PARTNERS IN SOLUTIONS;
ADVANCEMENTS IN AUTOMATED PLANNING - RAYSTATION AND RAYCARE

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ALL TECHNOLOGIES PRESENTED ARE IN RAYSTATION & RAYCARE

ADVANCING CANCER TREATMENT

RaySearch is advancing cancer treatment through pioneering software. Software has unlimited potential, and we believe it is now the driving force for innovation in oncology. Medical science never stands still, and neither does RaySearch. We work in close cooperation with leading cancer centers to bring scientific advancements faster to the clinical world. Today, our solutions support thousands of clinics worldwide in the fight against cancer. And this is just the beginning.

WITH ADVANCING TECHNOLOGY, WHAT ARE WE TRYING TO ACCOMPLISH WITH AUTOMATION?

- Higher quality plans for ALL patients, ALL disease sites, ALL oncology centers
- Done so efficiently
  - Solutions based on previous success and avoiding previous failures
  - Presentation of different treatment approaches automatically
  - Real time, Adaptive therapy for ALL
    - Automatic assessment and planning for (on-line) Adaptive Therapy

NEED FOR AUTOMATION IN RADIOTHERAPY

- Driven by disparity of treatment available to populations
  - Lack of advanced software, or hardware
  - Need for increased efficiency (More patients than staff that can plan)
  - Lack of trained professionals
- Goals of Automation
  - High quality treatment plans consistently and efficiently
  - Includes internal quality assurance
  - Improving plan quality by reducing dependence on expertise of individuals
  - Can be deployed world wide to radiation centers, regardless of hardware or software

AUTOMATION, A KEY FOCUS AT RAYSEARCH

Automation of standard procedures for better patient care

RayStation

- HARMONIZE YOUR TREATMENT PLANNING
- RayStation features plenty of tools to automate treatment planning:
  - Templates/ Plan generating protocols
  - Scripting
  - Fallback planning
  - Automated breast planning
  - Reduce Organ at Risk
  - MCO
  - Plan Explorer
  - Machine Learning

RayCare

- ONE ONCOLOGY WORKFLOW
- RayCare has been designed to enable tailored digital workflows including automated tasks for specific staff members.
- Task-based and rule-based scheduling for all resources
- Automatic capture and management of billable codes from tasks performed in the workflow

RAYSTATION FEATURES

PLAN GENERATION PROTOCOLS

Reduces planning time and enforces standardization

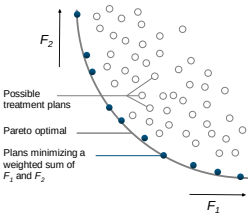
- A protocol is a list of plan generation steps which can be applied automatically
  - Examples of plan generation steps include
  - Atlas based segmentation
  - Plan creation
  - Set dose grid resolution
  - Add beams, optimization functions and settings
  - Dose computation
- When a protocol is run it will automatically create a plan using the included steps
- Eliminates repetitive work
- Reduces planning time and human error
- Enforces name conventions and standardization

SCRIPTING IN RAYSTATION

Create new capabilities in an easy and powerful way

- Scripts can **be recorded or programmed**
- Scripting language **Iron Python**, allows access to **Microsoft.NET**
- Read and write **all data** in RayStation
- Create and display windows, create pdf reports and **interface directly** with other applications such as **Matlab or Excel**
- A number of **general scripts are included in RayStation** and more example scripts are available on *github.com/raysearchlabs/scripting* or the scripting forum in RayStation Community

MULTI-CRITERIA OPTIMIZATION



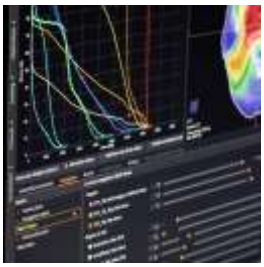
- Goal: minimize F_1 and F_2 **combination**
- Navigate Pareto line in real time in MCO interface

MULTI-CRITERIA OPTIMIZATION

Explore conflicting objectives in real time

- **Pre-computation** of all relevant plans that are Pareto optimal*
- Navigate plans in real time to **explore conflicting objectives**
- Select best **clinical trade-off** with real time interactive navigation tool
- What is the price I have to pay to get a even lower dose to..?

* A plan is Pareto optimal if it fulfills all the constraints and can not be improved in one objective without negatively affecting something else.



