University of Twente, Enschede
Friday, 22 April 2022

Student session 'Big data and deep learning'

Program:

- Wilfred van der Wiel (UT & University of Münster) – Material learning
- Nicole Koenderink (WUR) - Digital twin of the tropical supply chain
- Panel discussion: panel consists of speakers and 2 students (Romaly Grijpma (UT) and Kevin Vonk (UT))
- Anna Machens (BDSI, UT) – How can we make AI more trustable?
- Claudio Persello (UT-ITC) - Deep Learning and Earth Observation in Support of the Sustainable Development Goals
- Panel discussion: panel consists of speakers and 2 students (Romaly Grijpma (UT) and Kevin Vonk (UT))

Moderator: Noah van Dijk (UT)

Abstracts:

Wilfred van der Wiel (UT, University of Münster): Material learning

The strong increase in digital computing power in combination with the availability of large amounts of data has led to a revolution in machine learning. Computers now exhibit superhuman performance in activities such as pattern recognition and board games. However, the implementation of machine learning in digital computers is intrinsically wasteful, with energy consumption becoming prohibitively high for many applications. For that reason, people have started looking at natural information processing systems, in particular the brain, that operate much more efficiently. Whereas the brain utilizes wet, soft tissue for information processing, one could in principle exploit any material and its physical properties to solve a problem. Here we give examples of how nanomaterial networks can be trained using the principle of *material learning* to take full advantage of the computational power of matter[1].

We have shown that a designless network of gold nanoparticles can be configured into Boolean logic gates using artificial evolution[2]. We further demonstrated that this principle is generic and can be transferred to other material systems. By exploiting the nonlinearity of a nanoscale network of boron dopants in silicon, we can significantly facilitate classification. Using a convolutional neural network approach, it becomes possible to use our device for handwritten digit recognition[3]. An alternative material learning is approach is followed by first mapping our Si:B network on a deep neural network model, which allows for applying standard machine learning techniques in finding functionality[4]. Finally,

we show that the widely applied machine learning technique of gradient descent can be directly applied *in materio*, opening up the pathway for autonomously learning hardware systems[5].

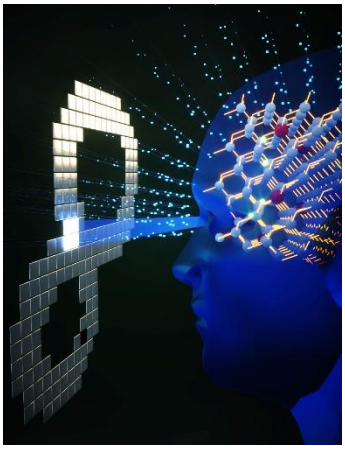

Figure 1: Artist's impression of digit recognition by a dopant network processing unit in silicon[3].

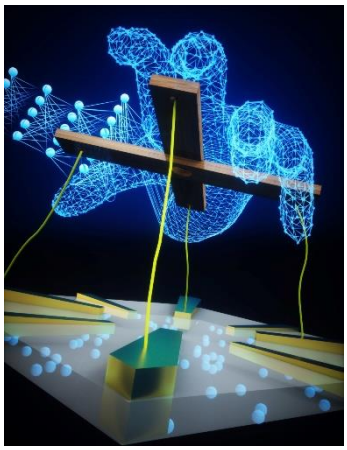

Figure 2: Artist's impression of training a dopant network processing unit by using a deep neural network[4].

References
[1] C. Kaspar *et al*. *Nature* **594**, 345 (2021)
[2] S.K. Bose *et al*. *Nature Nanotechnol.* **10**, 1048 (2015)
[3] T. Chen *et al*. *Nature* **577**, 341 (2020)
[4] H.-C. Ruiz Euler *et al*. *Nature Nanotechnol.* **15**, 992 (2020)
[5] M.N. Boon *et al*. arxiv.org/abs/2105.11233 (2021)

Nicole Koenderink (WUR): Digital twin of the tropical supply chain

Artificial intelligence is a technology that is nowadays broadly used in practice. In the agro food domain, the applications are abundant, ranging from livestock monitoring to precision agriculture, from decision support to automated handling of products. In this presentation, I will show the application of artificial intelligence in the integration with sensor fusion, big data analysis and physical modelling in forming a digital twin that helps in making optimal choices for tropical supply chains. The use of a digital twin in such a setting leads to better quality tropical fruits on the market and less food waste in the supply chain. Artificial intelligence is a key technology in making the digital twin work.

