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THE ISRAEL ACADEMY OF SCIENCES AND HUMANITIES

The Israel Academy of Sciences and Humanities and the National Academy of Sciences of the United States

Present

**The Inaugural US–Israel Blavatnik Scientific Forum on**

# COMPUTER SCIENCE AND ITS IMPACT ON OUR FUTURE

## Program and Abstracts


Organizing Committee

Michal Feldman, Shafi Goldwasser, David Harel, Aviv Regev, Shimon Ullman, Moshe Vardi


*Jerusalem, September, 16-18, 2019*

## The Israel Academy of Sciences and Humanities

The Israel Academy of Sciences and Humanities, established by law in 1961, is the preeminent scientific institution in Israel. It acts as a national focal point for Israeli scholarship in all branches of the sciences, social sciences, and humanities. The Academy comprises 128 of Israel's most distinguished scientists and scholars who operate in two divisions—the Sciences Division and the Humanities Division. It is tasked with promoting Israeli scientific excellence; advising the government on scientific matters of national interest; publishing scholarly research of lasting merit; and maintaining active contact with the broader international scientific and scholarly community.

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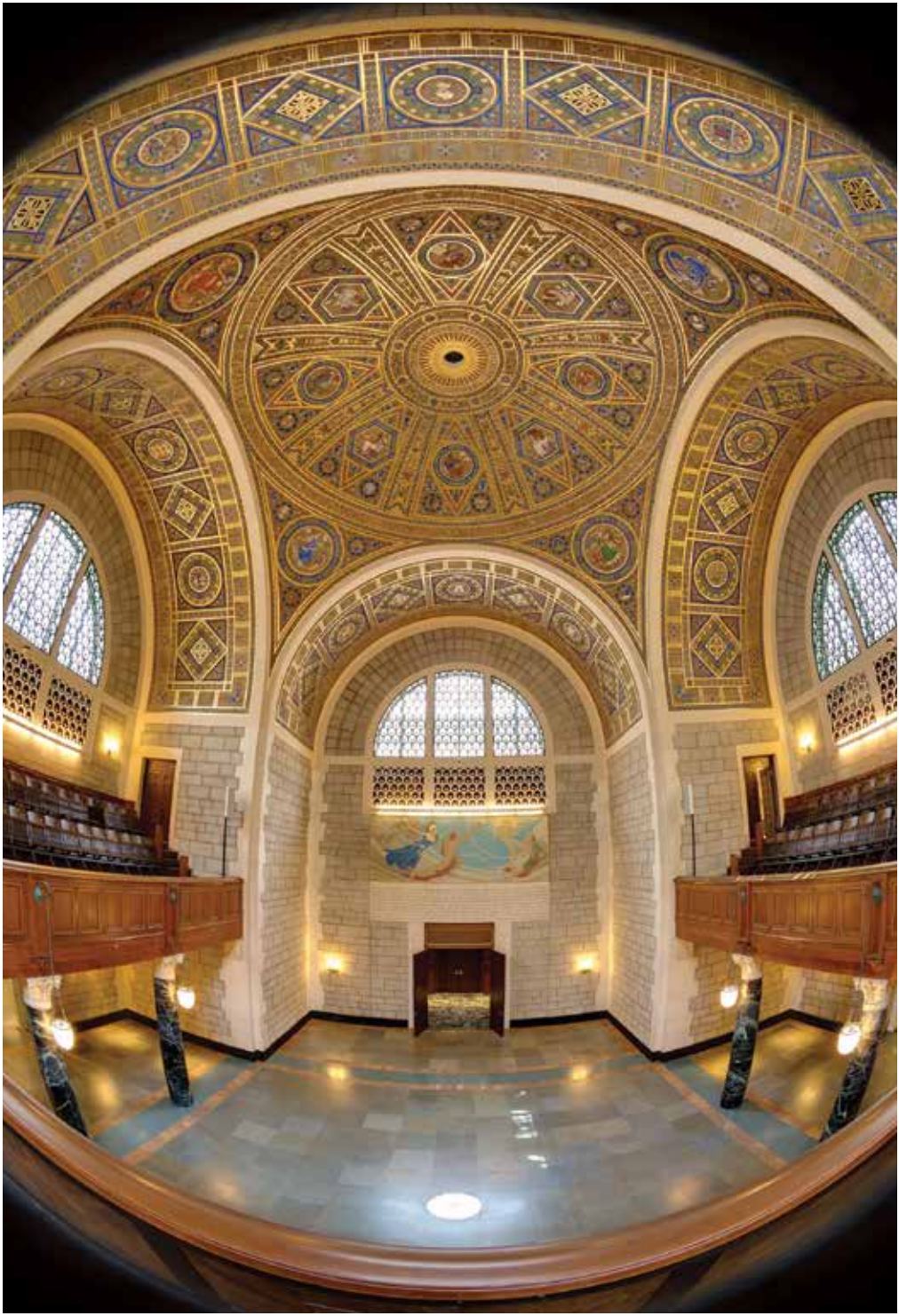
The Israel Academy of Sciences and Humanities © 2016 Udi Katzman
Left: The Albert Einsten Statue at the Israel Academy of Sciences and Humanities © 2016 Udi Katzman



