DVH EVALUATOR AND PLAN COMPARISON TOOL

The DVH Evaluator and Plan Comparison Tool is a set of scripts intended to be used with the Varian Eclipse treatment planning system. The Eclipse Scripting API (ESAPI) tools allow for quick computation of Dose Volume Histogram (DVH) parameters for any number of treatment plans or plan sums. Combined with a Visual Basic (VBA) macro embedded in ARIA workstations and Citrix servers, it allows analysis of a plan against constraints provided in ARIA Dynamic Documents.

This document provides basic information on the script, as well as an installation and use guide. This installation guide assumes the reader is relatively familiar with ESAPI and Visual Studio.

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CODE STRUCTURE

The DVH Evaluator script requires two separate programs to function. One is a Visual Basic (VBA) macro with a Microsoft Word template file which is used to extract planning goals from an ARIA Dynamic Document and save them to a `.csv` file. The other is a C# Eclipse Scripting API (ESAPI) script which reads in these `.csv` files and uses them to evaluate a treatment plan(s) or plan sum(s) against the planning goals and provide a visual summary of the analysis results.

Visual Basic (VBA) script and Microsoft Word template file

The VBA script consists of a VBA macro embedded in a Microsoft Word template file. A description of these files is given below.

- **`ExportConstraintsPerPatient_OpenSource.dotm`**
  - Microsoft Word macro-enabled template file.
  - This files contains the macro **`ExportConstraintsToCSVForPatient`**.
  - Call to macro is hardcoded to **`Alt+1`** keyboard shortcut.
  - Template is propagated to all users by placing in the Office Startup directory on all ARIA thick clients and Citrix app servers.
- **`ExportConstraintsToCSVForPatient`**
  - Macro for export of constraints from an ARIA Dynamic Document that follows the format of the example document **`Example_Prostate_Bed_Quantec.doc`** provided with this package.
  - The user export directory must be configured in the script before clinical use.

Eclipse Scripting API (ESAPI) Script

Below is a description of the main components of the ESAPI code. Not all files are described. The ESAPI code has been written for Eclipse Version 15.6. In order to run with other versions of Eclipse, modifications may be necessary which are outside the scope of this document.

The Visual Studio solution is divided into three projects.

- **`DVHEvaluator_Main`**
  - Creates **`DVHEvaluator_Main.dll`**, a helper file
  - Provides the main functionality of the program.
- **`DVHEvaluator`**
  - Creates **`DVHEvaluator.esapi.dll`**, which can be opened in Eclipse.
  - Calls the main program in single plan mode.
- **`PlanComparisonTool`**
  - Creates **`PlanComparisonTool.esapi.dll`**, which can be opened in Eclipse.
  - Calls the main program in Plan Comparison Mode.

Below is a description of some of the most important files and classes located within these projects.

- **`DVHEvaluator_Main.cs`**
  - The program begins here.
- **`DataModel.cs`**
  - The next file executed.
  - Includes the majority of the processing code, including reading DVH objectives and creating the output file.
- **`ConfigurationInfo.cs`**
  - Contains links to the directories in which the program will look for required files.
  - This should be updated to a network-accessible location for clinical use.
- **`GUI folder`**
  - Prompts user to select plans which should be used when in Plan Comparison mode.
  - **`PlanChooserView.xaml`** and **`PlanChooserViewModel.cs`** provide the main functionality
  - Other classes help create the list of plans for selection.
- **`Example Data folder`**
  - **`FIRSTLAST_123456789_Example_Prostate_Bed_Quantec.csv`**
    - Example of a **`.csv`** file in which the program finds the DVH constraints.
    - This can be automatically generated from ARIA dynamic documents using the script described elsewhere in this document.
    - The suggested filename format is given above. The filename must contain the patient ID as given in ARIA in order for the script to run.
  - **`Example_Prostate_Bed_Quantec.doc`**
    - Example of a dynamic document in ARIA which can be used to generate the above **`.csv`** file.

INSTALLATION

This installation guide assumes you are relatively familiar with ESAPI and Visual Studio. If you are not, please make use of the many resources available online and through Varian to become familiar.

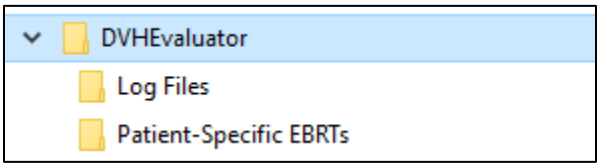
Setting up the resource folder.

