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Benelux AI Newsletter

The [29th Benelux Conference on Artificial Intelligence](#) takes places on 8-9 November in Groningen, The Netherlands. [Early registration](#) ends on 27 October.

Recommendation: O'Reilly's Artificial Intelligence Newsletter

I work for an industry that is researching and applying a wide variety of AI techniques in smart technology that focuses on improving people's health and enabling better outcomes across the health continuum. For this we keep a close eye on the latest developments in AI-software and hardware, but also on other big industries to see the directions they are heading into, especially within healthcare.

One great source of information is the Artificial Intelligence Newsletter of O'Reilly. "Receive weekly AI news, insights from industry insiders, and exclusive deals and offers." The latter can be a little annoying sometimes (twice a year they organize an AI conference and you get appropriately spammed for that), but the rest of the information is very interesting. The newsletter consists on average of 10 headings with click-through articles, see as example the latest newsletter [here](#) with an excerpt below. Interested to receive future editions? You can subscribe [here](#).

O'REILLY

Artificial Intelligence

Newsletter

11 September 2017

Janna Eggers explains **how to turn abstract AI into real business solutions.**

This video explains **how to use IBM Watson's APIs and natural language understanding to analyze the tone of social media posts like tweets.**

The *Atlantic* takes **an in-depth look at how Waymo is training self-driving cars.**

"Three-quarters of executives believe AI will enable their companies to move into new businesses. Almost 85% believe AI will allow their companies to obtain or sustain a competitive advantage. But only about one in five companies has incorporated AI in *some* offerings or processes." MIT Sloan presents **findings from the 2017 Artificial Intelligence Global Executive Study and Research Project.**

"If you want to **make yourself competitive and break into AI**, not only do you have to understand the fundamentals of ML and statistics, but you must push yourself to restructure your ML workflow and leverage best software engineering practices."

How to generate new images and fix old ones using neural networks.

Are you debating a build-in-house route (using open-source toolkits like Kaffe, Theano, and Tensorflow), the artificial intelligence as-a-service (AlaaS) approach, or something in between? **Here's what to consider.**

Agriculture is being digitized and farm data is growing. **What can AI do to help feed a growing population** with shrinking resources and cultivated acreage?

Here are **four trends in deep learning** from the Association for Computational Linguistics.

Reid Hoffman talks to Trevor Noah about AI.

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Interview: Luc Steels



What is your academic background and how were you drawn into the field of Artificial Intelligence?

I started actually studying languages and literature, without any awareness of computation at all: first at UFSIA in Antwerp and afterwards I was one of the first generation of UIA students, also in Antwerp. When I started there was no computer in sight. You have to imagine the distance between language studies and computers at that time. Yet, there was a course in linguistics about language processing by Jacques Noël from Liège and he was very well informed. He talked about processing and information retrieval, but he also gave a few courses on what was happening in Computational Linguistics and AI. He lectured about [Terry Winograd](#) for example, about what was going on at MIT or Stanford.

These lectures motivated me to participate in a summer school in computational linguistics in Pisa in 1972, organized by [Antonio Zampolli](#), a big man in language processing in Italy who died a few years ago. Being there was incredible because many important people like Terry Winograd, Bill Woods, [Roger Schank](#), Charles Fillmore, and [Martin Kay](#) were there. I mean, all these people who had built these amazing systems like [SHRDLU](#), were presenting at that meeting. This was an incredible world that opened for me and I had the unique opportunity to make contact with them, entering an exciting new field. That was how I got into it and then did my thesis in this area. After my PhD, I somehow managed to get into MIT. As a result, I found myself in 1977 in the

office of [Marvin Minsky](#) as a new student at the AI lab of MIT, starting a new adventure.

How do you look back on the evolution of AI research in Belgium?

When I was at MIT, there was nothing going on in Belgium. Whereas at the MIT Allab and with [Seymour Papert](#) and Minsky as my advisors I got catapulted in the middle of the action ([Patrick Winston](#), Gerry Sussman, David Marr and many other important AI researchers were also at MIT at that time). There was also an interesting connection with Stanford, since [John McCarthy](#) was very good friends with Minsky. AI, as a field, was still very young and there were maybe five labs in the US performing research in that field. While at MIT, I was also one of the first users of the [LISP machine](#). After MIT I went to work in a company, [Schlumberger](#), who was one of the first to start applying AI, more specifically expert systems. Through this experience, I got to know people like [Edward Feigenbaum](#) and many other key people from Stanford, who were collaborating on our Dipmeter Advisor project: We built one of the first industrial expert systems for the interpretation of logging data from oil exploration. I experienced thus both the world of the LISP machine at MIT and the world of expert systems, of which the initial ideas were coming out of Stanford.

