Normal Tissue Complication Probability in Radiotherapy: use R! for modeling clinical outcomes

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Background: A critical topic in radiation oncology, where statistical modeling is gaining an important role, day after day, is the definition of Normal Tissue Complication Probability (NTPC) calculation after the administration of radiotherapy treatment. The NTCP models can be achieved using procedures of optimization where radiation dose-volume data (usually matrices of radiation dose-volume data achieved by treatment planning workstations) are fitted on clinical outcomes data that are achieved by following patients after the radiotherapy treatments. These outcomes are usually provided as binary outcome (presence/absence of some side effects due to treatment).

Material and methods: *R* software has been used to create a series of functions for importing dose-volume data achieved by radiotherapy treatment planning workstations. Data have been processed by using `glm` function fitted on dose-volume data. Both profile likelihood and bootstrap methods for parameters confidence intervals have been implemented by creating ad-hoc functions. Parallel computing for speeding up bootstrap calculation has been implemented using **doMC**, **iterators** and **parallel** packages. Models used for the procedure of dose-volume fitting to outcome are normal (Gaussian) (Burman et al. 1991) and logistic cumulative density functions (Gay and Niemierko 2007). These two functions are extensively used in radiotherapy dose-response models because they have been shown to better describe the effect of radiations on normal tissues. An example of fitted model with dose response curves is given in fig. 1, the confidence intervals and the quantiles of cases distribution have been plotted too by `fit.NTCP` and `plot.NTCP` functions in the script.

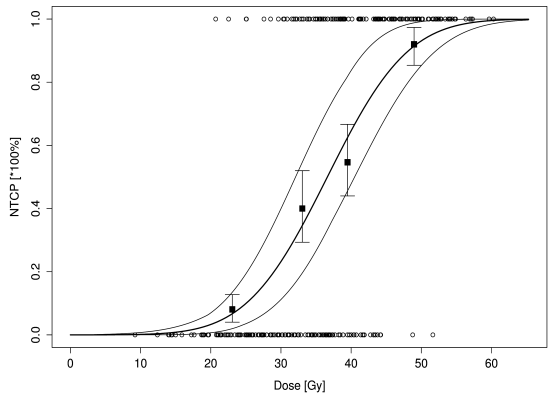

Figure 1. Example of plot of dose-response NTCP function.

Results and further developments: actually the functions of radiotherapy dose-response modeling have been packed in a single script by creating S3 functions to be used simply by loading the functions in the *R* environment. Further developments have been scheduled in order to release a complete package compiled according the requirements of CRAN for the R software package distribution.

References

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