Scripting and Automation Applications in Photo/Proton Clinics and Clinical Trials

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Disclosure

- Varian speaker agreement and grant support unrelated to this topic
- Contents of this talk reflects my own opinion and not that of the University of Pennsylvania

Learning Objectives

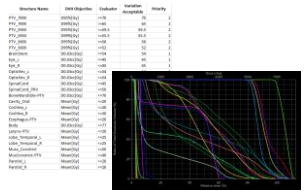
- Learning about **current application** of scripting and automation in photon and proton clinics, as well as clinical trials
- Learning about **new tools** that could simplify and enhance the application of scripting and automation
- Learning about **publicly available resources and commercial solutions** on automation and scripting

Acknowledgement

- Slides and contents contributed by
  - **Ryan Scheuermann, MMP** (DVH evaluator, Data analytics dashboard)
  - **Lingshu Yin, Ph.D.** (Proton QA Prep)
  - **Huaizhi Geng, Ph.D.** (Clinical trials application)
  - **Nate Anderson, M.S.** (Data analytics dashboard)
  - **Shi Liu, Ph.D.** (Stanford Auto Plan Check)
  - **Taoran Cui, Ph.D.** (ESAPI tips)
  - **Yang Sheng, Ph.D.** (ESAPI tips)
  - **Alan Nelson, DMP** (ESAPI tips)

Clinical Applications – Plan Quality Evaluation

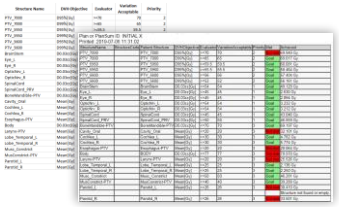
- Why Automating
  - Complicated parameters to check for plan quality
  - Time consuming and prone-to-miss
- What was built
  - Automated dosimetric parameter extractor based on physician's order and color coded compliance



Contributor: Ryan Scheuermann, MMP

Clinical Applications – Plan Quality Evaluation

- What was built
  - Automated dosimetric parameter extractor based on physician's order and color coded compliance
  - Developed based on Varian-provided code



Contributor: Ryan Scheuermann, MMP

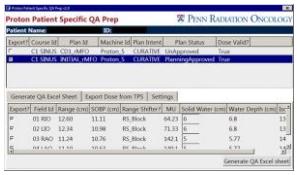
Clinical Applications – Plan Quality Evaluation

- How was it done
  - Word Macro using VBA to extract key information from physician's dynamic documents using RegExp
  - DVH parameters of interest recorded in an intermediate CSV file
  - Eclipse Scripting API to extract dosimetric parameters from treatment plan or plan sum based on CSV file
  - Display compliance with color code

Contributor: Ryan Scheuermann, MMP

Clinical Applications – Proton QA Plan Prep

- Why Automating
  - Proton QA plan preparation requires multiple steps and parameters
  - QA documents is patient-specific
- What was built
  - Automated script to browse for available QA plans



Contributor: Lingshu Yin, Ph.D.

Clinical Applications – Proton QA Plan Prep

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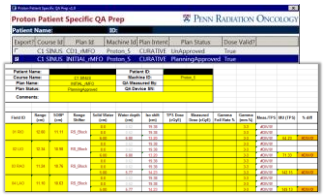

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Clinical Applications – Proton QA Plan Prep

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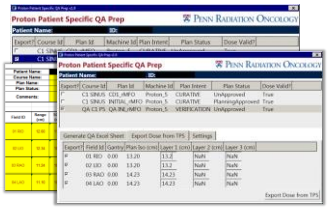
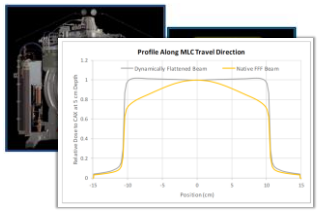
  - Automatic Generating of QA spreadsheet
  - Automatic Export of verification dose matrix at desired depth



Contributor: Lingshu Yin, Ph.D.

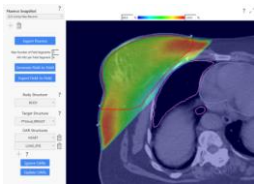
Clinical Applications – Implementing New Technology

- Why Automating
  - Introduction of a new treatment machine that only has FFF mode
  - Dosimetry team struggles to adjust for non-flat beam profiles for simple cases like tangential breast fields
  - Waiting for TPS major upgrade to include this feature is not practical



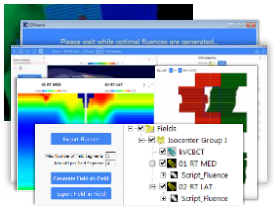
Clinical Applications – Implementing New Technology