After a short stay in Paris learning more about technology transfer, I came back to Belgium in 1982, to start the AI lab. But in Belgium the landscape was pretty empty. I remember that I was proudly shown the Cyber CDC computer where you could log in remotely so that you no longer had to use punched cards, whereas I was already used to desktop computers with windows, a mouse interface, local area network, laser printers, etc. MIT and other AI labs were totally ahead of what was available in Belgium. So, when I came here, I imported all this technology: we had the first local area network, the first LISP machines (in Belgium and even on the continent), the first laser printer from AGFA Gevaert and so on. I tried to equip the lab with the most advanced technologies and we used them to develop our first AI projects. 1982 and '83 were also the years that the European framework programs started. With my contacts, we submitted an AI proposal, which was also accepted. A lot of money appeared suddenly in Brussels and the university didn't know how to handle this.

After the start of the AI lab in 1982, I also founded the Belgian AI association. We had our first meeting in September of that year at the Vrije Universiteit Brussel. I actually recently found back the poster of that event. There was a group working on LISP in Liège and there was some interest in UCL on logic programming as well as in Leuven with [Maurice Bruynooghe](#). Computer science as a department was nonexistent. Here and there, there was somebody in a mathematics department or in engineering but

time, I had to admit it was only a few hundred, yet in hindsight ... So, it was always a struggle to convince people. Afterwards they then tell you, “why didn’t you tell us?”, but we actually did. And now this is happening again with this new interest in AI. This wave of statistical processing of data, everybody talks about it. We have good people in Belgium doing this, but not the critical mass to make the difference. So now the industry is coming again with a wish list of things they want: “Can you do this project, can you do that, ...”. But we don’t have the human resources as there was no support a decade ago to grow these resources. This should clearly change.

Looking at your career in AI, you have done so many different projects. Was there ever a topic you could not investigate due to lack of time, people etc. Does anything stand out?

At the moment, this research in language evolution is, let’s say, a little bit on the back burner because we don’t have the money. We had it for a while as you know, but then we moved it to grammar and it became impossible to get money for it. Even the AI people would say, “why do you need this?”. It’s very technical and when you use the word grammar they are afraid because they remember primary school. The linguists, they are not interested because people like Chomsky believe that language doesn’t evolve, so that’s the end of that. We are doing, I think, important work in grammar, very technical work with a few excellent people here, but it is a small community. Nevertheless, it may have a big impact in the future.

But my personal interest is in something bizarre that is happening, which is that AI is now in the collective imagination, appearing as a kind of wonder, you know, a magical thing. You have technical projects wherein they talk about immortality and about brain-computer interfaces, about mind uploading, agents that are replica’s of yourself. I’m interested in the cultural impact of AI on the collective beliefs, how people are trying to make sense of themselves, the difference between mind and body, the future of humanity. What you see is that all the things we work with, like agents, the cloud and so on, get interpreted in terms of concepts that are actually religious concepts, or used to be religious concepts. For instance, the after-life: an agent is like an angel, and then of course the concept of the devil emerges also. I find this cultural impact very fascinating. There is actually at the moment the opening of the [Ars Electronica](#) festival in Linz, which is the biggest festival in the world about technology and art, and the theme this year is AI. There is a talk on AI and spirituality, the keynote lecture given by a Buddhist monk, which is quite amazing. I’m studying this phenomenon but in order to play a role, although you could write papers but nobody will read them, I wrote instead an [opera](#).

There is currently a huge interest of companies in AI, which they mostly equate to data science and deep learning. What is your perspective on this “hype”?

In principle, I think it is great! But we have to manage it somehow. I think there are two roads to AI, the knowledge-based road, which in the past has been dominating AI research, and then the data-based one. In the knowledge-based approach, you try to get grips on the knowledge of humans and then you use that to build a system. In the beginning, it was by analysis, talking to the human expert and also by machine learning. But at that time, it was symbolic machine learning, like inductive logic programming. The other perspective is that of data science, which consists actually in many cases of statistical approaches, sometimes with neural networks, and particularly deep learning. But it is essentially statistical analysis of data.

