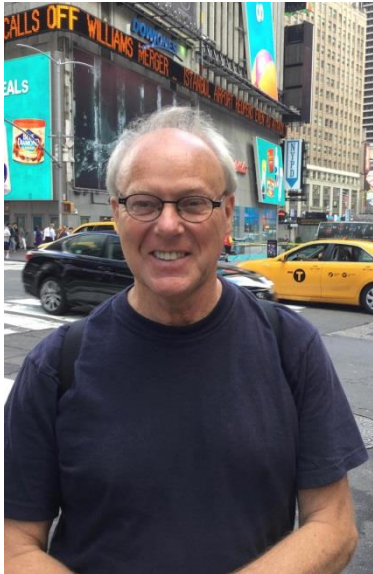


Interview with Professor Arvid Lundervold

Background

Arvid Lundervold grew up in the area around Lambertseter, Nordstrand and Bekkelaget in Oslo, and he took his natural science high school education at the private Kristelig Gymnasium in Oslo.

-Natural science was always of my interest, and six out of 20 students in my class later became medical doctors, so our class was a very motivated group, especially influenced and encouraged by our teacher in physics. Later I studied mathematics and physics at University of Oslo, and also philosophy for one year. We were a small group of students inspired by Professors Dag Prawitz and Dagfinn Føllesdal. I gradually also became interested in mathematical logic, algebra and topology and



then started a master's degree study in mathematics. Suddenly I also became interested in medicine, discontinued my master's and became MD in 1982, partly motivated by my uncle who was a clinical neurophysiologist at the National hospital. During my preclinical studies I was lucky to get a student fellowship at the Institute of Neurophysiology, which had an international reputation in neurophysiology (Profs. Per Andersen / Terje Lømo). There I worked together with John Hablitz and with him I got published my first paper dealing with hippocampal excitability and changes in extracellular potassium (Hablitz & Lundervold 1981), Arvid memorizes.

Professor Arvid Lundervold at Manhattan, NYC in June 2016 (Photo: Tonje Lundervold)

Motivation

-Following this academic start I finished medical school and took my internship for medical authorization at Bærum Hospital and district internship at Skjetten local medical center, so that I got my license and was able to continue with emergency medical service in the Oslo area. During this period I applied for and got a position at the IT department at the National Hospital (Rikshospitalet) in Oslo, interviewed and hired by the director Jacob Natvig. The recruitment was partly due to the fact that a medical doctor was responding to a non-medical position at the "Rikshospitalet's EDB avdeling". Gradually I got the opportunity to build up a unit denoted Center for Medical Informatics at the Hospital. During my time at the IT Department I learned a lot about IBM mainframes, SQL, and the statistical software system SAS being widely used for data analysis at the hospital. During the time at the Center for Medical Informatics, I also took part in the first RCN-supported initiative on electronic medical record systems in Norway, where the Department of Neurology were willing to participate as the experimental testbed. This was together with Prof. Leif Gjerstad (neurology) and Dr. Petter Hurlen, then at the Norwegian Institute of Public Health, who had a MSc degree in informatics and was also my study mate in medschool. Another important experience from the National hospital was the collaboration with Geir Kirkebøen, a gifted psychologist and computer scientist who introduced me to AI (Artificial Intelligence) and knowledge-based systems founded on "heuristic classification" theory. Together with him and Prof. Kjell Rootwelt (prof. in nuclear medicine) we developed an expert system for thyroid disease diagnosis. I thus felt that I was in a privileged position in this group of interdisciplinary experts working as a "knowledge engineer". Then I met Torfinn Taxt at the Norwegian Computing Center (Norsk Regnesentral) with even more excitement, connecting me to MRI during my civil service duty at the Norwegian Radium Hospital in Oslo. Torfinn had partly taken the same educational path as me some years earlier, being a medical

doctor, obtaining a PhD in muscle physiology, and with a completed MSc in physics. From the position at the National hospital I was recruited to the NCC and the BILD group (Image Analysis and Pattern Recognition) headed by Torfinn. In this group I got supervision and later collaboration with Torfinn and several influential statisticians and computer scientists, and I was a research scientist at the NCC from 1989 - 1994. During that time I was exposed to and worked with Unix and workstation technology, the LaTeX document preparation system, programming in Fortran and C, pattern recognition and statistical classification theory, and much of this were connected to inter-institutional projects and researchers with part time positions at the University of Oslo. Then, Torfinn got a professorship at University of Bergen and I got a part time recruitment position with travelling between Oslo (NCC) and Bergen (Department of Physiology) for a year. This opportunity of getting an academic position was the motivation for me to move to Bergen. The small research group on medical imaging consisting of Torfinn and me, located in the Department of Physiology and being funded by the RCN, were evaluated by an international committee according to agreements before UiB could take over - and I became Associate Professor when I got my PhD in 1995. The topic of my PhD thesis was "Multispectral analysis, classification and quantification in medical magnetic resonance imaging", Professor Arvid Lundervold tells.

