Complexity Script Documentation

Release 2.2

Regents of the University of Michigan

September 26, 2016

CONTENTS

CHAPTER

ONE

INTRODUCTION

The Complexity script is used to measure the aperture complexity in inversely planned volumetric modulated arc therapy (VMAT) plans and intensity-modulated radiation therapy (IMRT) plans. The script reports the calculated results of this complexity metric for all opened plans of the patient, for all arcs or fields of each plan, and for all control points per field. In addition, the Complexity script allows the user to compare these metric values to those of previous patients. This feature helps the user assess the relative complexity of the opened plans.

The Complexity script was created to help reduce the number of plans that fail quality assurance (QA). Consequently, the script may be used to help reduce the workload for the QA process. The Complexity script was designed to be used by dosimetrists, physicists, and researchers.

In this documentation and in the script, the aperture complexity metric is known as the *edge metric*. A patient's plan contains m fields, and each field contains n apertures (or *control points*). The edge metric E for an aperture a is calculated as

$$E(a) = \frac{x}{A}$$

where x is the total length of the MLC leaf *side* perimeter (Figure 1.1) and A is the area of the aperture. The edge metric for a field f is calculated as

$$E(f) = \frac{1}{W} \sum_{i=1}^{n} w_i E(a_i)$$

where n is the number of apertures, w_i is the weight of aperture a_i (set to the aperture meterset), and W is the sum of the weights. Similarly, the edge metric for a plan p is calculated as

$$E(p) = \frac{1}{Y} \sum_{j=1}^{m} y_j E(f_j)$$

where m is the number of fields for the plan, y_j is the weight of field f_j (set to the total meterset of the field), and Y is the sum of the weights.

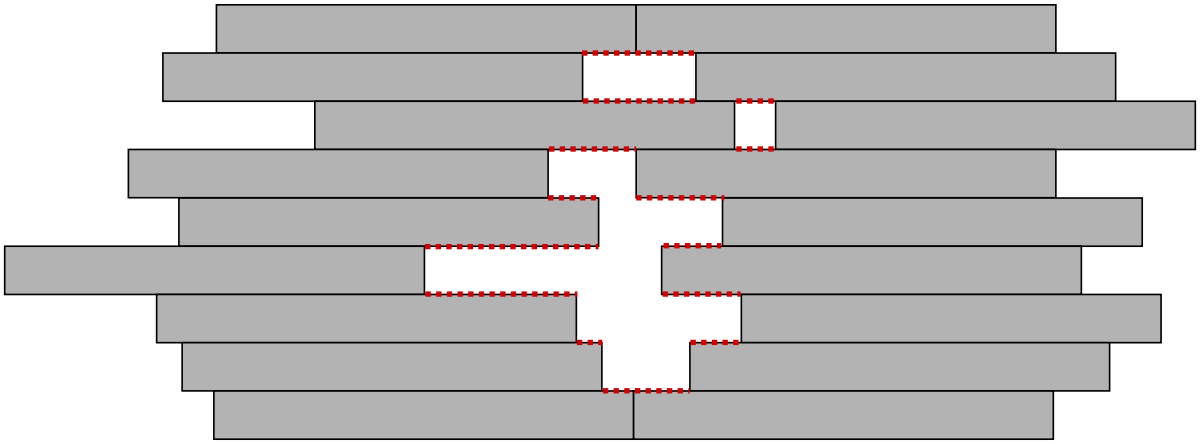

Figure 1.1: The MLC leaf side perimeter (dashed red lines)

CHAPTER

TWO

USING THE SCRIPT

To use the Complexity script, first make sure that the External Beam Planning application (i.e., Eclipse) is running and the patient and the VMAT plans of interest are open. Then:

1. Click on the **Tools** menu item, then select **Scripts...**.
2. Choose the location of the script by clicking on the **Change Directory...** button. The location of the script should have been given to you by the script developer.
3. Click on **Run**.

You will see a window similar to that shown in Figure 2.1.

In the top left quadrant of the window, the edge metric values for each plan and field are shown. Plans are grouped into their courses, which can be collapsed by clicking on the small arrow to the left of the course name. Fields are grouped by the plan in which they belong. For each plan or field, the edge metric value and the MU are shown. The column **Plot** allows you to show or hide each field in the plots.

