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 reflect 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)
  - Huashu Geng, Ph.D. (Clinical trial application)
  - Nate Anderson, M.S. (Data analytics dashboard)
  - Shu Uo, Ph.D. (Varian 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

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 Snipping 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
- Automatic Generating of QA spreadsheet

Contributor: Lingshu Yin, Ph.D.
Clinical Applications – Proton QA Plan Prep

- Why Automating
  - Proton QA plan preparation requires multiple steps and parameters
  - QA documents are patient-specific

- What was built
  - Automated script to browse for available QA plans
  - Automatic generating of QA spreadsheet
  - Automatic export of verification dose matrix at desired depth

Contributor: Lingshu Yin, Ph.D.

Images courtesy of Varian Medical Systems

Clinical Applications – Implementing New Technology

- Why Automating
  - Introduction of a new treatment machine that only has FF 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

- 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
  - Optional 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

- 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.

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

Contributor: Huaizhi Geng, Ph.D.
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

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 operation/module
  - 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

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
    - Adoption utilization across all networks
  - Throughput data
    - Revenue and financial decision support

Demo video from Tableau.com
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

- Standardization is pre-requisite and key

- 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 tables
    - QL Script from Mosaiq

https://www.aapm.org/pubs/reports/RPT_263_Supplemental/default.asp
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. How is the image data accessible via the API? (Visual Studio Intellisense helps)
      j. 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

- When you upgrade your system:
  - ESAPI relies 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 file changes.
  - Update version number in project properties to a unique number.

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