The great thing about AI is that it is a very dynamic, open and creative field. You always have other sciences that at some point feed into it. In the beginning, this was Logic. This direct line from the great logicians, the logical empiricists like [Reichenbach](#) or [Russel](#), to [McCarthy](#), who was a student of Reichenbach, provided an infusion from the logic side. Afterwards there was an infusion from computer science followed by an infusion from biology with genetic algorithms and things like that. Currently we see a similar infusion from statistics and complex systems science. AI is a field that is able, it is open enough, to have this inflow which is turning things upside down. This is great, it is a very good feature because you have many fields, like for instance linguistics, where the field is like a fortress: new ideas don't get in. They create schools of thought, which are tightly controlled, which is bad. So, I think these new waves are all very good but people have to realize that a lot of the machinery behind the semantic web for example is grounded in knowledge-based AI, see the work of [Frank van Harmelen](#) and colleagues in Amsterdam for instance. If you do data-driven AI, this is all very good, but there are very strong limitations to it, just as there are limitations to knowledge-based AI, such as the effort needed to do knowledge analysis.

Problems for the data driven approaches are things like explanation and robustness, in the sense that by minimal changes to the input the system will tell you there is an elephant in the picture whereas before it was identified as a flower. Also, the fact that it is produced by statistics makes it limited by definition because it takes the past and then makes a prediction only based on that. This does not work for human language for instance as it is an open system. You can easily invent new language on the spot. I mean new words reusing grammatical constructions in another way. That is also why the infusion in AI from Biology is so important: Biology is also an open system. Innovation happens in living systems, sometimes very quickly. We understand a bit of it

but not everything. To me all these ideas of how life, species and structures have emerged are essential to understand, as they provide insights to really go to the next phase in AI.

Also, the merging of the data-driven and knowledge-driven approaches is essential to getting explanations. We will need knowledge-based AI and language, contextual representations and all that stuff to produce an explanation why a system has drawn that conclusion. This is extremely important as people want to know why the system has made that decision about them: do they need to stay in prison or not, can they get a loan or not, all these things. The system should not just provide numbers or list the neurons that fired in a totally non-transparent network.

In Europe, there is a regulation coming up. A directive, which will be obligatory from 2018, that any system that makes a decision that affects a person has to provide explanations and is accountable. When you don't agree with a decision made by an insurance system for instance and the response is that it is because the AI system decided this, then there is a basis in Law to challenge that company. It is particularly relevant in the social domain if systems start to decide whether you can have access to social housing, all these kinds of things are happening. Also in Law, there was an article in De Morgen yesterday on legal expert systems. In the past the knowledge was coming from experts and now this is replaced by inference from data. This is a black box. There is going to be a big clash. Solving this problem of making explainable AI is one of the key topics that we should work on. It is not obvious how this should be done.

As you already mentioned, AI is an open and creative endeavor. In your [2007 article on the future of AI](#) you argued that it is the design aspect, building a system to understand it that makes AI unique. Is this still the case?

This is really a very important point. I think the importance of AI has been to take ideas from psychology, from linguistics, from philosophy, statistics, sociology, biology, physics, etc. and to turn that into operational systems. At the moment, biologists also believe that this is a good thing, and they are developing so called synthetic biology. They understand that if you build something then you understand it better. In Physics, I think Feynman once said "What I cannot create, I do not understand". In linguistics, this idea is far from accepted: "Why would we implement our grammar?". This idea, namely that you validate and work-out your ideas through programming, i.e. building models, is in the humanities still considered a weird idea. In most areas of psychology, they don't do this either. That is for me the importance and the role of AI with respect to understanding the mind. You get new ideas when you do that, you are creative using

local projects are too small. These European projects have their own dynamic, which is bad actually: there are review meetings and network meetings, with their summer schools inside the networks, and so on. All these things require our attention. Before this was more open and now these things are closed, which is a pity. So, it is not out of lack of interest but just because there are so many things happening. The second thing is that I believe that BNAIC is extremely important for the younger generation. I always encourage the younger generation to participate and establish their network also in a local context. The people that go are quite happy with the level of attention they get for their work. I'm not at all pessimistic, on the contrary. I think the BNAIC is a very important conference. Maybe we just should go more often ourselves. I have been invited speaker before, and will be again this year. The previous time was in Delft, I gave a talk about the ten big ideas of AI. It was very exciting as I got lost and did not find the location of the auditorium. I arrived only when they were already announcing me on stage! I was a bit stressed out.

