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Scripting in Eclipse: new opportunities to evaluate treatment plans

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GET THE SCRIPT!

Introduction:

The evaluation of treatment plans, and in particular the comparison of the dose distribution, is usually done in a subjective way. Literature provides many methods of quantitative comparison of treatment plans, nevertheless the possibilities of using them directly in treatment planning systems - also as popular as Eclipse TPS - are very limited.

The calculation of appropriate indices outside of TPS requires dose-volume histograms export and time-consuming, error prone data processing, which makes the whole process ineffective in clinical practice.

Background:

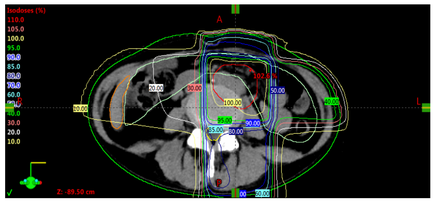
To avoid an inefficient one-by-one analysis of images with organs-isodoses relative arrangement (A), treatment planning systems provide statistics summaries. The most popular ones are dose statistics tables (B) and dose-volume histograms (C).

Usually, to evaluate plan one needs to conduct a complex analysis including:

- searching all important structures in the Dose Statistics table and evaluation of dose coverage, max. & mean dose (TPS Eclipse itself provides only Conformity Index and Gradient Measure as a consolidated plan evaluation)
- review of a dose-volume histogram and, in case of many plans, comparison of corresponding curves which in case of many organs at risk can give ambiguous conclusions

what makes the whole process subjective.

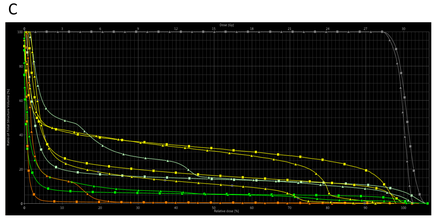
A



B

Show DVH	Structure	Plan	Volume [cm³]	Dose Covrd [%]	Min Dose [%]	Max Dose [%]	Mean Dose [%]	Conformity Index	Gradient Measure [cm]
☑	BODY	1	29054.8	100.0	0.0	106.7	5.3	N/A	N/A
☑	CTV	1	32.2	100.0	97.1	104.6	101.5	N/A	N/A
☐	Bladder, NOS	1							
☐	Rectum, NOS	1							
☑	CTV	1	166.8	100.0	94.0	106.3	100.8	2.00	2.08
☐	głowa k.u.L	1							
☐	głowa k.u.P	1							
☑	skin	1	2265.1	100.0	0.0	106.7	6.3	N/A	N/A
☑	oko	1	1076.8	100.0	0.4	106.5	16.6	N/A	N/A
☑	kanał kręgowy	1	46.8	100.0	0.0	98.1	31.4	N/A	N/A
☑	nerka L	1	129.5	100.0	0.0	105.5	19.2	N/A	N/A
☐	nerka P	1							
☑	liver	1	1125.1	100.0	0.1	104.0	1.4	N/A	N/A
☑	BODY	2	29054.8	100.0	0.0	102.8	5.0	N/A	N/A
☑	CTV	2	32.2	100.0	97.1	102.3	100.2	N/A	N/A
☐	Bladder, NOS	2							
☐	Rectum, NOS	2							
☑	CTV	2	166.8	100.0	94.2	102.8	99.7	0.74	4.00
☐	głowa k.u.L	2							
☐	głowa k.u.P	2							
☑	skin	2	2265.1	100.0	0.0	102.8	7.3	N/A	N/A
☑	oko	2	1076.8	100.0	1.1	102.8	23.9	N/A	N/A
☑	kanał kręgowy	2	46.8	100.0	0.0	97.5	27.5	N/A	N/A
☑	nerka L	2	129.5	100.0	1.5	94.1	13.7	N/A	N/A
☐	nerka P	2							
☑	liver	2	1125.1	100.0	0.7	89.4	4.1	N/A	N/A

C



Aim:

In order to overcome the described difficulties, the aim was to create a tool integrated with TPS Eclipse for quantitative comparative analysis of treatment plans, the use of which will not disturb the treatment plan preparation. The tool should allow the user to choose treatment plan evaluation index and it should allow to consider treatment priorities.

