Integer Programming Methods for Implementing Cancer Radiation

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Radiation therapy is one of the preferred therapy forms to fight cancer. In previous meetings of the GOR group on health, OR models have been presented which can be used to compute "good" radiation plans, i.e. a sequence of radiation profiles which will destroy the cancer, but leave healthy organs close to the cancer tissue unharmed.
In this talk, we will concentrate on the actual implementation of the radiation. The most modern way to do this is by modulation using pairs of metal leafs (so-called multileaf collimators, MLC) to block out the radiation of a uniform field. The goal is to represent the radiation profile by a sequence of elementary profiles.
In the OR model, each profile corresponds to an integer matrix and the elementary profiles can be written as matrices with entries consisting only of zeros and ones (0,1-matrix). The MLC problem can be formulated as the partitioning problem of writing a given integer matrix as sum of 0,1 matrices. The sequence has to satisfy a variety of constraints coming from technological constraints on the MLC set-up including the consecutive-1 property (where the 1s correspond to the area in which radiation can pass through).
In order to minimise the treatment time (a decisive parameter for successful therapies!) several objective functions are considered. We show how to tackle this problem using integer programming approaches and report on first numerical results, which show that our new OR approach is improving the quality of the radiation implementation compared with currently available software.