## The National Academy of Sciences

The National Academy of Sciences (NAS) is a private, non-profit society of distinguished scholars. Established by an Act of Congress, signed by President Abraham Lincoln in 1863, the NAS is charged with providing independent, objective advice to the nation on matters related to science and technology. Scientists are elected by their peers to membership in the NAS for outstanding contributions to research. The NAS is committed to furthering science in America, and its members are active contributors to the international scientific community. Nearly 500 members of the NAS have won Nobel Prizes, and the Proceedings of the National Academy of Sciences, founded in 1914, is today one of the premier international journals publishing the results of original research.

The National Academy of Engineering (NAE) and the National Academy of Medicine (NAM, formerly the Institute of Medicine) - were founded under the NAS charter in 1964 and 1970, respectively. The three Academies work together as the National Academies of Sciences, Engineering, and Medicine to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine. The National Academies' service to government has become so essential that Congress and the White House have issued legislation and executive orders over the years that reaffirm its unique role.

Left: National Academy of Sciences © 2012 Dan Bailey

# Program

## Day One / **Monday, September 16, 2019**

10:00 **Greetings**

**Nili Cohen**, President, Israel Academy of Sciences and Humanities (IASH)

**Ken Fulton**, Executive Director, National Academy of Sciences (NAS)

**SESSION I**

**Chair: David Harel**, Weizmann Institute of Science

### Quantum Science & Technology – Part I

10:15 **Charles H. Bennett**, IBM Thomas J. Watson Research Center
**The Quantum Impact on Technology and Fundamental Questions**

11:00 **Ady Stern**, Weizmann Institute of Science
**Harnessing Topological Physics for Quantum Computation**

11:45 **Coffee Break**

### Computer Science & Society – Part I

12:15 **Noam Nisan**, The Hebrew University of Jerusalem
**Complexity and Simplicity in Economic Design**

13:00 **Omer Reingold**, Stanford University
**Complexity-Theoretic Perspectives on Algorithmic Fairness**

13:45 **Lunch Break**

**SESSION II**

**Chair: Michal Feldman**, Tel Aviv University

### Computation and the Life Sciences – Part I

15:00 **Aviv Regev**, Massachusetts Institute of Technology
**Design for Inference in Biology**

15:45 **Ron Shamir**, Tel Aviv University
**Integrated Computational Analysis in Cancer and Precision Medicine**

16:30 **Coffee Break**

### AI & Autonomous Systems – Part I

17:00 **Sarit Kraus**, Bar-Ilan University
**Robot–Human Collaboration and Learning for Improving Human Well-Being**

17:45 **Eva Tardos**, Cornell University
**Learning in Multi-Agent Environments**

### Keynote Speaker

18:30 **Amnon Shashua**, The Hebrew University of Jerusalem; Mobileye
**The Promise of Machine Learning and AI in Transforming Industries**

## Day Two / **Tuesday, September 17, 2019**

**SESSION III**
**Chair: Shimon Ullman**, Weizmann Institute of Science

### Quantum Science & Technology – Part II

09:00 **Dorit Aharonov**, The Hebrew University of Jerusalem
**Quantum Information Science: A Computational Lens on Quantum Physics**

09:45 **Thomas Vidick**, California Institute of Technology
**Secure Computation with Quantum Devices: From Device-Independent Cryptography to Verification of Quantum Computers**

10:30 **Coffee Break**

### Computer Science & Society – Part II

11:00 **Shafi Goldwasser**, Massachusetts Institute of Technology
**Safe Machine Learning**

11:45 **Moshe Vardi**, Rice University
**Humans, Machines, and Work: The Future is Now**

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## Day Three / **Wednesday, September 18, 2019**

**SESSION IV**
**Chair: Moshe Vardi**, Rice University

### AI & Autonomous Systems – Part II

09:00 **Naftali Tishby**, The Hebrew University of Jerusalem
**Similarities and Differences between Deep Learning and our Biological Brains**

09:45 **Gal Kaminka**, Bar Ilan University
**Smart Swarms in the Wild and in the Small**

10:30 **Coffee Break**

### Computation and the Life Sciences – Part II

11:00 **Uri Alon**, Weizmann Institute of Science
**Design Principles of Physiological Circuits**

11:45 **Leroy (Lee) Hood**, Institute for Systems Biology
**Big Data, Wellness and Disease**

### Closing Remarks

12:30 **David Harel**, Weizmann Institute of Science;
Vice-President, Israel Academy of Sciences and Humanities

# Abstracts

*(in order of presentation)*

# Abstracts

## **Day One** / Monday, September 16, 2019

**SESSION I**

### The Quantum Impact on Technology and Fundamental Questions

**Charles H. Bennett**, IBM Thomas J. Watson Research Center

Beginning in the late 1960's quantum effects in information processing progressed from being viewed as a nuisance to be overcome, to an enabler of new kinds of communication and computation with potentially revolutionary consequences for information technology, to a source of insights into fundamental questions like the origin of spacetime.