1. Create a folder, ideally on a network-accessible location, where program-required files will be stored.

   e.g.: `\\ServerName\EclipseScripts\DVHEvaluator`
2. Create two sub-folders:
   a. For log files to be stored.

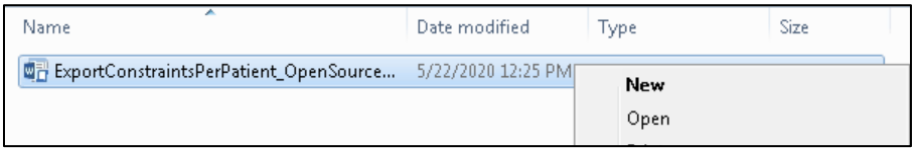
      e.g.: `…\Log Files`
   b. For DVH constraint .csv files to be stored once exported from ARIA.

      e.g.: `…\Patient-Specific EBRTs`
   c. Make note of this folder location, as you will need it later.



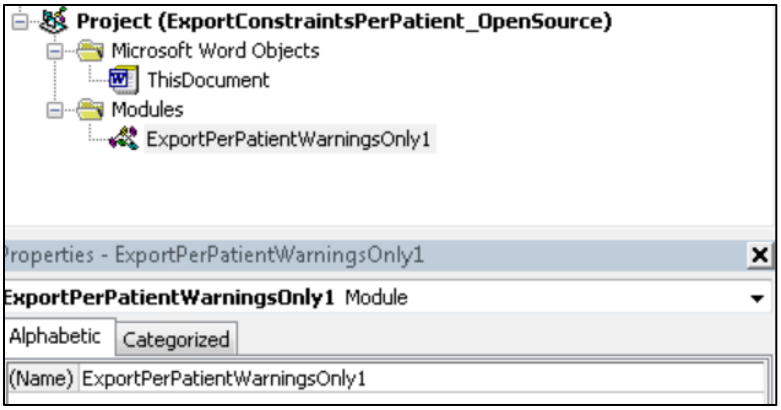
Configuring the Visual Basic macro

1. In Windows Explorer, right click on the file **`ExportConstraintsPerPatient_OpenSource.dotm`**, provided in the **`ExampleData`** folder. Choose **`Open.`** (Do not double click)



2. In Microsoft Word, go to the **`Developer`** tab and choose **`Visual Basic.`**
   a. If the **`Developer`** tab is not available, please refer to the documentation provided by Microsoft to add it: https://support.office.com/en-us/article/Show-the-Developer-tab-E1192344-5E56-4D45-931B-E5FD9BEA2D45

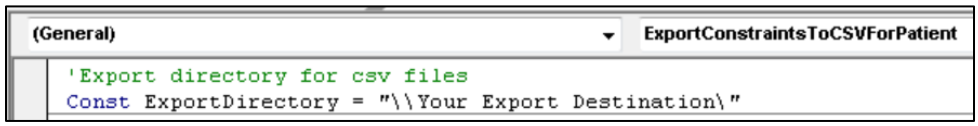
3. On the left side, select `Project (ExportConstraintsPerPatient_OpenSource)` --> `Modules` --> `ExportPerPatientWarningsOnly1`



   a. At the top of the file, assign the `ExportDirectory` variable to the filepath for `Patient-Specific EBRTs` directory created previously. Ensure the path ends in a backslash.

   b. **Tip**: It is best to use the full server name, rather than a drive letter, to ensure the server can be reached by all clients.

   e.g..`\\ServerName\EclipseScripts\Patient-Specific EBRTs\`



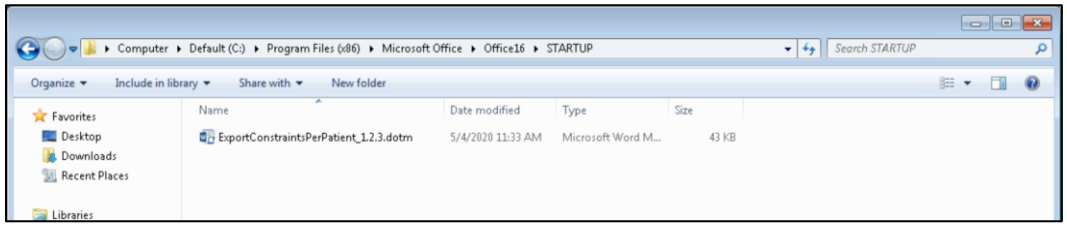
4. `Save` the file and exit.

