‘Deep learning’ in medical imaging raises diagnostics to a new level

The new 4TU programme, *Precision Medicine*, hopes to raise diagnostics to a new level by integrating a special form of artificial intelligence called deep learning with medical imaging techniques. The researchers’ goal is to provide better access to relevant medical information. This will mean a shift from a one-size-fits-all approach to a made-to-measure, personalized diagnosis for every individual. The researchers believe this is the best way to ensure that healthcare remains accessible and affordable for the long term. The programme will initially run for four years – although it emphatically has a long-term vision – and has received funding of €4 million.

Computers equipped with artificial intelligence are increasingly able to interpret and combine medical images from MRI, CT and other such scans with data from other imaging techniques such as PET and SPECT. Large patient data sets can be fed to a computer which can then make a correct diagnosis based on deep learning. These new technologies are also being applied in self-driving cars and speech recognition in mobile devices, for example. In the future, they will be indispensable for physicians who must interpret increasingly complex medical images.

The medical images of today do not only display anatomical information, they also provide functional, spectral, molecular and physiological information that is crucial for a diagnosis. These multidimensional layers of imaging data are extremely difficult for the human brain to understand and interpret. This is why the researchers have employed the intelligence and neural networks of computers. At the same time, they can make these computers even smarter by programming them with physical and biological laws in the form of inverse problems. This will allow physicians to make much more accurate diagnoses much faster and with a lot less data (which also means that patients will need to spend a lot less time in the MRI scanner). Moreover, the resolution of the imaging techniques – which is currently a physical limitation – could be drastically increased, both in place, time and spectrum sensitivity (super-resolution).

Researchers of the University of Twente, Eindhoven University of Technology and TU Delft are going to revolutionize medical imaging techniques, making a transition from standardized to personalized treatment possible. In our ageing society, where an increasing number of patients suffer from elderly disorders, providing access to adequate and affordable healthcare has become all the more important. If physicians can provide their patients with exactly the right treatment at exactly the right moment, it will improve their prognosis and ensure their continued vitality. This will lead to an overall improvement in patient care, while at the same time reducing the costs.

Entire chain

In the research programme entitled *Precision Medicine; by integrating Multiscale Functional Imaging and Advanced Machine Learning*, researchers from the three involved technical universities have combined knowledge obtained from the entire chain: from the physics of the generated signals and the biological and physiological interaction with the tissues, to the data that the imaging techniques provide. Where possible, these data are integrated simultaneously, for example using optical and acoustic sensors. This approach should enable physicians to obtain more information from existing images and identify relationships with existing data obtained from large, anonymized groups of patients. At the same time, the available data should provide more insight into the physical, physiological and biological processes involved in imaging, so that physicians can make better-informed decisions. In the long run, computers might be able to tell us exactly which combination of imaging techniques will ultimately produce the best diagnosis.

Long term

The programme is currently planned to run for four years, but what makes this research special is that the researchers are expressly taking the longer term into account; they have set out a research

vision with a fifteen-year time-scale. The long-term goal of the programme is better and faster detection of cancer and cardiovascular diseases, to shorten the time between the first signs of the disease and the diagnosis and to enable the creation of personalized risk profiles to increase the chance of prevention and reduce unnecessary treatments. An accurate diagnosis that leads to faster provision of the right treatment will also improve the patients' chance of survival and their quality of life after treatment.

The research programme is being coordinated by University of Twente professor Michel Versluis and comprises twelve technical research projects that are being conducted at the University of Twente, Eindhoven University of Technology and TU Delft. The researchers are cooperating intensively with clinical professors and various medical centres to ensure that the technology they develop harmonizes with the realities of clinical practice.