-We understand that your family means a lot to you. How was it to break up in Oslo and go to Bergen?

-Astri and I met early in Oslo because of family connections, and we got married in 1978. We moved the family including five children at that time, so it was quite a dramatic change for all to move to Oslo outside Bergen in 1994 (and all this because of me). Astri still worked on her PhD at that time, supervised by Prof. Ivar Reinvang, UiO, and within one year we experienced two PhD defences and one new child birth in our family. In addition to take care of six children, a big house and a husband, Astri soon became a specialist in clinical neuropsychology. She then got a position at Department of Neurology, Haukeland University Hospital, and later at UiB, and from 2005 she has been a full Professor at Department of Biological and Medical Psychology. Our children became very closely connected during the change of living and this closeness and friendship has kept on. We are happy they have chosen different educations and job positions according to their interests and opportunities, spanning from visual therapy, mathematics, communication advisor, primary school teaching, medicine, and 3D design and animation, Arvid says with pride. We are also happy they all live in the Bergen area.

Current research

-We see that you have been involved in many collaborative projects, research and teaching, and that you have published >100 publications. Is there a "red line" or common denominator in your activity from the 80's and up to now?

-Image analysis and processing, especially connected to MRI, has been my main activity which started in 1987 in Oslo, and I have been programming in C and later MATLAB on a weekly basis for more than 25 years. Furthermore, I concluded from my PhD work that classification, quantification and visualization of tissue types and tissue function in health and disease using combinations of MRI pulse sequences are possible. Today, these are being even more important in terms of imaging biomarkers, machine learning, and personalized medicine. The fascinating field of neuroimaging and functional MRI has exploded during the last 20 years both regarding methodological improvements and applications. By some fortunate circumstances, we were among the first in Europe to perform and publish an fMRI study (Lundervold et al. 1995). Using the 1.0 Tesla scanner at Department of Radiology to study primary visual processing MR-physicist Lars Ersland, Prof. Kenneth Hugdahl and other members of our pioneering team were able "to see the light" due to a combination of creative experimental setup and the skill to dig out the bits in time and space from the proprietary image

format of the Siemens scanner at that time. From my period at the Norwegian Computing Center, we were familiar with C programming and the XITE toolbox developed in the Department of Informatics at UiO, and statistical image and time series analysis – ingredients that were important to our success. Later, we used a similar processing machinery to carry out diffusion and perfusion imaging in which Cecilie Brekke Rygh did her Master's degree (Physiological Imaging of the Human Brain using Diffusion and Perfusion MRI) in Human Physiology (2001) and where Professor Olav Haraldseth (NTNU) served as external evaluator. In this context I would like to highlight the good cooperative environment between the three cities Oslo, Trondheim and Bergen within the medical imaging research field, also illustrated by the joint RCN-funded Norwegian Research School in Medical Imaging (headed by Prof. Haraldseth), Arvid explains.

-My current research interests are in the fields of medical image processing and pattern recognition, multimodal and functional imaging (in brain, kidney and in oncology), image segmentation, image registration, longitudinal imaging, imaging-based biomarkers, mathematical and statistical modeling including machine learning, which can be gathered under the umbrella image-based Computational Medicine, Professor Lundervold tells.

Concluding remarks

-You have been involved with MedViz since 2008. How would you summarize your experience so far?

-MedViz has created great opportunities for network collaboration to continue the medical imaging and visualization based research, innovation and teaching, and represents a powerful resource in Bergen. MedViz has therefore meant a lot to me and I appreciate very much all the good people, enthusiasm, and the opportunities to work with the exciting combinations of mathematics, informatics and medicine, which ultimately have put me in the direction of computational medicine. I also enjoy the collaboration with many students and researchers from both UiB, HiB and Erasmus collaborating institutions, Arvid adds.

-The new funding of MedViz from *Bergens forskningsstiftelse* these days, combined with supplementing basic funding from UiB and HUH, will create new opportunities in a physical medical visualization center, thus elevating MedViz from its current status as a virtual network. This will in turn become a very valuable source of competence around the modern state-of-the-art MRI scanners and other imaging modalities at the hospital, with the potential to create both excellent research and improved patient diagnostics and treatment, in the spirit of MedViz' slogan "From Vision to Decision", Professor Arvid Lundervold concludes.

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