NOBEL SYMPOSIA

PREDICTABILITY IN SCIENCE IN THE AGE OF AI

STIAS, 24 - 28 OCTOBER 2022

NOBEL IN AFRICA

A STIAS INITIATIVE

INTRODUCTION NOTE

Big Data refers to very large data sets collected for many reasons, typically without one definite goal in mind. Using techniques collectively known as Artificial Intelligence (AI), one can extract commercially very valuable information from such data. While famous data sets in the physical sciences are larger than any other, they have been gathered to answer a definite research question, such as, for instance, what is the mass of the Higgs boson, or are there gravitational waves. Such data acquisition follow the paradigm of theory-hypothesis-testing-knowledge. Big Data does not.

This raises the question whether science can also go directly to the data. One well-known (popular) expression of such a line of thought was a 2008 article in *Wired* magazine with the title "The end of the theory: the deluge of data makes the scientific method obsolete". By extrapolating this reasoning, instead of us trying to imagine how the world works, computers will find for us the laws of nature. Not necessarily take the form of intelligible mathematical relationships, but which work just as well, and which will make our lives easier and therefore happier.

The Nobel Symposium "Predictability in Science in the age of AI" aims to bring together leading experts in AI and sciences to discuss these issues. One main theme will be to find out the limits of the Big Data approach. It has been argued that knowledge, as opposed to data and facts, is contingent on meaning. Any finite amount of data can however take many meanings depending on context. A crucial question will hence be to what extent a Big Data approach requires working in a given context, and to what extent it allows for the creation of new knowledge.

The Nobel in Africa – NOBEL SYMPOSIA series is a STIAS Initiative in partnership with Stellenbosch University, under the auspices of the Nobel Foundation and the Royal Swedish Academy of Sciences with funding from the Knut & Alice Wallenberg Foundation.

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forward together
sonke siya phambili
saam vorentoe

The Nobel Symposium in Physics NS183 on "Predictability in Science in the Age of AI" is funded by the Knut and Alice Wallenberg Foundation and organized by the Stellenbosch Institute for Advanced Study (STIAS) in South Africa. The NOBEL SYMPOSIA mark is owned by the Nobel Foundation.

PROGRAMME

SUNDAY, OCTOBER 23		
17.00-19.00	Meet & Greet at STIAS, welcoming cocktail	

MONDAY, OCTOBER 24		
08.30-09.00	Registration	
SESSION 1.	**OPENING**	**Chair Hendrik Geyer**
09.00-09.15	Welcome	STIAS (Edward Kirumira – STIAS Director)
09.15-09.30	Introducing the Physics Nobel Symposium	Erik Aurell
SESSION 2.	**WHAT IS THE PROGRAMME ABOUT?**	**Chair Luca Gammaitoni**
09.30-10.30	What is predictability?	Angelo Vulpiani
10.30-11.00	Coffee	
11.00-12.00	More than just data analysis: What machine learning can do for science	Maria Schuld
12:00-13:00	Using Machine Learning to Address Real World Problems	Winston Soboyejo
13.00-14.00	Lunch	
SESSION 3.	**COSMOLOGY AND DYNAMICAL SYSTEMS (PART I)**	**Chair Yin-Zhe Ma**
14.00-15.00	How predictive are cosmological theories?	Vyacheslav Mukhanov
15.00-16.00	Simple at the Extremes: a new theory of the universe	Neil Turok
16.00-16.30	Coffee and depart for Stellenbosch University campus	
OUTREACH EVENT: Stellenbosch University, Jan Mouton Centre		**Chair: Francesco Petruccione**
16.30-18.00	How quantum physics democratised music: a meditation on physics and technology	Michael Berry Public Lecture
18.00-20.00	Stellenbosch University hosted Cocktail Reception	

TUESDAY, OCTOBER 25		
LAUNCH OF THE NOBEL IN AFRICA SYMPOSIA SERIES		
08.00	Light breakfast, tea and coffee	
09.00	MC	Claire Mawisa
	• Welcome	STIAS Director, Edward K. Kirumira
	• Stellenbosch University	Rector and Vice-Chancellor, Wim de Villiers
	• Wallenberg Foundations	Chairperson, Peter Wallenberg Jr
	• Nobel Foundation	Executive Director, Vidar Helgesen
	• Promoting Science and Innovation in Africa	Science for Africa Foundation, Judith Omumbo
10.30	Tea Break	
11.00	Themes of the Nobel in Africa Nobel Symposia Series	
	• **Physics:** Predictability in Science in the Age of AI	Erik Aurell
	• **Chemistry:** Tuberculosis and Antibiotic Resistance – From Basic Drug Discovery to Clinic	Fredrik Almqvist
	• **Economic Sciences:** Micro development research in the last 20 years	Jakob Svensson
11.45	The Nobel Prizes in 1932/33: Heisenberg, Schrödinger and Dirac	Mats Larsson
12.30	Lunch	

