POWER AND LIMITS OF ARTIFICIAL INTELLIGENCE

30 NOVEMBER - 1 DECEMBER 2016 • CASINA PIO IV • VATICAN CITY

" In the Encyclical *Laudato Si'* I stated that "we are called to be instruments of God our Father, so that our planet might be what he desired when he created it and correspond with his plan for peace, beauty and fullness" (53). In our modern world, we have grown up thinking ourselves owners and masters of nature, authorized to plunder it without any consideration of its hidden potential and laws of development, as if subjecting inanimate matter to our whims, with the consequence of grave loss to biodiversity, among other ills. We are not custodians of a museum or of its major artefacts to be dusted each day, but rather co-operators in protecting and developing the life and biodiversity of the planet and of human life present there. An ecological conversion capable of supporting and promoting sustainable development includes, by its very nature, both the full assuming of our human responsibilities regarding creation and its resources, as well as the search for social justice and the overcoming of an immoral system that produces misery, inequality and exclusion. "

Address of His Holiness Pope Francis to Participants in the Plenary Session
of the Pontifical Academy of Sciences, Consistory Hall, Monday, 28 November 2016

Introduction

One of the key issues today concerns the place of the human person in a growing digital environment of increasing complexity that not only expands the range of his or her capacities, but also may compete with them or even replace them. Over the past fifty years, robots and computers have progressively supplemented humans, initially only in relatively simple computational and manipulation tasks, but more recently in higher-cognitive tasks that used to be the prerogative of the human brain, including language, mathematics, probabilistic reasoning and decision making. A crucial question is how to enhance the productive interactions between humans and artificial intelligence (AI). As such interactions reach new orders of complexity, many researchers and philosophers feel that the outcome may defy our understanding and produce radical changes in our personal and social life in the near future.

Our Academy has already organized several meetings on the organization and functions of the human brain and mind (The educated brain, 2003; Human neuroplasticity and education, 2011; Neurosciences and the human person, 2012). We propose now to study the Power and limits of artificial intelligence.

What is the state of the art in AI software and machine learning? Can all aspects of brain function be mimicked by artificial systems? Will machines soon surpass us in all domains of human competence? What is the proper form of mathematics that may capture the operation of minds and brains? What is consciousness? Could a machine be endowed with an artificial consciousness? What would it take for a machine to possess a sense of self? Will intelligent machines soon pose a danger to humanity? Is it possible to design and construct an intelligent robot endowed with an artificial sense of ethics? How can we enhance the humanitarian uses of artificial intelligence and robotics, in particular in the field of education, health and emergencies?

We know that all these questions are very difficult to answer today, but we want to open a discussion between experts of the different fields in order to map the new cognitive environment that humanity is creating for the first time in history.

Antonio M. Battro
Stanislas Dehaene

Wednesday 30 November 2016

STATE OF THE ART IN ARTIFICIAL INTELLIGENCE, ROBOTICS, BRAIN MODELING, BRAIN-COMPUTER INTERFACES

Time	Event
09:00	**Werner Arber**, *Word of Welcome*
09:10	**Marcelo Sánchez Sorondo**, *Welcome Greetings*
09:20	**Stanislas Dehaene**, *Outline of the Workshop*
09:30	*Artificial Intelligence: A Survey of Achievements and Questions, Viewed from Mathematics* **Cédric Villani, Institut Henri Poincaré, PAS**
09:50	Discussion
10:10	*The Evolutionary Success of Cerebral Cortex: Computing in High Dimensional Dynamic Space* **Wolf Singer, Strüngmann Institute, Frankfurt, PAS**
10:30	Discussion
10:50	Coffee Break
11:20	*Breaking the Gap Between AI and Human Intelligence: What Are We Missing?* **Yann LeCun, Facebook**
11:40	Discussion
12:00	Lunch at the Casina Pio IV
14:00	*Comment: The Ethics of Artificial Intelligence* **Stephen Hawking, University of Cambridge**
14:05	*The Probabilistic Brain* **Alex Pouget, Université de Genève**
14:25	Discussion
14:45	*Building Machines That Learn and Think Like People* **Josh Tenenbaum, MIT**
15:05	Discussion
15:25	Coffee break
15:50	*Towards Artificial General Intelligence* **Demis Hassabis, Google DeepMind**
16:10	Discussion
16:30	*Motivation and Evaluation are Computationally Messy* **Patricia Churchland, UCSD, California**
16:50	Discussion
17:10	General Discussion
17:30	Presentation of **Antonio Battro**'s paper *Children and Robots*
18:00	Departure from the Casina Pio IV by bus for the visit to Palazzo Farnese
18:30	Dinner at the Casina Pio IV for those not attending the visit to Palazzo Farnese

Thursday 1 December 2016

PUTATIVE PREROGATIVES OF THE HUMAN BRAIN: EDUCATION, REASONING, CREATIVITY, CONSCIOUSNESS, SENSE OF SELF, ETHICS…COULD THEY BE CAPTURED IN MACHINES?