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### Harnessing Topological Physics for Quantum Computation

**Ady Stern**, Weizmann Institute of Science

I will give an overview talk on topological states of matter and the way they may be useful for battling de-coherence of quantum computers. To that end, I will start by explaining what topological states of matter are and why they are a perfect example of scientific beauty. I will then explain what de-coherence is, and why it is a major obstacle on the way to realizing quantum computers. Next, I will describe how topological states may help in overcoming this obstacle, and how they may pave the way to realizing a centuries-old human desire to eat the cake and have it too. Finally I will conclude by emphasizing the practical difficulties on the way.

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## Complexity and Simplicity in Economic Design

**Noam Nisan**, The Hebrew University of Jerusalem

As more and more economic activity moves to the Internet, familiar economic mechanisms are being deployed at unprecedented scales of size, speed, and complexity. In many cases this new complexity becomes the defining feature of the deployed economic mechanism and the quantitative difference becomes a key qualitative one. The talk will discuss some of the challenges and opportunities that this complexity-in several different senses of "complexity"– entails.

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## Complexity–Theoretic Perspectives on Algorithmic Fairness

**Omer Reingold**, Stanford University

A prominent concern, in the age of machine learning and data analysis, is that left to their own devices, algorithms will propagate–even amplify–existing biases. Common definitions of fairness are group-based, typically requiring that a given statistic be equal across a few demographic groups, socially identified as deserving protection. Such definitions tend to be easy to study and satisfy but are liable to provide exceedingly weak protection from unfair discrimination. This motivated the introduction of definitions that aim at individual-level protections. Such protection is much stronger and more nuanced but harder to satisfy. We will discuss a recent sequence of results, where protection is provided to a large collection of populations, defined complexity-theoretically. This gives a surprising approach to a question that has been debated by a variety of scientific communities; which population should be protected? Our approach suggests protecting every group that can be identified given the data and our computational limitations, which in a sense is the best we can hope to do. We will discuss this approach in different contexts as well as its relation to pseudo-randomness.

Based on joint works with Cynthia Dwork, Úrsula Hébert-Johnson, Michael P. Kim, Guy Rothblum and Gal Yona.

**SESSION II**

## Design for Inference in Biology and the Power of Random Experiments

**Aviv Regev**, Massachusetts Institute of Technology

Molecular biology is breathtaking in its potential for intricacy and complexity. Billions of DNA bases, encoding tens of thousands of genes, expressed in diverse spatio-temporal patterns, and acting within thousands of different cell types. In principle, the space of potential patterns, from genomes, to expression programs, cell types, or histologies, while not infinite, is enormous, although only a miniscule fraction of it is realized. A major effort in molecular biology is to discover those systems, and to decipher how their organization leads to biological function. Many of these foundational questions are addressed by experiments where the biological system is perturbed (through interventions) and measured (through observations), in order to comprehensively chart the system's components and architecture, and understand its response in different environments.

The dramatic enhancements in our ability to perform both observations and interventions over the past decades have offered the hope that it should be possible to tackle these challenges systematically. However, in principle, an astronomical gap remains between the scales of exhaustive experiments, and those that can be achieved in practice. Here, we propose new, algorithmically-driven efficient strategies to design experiments for such inference, leveraging the inherent latent structure of biological systems and the data we measure about them. In particular, I'll discuss how random experiments and composite experiments can make biological discovery vastly more efficient allowing us to tackle biological problems comprehensively even when we cannot experiment exhaustively, including in gene regulation, expression programs, spatial organization, and genetic interactions.

## Integrated Computational Analysis in Cancer and Precision Medicine

**Ron Shamir**, Tel Aviv University

Today's large biological datasets open novel opportunities in basic science and medicine. While inquiry of each dataset separately often provides insights, integrative analysis may reveal more holistic, systems-level findings. We demonstrate the power of integrated analysis in cancer on two levels: (1) in analysis of one omic in many cancer types together, and (2) in analysis of multiple omics for the same cancer. In both cases, we develop novel methods and observe a clear advantage of the integration. We also describe a new method for identifying and ranking driver genes in an individual's tumor, based on expression and mutation profiles.

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## Robot-Human Collaboration and Learning for Improving Human Well-Being

**Sarit Kraus**, Bar-Ilan University

Autonomous mobile robots can greatly improve human well-being. For example, robot assistance to older adults and people with physical impairments could be extremely beneficial in our aging society. Challenges in building functional robots that act in unstructured environments such as homes and hospitals are: current technological limitations in perception and action of robots in unstructured and highly variable environments; the variety of tasks at hand are complex involving man, machine and a dynamic interaction between them; the nature of functional robots that interact with people requires the development of general purpose policies that can be computed efficiently. In order to increase robot autonomy, there is a need to develop innovative algorithms and methodologies enabling a small number of human operators to work together, possibly by tele-operating the robots, with a large number of mobile robots located in different unstructured locations, such as homes. The robots will learn to improve their capabilities over time, enabling them to become more autonomous in facing new tasks and adapting to users changing needs. Operators can also assist the robots in the learning process. In this talk, I will discuss some preliminary results toward this vision.