Anna Machens (BDSI, UT): How can we make AI more trustable?

AI is organizing a large part of our lives already and will do so increasingly in the future. From filtering information or translating text all the way to decision making and driving assistance, we heavily rely on machine learning algorithms. Nevertheless, in some cases these algorithms are failing our expectations. How can we guarantee that AI will have a positive influence on society? Following the guiding principles of Responsible AI, methods are shown to restore trust.

Claudio Persello (UT-ITC) - Deep Learning and Earth Observation in Support of the Sustainable Development Goals

The continuous developments in Earth observation technologies and the increasing availability of voluminous geospatial data go hand-in-hand with the demand for accurate and scalable information extraction methods. This demand is motivated by many applications and the growing awareness of the necessity to monitor the Earth's system for the multiple threats to our natural environment, climate, and the sustainable development of human societies. Deep learning has revolutionized the way we analyze, fuse, and extract information from data. It allows us to streamline the processing workflow and generate actionable information in an efficient and reproducible manner. Moreover, departing from universities and research laboratories, the combination of Earth observation and deep learning has the opportunity to contribute to some of the most pressing global societal challenges, such as those identified by the United Nations in the 2030 agenda for sustainable development. This talk will present an overview of research activities showing where Earth observation and deep learning can contribute to monitoring and achieving the Sustainable Development Goals (SDGs).

Big data and deep learning

Big data en deep learning worden steeds meer gebruikt bij onderzoek. Ook in de media worden de termen steeds vaker gebruikt. Toch is het voor veel mensen nog moeilijk om een beeld te vormen bij de begrippen en meer te leren over de technieken en applicaties achter big data en deep learning. Daarnaast is het voor velen nog onduidelijk wat de impact is van deze technieken op ons leven en de wereld om ons heen. Om hier inzicht in te krijgen en om in kaart te brengen waar de ontwikkelingen naartoe gaan, zullen enkele sprekers uit verschillende werkvelden hun ervaringen en inzichten delen tijdens deze studentensessie. Over deze ervaringen zal gediscussieerd worden binnen een panel, samengesteld uit studenten en experts.
Binnen verschillende onderzoeksgebieden worden big data en deep learning gebruikt. Wat zijn hot topics binnen huidige onderzoekslijnen? Wat zijn de meest gebruikte technieken? Wat zijn beperkingen en uitdagingen bij het gebruik van big data? Diverse sprekers zullen vanuit hun expertise het onderwerp toelichten.
Over de maatschappij gesproken: wat is de impact van big data en deep learning op de samenleving? Op welke vlakken binnen de samenleving spelen ze een belangrijke rol? Hoe worden deze nieuwe technieken toegepast in sociaal onderzoek? Welke rol heeft privacy met betrekking tot het gebruik van big data? Tegen welke problemen zijn we de afgelopen tijd aangelopen en welke kunnen we verwachten? Deze vragen zullen worden bediscussieerd met het panel en het publiek, om zo de uitdagingen van big data en deep learning voor de maatschappij op te zoeken.

Deze sessie wordt georganiseerd door vier studenten technische natuurkunde aan de Universiteit Twente. Eén daarvan is Noah van Dijk: hij zal de sessie modereren.

Noah van Dijk volgt aan de Universiteit Twente een bachelor Technische Natuurkunde. Daarnaast is hij voorzitter van Studievereniging Arago, de studievereniging voor technische natuurkunde aan de Universiteit Twente