Teaching Machines How to Learn

Max Planck Center for Learning Systems founded jointly with ETH Zurich

Ceremonial opening: Max Planck Director Stefan Schaal, Swiss Ambassador Christine Schraner Burgener, Max Planck President Martin Stratmann, ETH President Lino Guzzella, Baden-Württemberg Minister of Economic Affairs Theresia Bauer, and Max Planck Director Bernhard Schölkopf (from left to right).

For humans and animals it comes naturally; machines, on the other hand, must acquire it: learning. The aim of the Max Planck ETH Center for Learning Systems in Tübingen, which was jointly established by the Max Planck Society and ETH Zurich, is to create the conditions necessary for this. The Center's researchers will initially investigate the principles of learning. "We first want to understand what lies behind the intelligence of living organisms, allowing them to organize perception, learning, and action, and to operate successfully in a complex environment," says Bernhard Schölkopf, Director at the Max Planck Institute for Intelligent Systems, who, together with Thomas Hofmann from ETH Zurich, will head the Center. The researchers intend to use these fundamental insights into intelligence to further develop machine learning methods.

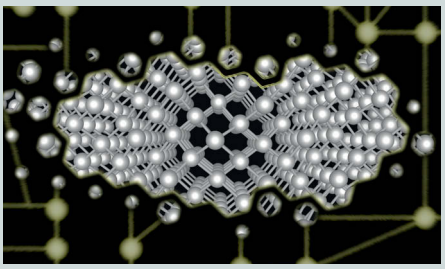
"The Center is a crucial component in the development of the research field of learning and intelligent systems in Baden-Württemberg. Through this cooperation we will ensure that European research in this field remains competitive in the global context," stressed Max Planck President Martin Stratmann at the opening of the Center in late November 2015.

Materials for the Technology of Tomorrow

European Center of Excellence supports the search for new materials

New technical developments are almost always based on better and often completely new materials. This is just as true for the next generation of smartphones as it is for catalysts for producing liquid fuels. Tracking down suitable materials for such wide-ranging applications is the aim of the European Center of Excellence for Novel Materials Discovery (NoMaD). The Center involves scientists from eight research facilities and four high-performance computer centers all over Europe. The EU has provided five million euros in funding for the Center.

"Many materials that could be of scientific and also technological interest are still completely unknown to us," says Max Planck Director Matthias Scheffler, who heads the Center. "Many fascinating characteristics of even known materials remain hidden from us." The materials and their characteristics are "calculated," meaning they initially exist only in virtual form. The cornerstone of this work is a database in which scientists provide general access to their knowledge about basic physical parameters.



Encyclopedia of materials: The Center of Excellence will document the characteristics of unknown substances and the hitherto undiscovered properties of known compounds.

Photos: Wolfram Scheible (top), Christian Carbogno/Fritz Haber Institute (bottom)

"It created peer pressure"

Bjorn Stevens, Director at the Max Planck Institute for Meteorology, on the global climate summit in Paris

At the UN climate conference in mid-December 2015, the 194 Parties to the United Nations Framework Convention on Climate Change approved a follow-up agreement to the Kyoto Protocol. Bjorn Stevens, Director at the Max Planck Institute for Meteorology in Hamburg, assesses the agreement and explains the tasks facing research in this area in the future.

Professor Stevens, what made the global climate summit in Paris a success?
Bjorn Stevens: I believe there are several reasons for this. Not least is the fact that we've been trying to explain the causes of global warming for decades, and research has provided plausible explanations for climate change. Other special circumstances also coincided in Paris. Preparations for the negotiations had begun well in advance and were very thorough, and the chief negotiators were very good. Moreover, the approach involving the nations formulating voluntary contributions rather than having emission reduction targets imposed on them from outside was a success. It created peer pressure, which wouldn't have happened with a legislative framework. Finally, there was a very cooperative atmosphere in Paris after the devastating terrorist attacks in November.

Will this agreement put an end to climate change?
No, but I am very optimistic nevertheless. What I mean is that the agreement represents a crucial step because the world is taking resolute action to deal with a global problem of this magnitude for the first time. We're still not on the road to limiting climate warming to a particular temperature, but we have taken the necessary steps to embark on this path.

There were lengthy debates in Paris about whether the temperature rise should be limited to 2 or 1.5 degrees. Aren't the forecasts too uncertain to allow such precise targets?
Correct, the uncertainty factor associated with calculations for the volume of carbon dioxide that we can release into the atmosphere while ensuring that the global mean temperature doesn't exceed one of these limits is a factor of two. And the capacity to emit twice as much carbon dioxide is really a lot. So we must observe how the climate reacts to the measures and possibly adapt them. Given that the Earth adapts slowly to change and there is extensive natural variability, this is no trivial matter.