Deploying the macro-enabled template file to ARIA

1. Copy the previously edited `ExportConstraintsPerPatient_OpenSource.dotm` into the Office Startup directory on **all ARIA thick clients or Citrix App servers**

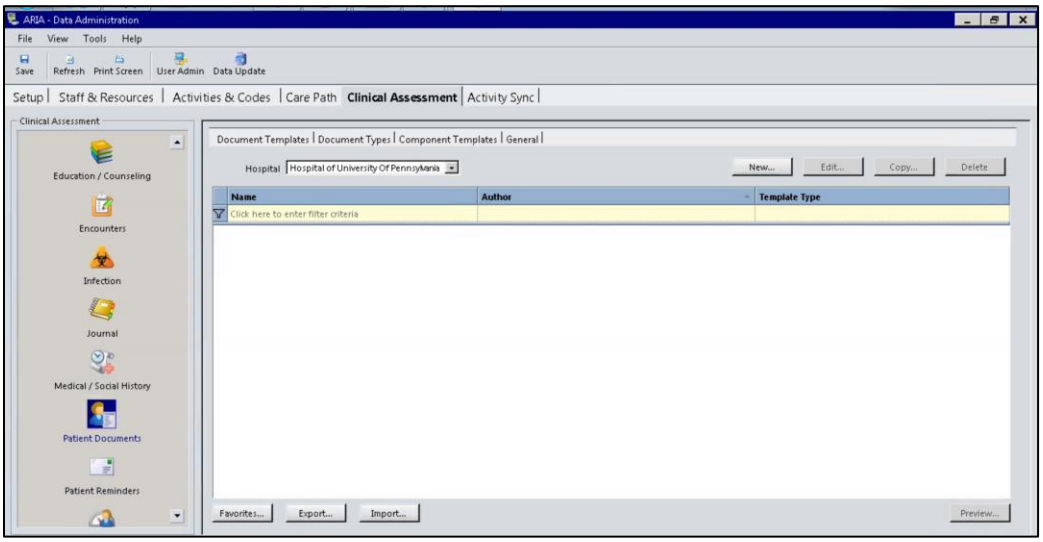
   a. C:\Program Files (x86)\Microsoft Office\Office16\STARTUP

   b. This filepath will be similar to that shown, though may vary depending on the version of Office installed