For VMAT plans, the plot in the top right quadrant of the window shows the edge metric per control point as a function of the control point's gantry angle. For IMRT plans, the plot shows the distribution (as a box plot) of the edge metrics per control point. Multiple fields may be shown on the same plot, and their color corresponds to the background color of the **Plot** column (when it is enabled and checked). The type of plot is automatically determined based on the active plan type, but it may be changed with the option **Plot type** below the table with metrics.

Below the **Plot type** option, there is the **Metric weight** option. It determines how the control point plot will display its edge metric values:

Weighted (normal) This is the normal edge metric calculation described in the Introduction.

Unweighted (metric only) This eliminates all weights from the calculation, so it is effectively the ratio of the MLC side perimeter and the aperture area.

Weight only This is simply the ratio of the MU for that aperture and the total MU for the field.

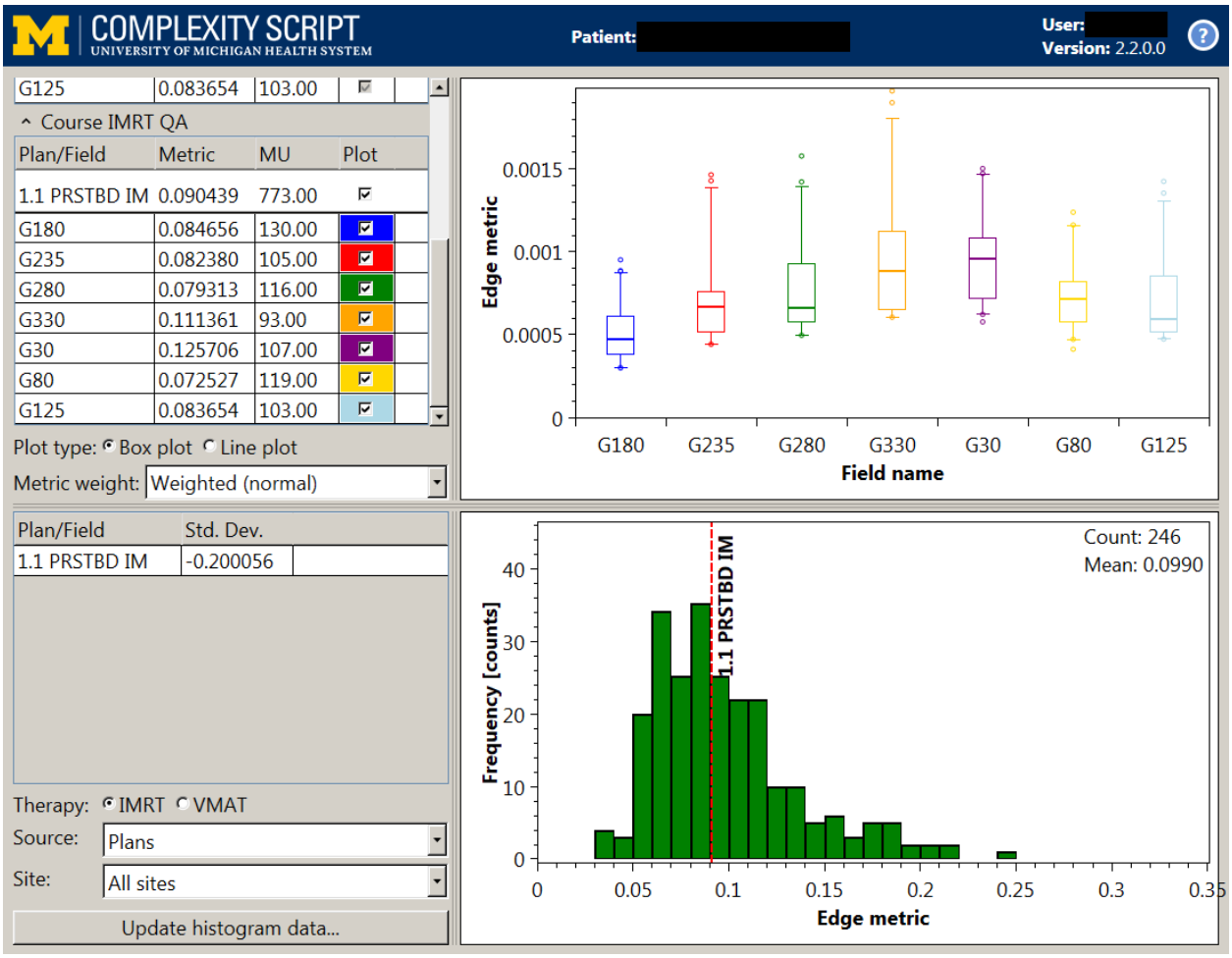

Figure 2.1: Starting window of the Complexity script

