UNLEASHING THE POWER OF MACHINE LEARNING

Machine learning is rapidly transforming many areas of technology. It will be a cornerstone of healthcare software in the future, and a core element of both RayStation and RayCare.

Fredrik Löfman, Head of Machine Learning at RaySearch, gives an update on progress, projects and future plans.

IS MACHINE LEARNING IN RAYSEARCH PRODUCTS YET?

Yes! We went live with machine learning in the RayStation 8B release in December 2018. The machine learning applications are automated organ segmentation and automated treatment planning, both of which are included in this release.

WHAT DO THESE APPLICATIONS ENABLE?

Automated organ segmentation enables fast and high-quality rendering of organ volumes. The method is based on deep learning, which is a sub-branch of machine learning. Deep learning is concerned with algorithms inspired by the neural networks of the brain. These artificial neural networks can learn many levels of abstraction to perform complex tasks and are very suitable for segmenting medical image data. The method is very fast. All organs included in the neural network model are generated in less than a minute, and accuracy continues to increase as the system learns from additional data.

Automated treatment planning is functionality we have developed in collaboration with Princess Margaret Cancer Centre in Toronto, Canada. RayStation is delivered with models trained on the center's data and it is also possible for a clinic to train models on its own clinical data. We use machine learning to predict personalized dose for the patient, then generate a deliverable treatment plan without the need for manual planning steps.

This approach is very useful as we get a lot of information when we apply the model. This makes it possible to generate a wide range of alternative plans with slightly differing characteristics, so it's easier for the clinician to understand trade-offs and match the plan to the individual. The machine learning models for segmentation and planning are trained offline, and the generation of treatment plans and organs can be scripted for full automation.

In combination, these two applications will be extremely useful for automating the treatment planning process, which can enable clinical implementation of online adaptive therapy.

WHAT ELSE IS IN THE PIPELINE?

One area where we have made excellent progress is deep learning for automated target volume delineation, where we have a very fruitful research collaboration with Massachusetts General Hospital in Boston. We believe the uncertainty in target volume is one of the largest issues to be addressed in radiation oncology to increase treatment precision and improve treatment outcomes. This project is an important step towards increasing certainty and consistency in target volume delineation.

There are many more possibilities for machine learning. We are also looking at machine learning approaches for image transformation, data structuring, decision support, quality assessment and anomaly detection.

During 2019, we will integrate machine learning with Plan Explorer in RayStation, enhancing the automatic generation and navigation of treatment plan alternatives.

WHAT ABOUT RAYCARE?

The plan from the outset has been for RayCare to become a learning system. Currently, we are working on identifying the areas where machine learning will be most useful and most beneficial. The wealth of data that RayCare generates will enable great insights with the right analytics tools and is the ideal

starting point for a machine learning system. We see several opportunities in RayCare to help clinics streamline their workflows and support users in their daily work.

WHAT IS THE APPROACH TO DATA HANDLING?

Data is critical as it's the foundation for machine learning. To this end, we have developed prototypes of RayAnalytics, an oncology data platform for gathering, structuring, visualizing and analyzing data related to workflows, treatments and processes. The aim is for a shared platform that will support model sharing, enable researchers and groups to access clinical data in a structured way and get more insight from data.

RayAnalytics simplifies the selection of training data for machine learning and enables better models, which will lead to improved treatment consistency within and between clinics. There is already a great deal of interest in this capability.

WHAT ARE YOU MOST EXCITED ABOUT?

It's exciting to be up and running with machine learning capabilities in RayStation. But we are always thinking several steps ahead; we have many exciting developments in progress, not least building an analytics platform and developing machine learning applications in RayCare. Also, I'm very happy with the fantastic collaborations we have established with some of the leading cancer centers in Europe and North America. Their dedication and clinical input are critical to us.

Machine learning is one of the fastest-paced areas of technology. New discoveries and approaches are emerging all the time, so we have to keep innovating and moving forward, applying new methods to existing problems where they can make an impact to support end-users and make our products smarter. The opportunity for clinics to share knowledge through machine learning is very interesting and has huge potential. I'm confident that 2019 will be a big year for machine learning.

RaySearch Laboratories