brain: Towards a New Model for Cognitive Geometry



In 2018, our paper on the *FCU—The Fundamental Code Unit of the Brain: Towards a New Model for Cognitive Geometry* was published in the *Cognitive Computation* journal.

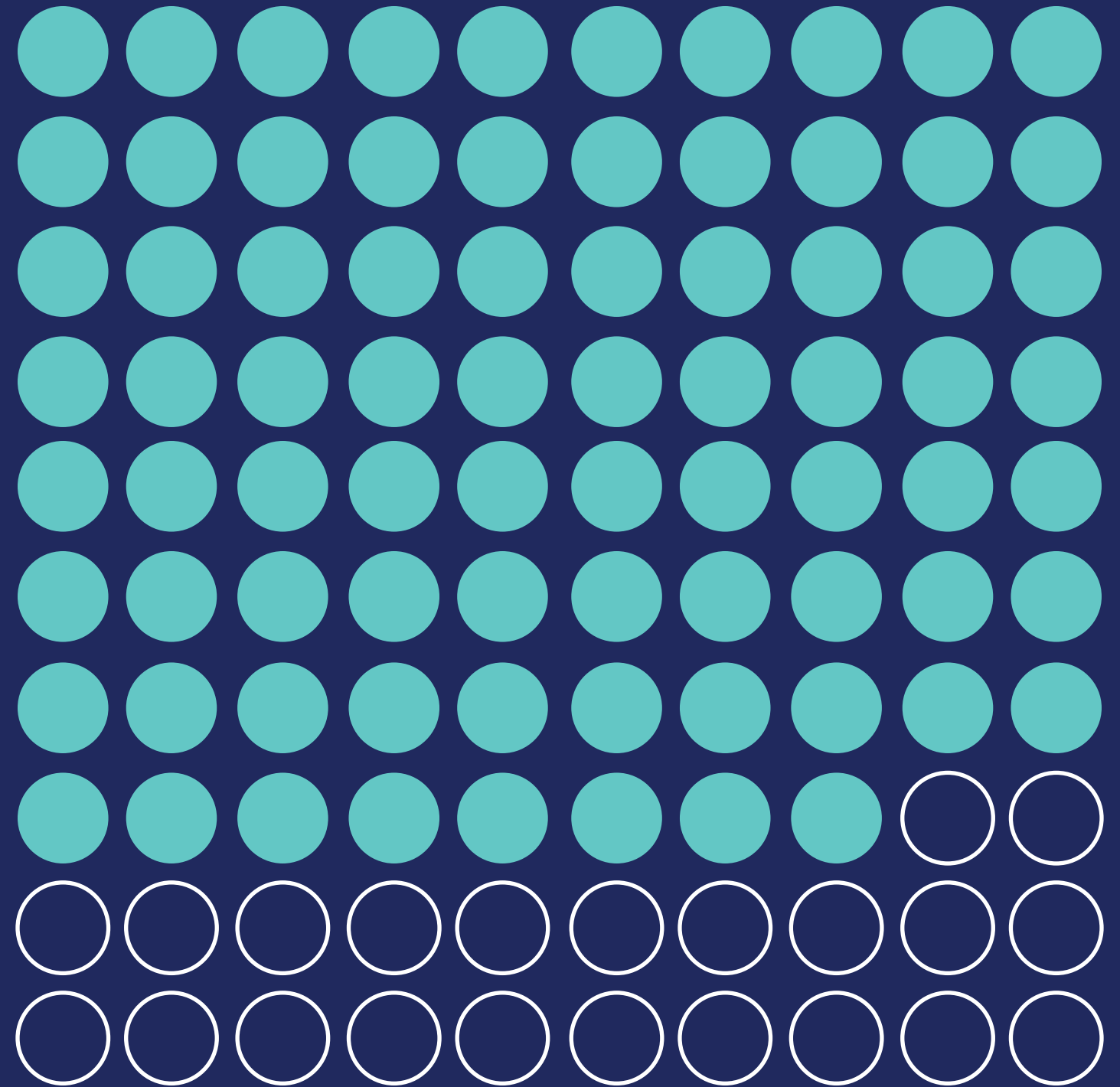
“As humans living in a complex world, our success and survival depends on our ability to simplify and understand what we observe in our environment, a process of formulating and reformulating received information into cognitive models and systems. Cognitive agents organize objects, concepts, and ourselves into schemes consisting of fundamental units, which then constitute an overarching structure. Once created, cognitive agents continue to develop and refer to these models with every new experience and observation; in fact, these models could be said to form the basis of all our subsequent cognitive processes. For researchers and theorists working to understand the human brain, the significance of these behaviors supports the effort to identify a “fundamental unit” of thought. By defining and then organizing these units into the larger processes that form human consciousness, we might advance new ways of thinking about cognition and awareness.”

THE FCU EXPLAINED

The Fundamental Code Unit (FCU) proposes a new way of conceptualizing the cognitive processes of the human brain by way of quantification. This means having emotions, behavior and physical manifestations of thoughts such as speech be translated into mathematical equations. Regardless of where one’s

origins stem from, what language they speak or memories they have accumulated over the years, a unified fundamental code would help us visualize the way the individual mind functions. We know that consistent firing of neuronal networks is required for encoding information that is needed for the construction of short-term memory. That means that the physical state of the neurons involved in the memory-forming process is also changing. In addition, the FCU takes into account how information in the brain is transmitted as spikes. Spikes represent the transmission of signals from one neuron to the other. Though it is unclear how these spikes encode the information that the brain later on processes, these spikes compose the basic units of thought. The FCU categorizes the brain regions into separate activation sets (cluster of active neuronal areas labelled nodes) and concept activation sets that communicate for a uniform goal. This allows us to mathematically visualize the brain as a massive power station, subdivided into smaller electrical grids all communicating with one another at astounding speeds. *The Fundamental Code Unit* opens the door to predictably tracing the pathway of a single thought from origin to completion. This is a significant stepping stone on the road to understanding how the brain produces, analyzes and processes our thoughts. It provides us deeper insights as to how the brain functions. Furthermore, it allows us to better understand illnesses that trouble the brains’ emotions and cloud its judgments. The FCU is a way for human beings and eventually artificial intelligence to learn more about the origin of thought and the potential of the brain.

