Linear Programming approach for Radiation treatment planning

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1 Abstract

In the field of Radiotherapy, the main problem remains planning of the radiation dosimetry. Radiation should be distributed in a way that tumor's tissue receive the density higher than critical dose specified for ill tissue's local collapse. Meanwhile the healthy area in vicinity of tumor should recieve the lowest possible density of radiation.

Let's construct a simple $(x, y) \in \mathbb{R}^2$ model of radiation beams formed in a square and applied to a square shaped area.

Dividing the tissue to small squares (cells) of the same surface, each cell is representing a healthy or ill part of it. The applied radiation has N sources providing a different density. For case of a square shaped radiation, each cell receives a density of $R_{i,j} = a_i x + b_j y$. Our conditions dictate that the healthy cells status after radiotherapy is $R_{i,j} \leq D$ and tumor cells status is $R_{i,j} \geq D$, where D is critical radiation dose.

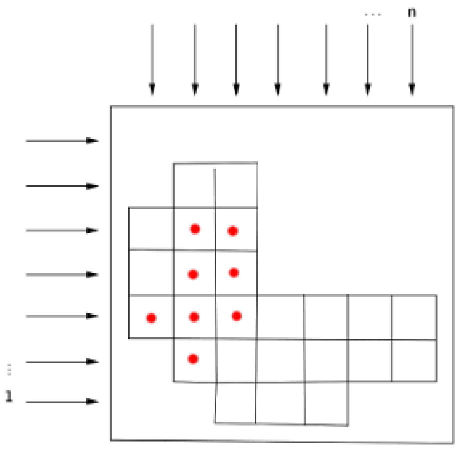

Figure 1: 2D model of tissue exposed to square-formed radiation. Squares filled with red color are marked as ill part of the tissue (tumor).

The density of radiation as a function of its distribution will be optimized by method of linear programming. Specifically, our linear minimization problem will be solved by the Simplex method. We will first discuss the problem described above, and later on, for more realistic results, we will also examine radiation source in a shape of a circle. At last, the dependency of the thickness of healthy cells on tumor cells will also be shown.

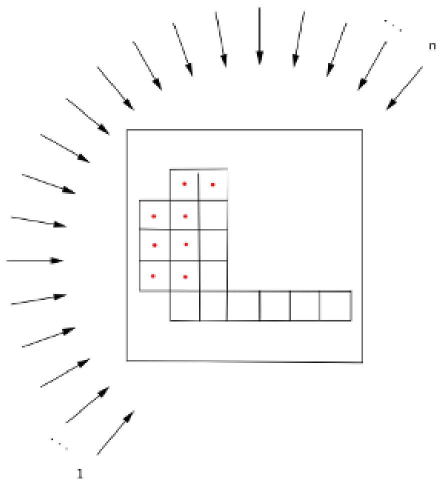

Figure 2: 2D model of tissue exposed to circle-formed radiation. Squares filled with red color are marked as ill part of the tissue (tumor).

References

[1] V. Chvátal: Linear Programming, Freeman, New York, 1983.

[2] A. Olaffson, S. J. Wright: Linear Programming Formulations and Algorithms for Radiotherapy threatment Planning, University of Wisconsin, 2006.

[3] R. J. Vanderbei: Linear Programming: Foundations and Extensions, 2. edition, Kluwer, Boston, 2001.