But, you see there are conferences like IJCAI, ECAI, AAI, etc. We also organized last year one of the Stanford AAI Symposia in Palo Alto about our work in grammar. I guess people work more at an international level but in my opinion BNAIC remains important.

Any advice for the BNVKI board ?

In Belgium, there are not many groups in AI, this is something that I hope, with this new wave of attention for AI, will change. This is also why I have organized recently a debate at the Academy of Sciences and Arts in Brussels. In my opinion, we need a new big action for AI in Flanders. It doesn't have to be as big as IMEC (an institute in micro-electronics with steady structural funding) but something like it. Not with a few PhD students here and there. That is not going to do it. In the Netherlands, the situation is better because they have good educational programs specific for AI, they have a number of good institutes, so things are much better. If you look at the universities in Belgium, in relation to the importance that AI now has, economically, something should be done. Integrating AI techniques within other different disciplines is excellent but is not the same as educating for AI research. You need people who take AI as their problem and not image processing or some problem in economics. In my experience, it takes 5 years for somebody who has done computer science to really understand AI.

What advice would you give to a student interested in AI in terms of roads to explore or pitfalls to avoid?

I would say that a very solid introduction to computer science is essential. Not just a bit of programming in Java or some other language. You should have the ability to write an interpreter to design your own new programming language. You should know how to deal with parallel architectures, know what is going on in web technologies, etc. You need the mindset of a computer scientist in the first place. You can then bring in an additional field, for example linguistics or psychology or neuroscience, but just as well physics or sociology. My experience is that for a computer scientist to learn about grammar is easy. But for someone coming from linguistics to learn computer science, that is very difficult.

Any final comments?

I would like to say the following: I started out in AI in 1972. My first conference was the AISB in Edinburgh, where I had a paper on case grammar. It was very small and [Maggie Boden](#) came to talk to me afterwards, encouraging my work. I'm still doing AI now. For me AI has been and still is one of the most, and maybe the most, interesting creative and dynamic field of science over the past 50 years. It has never been boring. When you assume that you have reached a steady state, something new and exciting pops up and blows your mind, like now with deep learning and other topics. But there will be other things coming afterwards. I'm sure absorption of ideas from biology is the next big thing. I cannot predict when this will happen but at some point AI systems will become so complex that they cannot learn anymore from humans and it will not be possible to engineer them. We will have to switch then to self-developing systems that interact in sound ecosystems that are constantly evolving, not only at the material level of embodied AI but also the mental and cultural level. AI is going to be an incredibly exciting field for a long time to come. We need the brightest people in order to make breakthroughs

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The VIPER project: Visual Person Detection Made Reliable



The VIPER project was a two-year Technology Transfer project, sponsored by [Flanders Innovation & Entrepreneurship](#), and conducted by the research group [EAVISE](#) of KU Leuven, Campus De Nayer, in collaboration with a consortium of a dozen different companies. The goal of this project was to study reliable methods of detecting people in camera footage for security and safety-critical applications. In particular, we looked at the use of infrared cameras as a way of building more reliable systems, and we examined AI techniques for detecting abnormal behaviour in the observed subjects.

Together with the participating companies, we examined several concrete case studies with industrial relevance. Examples include a system for warning operators of heavy machinery of the presence of people near the machine, and a system for suicide-prevention on a railroad platform.



This resulted in experimental results, open-source code and a number of scientific publications, such as:

[Van Beeck, K., Van Engeland, K., Vennekens, J., Goedemé, T. \(2017\). Abnormal Behavior Detection in LWIR Surveillance of Railway Platforms. *Proceedings of the 14th IEEE International Conference on Advanced Video and Signal based Surveillance \(AVSS\)* \(accepted\). The IEEE International Conference on Advanced Video and Signal based Surveillance \(AVSS\). Lecce, Italy, 29 August - 1 September 2017, 2017.](#)

On November 9th, a broad symposium will be held to conclude this project. Here, the results of the project will be presented and participants will get the opportunity to meet the participating research groups and industrial partners. You are very welcome to join us at Campus De Nayer (Sint-Katelijne-Waver, Belgium) for this event! More information about both the project and the symposium can be found [on the project website](#).