Symposium sessions continue:

SESSION 3	COSMOLOGY AND DYNAMICAL SYSTEMS (PART II)	Chair Angelo Vulpiani
14.00-15.00	Revisiting the Master Equation in random graphs	Roberto Mulet
15.00-16.00	Reservoir Computing for predicting and modelling chaotic systems	Massimo Cencini
16.00-16.30	Coffee	
16.30-18.00	Panel discussion.	Moderator: Magnus Boman
	Panelists: speakers and chairs of the first two days.	

NOBEL IN AFRICA LAUNCH DINNER AT NOOITGEDACHT ESTATE	
18.00-22.00	Dinner programme & entertainment

WEDNESDAY, OCTOBER 26		
SESSION 4	**COMPLEXITY, SPIN GLASSES AND AI**	**Chair Sabrina Maniscalco**
09.00-10.00	Machine learning and Occam razor	Matteo Marsili
10.00-10.30	Coffee	
10.30-11.30	The spin glass physics behind hard inference problems	Federico Ricci-Tersenghi
11.30-12.30	Search and Prediction in Random Graphs	Scott Kirkpatrick
12.30-14.00	Lunch	
SESSION 5	**EPIDEMIOLOGY AND PANDEMIOLOGY I**	**Co-Chairs Erik Aurell and Erling Norrby**
14.00-15.00	Data and AI to help fight the COVID-19 pandemic: the Valencian experience	Nuria Oliver
15.00-16.00	Predicting human behaviour during a pandemic: what a true AI would have scried and why real AIs cannot	Florian Burckhardt
16.00-16.30	Coffee	
SESSION 6	**EPIDEMIOLOGY AND PANDEMIOLOGY II**	**Co-Chairs Erik Aurell and Erling Norrby**
16.30-17.30	Trans disciplinary research in South Africa helping the world in the COVID response	Tulio de Oliveira
17.30-18.30	Unstructured discussion time	
18.30	Dinner / 'Braai' at STIAS	

THURSDAY, OCTOBER 27		
SESSION 7	**QUANTITATIVE BIOLOGY / BIOLOGICAL PHYSICS I**	**Chair Francesco Petruccione**
09.00-10.00	Learning to navigate complex environments	Massimo Vergassola
10.00-10.30	Coffee	
10.30-11.30	Oscillations, DNA repair and Resonances in Cell Dynamics	Mogens Høgh Jensen
11.30-12.30	Prediction in immune repertoires	Aleksandra Walczak
12.30-14.00	Lunch	
SESSION 8	**QUANTITATIVE BIOLOGY / BIOLOGICAL PHYSICS II**	**Chair Ingemar Ernberg**
14.00-15.00	Learning the shape of the protein universe	Armita Nourmohammad
15.00-15.30	Coffee	
15.30-16.30	Cooperativity, self-organization and control in collective animal behavior	Irene Giardina
16.30-17.30	Sing along with the environment: extended mean-field models for collective behaviour in cell populations	Leihan Tang
17.30-18.30	Unstructured discussion time	
18.30	Free Evening	

FRIDAY, OCTOBER 28		
SESSION 9	**AI**	**Chair Petri Myllymäki**
09.00-10.00	Will Deep Learning Disrupt the Natural Sciences?	Max Welling
10.00-10.30	Coffee	
10.30-11.30	Using machine learning to predict protein-protein interactions	Arne Elofsson
11.30-12.30	Assessing transfer entropy from biochemical data	Yoshiyuki Kabashima
12.30-14.00	Lunch	
SESSION 10	**QUANTUM AND AI**	**Chair Magnus Boman**
14.00-15.00	Quantum Randomness, Determinism and Foundations of Science	Pawel Horodecki
15.00-15.30	Coffee	
15.30-17.00	Panel discussion	Moderator: Erik Aurell
	Panelists: speakers of all days	
19.00-21.00	Closing Dinner, Venue: Mont Marie	

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