09:00	*The Impact of Augmented Reality, Wearables and Robotics In Neuroscience and Neuropsychiatry* **Olaf Blanke, EPFL**
9:20	Discussion
9:40	*What is Consciousness, and Could Machines Have It?* **Stanislas Dehaene, Collège de France, PAS**
10:00	Discussion
10:20	Coffee break
10:50	*What Really Matters: Children's Inferences About Learning, Trying and Caring* **Laura Schulz, MIT**
11:10	Discussion
11:30	*Artificial Intelligence and Human Minds: Perspectives From Studies of Infants* **Elizabeth Spelke, Harvard**
11:50	Discussion
12:10	Lunch at the Casina Pio IV
14:00	*The Limits and Potential for Brain Computer Interfaces* **John Donoghue EPFL, Lausanne**
14:20	Discussion
14:40	*Collaborative Human-Robot Autonomy* **Manuela M. Veloso, Carnegie Mellon University**
15:00	Discussion
15:20	*Who Am I?* **Laurie Paul, North Carolina Chapel Hill**
15:40	Discussion
16:00	Coffee Break
16:30	General discussion and drafting of final statement by all participants (discussion led by **Stanislas Dehaene**)
18:30	Dinner at the Casina Pio IV

Prof. Werner Arber
President of the Pontifical Academy of Sciences;
Biozentrum, Department of Microbiology
University of Basel
Basel (Switzerland)

Prof. Alexandre Pouget
Université de Genève,
Department of Basic Neurosciences,
(Switzerland)

Prof. Olaf Blanke
Laboratory of Cognitive Neuroscience
Brain-Mind Institute
Ecole Polytechnique Fédérale de Lausanne (EPFL)
Lausanne (Switzerland)

H.E. Msgr. Marcelo Sánchez Sorondo
Chancellor,
The Pontifical Academy of Sciences
(Vatican City)

Prof. Patricia Churchland
University of California,
San Diego, CA (USA)

Prof. Laura Schulz
Massachusetts Institute of Technology,
Department of Brain and Cognitive Sciences ,
Cambridge, MA (USA)

Prof. Stanislas Dehaene
Inserm-CEA, Cognitive Neuroimaging Unit
CEA/SAC/DSV/DRM/NeuroSpin
Gif sur Yvette (France)

Prof. Wolf J. Singer
Max-Planck-Institute for Brain Research,
Frankfurt am Main (Germany)

Prof. John Donoghue
Henry Merritt Wriston Professor,
Brown University,
Department of Neuroscience,
Providence, Rhode Island (USA)

Prof. Elizabeth Spelke
Harvard University,
Department of Psychology,
Cambridge, MA (USA)

Prof. Demis Hassabis
Google DeepMind Technologies;
Bullfrog Productions;
Lionhead Studios; University College London;
Computer Laboratory, University of Cambridge (UK)

Prof. Josh Tenenbaum
Massachusetts Institute of Technology,
Department of Brain and Cognitive Sciences,
Cambridge, MA (USA)

Prof. Stephen W. Hawking
University of Cambridge,
Department of Applied Mathematics
and Theoretical Physics,
Cambridge (UK)

Prof. Manuela Veloso
Herbert A. Simon University Professor,
Carnegie Mellon University,
Head, Machine Learning Department
School of Computer Science, Pittsburgh, PA (USA)

Prof. Yann LeCun
Director of AI Research, Facebook;
Silver Professor of Computer Science, Neural
Science, and Electrical and Computer Engineering,
New York University, NY (USA)

Prof. Cédric Villani
Institut Henri Poincaré (UPMC/CNRS),
Paris (France)

Prof. Laurie Ann Paul
University of North Carolina at Chapel Hill,
Department of Philosophy,
Chapel Hill, North Carolina (USA)