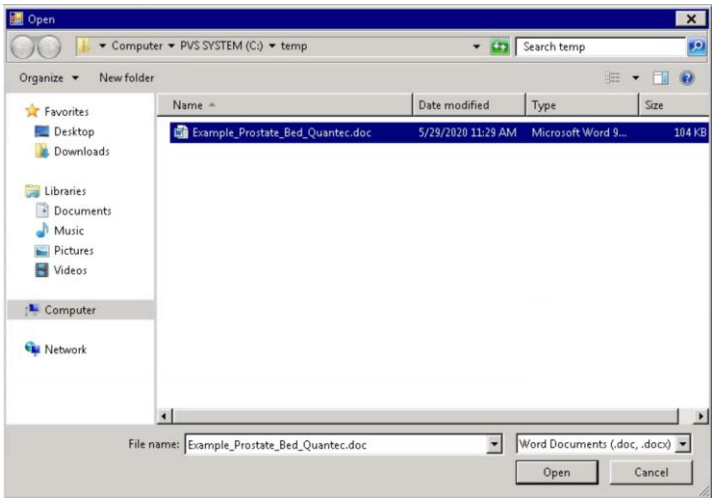


Loading the document template into ARIA

1. In ARIA, go to **`Data Admin`** --> **`Clinical Assessment`** --> **`Patient Documents`** --> **`Import`**



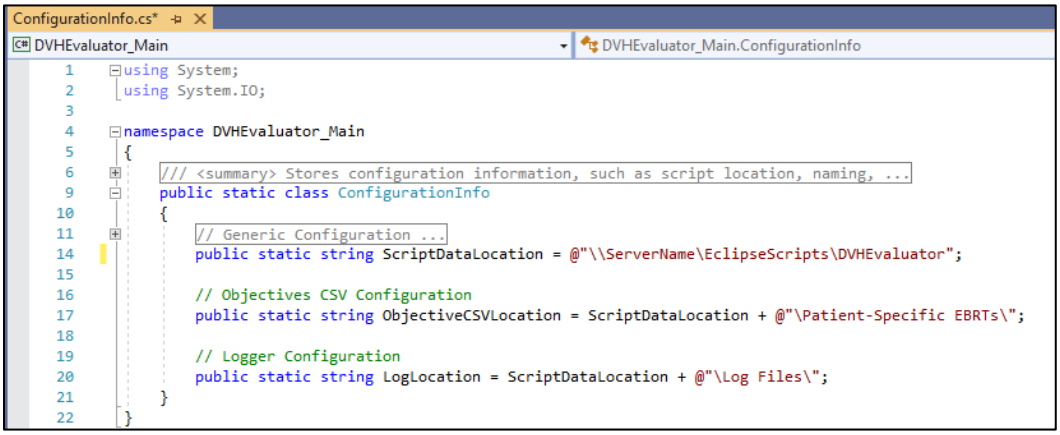
2. Select **`Example_Prostate_Bed_Quantec.doc`** --> **`Open`**



3. **`Assign a Document Type`** --> **`Import`**
    a. Additional document templates can be added for practice-specific planning goals, **provided the structure of the document is not modified**

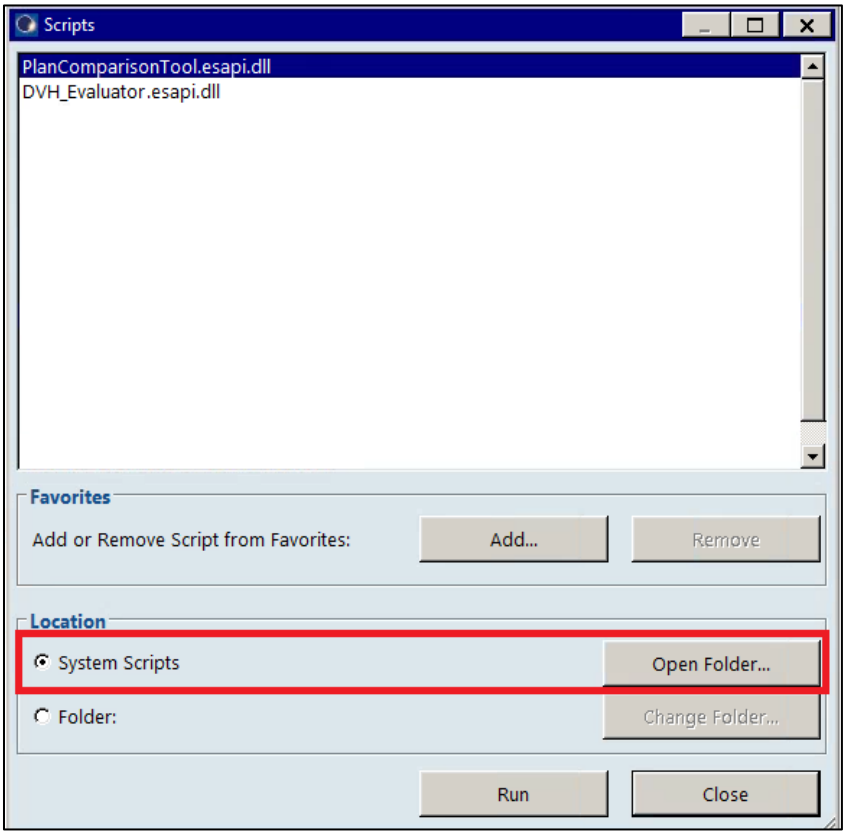
Building and deploying the ESAPI script

1. Prepare the files.
    a. If the files are provided in a **`.zip`** file, extract all files.
    b. Ensure that the main folder is named **`DVHEvaluator_Main`**.
    c. This folder should contain the file **`DVH_Evaluator.sln`**, as well as the folders **`DVHEvaluator`**, **`PlanComparisonTool`**, and several other files and folders.
    d. Modifying any of the file or folder names may cause errors when attempting to compile the code within Visual Studio.
    e. **Note**: The ESAPI code has been written for Eclipse Version 15.6. In order to run with other versions of Eclipse, modifications may be necessary which are outside the scope of this document.
2. Open the provided solution file (**`DVH_Evaluator.sln`**) in Visual Studio.
3. Open the file **`ConfigurationInfo.cs`**, which is located in the **`DVHEvaluator_Main`** project.
4. Update the **`ScriptDataLocation`** variable to the path to the Resource Folder that was previously created.
    a. Your path should replace the words **`Place_your_export_folder_here`**.
    b. **Tip**: It is best to use the full server name, rather than a drive letter, to ensure the server can be reached by all clients.
    e.g.: ***`\\ServerName\EclipseScripts\DVHEvaluator`***



5. Build the solution (**`Build --> Build Solution`** or **`F6`**).
    a. This should produce three files:
    `DVHEValutor.esapi.dll`
    `DVHEvaluator_Main.dll`
    `PlanComprisonTool.esapi.dll`
    as well as supplemental files. By default, these are stored in the **`\build`** folder.