The histogram at the bottom right shows the edge metrics for the selected plans or fields in relation to other patients' edge metrics. At the top right of the histogram, the total number of values used for the histogram are shown as well as the mean edge metric for all values. The data for the histogram may include VMAT or IMRT plans, depending on the option chosen (see below).

To the left of the histogram, the standard deviation from the mean edge metric is displayed for each plan or field shown. Below that, there are several options that change the way the histogram is displayed. First, there is the **Therapy** option, where **IMRT** shows data only from IMRT patients, and **VMAT** shows data only from VMAT patients.

Second, there is the **Source** option with two choices:

Plans The histogram is based on the edge metrics of plans for the patients analyzed.

Fields The histogram is based on the edge metrics of individual fields for the patients analyzed (see Figure 2.2).

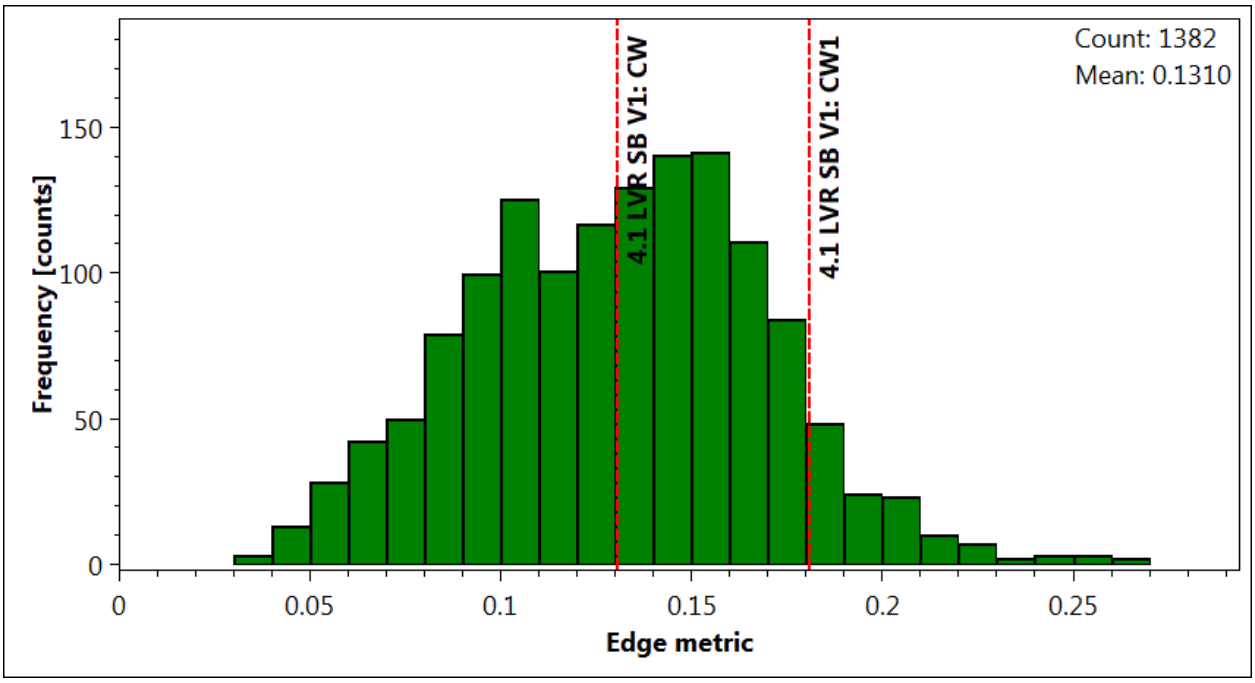

Figure 2.2: Histogram plot with the **Fields** data source selected

The third option is the **Site** with several options, depending on the available sites for the histogram data. These options restrict the data for the histogram shown to the plans that focused on the chosen site. The statistics displayed are re-calculated for the new histogram values.