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Description of Research Seminar: Simultaneous beam angle and fluence intensity multi-objective optimisation in intensity modulated radiation therapy

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Participants:	UGOE UNIKL DTU UOA UC
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Research Seminar

offered by Guillermo Cabrera G. (UoA)

in July 15th, 2013

in Kaiserslautern, Germany

Subject: Multi-objective optimisation in intensity modulated radiation therapy

Problem: External radiation therapy is one of the major treatment forms for cancer. Its goal is to eradicate tumour cells by delivering ionising radiation from an external source to a planning target volume including the tumour without compromising surrounding normal tissue and organs at risk. However, because of the physics of radiation delivery, there is a tradeoff between tumour control and normal tissue sparing. The most common form of radiation therapy is intensity modulated radiation therapy (IMRT). In IMRT, radiation can be modulated using a device called multi-leaf collimator. To design a treatment plan, the number and directions of radiation beams are determined first. Then, the optimal fluence of radiation for each beam angle needs to be computed. Finally, a sequencing problem needs to be solved to control the movement of the MLC leaves during delivery of the optimised fluence. In this seminar the focus is on the second problem, known as the fluence map optimisation (FMO) problem. This problem is addressed from a multi-objective point of view. Objectives of our multi-objective model are based on a well-known measure of the biological effects of the delivered radiation dose called the generalised equivalent uniform dose ($gEUD$). $gEUD$ is a convex as well as positively homogeneous function of the dose delivered to a specific region. Therefore, the objectives of our multi-objective problem are the maximisation of the $gEUD$ for the tumour and the minimisation of the $gEUD$ for all the organs at risk and normal tissues.

Main Results: We have demonstrated that positively homogeneous multi-objective optimisation problems with p objective functions can be solved as multi-objective optimisation problems with p - 1 objectives. We have sketched a procedure that allows the generation of an infinite number of efficient solutions located on a finite number of rays, each of which corresponds to an efficient solution of the reduced p - 1 objective problem. We have shown how these findings can be used to solve the multi-objective FMO problem with $gEUD$-based objectives.

Participants: Researchers from UoA

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