## Learning in Multi-Agent Environments

**Eva Tardos**, Cornell University

In many online systems, participants use data and algorithms to experiment and learn how to best use the system. Examples include traffic routing as well as online auctions. Game theory classically studies Nash equilibrium as the outcome of selfish interaction, and has many examples illustrating that selfish behavior can lead to suboptimal outcome for all participants. Over the last decade, we developed good understanding of how to quantify the impact of strategic user behavior on overall performance in Nash equilibria of games. In this talk we will focus on games where players use a form of learning that helps them adapt to the environment. We ask if the quantitative guarantees obtained for Nash equilibria extend to such out of equilibrium game play, possibly even in dynamically changing environments? Or possible even better, does learning lead the agents to outcomes that are better than the (worst) Nash equilibrium?

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## The Promise of Machine Learning and AI in Transforming Industries

**Amnon Shashua**, The Hebrew University of Jerusalem; Mobileye

The fast-moving field of artificial intelligence is transforming industries. I will focus on two examples in some details. First, the field of transportation is undergoing a seismic change with the coming introduction of autonomous driving. The technologies required to enable computer driven cars involves the latest cutting edge artificial intelligence and machine learning algorithms. I will review the various innovations and challenges associated with bringing autonomous driving to reality and the changes it will likely bring to society at large. Second, "AI as a Companion" is likely to is gaining momentum and, at some point, computers will transform from a tool to a companion. I will focus on two segments of society, the visual impaired and the hearing disabled, for which the current state of the art has a game-changing effect.

## **Day Two** / Tuesday, September 17, 2019

**SESSION III**

### Quantum Information Science: A Computational Lens on Quantum Physics

**Dorit Aharonov**, The Hebrew University of Jerusalem

While the jury is still out as to when and where the impressive experimental progress on quantum gates and qubits will indeed lead one day to a full scale quantum computing machine, a new and not-less exciting development has been taking place over the past decade. Computational notions such as reductions, hardness, and completeness are quickly starting to be integrated into the very heart of the research of many body quantum systems. The computational perspective brings deep new insights into physical questions that seem completely unrelated to computers, including precision measurement and sensing, testing quantum mechanics, condensed matter physics and even black holes and quantum gravity. I will try to explain some of these intriguing connections and implications, and time permitting, will ponder about what next.

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### Secure Computation with Quantum Devices: From Device-Independent Cryptography to Verification of Quantum Computers

**Thomas Vidick**, California Institute of Technology

Quantum cryptography is at present one of the most technologically mature applications of quantum information. The discovery of the unprecedented possibilities of quantum states for secure communication predates the algorithmic discoveries of quantum computing. Yet the recourse to quantum states of matter presents unique difficulties: due to the superposition principle, quantum states are exponentially complex; due to the uncertainty principle, the information they encode cannot be read off without disturbance.

Thus arises one of the most pressing challenges of the field of quantum computing: how can "classical" human beings and machines test, control and verify the behavior of quantum computing devices? In the talk I will trace the history of this question, from its origins in the study of device-independent quantum cryptography to recent discoveries on the verification of quantum devices.

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## Safe Machine Learning

**Shafi Goldwasser**, Massachusetts Institute of Technology

Cryptography and Computational Learning have shared a curious history: a scientific success for one often provided an example of an impossible task for the other. Today, the goals of the two fields are aligned. Cryptographic models and tools can and should play a role in ensuring the the safe use of machine learning. We will discuss this development with its challenges and opportunities.

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## Humans, Machines, and Work: The Future is Now

**Moshe Vardi**, Rice University

Automation, driven by technological progress, has been increasing inexorably for the past several decades. Two schools of economic thought have for many years been engaged in a debate about the potential effects of automation on jobs: will new technology spawn mass unemployment, as the robots take jobs away from humans? Or will the jobs robots take over create demand for new human jobs?

I will present data that demonstrate that the concerns about automation are valid. In fact, technology has been hurting working-class people for the past 40 years. The discussion about humans, machines and work tends to be a discussion about some undetermined point in the far future. But it is time to face reality. The future is now.

## **Day Three** / Wednesday, September 18, 2019

**SESSION IV**

### Similarities and Differences between Deep Learning and our Biological Brains

**Naftali Tishby**, The Hebrew University of Jerusalem

The new phase of artificial intelligence, in particular the one based on artificial neural networks, is truly revolutionizing the world. Problems considered extremely difficult for machines, like human face recognition, speech recognition and natural language understanding, are now done routinely on small devices like our smartphones. The striking fact is that this amazing progress was achieved not by ingenious mathematics and engineering but by a very naive attempt to mimic the human brain. How similar is the current AI to biological intelligence? Do they both suffer from similar lack of robustness and interpretability? Are some of the deficiencies of AI unavoidable? Are we on the right track to use AI for better understanding of our own brains? I will touch on some of these issues in view of the progress made in both AI and neuroscience.