(Would you like to have your own project reports or event invitations included in the BNVKI newsletter? Email editor@bnvki.org!)

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What's Hot: Machine Learning for the Quantified Self

Abstract

Nowadays, an ever increasing number of sensors surround us that collect information about our behavior and activities. Devices that embed these sensors include smartphones, smartwatches, and other types of personal devices we wear or carry with us. Machine learning techniques are an obvious choice to identifying useful patterns from this rich source of data. Here, we briefly describe the challenges that occur when processing this type of data and discuss what might be promising avenues for future work. This paper draws inspiration from a book we have recently written that will be published by Springer shortly .

1 Introduction

Have you ever thought about the huge amount of sensor data your smartphone generates about you? A typical smartphone includes sensors such as an accelerometer, a magnetometer, a gyroscope, a GPS tracker, and a light sensor. It registers the apps you are using, the phone calls you are making, and can be used to ask questions about your current mindset. And this is only the smartphone, we can name a multitude of other devices that collect data from sensors that surround us. An illustrative dataset is shown in Figure 1, taken from CrowdSignals.

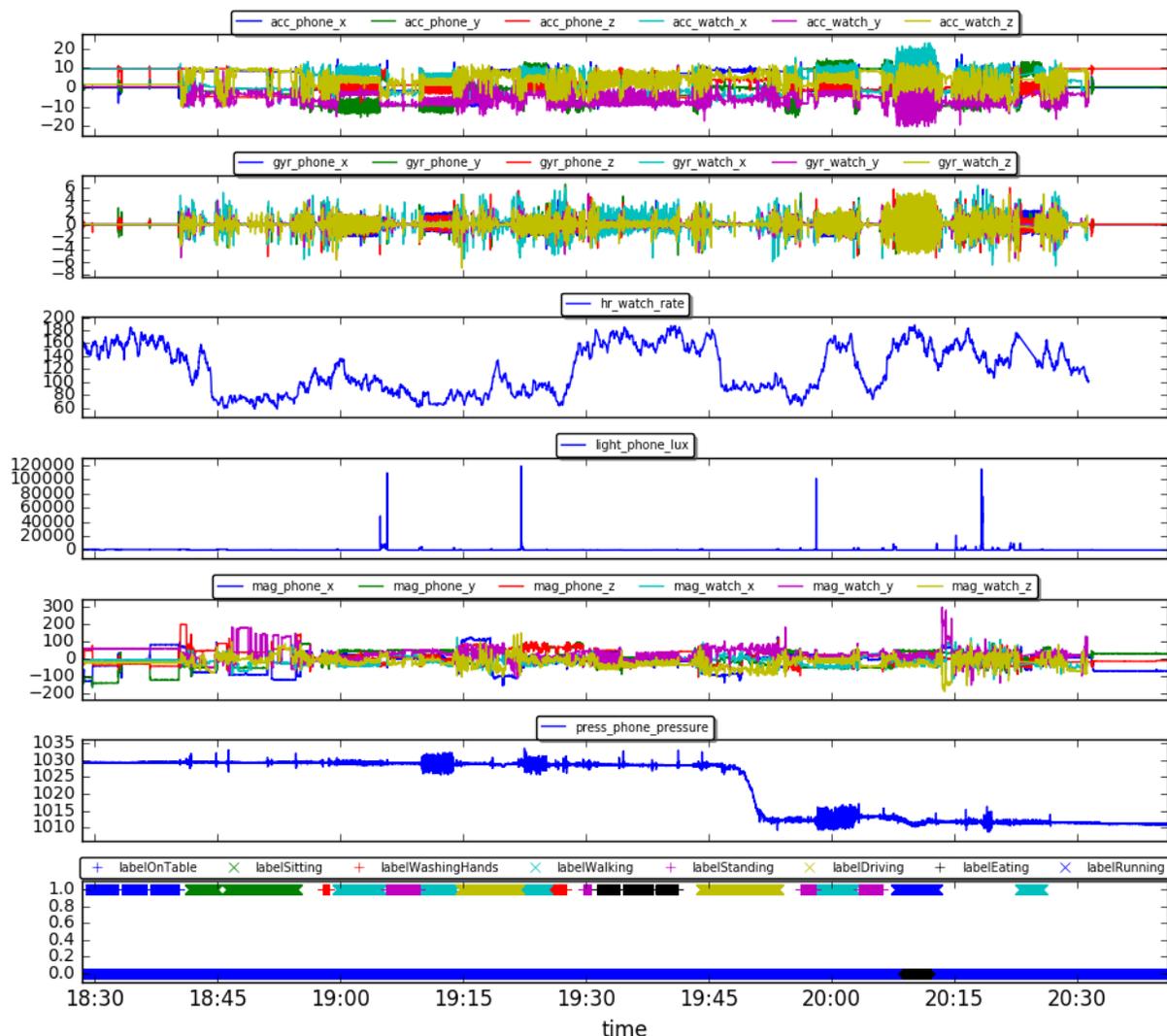


Figure 1: Example quantified self dataset with a variety of sensors and labels on the activity provided by the user

With such sensor information we can gain insight into ourselves, or others can use this information. For the latter, think of a physician or an app that is trying to drive us towards healthier behavior. The *quantified self* is a term used to describe this phenomenon. The term was first coined by Gary Wolf and Kevin Kelly in Wired Magazine in 2007. Melanie Swam defines the quantified self as (cf.): "The quantified self is any individual engaged in the self-tracking of any kind of biological, physical, behavioral, or environmental information. There is a proactive stance toward obtaining information and acting on it". To act upon the collected information is far from trivial. The huge amount of data that originates from different sources and the large variation in reliability makes it very difficult to identify the crucial information. Various machine learning techniques can help to pre-process the data, generate models that infer the current state of a user (e.g. the type of activity), and predict future developments (how will the health state evolve). Ultimately, these models enable personalization of

software applications by learning the way in which to optimally intervene on an individual user level.

In this brief article, we will explain how the quantified self data is different from other types of data when considering it from a machine learning perspective and discuss the state-of-the-art as well as prominent research challenges.

2 What makes the quantified self different?

While it may seem as just another typical machine learning problem, the quantified self data has a unique combination of characteristics:

