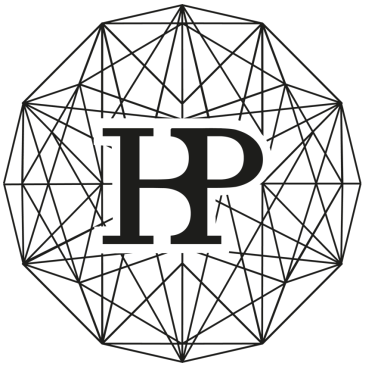

Human Brain Project
Education Programme

4th HBP School – Future Computing
Brain Science and Artificial Intelligence

12-18 June 2017, Obergurgl University Center, Austria

Speaker Abstract Collection
Alphabetical order according to presenting author

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List of Abstracts (in alphabetical order)

Robotics

Gordon Cheng
Technical University of Munich

No abstract provided.

Machine Learning I: Learning Predictive Models from Big and Complex Data

Sašo Džeroski
Jožef Stefan Institute

The most commonly addressed task in machine learning is the task of predictive modeling, where the value of a dependent variable needs to be predicted from the values of several independent variables. Typically, a predictive model is learnt from a set of training data in the form of a table, where rows correspond to objects of interest (examples) and columns correspond to variables used to describe them. Increasingly often, we need to learn models from big data, which may have many examples and many input/output dimensions, or may be streaming at very high rates. The data can also be complex and involve structured output values (of the dependent variable) or incompletely labelled data (with missing values of the dependent variable).

The talk will first give an introduction to the basic task of predictive modeling and some methods for solving this task. It will then cover different tasks encountered when learning from big and complex data. It will next present some methods for solving such tasks, focusing on structured-output prediction, semi-supervised learning (from incompletely annotated data), and learning from data streams. Some illustrative applications of these methods will also be described.

Machine Learning II: Automated Modeling of Dynamic Systems

Sašo Džeroski
Jožef Stefan Institute

Models are of key importance in science and engineering. They provide simplified representations of complex dynamics systems, whose state changes over time, and allow us to simulate and study their behaviour. Models are predominantly constructed manually, following the theoretical modeling paradigm, which is based on the knowledge of domain experts and is thus labour intensive and time-consuming. In contrast, empirical modeling, which is data-driven, can be efficient, but often fails to provide an understanding of the studied system.

We integrate the knowledge-driven and data-driven paradigms of modeling dynamic systems and present approaches that learn models by taking into account both observed data and domain knowledge. We introduce the paradigm of porcess-based modeling, which represents systems as collections of entities and processes (of interactions among entities). We describe some recent approaches to inductive process-based modeling and illustrate their use for learning models of biological systems.

Systems sciences study complex systems in nature and society, focusing on system dynamics, i.e., on how the state of a system changes with time. To this aim, they use models, which play a central role in the systems science tasks of analysis, identification, design, and control. A major bottleneck in systems sciences is the manual construction of models. The talk will present ambitious research plans (on which work has already started) to alleviate this bottleneck by developing novel approaches in artificial intelligence and machine learning that will support the four main tasks in systems science (analysis, control, identification and design). The methods will be applicable to many practical problems coming from different systems sciences, such as systems biology and medicine and synthetic biology.

Databases and cloud

Thomas Heinis
Imperial College London

Databases and data management are becoming ever more pervasive and part of our daily life (and research)! Solid understanding of data management approaches, tools and techniques in the Cloud accelerates research as it cuts down data analysis time considerably. In this presentation I will first briefly revisit fundamental database concepts and will then move on to talk about how data management technology has evolved into the Cloud in recent years in response to emerging web and scientific applications. After giving an overview over new noSQL approaches, I will finally discuss data management tools and approaches in the Cloud.

Neuro-computing and neuromorphic information processing systems

Giacomo Indiveri
ETH Zürich

Artificial computing systems are vastly outperformed by biological neural processing ones for many practical tasks that involve sensory perception and real-time interactions with the environment, especially when size and energy consumption are factored in. One of the reasons is that the architecture of nervous systems, in which billions of neurons communicate in parallel mainly via asynchronous action potentials, is very different from that of today's mainly serial and synchronous logic devices and systems.

Recent machine learning algorithms have taken inspiration from the nervous system to develop neuro-computing algorithms that are showing state-of-the-art performance in pattern recognition tasks. In parallel, different types of brain-inspired hardware architectures are being developed that reproduce some of the principles of computation used by the nervous system. These architectures represent a promising technology for both implementing the latest generation of neural networks, and for building faithful models of biological neural processing systems.

In this tutorial I will focus on three main topics: (1) I will give a historical perspective of the fields of neuro-computing and neuromorphic engineering; (2) I will present examples of spike-based neural network architectures that can be used to perform state-of-the-art pattern recognition; and (3) I will cover the design of large-scale networks of spiking neurons in VLSI technology, presenting a set of analog and digital electronic circuits that can be used to implement spiking neurons and spike-timing dependent plasticity learning synapses. I will show examples of VLSI neuromorphic information processing systems and present application examples that exploit their on-line learning properties.

High Performance Computing

Erwin Laure
KTH Royal Institute of Technology

In this lecture we give an overview of the use and challenges in High Performance Computing. We discuss recent changes in computing hardware and how these effect our ability to compute efficiently and present several approaches to program large scale supercomputers.

The era of cognitive computing

Karlheinz Meier
Heidelberg University

We are living in an era of transformation. Computers are no longer just tools to perform more precise and faster calculations, but rather store, distribute and interpret all knowledge humankind has ever collected. The omnipresence of data collecting devices produces information at a rate that excludes any human intervention at the source.

Cognitive computing offers the exciting capability to make sense of this information, connecting the dots, finding causal relations and make predictions about things to come.

Brain inspired technologies are already playing an important role in this development. Deep networks are very simple models of a brain architecture. It remains to be seen if more biological detail adds capabilities. In particular when it comes to learning this seems to be the case.

The lecture will focus on the question of how much biology is needed to advance cognitive computing. It will summarize ongoing research and future plans.

From tiny to giant eyes: The visual reality of animals

Dan-E. Nilsson
Lund University

Animal eyes range in size from fractions of a millimetre to as large as a basketball. They serve a multitude of different visual tasks, and they do it under extremely varying light conditions, from bright sunlight to starlight or the darkness of the deep sea. The visual reality that we experience is specifically human. Other animals live in different visual realities. Some see in the ultra violet, some see colour with more than three channels, and some see the plane of polarisation. Different species see different amounts of detail and contrast, and they do it with very different time resolution. The talk will take you on a guided tour through the animal kingdom and let you peep into the visual world of diverse animal species from simple to advanced.

Principles of brain computation

Mihai Petrovici
University of Bern

No abstract provided.