OBSERVERS

Ghislaine Dehaene-Lambertz
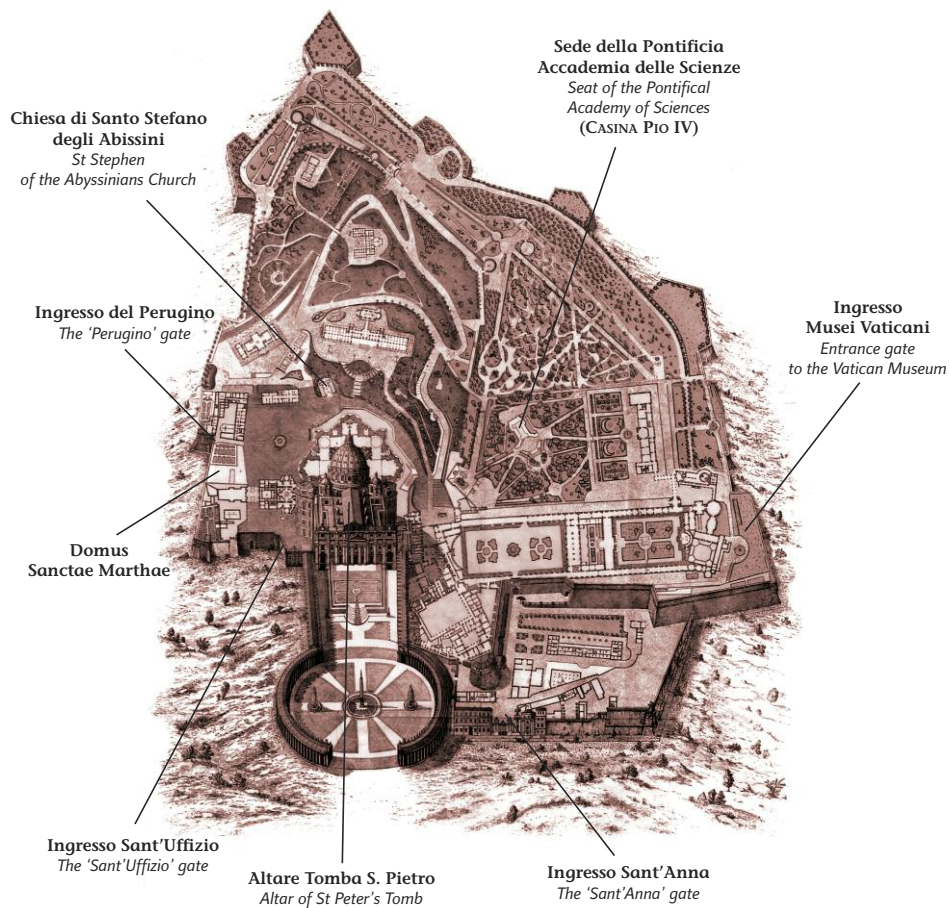Tanguy Chouard
Thomas Hertog
Dominique Lambert

Manuela de Montalembert
Marc-René de Montalembert
Nicolas Senez
Marin Soljacic

ACADEMICIANS

Jürgen Mittelstraß
Martin Rees
Pierre Léna

1) On 30 November and 1 December a bus will depart from Casa Bonus Pastor for the Academy 30 minutes before the beginning of the first session (8:30). The same bus will be at the Domus Sanctae Marthae 15 minutes before the beginning of the first session (8:45).

2) On 30 November a bus will be available at 18:00 to accompany the participants to Palazzo Farnese for a tour. After the visit participants are free for dinner. No transportation has been arranged to go back to the hotels.

3) On 1 December a bus will depart from the Casina Pio IV after the dinner to accompany the participants to their hotels.

**Chiesa di Santo Stefano
degli Abissini**
*St Stephen
of the Abyssinians Church*

**Sede della Pontificia
Accademia delle Scienze**
*Seat of the Pontifical
Academy of Sciences*
(Casina Pio IV)

Ingresso del Perugino
The 'Perugino' gate

**Ingresso
Musei Vaticani**
*Entrance gate
to the Vatican Museum*

**Domus
Sanctae Marthae**

Ingresso Sant'Uffizio
The 'Sant'Uffizio' gate

Altare Tomba S. Pietro
Altar of St Peter's Tomb

Ingresso Sant'Anna
The 'Sant'Anna' gate

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