AbstractID: 4822 Title: Efficient Selection of Beam Number and Orientations for Intensity Modulated Radiotherapy (IMRT) by Emulating an Ideal Dose Distribution

Purpose: Since radiotherapy treatments only utilize a limited number of beams, it is important that these beams be carefully selected to extract maximum benefit. Here we propose a novel, fast, scheme that selects beam number and orientations for IMRT with the goal of emulating an ideal dose distribution resulting from a very large number of beam orientations.

Method and Materials: The procedure starts by optimizing IMRT fluences for a large number of beam orientations (ideal dose distribution). A subset of these orientations is then sequentially selected to emulate this ideal distribution, using an orthogonal QR factorization method (dose-volume constraints are respected). The use of QR factorization, rather than a full optimization, makes the process time-efficient. During the procedure, previously selected beams are replaced by beams that are more capable of emulating the ideal distribution. The number of beams is chosen as that above which there are only marginal gains in a least-squares objective function. The procedure was tested on a head-and-neck case (non-coplanar orientations) and a prostate case (coplanar orientations).

Results: For the head-and-neck case, the objective function (normalized to 1 for the ideal distribution) decreased with increasing orientations as: 14.43 (3 beams), 9.26 (4), 2.59 (5), 1.81 (6), 1.64 (7). Beyond 6 beams, objective function gains are marginal. The actual plan used to treat this patient yielded a 455% higher objective function, for the same number of beams (6). For the prostate case, the corresponding numbers were: 1.69 (3 beams), 1.30 (4), 1.15 (5), 1.11 (6). In this case 5 beams appear sufficient. The actual clinically used beams were 6% higher (5 beams). Computer time was on the order of 1 -3 hours on a 1 GHz laptop processor.

Conclusion: The procedure presented here shows great promise in extracting greater benefit from IMRT by optimizing beam number and orientations.