How will climate change, which will definitely happen, impact the planet at a regional level?
A lot of questions remain open here. The most important questions for Europe may be whether the winter storms will move north or south, whether they will become stronger or weaker, or whether they will continue to follow the same patterns for a longer period. The latter is likely what led to the recent floods in the UK. Unfortunately, we still don't understand enough about the factors on which regional changes in the climate depend.

Should future research be focused on clarifying this?
A lot of resources are currently being invested in producing forecasts for individual regions and calculations as to how a region responds when a certain volume of greenhouse gas is released into the atmosphere. However, when it comes to regional forecasts, we are living in a house of cards that can easily collapse. We are too reliant on the existing models for these kinds of calculations. We would like to believe that the models are viable, but we have little or no proof of this. So we need to take a realistic look at what we know and what we don't know. If we're honest, we must invest a lot more in basic research to obtain reliable regional forecasts.

What are the most important factors of uncertainty here?
Because this question touches on my own research, my view on this is somewhat biased. Nevertheless, I think most scientists would agree that we still don't understand the role of clouds sufficiently well. How do clouds influence the speed and extent of global warming? In addition, the question has recently arisen as to how clouds affect the regional climate and its changes. Another big question is where the carbon dioxide that was absorbed on land has gone to. And whether or not the land masses will retain their enormous appetite for carbon or whether, in the worst case scenario, the carbon that has been absorbed will be released again.

Bjorn Stevens

Will the basic researchers have completed their work when they answer these questions?
Certainly not. In my view, the value of basic research lies elsewhere: only basic research provides real surprises. Many people don't admit to themselves that the limits of their thinking are too narrow. When it comes to broadening our view of the world, there's nothing more powerful than basic research. And by the surprises we encounter through it, I don't mean that things turn out differently than we thought, but that things happen that we didn't expect at all. The greenhouse effect of carbon dioxide wasn't discovered because a politician said: "Take a look at what happens when we blow carbon dioxide into the atmosphere." This role was discovered because we wanted to understand the thermal budget of the atmosphere. People were also doing research on ozone in the atmosphere long before the hole in the ozone layer was discovered. The basis for understanding how it came about had already been established. And the ozone hole might never have been discovered if someone hadn't studied ozone in the atmosphere out of pure curiosity.

Interview: Aaron Lindner and Peter Hergersberg

Photo: David Ausserhofer for the MPI for Meteorology

A Window to the Radio Sky

Max Planck Society contributes to the MeerKAT telescope in South Africa

An ear into space: A MeerKAT radio antenna tunes into the African night sky.

It will be the biggest and most sensitive radio telescope in the southern hemisphere: in a matter of just a few years, 64 individual dish-shaped antennas with a diameter of 13.5 meters will tune into the atmosphere and examine distant X-ray bursts, pulsars, and interstellar clouds within the Milky Way with great precision. This gigantic "ear" known as the MeerKAT is being built around 90 kilometers outside the South African town of Carnarvon on the Northern Cape. There is very little terrestrial interference radiation there in the semi-desert Karoo region, which means that the system's sensitivity can be exploited to the full. One of the telescope's important receiver systems comes from the Max Planck Institute for Radio Astronomy in Bonn. The Max Planck Society is providing 11 million euros for the development and construction of the telescope.

"The MeerKAT project is a milestone in radio astronomy. The installation of this receiver system will give astronomers access to a world-class instrument," said Max Planck President Martin Stratmann at the signing of the cooperation agreement for the project. In addition to President Stratmann, the ceremony was also attended by the South African Minister for Science and Technology, Naledi Pandor.

New Impetus for Open Access

Berlin conference discusses the rededication of funds for academic journals

Open access – free access to articles published in scientific journals – is set to be advanced in a new way. The idea is for academic journals that were previously available on a subscription basis only to now be made freely accessible everywhere. To achieve this, research institutions should invest the money they currently spend on subscriptions in the publication process itself. This was the finding of an international conference that was held in Berlin and organized by the Max Planck Society. Studies carried out by the Max Planck Digital Library had shown that the conversion to open access can be achieved with existing financial resources.

