SCRIPTING RESERVATIONS
Thou shalt not delegate

Scripting permits automation of treatment planning processes and has the potential to lessen manual interventions and human labor with the ambition to standardize workflows and patient treatments. Some reservations:

› Scripting is shifting the responsibilities of vendors to end-users
› Scripting is segregating users rather than leveraging the field
› Scripting is biased and relies on experience and expert knowledge
› Scripting does not guarantee improved quality of care

Medical device companies should warrant improved clinical outcomes for patients. However, experience dictates outcomes. It is no longer ethical for medtech companies to push liability solely on its customers.
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A series of dedicated software modules serving multiple clinical specialties

IMPLEMENTED PLAN AUTOMATION
Mirroring algorithm for minimizing radiological depth

The software calculates the average radiological depth for all treated metastases for the arc geometry loaded and for the arc geometry mirrored across the sagittal plane.

The software will determine whether the original setup or the mirrored version gives the shortest average radiological depth for all treated metastases.

The geometry with the shortest average radiological depth is selected and used for further plan optimization.
IMPLEMENTED PLAN AUTOMATION
Packing algorithm – Intelligently assigning targets to arcs

- A brute-force random numbers algorithm searches for the most optimal distribution of targets by assigning as many targets to as many arcs as possible.
- If two targets share a leaf pair, the algorithm assigns them to different arcs of the same gantry angle. Else, both targets are assigned to the same arc.
- Exceptions are made for situations in which two targets share a mutual pair of a few gantry angles at the extremities of an arc's gantry span. These exceptions will be recorded in the subsequent plan optimization.

IMPLEMENTED PLAN AUTOMATION
Beam margin optimization for controlled dose heterogeneity

IMPLEMENTED PLAN AUTOMATION
Automatic creation of invisible tuning structures
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IMPLEMENTED PLAN AUTOMATION
4π arc setup optimization

IMPLEMENTED PLAN AUTOMATION
Halo algorithm for critical organ sparen

A Halo is an invisible virtual planning object that is automatically created by expanding the Most Important OAR uniformly into all directions. The size of the Halo is related to the Tolerated Coverage Volume of the target. A Halo is created in such a way that the overlapping volume between the Halo and the targeted voxels matches the difference between the Desired and the Tolerated Coverage Volumes. The target voxels covered by the Halo will then be marked as "to be sacrificed" for the optimization. These voxels do not have to fulfill the desired target dose.
IMPLEMENTED PLAN AUTOMATION
Dose shaper for intuitive plan optimization

1. The Dose Shaper allows local shaping of the isodose lines. This feature allows to straightforward "drag and drop" manipulation of the isodose lines.
2. Only one isodose line can be manipulated. As the impact of the dose shaper on the target coverage can be dramatic, it is recommended to use small modifications.
3. For a certain treatment plan only one isodose line can be shaped. To start shaping an isodose line, all previous shaping steps have to be undone.

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IMPLEMENTED PLAN AUTOMATION
SmartBrush Spine for automated clinical target volume generation
IMPLEMENTED PLAN AUTOMATION

Target splitting

For complete vertebrae, the PTV is divided into 8 parts. The parts are subsequently merged until 4 parts are left. At each merging step, two parts are chosen so that the sum of the convex hull volumes of the parts left after merging is minimal.

For partial vertebrae, the PTV is divided into 2 parts by trial-and-error. At each voxel on the skeleton of the PTV, a plane is determined that minimizes the intersection area of the plane and the PTV. The planes are parallel to the craniocaudal axis. If the summed convex hull volumes of the 2 parts is smaller than the convex hull volume of the original PTV, one of the 2 parts may be split again if allowed by the "Maximum number of arcs" parameter.

IMPLEMENTED PLAN AUTOMATION

Arc duplication

PROKNOW TREATMENT PLANNING CHALLENGE
Five brain metastases radiosurgery treatment planning

<table>
<thead>
<tr>
<th>Metric</th>
<th>Min/Max</th>
<th>Ideal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of each GTV covered by 20 Gy</td>
<td>95</td>
<td>99</td>
</tr>
<tr>
<td>Maximum dose to the outer contour</td>
<td>&lt; 40</td>
<td></td>
</tr>
<tr>
<td>Dose (Gy) covering 0.3 cc of the Brainstem</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Volume (cc) of the Normal Brain covered by 10 Gy</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>Volume (cc) of the Normal Brain covered by 12 Gy</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Volume (cc) of the Optic Chiasm covered by 8 Gy</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>Maximum dose (Gy) to the Optic Chiasm</td>
<td>8</td>
<td>2.5</td>
</tr>
<tr>
<td>Volume (cc) of the Optic Nerves covered by 8 Gy</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>Mean dose (Gy) to the Hippocampus</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Maximum dose (Gy) to the Lenses</td>
<td>&lt; 2</td>
<td></td>
</tr>
<tr>
<td>Maximum dose (Gy) to the Eyes</td>
<td>&lt; 8</td>
<td></td>
</tr>
</tbody>
</table>
TREATMENT PLANNING STANDARDIZATION
Intermediate results from the global plan comparison study

For ten Elements customers from United Kingdom, Europe and Latin America, ten different plans were compared for planning a five-brain metastases case. The results were compared against a database of sixty-one plans created by a total of six Eclipse planners located in United States, France, and Australia. Each planner worked on a total of ten cases. The planning times ranged from one to ten years.

The estimated planning times in minutes were 75.6 ± 63.0 for Elements versus 676.1 ± 760.3 for all other treatment planning systems.

More information on this project can be found at:

- Eclipse Elements...