1. sensory data is extremely noisy and many measurements are missing
2. measurements are performed at different sampling rates
3. the data has a highly temporal nature and various sources have to be synchronized
4. there are multiple datasets (one per user) which can vary in size considerably

In order to make this data accessible for machine learning approaches, these characteristics often require substantial efforts in data pre-processing. Furthermore, due to the multi-user setting learning has to account for heterogeneity and at the same time enable learning across users quickly.

3 What is the current state of the art?

Activity recognition is definitely the prime example when it comes to machine learning on quantified self data. Ample examples have been reported (e.g. ,), and lots of datasets have been made available to benchmark new approaches. Most emphasis has gone into the identification of useful features based on sequences of measurements, including features from the time-and frequency domain. In the time domain, features summarize the measured values over a certain historical window while in the frequency domain one tries to distill features on the assumption that certain sensory values contain some periodicity (e.g. walking results in periodic accelerometer measurements at a frequency around 1Hz). Reported accuracies are as high as 98% (cf.).

Recently, also some work (see e.g.) is seen in machine learning that tailor interventions using reinforcement learning: how can we support the user better towards his/her goals? Here, learning quickly from only a few data points is also key to avoid the disengagement of the user.

4 What are the research challenges?

There are still many opportunities for research, here are a few we consider to be of importance:

1. *personalize applications*: often, the current research focus is on prediction that are rarely used to inform decisions. In future, the focus should shift towards learning how to best support the user based on the data we collect and the feedback we obtain from the user. We should do this safely (i.e. not provide harmful suggestions) and efficiently (with limited experiences needed per user).

2. *handle heterogeneity*: we should be able to learn across different devices with different capabilities and sensors and also learn over different users. Additionally, if users carry multiple devices at the same time, they should act in a symphony, e.g. providing a message on a smart watch rather than on a phone when a person is in a meeting.

3. *more effective predictive modeling*: currently a lot of effort is spent on identifying useful features, effort should focus on deriving the most informative ones automatically (e.g. using deep learning). In addition, embedding of domain knowledge to avoid learning known information, exploiting the temporal patterns better, and also being able to explain the resulting models are key to bring the domain further.

4. *do validation*: while there are lots of apps that exploit the data from the quantified self, very few are evidence-based (cf.). The effectiveness of apps should be studied better, possibly using more modern forms of evaluation such as A/B testing rather than the classical randomized controlled trials.