MULTI-CRITERIA OPTIMIZATION

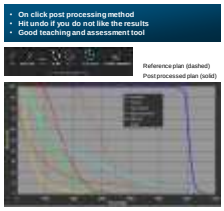
Clinical findings

- Planners and physicians can find **solutions they didn't know existed**
- When physicians perform the navigation they select **plans with higher OAR** sparing at the expense of slightly target under dosing because they can see exactly where it happens
- The total **treatment planning time** is significantly reduced without compromising plan quality
- Planners with **limited experience** and knowledge can produce **clinically acceptable plans**

REDUCE ORGANS AT RISK

Automatically aim for improvements without compromising any goals

- Once a plan satisfying the clinical goals has been found, there are often aspects of the plan that can be further improved upon
- The reduce organ at risk functionality is based upon the observation that it is normally easier to achieve a better plan if you have a reference plan as a starting point
- The dose distribution of the current plan is set as reference dose
- The system will try to change the segment weights and the machine parameters to see if there is a way to improve the OARs without negatively effect the PTV
- If improvements are not possible the plan is unchanged



FALLBACK PLANNING

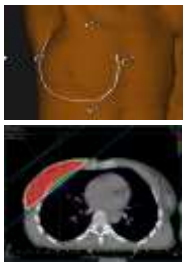
Automatically create additional plans

- Key step towards automated planning
- Tool for creating additional plans
- In a contingency situation enabling a patient to be treated on another machine, with a different modality and/or treatment technique, in case the original machine is unavailable
- Evaluate if improved results can be achieved with a different treatment technique
- Plans of any modality can be converted

AUTOMATED BREAST PLANNING

Tangential breast IMRT planning – one click solution

- Applicable for most early stage breast cancer patients suitable for tangential breast IMRT
- A wire is placed around the breast tissue or along the chest wall together with four markers denoting the superior, inferior, lateral and medial margins
- Automatic contouring of all the relevant target and risk organs
- Automatic setup of beams, including heuristic optimization of gantry and collimator angles
- Automatic creation of objective functions, optimization and segmentation settings and clinical goals
- With scripting this procedure can be done for a large number of cases at once



AUTOMATED BREAST PLANNING

Licensed from Princess Margaret Cancer Center, Toronto, Canada – Clinical findings

- Used at the Princess Margaret Cancer Centre, Toronto, Canada since June 2009, with more than 3,000 patients receiving treatment
- 6-7 minutes for a complete treatment plan
- 97 % of all tangential breast IMRT planned with automated tools
- Decreases in the number of overall plans rejected and number of plan rejections due to planning errors
- Adds efficiency, standardization and quality to the treatment planning process

Automation and Intensity Modulated Radiation Therapy for Individualized High-Quality Tangent Breast Treatment Plans

PLAN EXPLORER

Treatment planning will never be the same

- Automatic generation, based on given clinical objectives, of multiple plans for the different treatment techniques and beam settings available at the clinic.
- Choose plans instead of designing them

PLAN EXPLORER

Potential clinical benefits

- Explore different treatment techniques that would have been too time consuming to consider in the everyday routine
  - The best treatment setup (machine, #beams, #segments) is not known beforehand
  - Same, or better plan quality can be achieved with a different treatment setup (time, MU, #segments)
- Optimize the use of your current treatment delivery machines
- Get more time to evaluate the plans

RAYCARE DEVELOPMENT PARTNERS

- Close collaboration with a range of partner clinics globally
- Clinicians involved in specifying functionality and design
- Continuous evaluation by different user categories
- Partnership spans all the way to clinical implementation

RAYCARE ADVANTAGES

The vision for the next generation OIS

- Seamless integration with RayStation treatment planning
- Designed for Adaptive Therapy
- Tumor Board Management
- Active Oncology Workflows
- Schedule and Resource Optimization
- Comprehensive Cancer Treatment
- Platform-independent Architecture
- Enterprise-wide Integration
- Structured for Data Analysis and Machine Learning

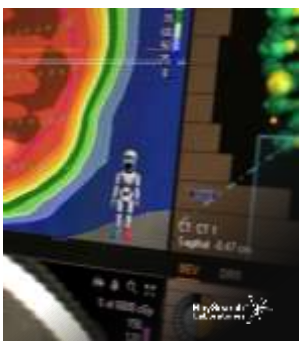
MACHINE LEARNING SYSTEM

- Dedicated team established in 2017
- Two applications, which were developed by this team will be released within RayStation in December of 2018
- Will implement both classical machine learning techniques as well as deep learning methods.
  - Deep Learning → ROI models
  - Machine Learning → Dose Prediction
- Data analytics and machine learning will be cornerstones in both RayCare and RayStation
  - Empowering the user by presenting relevant information at the right time. Enabling clinics to make us of their data and to build learning models.

FUTURE OF TPS?

Workflow prediction 2-7 years

- Plans will be created automatically for 50-75% of patients.
- Automated dosimetric and physical assessment during treatment will become the norm.
- Plans will be optimal and personalized for patients, and this will be the focus as opposed to beam angle selection (for example).
- Automation will also include retrospective analysis, error statistics, robust optimization, data mining and clinic specific operational efficiency. Treatment variables never before considered will become part of the planning process.
- Powerful OIS will need to incorporate data as described above



THE FUTURE…

Advancing technology does not eliminate the need for educated planning staff!

However, we will be doing things differently…

- Roles or responsibility will change

  Dosimetrists will drive computer solutions for adaptive therapy (what is important clinically, when, how, etc.). Therapists may become more involved in the day to day dose tracking.

- New roles and ways of working are needed for us to achieve higher quality plans, more often, for all patients