A Review of “A Chance Constrained Programming framework to handle uncertainties in radiation therapy treatment planning” by Dr. Gino Lim

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# Overview of Seminar Subject

In 2015, NCI estimates 1620 people per day died because of cancer and cancer is the second leading cause of deaths in the US. Radiation therapy treatment, a very effective approach for fighting with cancer, is becoming more and more important. A good radiation therapy plan will largely improve the treatment effect and minimize damages on patients’ body as well as life quality. In this talk, the speaker presents their novel mathematical programming based radiation therapy planning scheme.

# Key Topics

The study consists of 2 parts. The first part is an overview of the radiation therapy treatment planning and the challenges in designing plan. Followed by that, stochastic optimization models are introduced and details are discussed

1. **Overview of the radiation therapy treatment planning and challenges**

The radiation therapy treatment always starts with acquiring digital images of the internal anatomy. And physician or therapist needs to delineating the targets and the critical structures. The reason is because that radiation kills concerous cells and it also destroys healthy cells. We always want to deliver high dose of radiation to the target regions (tumor region) while avoiding excessive does on critical structures (normal tissues and organ-at-risk). The challenge for radiation therapy planning is uncertainty. Currently most radiation therapy machine is based on pencil beam model. The major advantages of this model is that it can concentrate the radiation onto a very small region, which can be much smaller than the machine control accuracy. Hence, the uncertainty is caused the machine control. It can be very hard to further improve the machine control accuracy. Therefore, the speaker’s team proposes to search along another trail, the robust optimization approach and try to use power of operations research to optimize the radiation therapy design.

1. **Stochastic optimization models for radiation therapy planning**

To address uncertainty in radiation therapy planning, the speaker’s team proposes two different mathematical programming model: chance constrained programming (CCP) and distributional robust CCP (DR-CCP). The motivation for the above models is that the uncertainty is un avoidable and in clinical work usually physician would prefer having a treatment plan with a minimum violation of feasibility. It is perfect for CCP as it was designed to handle the case that one can allow the constraints violated within some tolerance with some probability at most. By using the technique in CCP, the speaker’s team derives the CCP-N model, which first maximizess the confidence levels and then optimize the hard bounds. Furthermore, by utilizing a more advanced technique called distributional robust optimization, DR-CCP model is also proposed. Finally, the numerical tests justify the correctness and efficiency of both CCP-N and DR-CCP.

# Contributions of the Work Presented to the Tools or Practice of Operations Research

The study develops user friendly optimization approaches CCP-N and DR-CCP for radiation therapy planning problem. Confidence levels and uniformity of does distributions, as well as the plan’s quality and robustness are optimized. The effectiveness of developed models is tested and verified using real patient data.

# Assessment of the Presentation

## Transparencies: The slides are carefully designed and the story line is very clear and attractive.

## Other visual aids: The figures and plots are very helpful.

## Speaking style: The speaker keeps a very good pace and easy to follow.

## Organization of the presentation: Well organized. The presentation starts the background on radiation therapy and end up with details in model and numerical examples.

## Addressing questions: Very good. The presenter answers questions with helpful details

## Summary

This work address a very important problem in healthcare, the radiation therapy planning problem. A very good overview on motivation is given and we can easily know why it is important and challenging. After clearly delivering the uncertainty in radiation therapy planning is unavoidable, the mathematical programming approach is proposed. From my understanding, it is a very smart idea. Because we could maximize the power of the current clinical settings. Paying more effort on developing new radiation therapy machine without knowing whether we have already made full use of what we have is not wise.