6. Move all files from the **`\build`** folder to the folder from which it will be run in Eclipse. You may choose to use the **`System Scripts`** folder, which can be found in Eclipse by going to **`Tools --> Scripts`**, and choosing **`Open Folder…`** next to **`System Scripts`**.



7. If necessary, approve the scripts in Eclipse. Depending on your local ARIA configuration, scripts may need to be approved by an ARIA administrator prior to running. Consult with your local ARIA administrator if you are unsure.

Application Use

Adding the patient document and extracting constraints

1. Open a Patient in the **`Documents`** workspace
2. **`Add new document from template`** --> **`Example_Prostate_Bed_Quantec`** (or other template with same structure)
3. Click within document
    a. The document information banner may be selected by default.
    b. Click anywhere within the document
4. Press **`Alt+1`**
    a. A **`.csv`** file will be created in the **`Patient-Specific EBRTs`** directory defined above with the following naming convention:
    `(FirstName)(LastName)_(MRN)_(TreatmentSite)_(entered/approved)_(entry/approval date).csv`
    b. Warning messages will indicate if:
        i. The document does not match the expected document format
        ii. The constraints table within the document cannot be identified
        iii. Individual constraints have unrecognized formats
    c. A message box indicating successful export will be displayed with filepath and **`.csv`** file name.
    d. If an error indicates that the output path does not exist, ensure that the path is accessible and has write-access from the ARIA thick client or Citrix App server from which it is running.

Running the program

1. Open a plan or plan sum in Eclipse for a patient for which a DVH Constraints **`.csv`** file exists.
2. Ensure that a DVH Constraint **`.csv`** file for this patient exists in the Resource Folder created previously. This file must be formatted and named according to the convention given in the **`ExampleData`** folder.
3. Running the DVH Evaluator (single plan).
    a. Go to **`Tools --> Scripts`**, and select **`DVHEvaluator.esapi.dll`**. Click **`Run`**.

b. The program will look for a `.csv` file matching the current patient ID in the previously defined folder. Once found, it will analyze the currently loaded plan against the DVH metrics in the file.
c. The results will be displayed in an HTML file, launched with the system default HTML viewer, usually a web browser.

4. Running the Plan Comparison Tool (multiple plans)
   a. Go to `Tools --> Scripts`, and select `PlanComprisonTool.esapi.dll`. Click `Run`.
   b. The program will look for a `.csv` file matching the current patient ID in the previously defined folder.
   c. A window will launch which allows the user to select plans or plan sums in the current patient for comparison.
      i. By default, all currently opened plans and plan sums are selected.
      ii. Plans with invalid dose are not selectable.
      iii. `Run Report`: Click to analyze the currently selected plans.
      iv. `Change EBRT`: Click to choose a different DVH metric `.csv` file.
      v. `Save as CSV`: Click to save all results to a `.csv` file.
   d. The results will be displayed in an HTML file, launched with the system default HTML viewer, usually a web browser.
5. If the program encounters an unrecoverable error, a message box will be displayed to the user indicating the problem and the program will exit. Some common errors are below:
   a. *A patient or plan is not loaded.*
   b. *Too many plan sums are loaded in Eclipse.*
   c. *The directory containing the DVH metric .csv files cannot be found.*
6. If the program encounters minor errors at the analysis step, these will be displayed as Warnings next to the Results on the HTML output file. The bottom of the page will display a summary of all warnings. Some common warnings include:
   a. *The structure was not found or is empty.*
   b. *The DVH metric was not of recognized type.*
   c. *The dose grid does not fully cover the structure.*

Usage Logs

- By default, the program records to a usage log each time the program is run. These logs are stored in the location specified in the **`ConfigurationInfo.cs`** file within ESAPI.
- A new log file is created each day, in both **`.csv`** and **`.log`** formats, to keep the file sizes small. External software can be used to combine the logs and provide usage stats, if needed.
- The log also includes the full trace for any errors encountered. This is useful for the script administrator when troubleshooting errors reported by other users.