*Howard, N. & Hussain, A. *Cogn Comput* (2018) 10: 426. <https://doi.org/10.1007/s12559-017-9538-5>



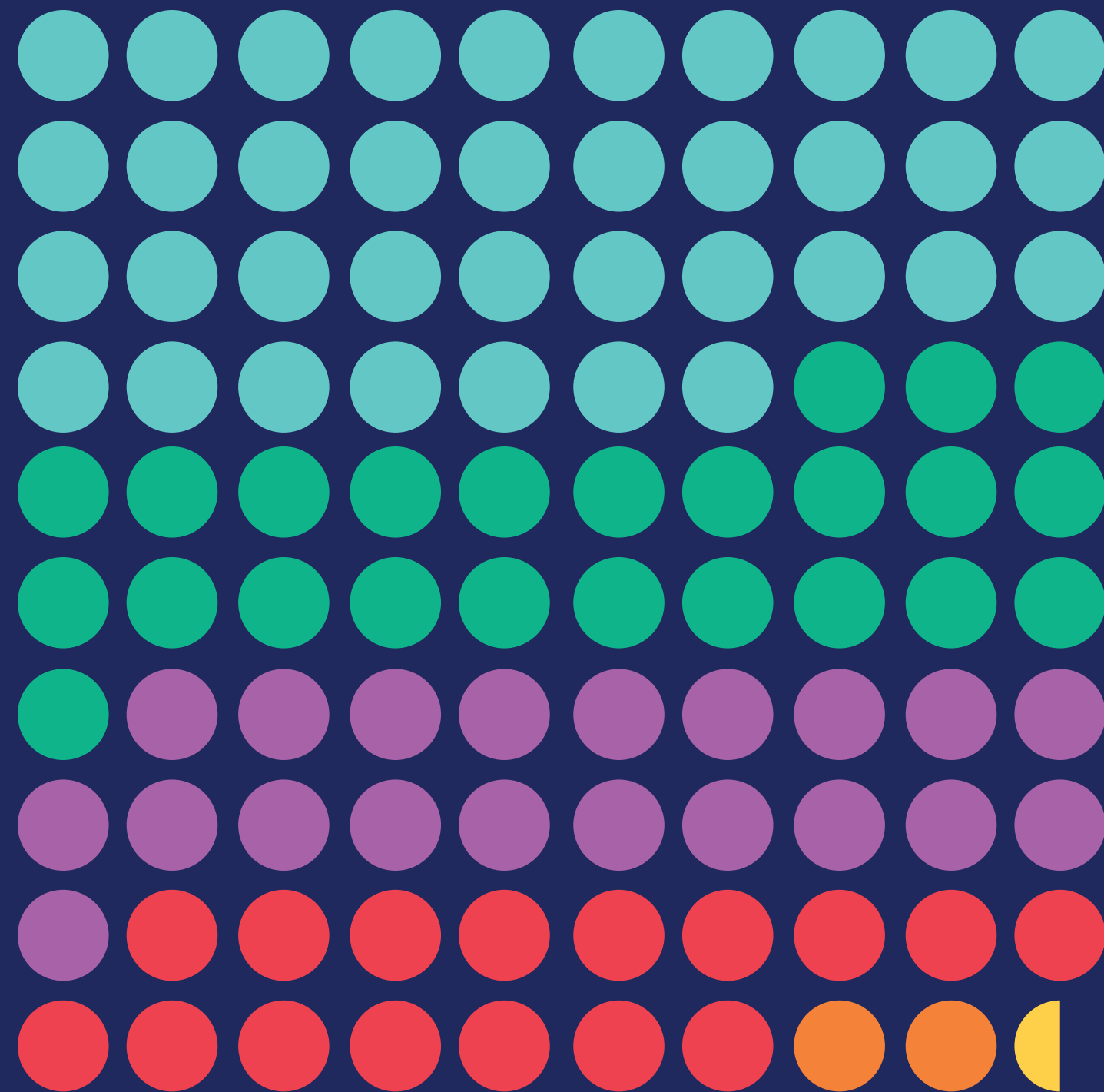
One circle=1%

78%

OF DONATIONS WENT TO PROJECTS

\$55,700

IN OPERATING EXPENSES



One circle=1%

- STAFF SALARIES: 37%
- PROFESSIONAL FEES: 34%
- MARKETING: 20%
- SUPPLIES & SOFTWARE: 16%
- TRAVEL & MEALS: 2%
- CC FEES: LESS THAN 1%

	REVENUE	2017	2018
	CONTRIBUTIONS	121,325.28	253,133.22
	RESEARCH PROJECTS	32,776.17	195,979
	GENERAL & ADMINISTRATIVE	98,029.44	57,154.22
	TOTAL	130,805.61	251,678.61
	CHANGE IN NET ASSETS	(2,409.97)	(4,872.04)
	NET ASSETS: BEGINNING OF YEAR	2,013.29	4,423.26
	NET ASSETS: END OF YEAR	4,423.26	9,295.30

*Unaudited financial statements