The Radiation Planning Assistant (RPA)

Automation and Standardization of Planning, Plan Evaluation and System Testing through Advanced Programming in Treatment Planning Systems, AAPM 2018

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Conflicts of Interest

• Funded by NCI UH2 CA202665
• Additional funding from Varian Medical Systems
• Equipment and technical support provided by:
  • Varian Medical Systems
  • Mobius Medical Systems
• Other, not related projects funded by NCI, CPRIT, Varian, Elekta

Specific goals of the Radiotherapy Planning Assistant (RPA)

• Generate high quality treatment plans that are:
  • Generated from scratch in less than 30 minutes.
  • Internally QA’d in an automated fashion within the system.
• Limit need for the radiation oncology physician to:
  • Delineate the target (location).
  • Provide the radiation prescription.
  • Approve the final plan.
• Limit need for medical physicist to:
  • Check final plan
• Create a system that can be used by an individual with:
  • A high school education.
  • ½ day of training (online and video) on the RPA itself.
  • (dosimetrists still needed for unusual/complex cases)
General philosophy

- Take advantage of Eclipse, but avoid the need for the user to actually use Eclipse
- Use Eclipse functions whenever possible (API)
- Combine with purpose-written tools
- Many functions (e.g. contouring) happen before sending to Eclipse (dicom)
- Others use API
- Internal verification for everything
- Work closely with eventual users
- Deploy at MDACC whenever possible
  - (although project aimed at supporting cancer treatments in low- and middle-income countries)

Primary Planning
- CT Table Removal
- Body Contour Definition
- Marked Isocenter Detection
- Atlas-Based Contouring
- Create Fields
- Optimize Dose
- Calculate Dose
- Plan Documentation

Secondary Verification
- CT Table Removal
- Body Contour Definition
- Marked Isocenter Detection
- Atlas-Based Contouring
- Create Fields
- Optimize Dose
- Calculate Dose

Do primary and secondary methods agree?

Plan Documentation

MD approves plan?

Yes

Transfer Plan to Record and Verify

No

Manual planning

RADIATION PLANNING ASSISTANT

ARIA® DB

RT Data Model

DICOM Services

Dose Calculation Engine

DVH Engine

RPA

Plan Order

Radiotherapy Treatment plan
C#.NET Script Here

Eclipse Scripting API
- RT Data Model
- DICOM Services
- Dose Calculation Engine
- DVH Engine
- ARIA DB

Based on slides from Wayne Keranen, Varian

Plugin Script
- Eclipse calls you
- Operates on current patient

Standalone EXE
- You call Eclipse
- Operates on any number of patients

Detailed Project Highlights:
Head & Neck Autocontouring
- Physician-drawn GTV
- Automatically contoured normal tissue and CTVs
- Supplement with autocontoured planning structures
- Isocenter at target center
- Collimator size/angle based on targets
  - 30° and 330° collimator angles, symmetric fields, 18cm max
  - 90° collimator angle
- WUSTL Rapid Plan Model
- Population Constraints (weights etc.)
- Normalize such that all PTVs receive ≥98% of prescribed dose to 95% volume

Detailed project highlights: Plan Optimization
- Physicist scoring of automatic contours
- Contour edits in clinical practice
- Isocenter at target center
- Collimator size/angle based on targets
- WUSTL Rapid Plan Model
- Population Constraints (weights etc.)
- Normalize such that all PTVs receive ≥98% of prescribed dose to 95% volume
**Detailed Project Highlights: Head & Neck Plan Quality**

- RPA generated plans are of high-quality, comparable to manually generated plans in target coverage and normal tissue sparing.
- Unacceptable plans are nearly always easily identifiable – and flagged to the user.

**Dosimetric impact of OAR autocontouring**

- High Dose PTV
- Contralateral Parotid
- Ipsilateral parotid
- Brainstem

**Detailed Project Highlights: Use of Multiple Algorithms to Ensure Plan Quality & Safety**

- PRIMARY CALCULATION
  - Peak detection
  - Average agreement: 2.6mm
- VERIFICATION CALCULATION
  - Average agreement: 0.6mm
- ANNOTATED MANUAL VERIFICATION
  - Active contour
  - Peak detection
Automatic radiation planning promises to increase availability of radiation therapy worldwide by:

- Reducing the planning burden
- Reducing staff shortages
- Increasing the quality and efficiency of radiation plan creation
- Integrated in-house tools (e.g. autocontouring) with Eclipse and Mobius:
  - API
  - Dicom import/export
  - JSON objects
- The RPA successfully generates acceptable, treatable radiation plans for:
  - Cancers of the uterine cervix (4-field box)
  - Cancers of the head/neck (VMAT)
- Key components of the RPA are being used clinically in the USA:
  - Autocontouring of head/neck normal tissues
  - Autogeneration of cervical cancer field borders
- Aiming to deploy clinically early in 2019

Radiation Planning Assistant (RPA) Project Summary: August 2018

- Principal Investigators:
  - Lawrence Court, PhD – physics (MD Anderson)
  - Beth Beadle, MD/PhD – radiation oncology (Stanford)
  - Lawrence Court, MD – radiation oncology (Stanford)
  - Laurence Court, MD – radiation oncology (Stanford)
  - Rachel McCarron – H&N algorithms
  - Kelly Kitting, MD – GYN, breast algorithms
  - Carlos Cardenas – deep learning
  - Jinhong Fang, PhD – atlas segmentation
  - Peter Bank, MD – radiation physics
  - Ann Klopp, MD/PhD – GYN planning
  - Anja Strozier, MD – GYN planning
  - Serené Shalekman, MD – breast
  - David Followel, PhD – audio/deployment
  - James Korte and dosimetry team
- Commercial Partners:
  - Varian Medical Systems
  - Mobius Medical Systems
- Primary Global Partners: AFRICA
  - Stellenbosch University, Cape Town
  - University of Cape Town, Cape Town
- Primary Global Partners: ASIA
  - University of Santo Tomas, Manila
- Principal Global Partners: USA
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