- What was built
  - EZFluence, a commercial solution by Radformation
  - Available on Varian Market Place
  - A FDA-approved solution to automatically perform simple 2D/3D planning using ESAPI as interface with TPS



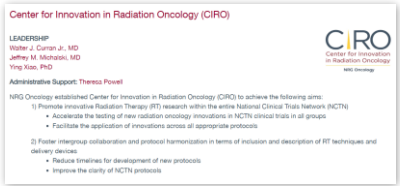
Clinical Applications – Implementing New Technology

- How was it done
  - Physician sets initial MLC aperture to define irradiated volume
  - MLC aperture, dose information, and CT data sent to EZFluence optimizer via TPS scripting
  - EZFluence calculates optimal fluence or segments to deliver uniform dose to irradiated volume
  - Optimal fluence or segments can be automatically imported back to TPS via scripting interface
  - Final dose calculation done based on "Script Fluence" or "Segments"



Some images courtesy of Radformation

National Clinical Trials – NRG Resource



Center for Innovation in Radiation Oncology (CIRO)

LEADERSHIP
Walter J. Curran Jr., MD
Jeffrey M. Michalski, MD
Ying Xiao, PhD

Administrative Support: Theresa Powell

NRG Oncology established Center for Innovation in Radiation Oncology (CIRO) to achieve the following aims:

1) Promote innovative Radiation Therapy (RT) research within the entire National Clinical Trials Network (NCTN)
   - Accelerate the testing of new radiation oncology innovations in NCTN clinical trials in all groups
   - Facilitate the application of innovations across all appropriate protocols

2) Foster intergroup collaboration and protocol harmonization in terms of inclusion and description of RT techniques and delivery devices
   - Reduce timelines for development of new protocols
   - Improve the clarity of NCTN protocols

CIRO Center for Innovation in Radiation Oncology NRG Oncology

https://www.nrgoncology.org/Scientific-Program/Center-for-Innovation-in-Radiation-Oncology

National Clinical Trials – Structure Naming Consistency

- Why Automating
  - Structure naming consistency is key to manage large-scale multi-institutional data
  - Time-consuming to manually check and correct
- What was built
  - MIM script (workflow) to automatically check for naming and correct based on auto/manual matching

Contributor: Huaizhi Geng, Ph.D.

National Clinical Trials – Structure Naming Consistency

- How was it done
  - Use MIM workflow to identify structure set and compare to pre-set names
  - Use MIM automated feature to generate correctly named structures

Contributor: Huaizhi Geng, Ph.D.

National Clinical Trials – Dosimetric Evaluation

- Why Automation
  - Large number of clinical protocols and submitted cases
  - Manual check is time consuming and error-prone
- What was done
  - Automatic generation of MIM script for a given protocol
  - Automatic extracting of key dosimetric parameters using MIM script

Contributor: Huaizhi Geng, Ph.D.

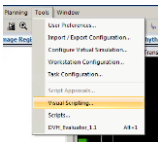
National Clinical Trials – Dosimetric Evaluation

Contributor: Huaizhi Geng, Ph.D.

https://www.nrgoncology.org/ciro-genitourinary

New Tools – Visual Scripting

- What is visual scripting
  - Building applications by connecting different modules
  - Visually and intuitively arrange simple modules to achieve complex functionalities
- TPS visual scripting applications
  - Extract dose information
  - Access plan parameters
  - Serve as references to learn code-based scripting



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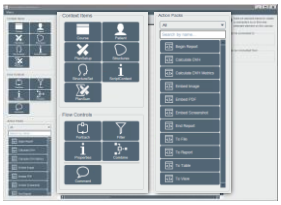
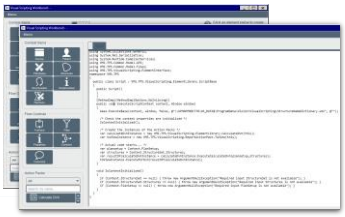


New Tools – Visual Scripting

- TPS visual scripting examples
  - Extract DVH information
    - Use Calculate DVH operator
    - Use Flow control to do for loops
    - Use Filter to select input variables
    - Can output to table, view, or file

New Tools – Visual Scripting

- TPS visual scripting examples
  - Use visual scripting to learn about actual ESAPI coding
  - Explore actual code behind each operators/modules
  - Build complex script based on barebones code generated by visual scripting



New Tools – Data Warehouse and Visualization

- Faster analytics enabled by AURA data warehouse
  - Abstraction of production data
  - Combines both TPS data and OIS data
  - Aggregate and simplified data warehouse populated using Extract Transform Load (ETL) script
  - Most report generation does not impact production system's performance