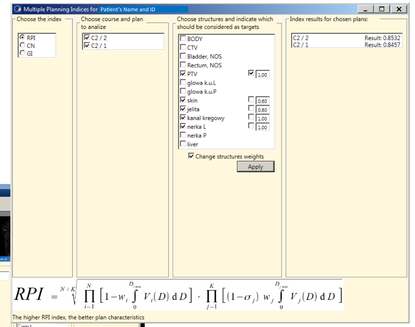
Materials and Methods:

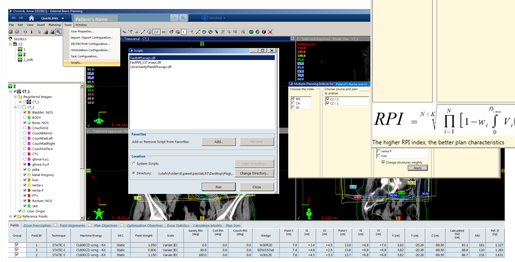
To achieve the goals, the Eclipse Scripting API (ESAPI) [1] was used, which gives access to many treatment plan parameters and allows to create applications integrated with the Eclipse system. According to the ESAPI methodology, the domain logic of the program was prepared in C #, the graphic user interface in WPF, and also the libraries provided by VMS were used: VMS.TPS.Common.Model.API, VMS.TPS.Common.Model.Types. The Linq to Objects component was used to improve collections manipulation.

Results:

Compare plans in just a few clicks:

1. Tools -> Scripts... -> Choose desired script
2. Choose index as a base to comparison
3. Choose plans from available in patient context





4. Choose structures and assign them weights (only RPI index)
5. Analyse results

Conclusions:

The prepared plugin enables real time comparison of treatment plans by calculating several selected evaluation indices — Radiation Planning Index, Conformation Number, Gradient Index (where the first one allows to take into consideration treatment priorities — one may select structures and assign them weights).

The presented method can significantly facilitate the final decision on the selection of the treatment plan without prolonging the entire treatment preparation process.

The tool can be very useful when designing new planning techniques or comparing the existing ones when to apply to non-typical treatment circumstances; the script is able to compare any number of plans on a basis of identical assumptions. Through the reasoned choice of indices it provides the universal evaluation tool for plans created in the TPS Eclipse.

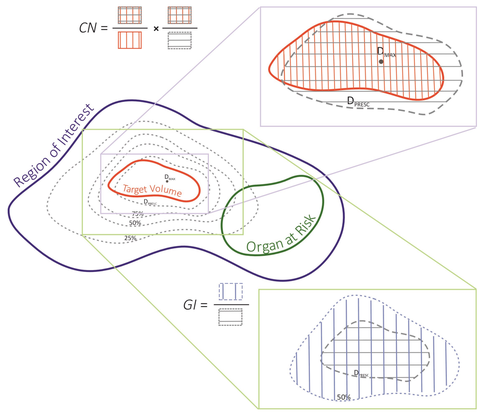
How to get:

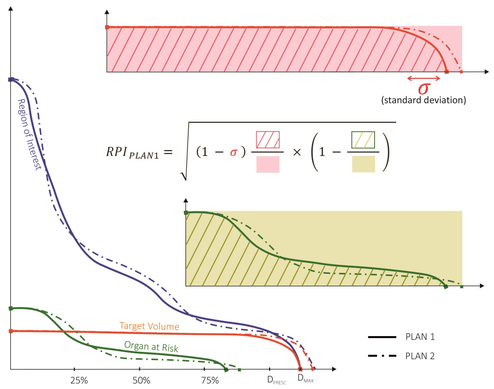
Go to https://github.com/IOG-RTPlanning/FastMPI/releases/tag/v1.0 or scan the QR code.

Currently available indices:

The indexes are chosen to facilitate multipronged comparative quantitative analysis of plans.

- Conformation Number (CN) [2] — compares a prescribed isodose volume to a target volume and checks how the former one covers the later one
- Gradient Index (GI) [3] — lets to check how much dose will be applied to tissue outside a target volume





- Radiation Planning Index (RPI) [4] — the geometric mean of (weighted) contributions from all chosen structures with dose relative to max dose for given structure and for all plans
  - takes into account protected structures
  - useful for multi-target plans
  - through standard deviation take cognisance of homogeneity of dose in a target

Bibliography:

1) Eclipse Scripting API Reference Guide (version 13.7), Varian Medical Systems, document ID: P1013132-001-A , June 2015
2) L. Feuvret et all, „Conformity Index: A Review" Int. J. Radiation Oncology Biol. Phys. Vol. 64, No. 2, pp. 333-342, 2006
3) I. Paddick et all, „A simple dose gradient measurement tool to complement the conformity index", J. Neurosurg. (Suppl.) Vol. 105, pp. 194–201, 2006
4) K. Slosarek et all, „Radiation Planning Index for dose distribution evaluation in stereotactic radiotherapy", Rep. Pract. Oncol. Radiother. Vol. 13/4/, pp. 182-186, 2008