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### Smart Swarms in the Wild and in the Small

**Gal Kaminka**, Bar Ilan University

Swarms are ubiquitous in natural creatures, but rare in synthetic agents. Human pedestrians, crowds and audiences, animals moving collectively, insect colonies and hives, all act as swarms: coordinating based on limited local information, yet generating significant group-wide effects. Their synthetic counterparts are often academically fascinating, but just so. This talk will highlight two high-risk, high-payoff research efforts, where artificially-created swarms open doors to high-impact science: the use of robots to study whether insect swarms can be rational (in the decision-theoretic sense), and the automated generation of swarm-drugs, made from molecular robots (affectionately called nanobots). I will present preliminary promising results, and discuss current and future steps to fulfill the promise of synthetic swarms.

## Design Principles of Physiological Circuits

**Uri Alon**, Weizmann Institute of Science

To understand human physiology, it is important to find mathematical principles that can unite different systems. I will describe advances in understanding of principles that allow hormone systems to work despite huge variations in physiological parameters. These principles offer new ways to understand the origin of several diseases.

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## Big Data, Wellness and Disease

**Leroy (Lee) Hood**, Institute for Systems Biology; Providence St. Joseph Health

A systems approach to human health and the big data derived from genome and longitudinal phenome of individuals leads to analyses that are transforming our understanding of wellness and disease. We have employed genome and "deep phenotyping" to make billions of measurements on individual humans–assaying hundreds of biological networks--to generate thousands of longitudinal data clouds that have given remarkable new insights into many aspects of human wellness and disease. Further, they lead us to a 21st century medicine that is predictive, preventive, personalized and participatory (P4) and that in turn leads one to the conclusion that healthcare has two major domains–wellness and disease. The objective of 21st century medicine will be to understand deeply wellness and disease and to identify and reverse the early transitions between the two–the preventive medicine of the 21st century. These insights have far-reaching implications for the practice of 21st century medicine, some of which will be discussed.

# Biographies

*(in alphabetical order)*

# Biographies

## Dorit Aharonov

### The Hebrew University of Jerusalem

Dorit Aharonov is a faculty member of the School of Computer Science and Engineering at The Hebrew University in Jerusalem. Aharonov completed her BSc in physics and mathematics at The Hebrew University, then continued to one year of MSc studies in physics at the Weizmann Institute, followed by a PhD in computer science and physics at The Hebrew University, which she completed at 1999. After a postdoc at the Institute for Advanced Study, Princeton and at the University of California, Berkeley, she joined The Hebrew University in 2001. She was awarded the Krill Prize for Excellence in Scientific Research in 2006, an ERC Grant for Starting Researchers in 2011, and the Michael Bruno Memorial Award in 2014. Aharonov's research attempts to use the computational perspective to clarify how quantum systems differ from their classical counterparts, Overall, she is interested mainly in the way fundamental questions about quantum mechanics can be cast in terms of computational complexity questions.

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## Uri Alon

### Weizmann Institute of Science

Uri Alon earned his BSc and his MSc in physics from The Hebrew University of Jerusalem. He completed his PhD in physics at the Weizmann Institute of Science, and was a postdoctoral fellow in experimental biology in the Departments of Physics and Molecular Biology at Princeton University. He is currently a professor at the department of Molecular Cell Biology at the Weizmann Institute of

Science. Prof. Alon works at the interface between physics and biology, and is one of the founders of the field of systems biology. He has received many awards, including the 2014 Nakasone prize, the Jacques Solvay Chair in Physics and the Michael Bruno Memorial Award.

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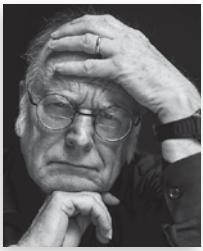

## Charles H. Bennett

### IBM Thomas J. Watson Research Center

Born in New York City in 1943, the son of music teachers, Charles H. Bennett received his BA in chemistry from Brandeis University and his PhD from Harvard in 1971. Since 1972 he has worked for IBM's Research Division on various aspects of the relation between physics and information processing, including the thermodynamics of computing and the Maxwell's Demon problem; quantum communication and computation; and quantum cryptography. Most recently he has become interested in the application of quantum information ideas to cosmology.

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## Nili Cohen

### President, Israel Academy of Sciences and Humanities

Nili Cohen, Israel Prize Laureate for legal research, President of the Israel Academy of Sciences and Humanities since 2015, received her LL.B. magna cum laude, LL.M. summa cum laude, and PhD from Tel-Aviv University. As a student, she was the co-founding editor of Tel-Aviv University Law Review. She is the recipient of the Sussman Prize (twice), the Zeltner Prize, the Minkoff Prize for excellence in Law, and the Rector Prize for Excellence in Teaching (thrice). She was the incumbent of the Benno Gitter Chair in Comparative Contract Law. She served as Vice-Rector and subsequently as Rector of Tel-Aviv University. Her research focuses on contract law, tort law, the law of unjust enrichment, and law and literature.