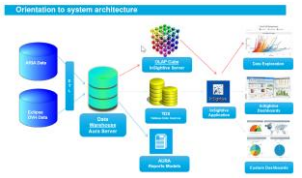
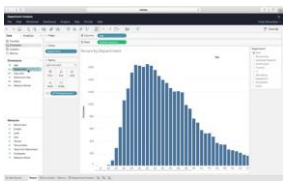


Image from Varian InSightive™ analytics 1.6 workbook

New Tools – Data Warehouse and Visualization

- Data analytics support operational decision-making at Penn
  - Machine performance
    - New purchase and upgrades
  - Team performance
    - Case and task assignment
    - Expertise distribution
  - Adoption of new technologies
    - RapidPlan utilization across all networks
  - Throughput data
    - Revenue and financial decision support

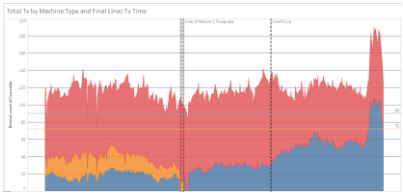


Demo video from Tableau.com

Data Visualization Example: Case Assignment

Contributor: Ryan Scheuermann, MMP, Nate Anderson, MS

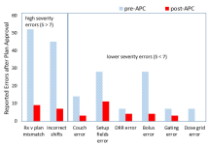
Data Visualization Example: Halcyon Implementation

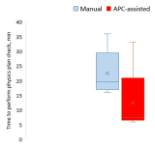


Contributor: Ryan Scheuermann, MMP, Nate Anderson, MS

Take Home Messages and Tips

- Scripting and Automation can help **increase efficiency & reduce error**





- *Quantifiable metrics: Error frequencies*
  - ✓ *Rx mismatch: ↓ 82.7%*
  - ✓ *Shift errors: ↓ 84.4%*
- *Average time gained using APC assistance was **10.1±7.3** minutes.*

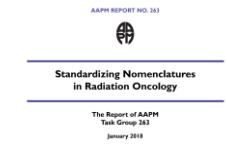
Contributor: Shi Liu Ph.D., Stanford University

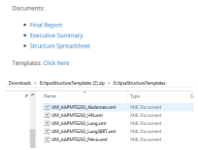
Take Home Messages and Tips

- Scripting and Automation support decision making for
  - **Individual patient care**
    - **TPS scripting, commercial solutions, complement TPS functionalities**
  - **National clinical trials**
    - **Consistency in naming, reporting, dose volume analytics**
  - **Institutional operation and business administration**
    - **New equipment implementation**
    - **Team performance and task distribution management**
    - **Real-time and interactive**

Take Home Messages and Tips

- Standardization is **pre-requisite and key**





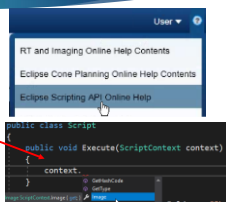
https://www.aapm.org/pubs/reports/RPT_263_Supplemental/default.asp

Take Home Messages and Tips

- You **don't need to know coding** to use scripting and automation
  - Drag and drop solutions available, for example
    - Visual scripting from Eclipse
    - Workflow from MIM
    - IQ Script from Mosaiq

Take Home Messages and Tips

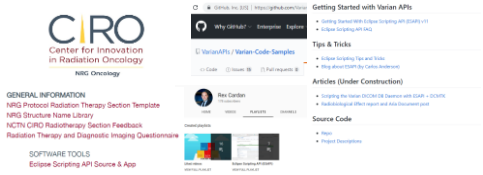
1. Determine what you want to do
   a. A project that motivates you will help you push through barriers that you will definitely encounter
2. Divide and Conquer
   a. Break the task down into manageable pieces
   b. Example: You want to display a transverse CT slice
      i. Explore the Scripting API
         - How is the image data accessible via the API? (**Visual Studio Intellisense helps**)
         - Experiment with the data & functionality to make sure you understand it.
           - e.g. Do you understand the coordinate system of the Image? Can you correctly relate it to patient orientation and source position?



From Alan Nelson, DMP, DABR, Chief Science Officer, Radformation

Take Home Messages and Tips

- **Rich community resources** to help you get started



Take Home Messages and Tips

- When you upgrade your system
  - ESAPI rely on classes and methods defined by Varian-supplied assemblies
  - Assembly that shipped with your TPS changes from version to version
  - Your code may need to be modified to fit updated assemblies
    - E.g. name of class properties
- When you update your script
  - Approved Script requires version number to be unique when the script dll file changes
  - Update version number in project properties to a unique number

Contributor: Yang Sheng, Ph.D., Taoran Cui, Ph.D.

Thank you