5 Conclusions

The area of Machine Learning for the Quantified Self is a challenging and exciting area within Artificial Intelligence. It comes with its own unique characteristics, resulting in lots of open issues that still need to be addressed. Of course, these developments will also come from closely related fields and cooperation will be mutually beneficial. An example is the area of predictive models using Electronic Medical Records, which exhibit strong similarities in terms of the type of data and the goals.

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Event report: Benelearn 2017

Under a beautiful Dutch Summer sun, the 26th annual machine learning conference of the Benelux (Benelearn 2017) was held in Eindhoven, the Netherlands, on June 9 and 10. As always with Benelearn, the focal point was on the machine learning, data mining, and AI community of universities and research institutes located in Benelux member states. However, because of Eindhoven's favorable location in terms of connectivity (the conference venue being close to both Eindhoven Airport and the vast catchment area of the Ruhrgebiet), the organizers also explicitly invited international contributions. This has led to a substantial expansion of Benelux territory: author affiliations of accepted papers encompassed thirteen countries on three continents.

A total of 98 participants gathered for keynotes by Toon Calders (Data mining, social networks and ethical implications), Jean-Charles Delvenne (Dynamics and mining on large networks), Holger Hoos (The transformative impact of automated algorithm design: ML, AutoML and beyond), and Max Welling (Generalizing Convolutions for Deep Learning). In addition to the standard conference track, this year's Benelearn edition had three special tracks: one on Complex Networks, one on Deep Learning, and the Industry track. The affinity of the conference host city for industry was additionally highlighted by the conference dinner, which was held among the exhibits in the DAF Museum.

The 27 papers presented in talks during regular sessions were augmented by 21 papers presented in the closing poster session. Particularly noteworthy were the two winners of the Benelearn 2017 Distinguished Paper Awards: the one was bestowed on "Towards Optimizing the Public Library: Indoor Localization in Semi-Open Spaces and Beyond" by Martijn van Otterlo and Martin Warnaar, and the other on "Identifying writing tasks using sequences of keystrokes" by Rianne Conijn and Menno van Zaanen. Congratulations to these authors!

If you want to read more about Benelearn 2017, feel free to visit our website at <http://wwwis.win.tue.nl/~benelearn2017/>. The conference proceedings can be found at <http://wwwis.win.tue.nl/~benelearn2017/proceedings.pdf>.

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multiple impacts on this node. The approach covers specific types of (recurrent) neural networks and social networks, but it is more generic; it also covers, for example, probabilistic and possibilistic approaches in which product or max- and min-based combination functions are used. By choosing suitable combination functions, every process that can be modelled as a smooth state-determined system by first-order differential equations, also can be modelled by the presented temporal-causal network format. Adaptive networks are covered by connection weights of the network that change over time, which, for example, can be used to model Hebbian learning in adaptive networks of mental states, or network change in social networks.

The temporal-causal network modelling format used makes it easy to take into account theories and findings about complex brain processes and social processes known from Cognitive, Affective and Social Neuroscience and Cognitive and Social Sciences, which, for example, often involve dynamics based on interrelating cycles, which themselves can also change over time. The approach enables to address, for example, complex phenomena such as the integration of emotions within all kinds of mental and social processes, of internal simulation and mirroring of mental processes of others, and of evolving social interactions. Many of such examples are illustrated in different chapters of the book.

Usually dynamic properties of dynamic models can be analysed by conducting simulation experiments. But sometimes properties can also be found or verified by calculations in a mathematical manner, without performing simulations. Mathematical techniques addressing this are also discussed. Such types of properties found in an analytic mathematical manner can be used for verification of the model by checking them for the values observed in simulation experiments. The properties analysed by the methods discussed cover stationary points and equilibria, increasing or decreasing trends, and recurring patterns: limit cycles.

The book forms the basis of a multidisciplinary course and has been written with such a multidisciplinary audience in mind without assuming much prior knowledge. In principle, the detailed explanations in the book allow it to be used as an introduction in Network-Oriented Modelling for multidisciplinary Master and Ph.D. students. In particular this implies that, although some more technical mathematical and formal logical aspects have also been addressed, they have been kept to the minimum, and are presented in a concise manner in a separate part that can be skipped if not needed.

Jan Treur, *Network-Oriented Modeling: Addressing Complexity of Cognitive, Affective and Social Interactions*. Springer Publishers, Series in Complex Systems, 2016, pp.

499. Download: <https://link.springer.com/book/10.1007/978-3-319-45213-5>

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