## Michal Feldman

### Tel Aviv University

Michal Feldman is a Professor of computer science in the Blavatnik School of Computer Science at Tel Aviv University and a researcher at Microsoft Research (MSR) Herzliya. Her research focuses on the intersection of computer science, game theory and microeconomics. She received her PhD from the University of California at Berkeley in 2005, and did her postdoc at The Hebrew University (2005-07). She was a faculty member in the School of Business Administration and the Center for the Study of Rationality at The Hebrew University (2007-13), and a visiting professor at Harvard University and Microsoft Research New England (2011-13). She serves on the editorial board of various journals, including GEB, MOR, JCSS and ACM TEAC. She is the vice chair of ACM SIGecom, and served as the PC chair of ACM EC 2015. She is the recipient of various grants and fellowships, including ERC (European Research Council), Marie Curie IOF, Alon, ISF and Amazon Research Award. She is an alumna of the Israeli Young Academy and the Global Young Academy.

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## Kenneth R. Fulton

### Executive Director, National Academy of Sciences

Kenneth R. Fulton is the Executive Director of the National Academy of Sciences. Following service in the U.S. Navy, where he was trained as a linguist, he joined the staff of the Academy in 1971. He served in several staff positions in the National Research Council before being appointed to the Academy's executive office in 1980, first as director of membership, then as special assistant to the president, and in 1994 as executive director. In his capacity as executive director, Mr. Fulton manages the Academy's membership and program activities – including the Blavatnik US-Israel Scientific Forum – and is the publisher of the Proceedings (PNAS), the Academy's journal of original research. He is also the executive director of The National Academies' Corporation.

Mr. Fulton holds a bachelor's degree in the social and behavioral sciences, and a masters degree in management. He is a Fellow of the American Association for the Advancement of Science and a member of the Cosmos Club in Washington, DC.

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## Shafi Goldwasser

### Massachusetts Institute of Technology

Shafi Goldwasser is the director of the Simons Institute for Theory of Computing at UC Berkeley. She is also a professor of computer science and applied mathematics department at the Weizmann Institute of Science in Israel. Goldwasser received a BS degree in applied mathematics from Carnegie Mellon University in 1979, and MS and PhD degrees in computer science from the University of California, Berkeley, in 1984. Goldwasser's contributions include the introduction of probabilistic encryption, zero knowledge proofs, elliptic curve primality testing, proofs of hardness of approximation, and combinatorial property testing.

She was the recipient of the ACM Turing Award for 2012, Gödel Prizes in 1993 and in 2001, the ACM Grace Murray Hopper award in 1996, the RSA award in mathematics in 1998, the ACM Athena award for women in computer science in 2008, the Benjamin Franklin Medal in 2010, the IEEE Emanuel R. Piore award in 2011, the Simons Foundation Investigator award in 2012, and the BBVA Foundation Frontiers of Knowledge award in 2018. She is a member of the NAS, NAE, AAAS, the Russian Academy of Science, the Israeli Academy of Sciences and Humanities, and the London Royal Mathematical society. She a holds honorary degrees from Ben Gurion University, Bar Ilan University, Haifa University, Oxford University, University of Waterloo and the Barnard College Medal of Distinction.

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## David Harel

### Weizmann Institute of Science

David Harel is Vice President of the Israel Academy of Sciences and Humanities, and has been at the Weizmann Institute of Science since 1980, serving in the past as Dean of the Faculty of Mathematics and Computer Science. He has worked on logic and computability, software and systems engineering, modeling biological systems, odor reproduction, and more. He invented Statecharts and co-invented Live Sequence Charts. Among his books are Algorithmics: The Spirit of Computing, Computers Ltd.: What They Really Can't Do and Come, Let's Play: Scenario-Based Programming Using LSCs and the Play-Engine.

His awards include the ACM Karlstrom Outstanding Educator Award, the Israel Prize, the ACM Software System Award, the EMET Prize, and five honorary degrees. He is a fellow of ACM, the IEEE and the AAAS, a member of the Academia Europaea and the Israel Academy of Sciences and Humanities, and a foreign member of the US National Academy of Engineering, the American Academy of Arts and Sciences and the US National Academy of Sciences.

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## Leroy (Lee) Hood

### Institute for Systems Biology

Leroy (Lee) Hood is Senior Vice President & Chief Science Officer of Providence St Joseph Health; and Chief Strategy Officer & Co-Founder of the Institute for Systems Biology. He received his MD from Johns Hopkins and PhD from Caltech. He was a faculty member at Caltech (1970-1992) and University of Washington (UW) (1992-2000). He founded the first cross-disciplinary department of biology at the UW and in 2000 cofounded the independent Institute for Systems Biology where he served

as the institute's president until 2019. He has pioneered 4 important technologies at Caltech (automated DNA and protein sequencing and DNA and peptide synthesis) – which formed the technological foundations for modern biology. He cofounded 17 biotechnology companies, including Amgen and Applied Biosystems. In 2016, he became Chief Science Officer of Providence St. Joseph Health, the third largest nonprofit healthcare systems in the United States. Dr. Hood has published over 850 peer-reviewed articles and currently holds 36 patents.

