EPSTEIN INSTITUTE SEMINAR ▪ ISE 651

Optimal Fractionation in Radiotherapy

ABSTRACT - The goal in radiotherapy for cancer is to maximize tumor-kill while limiting toxic effects on nearby healthy anatomies. This is attempted via a two-pronged approach: spatial localization of radiation dose, and temporal dispersion of radiation dose.

The spatial component involves prescribing a high dose to the tumor and putting upper limits on the dose delivered to the healthy anatomies. The radiation field's intensity profile is then optimized to meet this treatment protocol as closely as possible. This is called fluence-map optimization. The temporal component of the problem involves breaking the total planned dose into several treatment sessions called fractions, which are administered over several weeks. This gives the healthy tissue some time to recover between sessions, as it possesses better damage-repair capabilities than the tumor. The key challenge on this temporal side is to choose an optimal number of fractions and the corresponding dosing schedule. This is called the optimal fractionation problem, and has been studied clinically for over a hundred years.

I will utilize the prevalent linear-quadratic model of radiation dose-response to discuss the optimal fractionation problem from a mathematical viewpoint. The resulting formulation is a nonconvex quadratically constrained quadratic program (QCQP), whose exact solution had remained elusive for a long time. I will show the perhaps surprising result that this nonconvex QCQP can in fact be tackled exactly in closed-form via the solution of a linear program with two variables. I will also present implications of this result to robust and inverse variants of the optimal fractionation problem. If time permits, I will present an extension and an exact solution method rooted in Karush-Kuhn-Tucker conditions, for the problem of simultaneously selecting an optimal radiation treatment modality and a fractionation plan

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SPEAKER BIO – Archis is a Professor and Associate Chair in the Department of Industrial & Systems Engineering at the University of Washington in Seattle, where he currently holds the College of Engineering Endowed Professorship in Healthcare Operations Research. He joined the University of Washington as an Assistant Professor in 2006 after receiving a PhD in Industrial and Operations Engineering from the University of Michigan in 2006, and an MS in Management Science and Engineering from Stanford in 2003. He completed his undergraduate education at the Indian Institute of Technology, Bombay, India, in 2001. Archis is a recipient of the NSF CAREER award, and of the award for Excellence in Teaching Operations Research from the Institute of Industrial Engineers. Archis has served on the editorial boards of several journals.

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