To kick off the conversion process in practice, over 90 representatives of international research organizations in 19 countries came together in Berlin. In the follow-up to the conference, plans are being made to incorporate the outcome of the discussion into a declaration of intent that follows on from the "Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities" of 2004. Accordingly, scientific institutions and funding bodies throughout the world will be invited to sign the expression of interest and contribute to its implementation.

Greater openness: Max Planck Director Ulrich Pöschl (right) and Gerard Meijer, President of Radboud University, organized and chaired the 12th Berlin Conference.

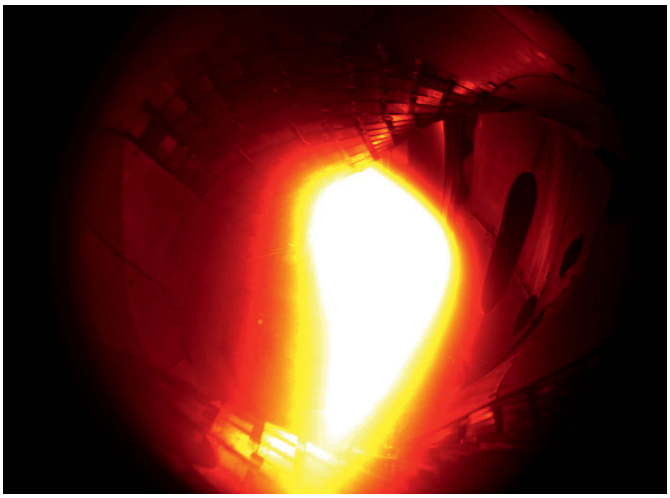
Photo montage: SKA South Africa (March 2014), Georg Botz (CC-BY-SA)

Greifswald Fusion Device Powered Up

A helium plasma was generated in the Wendelstein 7-X for the first time

The plasma researchers' patience and efforts have paid off. A good ten years after work began on the assembly of the Wendelstein 7-X fusion device at the Max Planck Institute for Plasma Research in Greifswald, physicists generated the first plasma in it in early December 2015. "We started with a plasma made from the noble gas helium because the plasma state is easier to reach with helium," explains Thomas Klinger, Director at the Max Planck Institute for Plasma Research and head of the Wendelstein 7-X project: "We won't switch to the actual research object, a hydrogen plasma, until 2016."

In the next stages of the research, the scientists aim to extend the duration of the plasma discharges and study how the helium plasmas can best be generated and heated up using microwaves. In doing this, the researchers are preparing the first experiments with hydrogen plasmas, which is ultimately intended to melt into helium in the fusion experiments. With the Wendelstein 7-X, the world's biggest stellarator-type fusion device, the scientists hope to prove that this model is suitable for use as a power plant.



Shining bright: The first plasma in the Wendelstein 7-X fusion device in Greifswald consisted of helium and reached a temperature of one million degrees Celsius.

Photo: MPI for Plasma Physics

On the Net

The Universe on Film
What do the chemical elements in our bodies have to do with the stars? What lies behind exoplanets? What are supernovas? An extraordinary film project provides answers to these fascinating questions from the field of astronomy. Scientists in Heidelberg have teamed up with colleagues from the University of Cambridge to produce seven five-minute films that explain recent discoveries about planets, stars and the Milky Way to a lay audience. Two animated films – "What are stars made of?" and "Why am I like a star?" – are particularly suitable for children of ages 6 to 12. All of the videos can be viewed online and are also available free of charge as a bilingual DVD (German/English).
www.mpia.de/entdecke-unser-universum

Oh, how lovely!
Fascinating! Moving! Thrilling! Who likes what, why and under what conditions? These are exactly the questions that scientists at the Max Planck Institute for Empirical Aesthetics in Frankfurt are seeking to answer. The newly established institute has three departments so far: one focusing on language and literature, another on music, and the third on neuroscience. The institute's website not only provides information about the research carried out there, it also gives interested readers an opportunity to participate in its research. Study participants are constantly being sought for ongoing research projects.
www.aesthetics.mpg.de/en.html

Europe-Wide Success
Each year, the European Research Council awards its Starting Grants to young scientists. Three women and seven men from Max Planck institutes were successful in the second round of applications for 2015. Each grant comes with funding of up to 1.5 million euros. The Max Planck Society was by far the most successful research organization in Germany, ahead of Ludwig-Maximilians-Universität München, which had five successful applicants, and institutes of the Helmholtz Association, with two. The French research organization Centre national de la recherche scientifique (CNRS), which had twelve successful applicants, was the only institution in all of Europe to be awarded more ERC Starting Grants than the MPG.
www.mpg.de/9809717/erc-starting-grants-2015