MSIS 638

Case 2.4a

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1. Consider the radiation therapy treatment planning discussed in Chapter 2. Assume there are 30 coplanar candidate beams. If the physician wants to choose five beams, how many combinations are possible? (Hint: search “how many ways you can choose items out of items?”)

Approach 1.

30\*29\*28\*27\*26 / 5\*4\*3\*2 = 142,506 (ways)

Approach 2.

30! / 5! \* (30-5)! = 30\*29\*7\*27\*26= 142,506 (ways)

Reference:

<https://www.nagwa.com/en/videos/412140487378/>

1. Given that the impact of adjacent beams is similar, a good heuristic to reduce the computation time is excluding configurations in which two or more beams of the five selected beams are adjacent. We want to find an upper bound on the number of possible configurations in which no two beams are adjacent.

* 1. Group each two adjacent beams into one group (beams 1 and 2 will be grouped together, beams 3 and 4 will be grouped together, etc.). How many groups will there be?

15 groups by counting (1,2), (3,4), (5,6), (7,8), etc.

* 1. Given that choosing adjacent beams is not allowed, at most one beam in each group can be chosen. How many ways you can choose five beams from different groups of beams?

Using interpolation method: (30-5 =25, 25+1=26)

26! /5! (26-5)! = 26\*25\*24\*23\*22 / 5\*4\*3\*2 = 65,780

* 1. Comparing the number of possible configurations before and after grouping beams, calculate the percentage reduction in the number of possible configurations, and hence, the computation time.

15\*14\*13\*12\*11 / 120 = 3003

Before: 142506 ; After: 65780

142506-65780 / 142506 = 0.54 = 54%

1. Explain why the *actual* number of possible configurations in which no adjacent beams are chosen is indeed smaller than the number calculated above.

The reason why actual number of possible configurations are lesser than calculated numbers above is about the effectiveness of implementation. With adjustment, some configurations might not be suitable for the situation. We need to find the optimal solutions by testing before getting the conclusion. To figure out the actual possible way of combination, we need to take more limitations and read world setting into accounts.