Dr. Hood is the recipient of many national and international awards, including the Lasker Award for Studies of Immune Diversity (1987), the Kyoto Prize in advanced technology (2002), the Heinz Award for pioneering work in Systems Biology (2006) and the National Medal of Science in 2013 from President Obama. He is a member of all three US national academies–science, medicine, and engineering.

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## Gal Kaminka

### Bar Ilan University

Gal A. Kaminka is a professor at the computer science department and the brain sciences research center, at Bar Ilan University (Israel), where he leads the MAVERICK research group. His research expertise includes multi-agent and multi-robot systems, teamwork and coordination, behavior and plan recognition, and modeling social behavior. He received his PhD from the University of Southern California (2000), spent time as a post-doctorate fellow at Carnegie Mellon University (until 2002), and a year as a Radcliffe Fellow at Harvard University's Radcliffe Institute for Advanced Study (2012). Prof. Kaminka is the 2013 recipient of the Israeli national Landau Prize in exact sciences and a Fellow of the European Association for Artificial Intelligence. He is also co-founder and CTO of BladeRanger, developing robots for solar energy installations.

## Sarit Kraus

### Bar Ilan University

Sarit Kraus (PhD in Computer Science, The Hebrew University, 1989) is a Professor of Computer Science at Bar-Ilan University. Her research is focused on intelligent agents and multi-agent systems (including people and robots). For her work she has received many prestigious awards. She was awarded the IJCAI Computers and Thought Award, the ACM SIGART Agents Research Award, the EMET Prize and was twice the winner of the IFAAMAS Influential Paper Award. She is an ACM, AAAI and ECCAI fellow and a recipient of an advanced ERC grant. She also received a special commendation from the City of Los Angeles, together with Prof. Tambe, Prof. Ordonez and their USC students, for the creation of the ARMOR security scheduling system. She has published over 350 papers in leading journals and major conferences and has co-authored five books. She is a member of the board of directors of IFAAMAS and is the IJCAI 2019 program chair.

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## Noam Nisan

### The Hebrew University of Jerusalem

Noam Nisan is currently the Dean of the School of Computer Science and Engineering at The Hebrew University of Jerusalem where he has been a faculty member since 1990. He received his PhD in Computer Science from U.C. Berkeley in 1988 and has spent a few years as a researcher at Google and at Microsoft. His research focuses on the border of computer science, game theory, and economic theory for which he has won several awards including the Gödel Prize, Knuth Prize, and Rothschild Prize.

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## Omer Reingold

### Stanford University

Omer Reingold is the Rajeev Motwani Professor of Computer Science at Stanford University. Past positions include Samsung Research America, the Weizmann Institute of Science, Microsoft Research, the Institute for Advanced Study in Princeton, NJ and AT&T Labs. His research is in the foundations of computer science and most notably in computational complexity and the foundations of cryptography with emphasis on randomness, derandomization and explicit combinatorial constructions. He has a keen interest in the societal impact of computation. He is an ACM Fellow and among his distinctions are the 2005 Grace Murray Hopper Award and the 2009 Gödel Prize.

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## Aviv Regev

### Massachusetts Institute of Technology

Aviv Regev, PhD, a computational and systems biologist, is a core member and Chair of the Faculty at the Broad Institute, a professor of biology at MIT, and an investigator at the Howard Hughes Medical Institute. Regev's research combines experimental and computational approaches to decipher how complex molecular circuits function in cells and between cells in tissues. She is the Founding Director of the Klarman Cell Observatory and Cell Circuits Program at the Broad, and the Founding Co-Chair of the international initiative to build a Human Cell Atlas (HCA), whose mission is to create comprehensive reference maps of all human cells. Her lab has been a pioneer of single-cell genomics–inventing key experimental methods and computational algorithms in the field. Among her honors are the NIH Director's Pioneer Award, the Overton Prize and the Innovator Award from the International Society for Computational Biology (ISCB), the Earl and Thressa Stadtman Scholar Award from the American Society of Biochemistry and Molecular Biology, and the Paul Marks Prize. She is a Fellow of the International Society of Computational Biology and a Member of the National Academy of Sciences.

## Ron Shamir

### Tel Aviv University

Ron Shamir (PhD UC Berkeley 1984) is the Sackler Professor of Bioinformatics in the Blavatnik School of Computer Science at Tel Aviv University (TAU). His group develops algorithms and tools for understanding the genome and human disease. Shamir is the founder and head of the Edmond J. Safra Center for Bioinformatics at TAU. He has published about 300 scientific works, including 17 books and edited volumes, and has supervised more than 50 research students. He received the Landau Prize in Bioinformatics, the Kadar Family Prize for Excellence in Research, and is a fellow of the ISCB and the ACM.

