A Conversation with Ella Peltonen: Why theoretical machine learning and distributed systems researchers should find a common language

INNOVATION LEADERS

by Bushra Anjum

Editor's Introduction

In this interview, Ubiquity's senior editor Dr. Bushra Anjum chats with Dr. Ella Peltonen, a research scientist with the Center for Ubiquitous Computing, University of Oulu, Finland, about the traditional divide between theoretical machine learning and the more applied fields of distributed systems. They then discuss the need for environments and opportunities where researchers from both theory and application areas can discuss, share their latest findings, and understand each other.

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Dr. Ella Peltonen is a research scientist with the Center for Ubiquitous Computing, University of Oulu, Finland. She gained her Ph.D. at the University of Helsinki and did her postdoc period at the Insight Centre for Data Analytics, University College Cork, Ireland. Dr. Peltonen has undertaken several research visits, including the University of California, Berkeley, US, University of Cambridge, UK, University College London, UK, and University of Melbourne, Australia. Her research focuses on pervasive everyday sensing, edge-native machine learning, and “from data to actions,” including ubiquitous recommendation systems and data analytics. She has been granted Marc Weiser Best Paper Award 2015, Rising Stars in Networking and Communications 2017, The European Initiative EPIC Grant 2018, and Nokia Foundation Jorma Ollila Grant 2018. Ella is a member of the ACM Future of Computing Academy and can be reached via ellaDOTpeltonenATouluDOTfi, and Twitter @Ella_Peltonen.

What is your big concern about the future of computing to which you are dedicating yourself?

I started by studying both theoretical machine learning and more applied fields of distributed systems and found my community and place in ubiquitous computing. My research focuses on both novel theoretical algorithms and real-life sensing systems. Being “in-between” theory and application has shown me how difficulties some of these discussions become. I witness theoretical computer science rapidly moving in the direction of optimizing algorithms that are not really implemented into practice. I also see system research evading “too mathematical” approaches by sticking in the same Python libraries they have always used. The situation can be summarized as follows: People working with novel applied algorithms assume there is unlimited performance, and computational power, coming somewhere from within the system; whereas system theory people think algorithms come as simple libraries they can take into use anytime. The hard truth is, there are no such libraries and no unlimited sources of optimization for anyone! There has to be collaboration and research that takes both perspectives into account.

Theoretical machine learning and artificial intelligence fields have gained popularity and success and are also utilized in ubiquitous computing. However, questions of real-world applicability, performance, and energy costs of running data-intensive neural networks, and many of the data-related privacy and ethical issues, remain unanswered. From my point of view, the most important questions are whether these algorithms really work well in the real world with real data that can be untrustworthy, messy, and come into the system faster than ever assumed when the algorithms were first demonstrated. With real-time sensing systems providing actual context-aware recommendations and decision support, it is crucial that the algorithms operate accurately, reliably, and fast. To make this possible, novel theoretical solutions in online learning and recommendation systems are needed.

When were you first exposed to the dichotomy between theoretical and applied research?

I focused on machine learning and applied mathematics during my undergraduate studies. However, the first theoretical conference was a shock. I was surprised to see professional researchers presenting slides full of math that were impossible to understand without spending hours with the original papers! No one really asked questions, neither there were any corridor chats. I agree this might have been just my personal experience and not presenting the whole picture of the theoretical community. However, it was one of my main reasons I switched to doing my Ph.D. in sensing and distributed systems. Later I found my place in the ubiquitous and pervasive computing community. However, looking back at the experience, we need more people who care about both aspects: people who want theoretical papers to be understandable for practitioners and applied researchers interested in theory. We need more interaction, time to explain, and desire to combine theory and practical implementations.

During my Ph.D., I focused on modeling multidimensional and massive-scale data in smartphone sensing. Nowadays, I am working with applications in urban computing, vehicular computing, and smart traffic. I like to build and work in multidisciplinary teams. My students have various backgrounds in HCI, data analytics, mobile programming, edge computing, etc. I see the best results come from teams where people have different backgrounds and skills sharing their own experiences for the common benefit. And my main message for anyone in the field: Present your results so that anyone can understand. Math is cool, no two opinions on that. At the same time, coolness cannot override understandability.

What project are you currently leading that bring together researchers and practitioners from diverse disciplines together?

I am currently working with an initiative to build driving-assistance applications for people driving long distances in rural environments. We aim to study the driver's cognitive load and responses to the long-term performance by utilizing wearable and internal sensors, and vehicle's movements. We further involve weather information, road condition, and other

available sources to provide real-time recommendations about route choices, service stations, and even possible animals on the road. The work involves specialists in medical and physiological fields, rural computing involving edge technologies, real-time sensing, and effective machine learning and recommendation algorithms.

Another current research project focuses on the intelligent edge and Internet of Things, with my main focus on something I call sensing-human interaction. There, various expertise on sensing systems and technologies, HCI, and novel machine learning algorithms come fluently together.

I am actively looking for collaboration with researchers interested in bringing together theoretical and practical perspectives of real-time systems for real-world problems, whether their background is in sensing, AI/ML, or HCI. In the future, I wish to see more environments—conferences, seminars, and workshops—where researchers from both theory and application areas can discuss, share their latest findings, and understand each other. I am especially happy to support Ph.D. researchers in their work because often the most passionate and novel ideas come from those fresh in the field. Or, whether you are junior or senior, but found my work interesting, I am always happy to provide visiting talks in person and in these times, also online.

Biography

Bushra Anjum is a software technical lead at Amazon in San Luis Obispo, CA. She has expertise in Agile Software Development for large scale distributed services with special emphasis on scalability and fault tolerance. Originally a Fulbright scholar from Pakistan, Dr. Anjum has international teaching and mentoring experience and has served in academia for over five years before joining the industry. In 2016, she has been selected as an inaugural member of the [ACM Future of Computing Academy](#), a new initiative created by ACM to support and foster the next generation of computing professionals. Dr. Anjum is a keen enthusiast of promoting diversity in the STEM fields and is a mentor and a regular speaker for such. She received her Ph.D. in computer science at the North Carolina State University (NCSU) in 2012 for her doctoral thesis on Bandwidth Allocation under End-to-End Percentile Delay Bounds. She can be found on Twitter [@DrBushraAnjum](#).

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