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## Amnon Shashua

### The Hebrew University of Jerusalem; Mobileye

Amnon Shashua is the Sachs Professor of Computer Science at The Hebrew University of Jerusalem, specializing in computer vision and machine learning. Shashua has published over 120 papers and holds over 45 patents. Shashua has founded three startups: CogniTens (1995) specializing in industrial metrology; Mobileye (1999) cofounded with Ziv Aviram which develops system-on-chips and computer vision algorithms for driving assistance systems and is developing a platform for autonomous driving to be launched in 2021; and OrCam (2010) which harnesses computer vision and artificial intelligence to assist the visually impaired and blind. In 2017 Mobileye was acquired by Intel Corporation and Prof. Shashua is currently the President & CEO of Mobileye and a Senior Vice President at Intel. Shashua was recognized as the Electronic Imaging (EI) Scientist of the Year (2019) by the Society for Imaging Science and Technology (IS&T) for his contributions to computer vision and machine learning, for advancing autonomous driving and furthering development of wearable assistive devices for the blind and visually impaired. Shashua and his team were also finalists in the European Inventor Awards of 2019, awarded by the European Patent Office, for their advanced driver assistance technology.

## Ady Stern

### Weizmann Institute of Science

Ady Stern was born in Beer-Sheva, lives in Tel-Aviv, and works at the Department of Condensed Matter Physics at the Weizmann Institute of Science in Rehovot. He completed his BSc studies in both mathematics and computer science and a PhD in physics, all from the Tel Aviv University. He joined the Weizmann Institute of Science in 1995, after three years of postdoctoral research as a Junior Fellow at Harvard University.

Prof. Stern studies quantum mechanical aspects of electronic systems and hopes to be part of the second quantum revolution. He is interested both in the purely theoretical aspects of this area of research and in developing models that provide a basis for conducting and analyzing empirical experiments. In his spare time, Prof. Stern likes to lecture on popular science to general audiences.

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## Éva Tardos

### Cornell University

Éva Tardos is a Jacob Gould Schurman Professor of Computer Science at Cornell University. She was Department Chair 2006-2010, and Associate Dean of Computing and Information Sciences 2012-2014. She received her PhD from Eötvös University in Budapest. She joined the faculty at Cornell in 1989. Tardos's research interest is algorithms and game theory. She has been elected to the National Academy of Engineering, the National Academy of Sciences, the American Academy of Arts and Sciences, and to the Hungarian Academy of Sciences. She is the recipient of a number of awards including the IEEE von Neumann Medal in 2019.

## Naftali Tishby

### The Hebrew University of Jerusalem

Naftali Tishby is a professor of computer science, and the incumbent of the Ruth and Stan Flinkman Chair for Brain Research at the Edmond and Lily Safra Center for Brain Science (ELSC) at The Hebrew University of Jerusalem. Tishby received his PhD in theoretical physics from The Hebrew University in 1985 and was a research staff member at MIT and Bell Labs from 1985 to 1991. His current research is at the interface between computer science, statistical physics, and computational neuroscience. He pioneered various applications of statistical physics and information theory in computational learning theory. He introduced new theoretical frameworks for optimal adaptation and efficient information representation in biology, such as the Information Bottleneck Method and the Minimum Information Principle for neural coding. Prof. Tishby is a winner of the Landau Award in Computer Science (2015) and the IBT Award in Mathematical Neuroscience (2019).

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## Shimon Ullman

### Weizmann Institute of Science

Shimon Ullman is the Samy and Ruth Cohn Professor of Computer Science at the Weizmann Institute of Science. Previously, he was a professor at the Brain and Cognitive Science at MIT. His areas of research combine computer and human vision, human cognition, and brain modeling. He is a recipient of the 2008 David. E. Rumelhart Prize for Contributions to the Theoretical Foundations of Human Cognition, the 2014 EMET Prize for Art, Science and Culture, and the 2015 Israel Prize in Computer Science. He is a member of the Israel Academy of Sciences and Humanities and the American Academy of Arts and Sciences.

## Thomas Vidick

### California Institute of Technology

Thomas Vidick is Professor of Computing and Mathematical Sciences at the California Institute of Technology. He received a B.A. in pure mathematics from École Normale Supérieure in Paris and a PhD from UC Berkeley. His PhD thesis was awarded the Bernard Friedman Memorial Prize in Applied Mathematics. His research lies at the interface of theoretical computer science, quantum information and cryptography. He is the recipient of an NSF Career Award (2015), a CIFAR Azrieli Global Scholar Award (2017), and a Presidential Early Career Award for Scientists and Engineers (2019).

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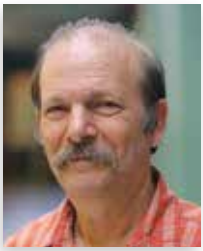

## Moshe Vardi

### Rice University

Moshe Y. Vardi is a University Professor, and the George Distinguished Service Professor in Computational Engineering and Director of the Ken Kennedy Institute for Information Technology at Rice University. He is the author and co-author of over 600 papers, as well as two books. He is the recipient of several scientific awards, is a fellow of several societies and a member of several honorary academies. He holds six honorary doctorates.

He is a Senior Editor of Communications of the ACM, the premier publication in computing, focusing on societal impact of information technology.

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