



Memorial Sloan Kettering
Cancer Center

A novel computationally tractable algorithm to integrate **SOFT AND HARD** dose-volume constraints into imrt fluence optimization

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ECHO brief introduction



Planner runs ECHO plug-in from TPS

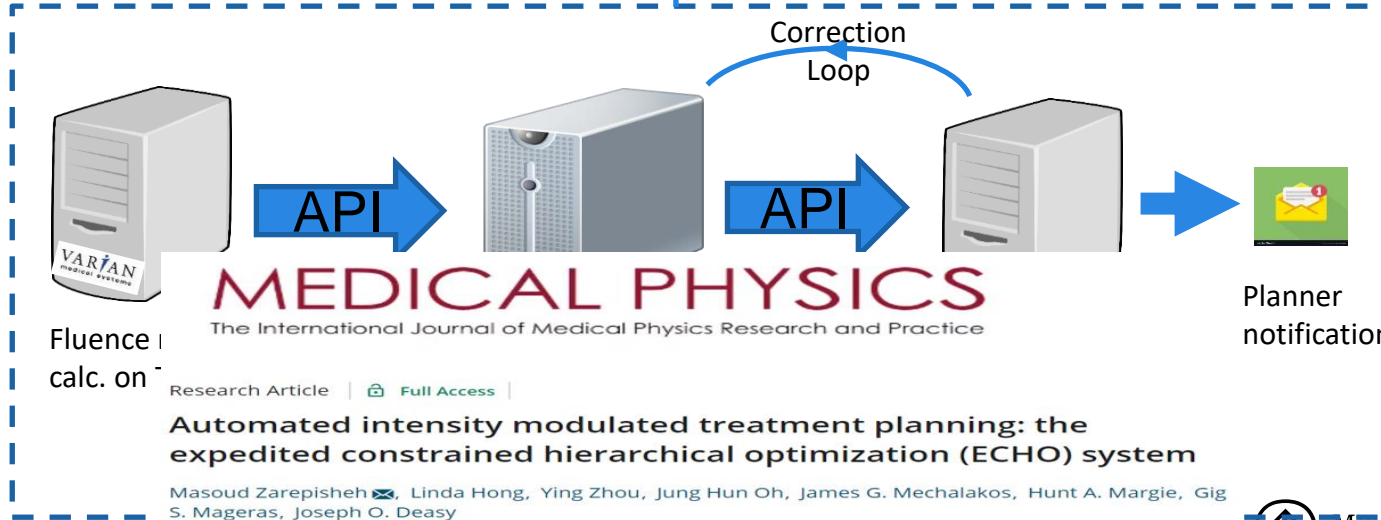


Planner evaluates the plan



~1 hour

MSKCC ECHO





Dose Volume Histogram (DVH) Constraints

1. Commonly used in clinic
2. Result in computationally challenging non-convex problems

Mixed Integer Programming (MIP)

- ❖ Mathematically rigorous **BUT** computationally expensive

$$\text{DVC: } V(1 \text{ Gy}) \leq 70\%$$

$$b_i = \begin{cases} 1 & \text{if } D \geq 1 \\ 0 & \text{if } D < 1 \end{cases}$$

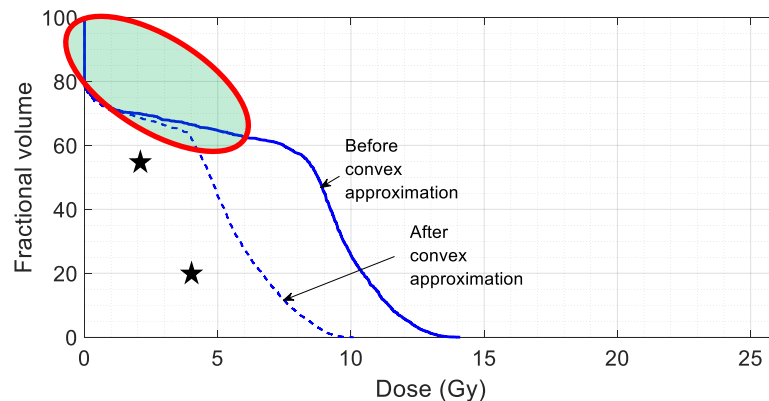
Binary variable

$$\sum_{i=1}^N b_i \leq 70\% * N$$

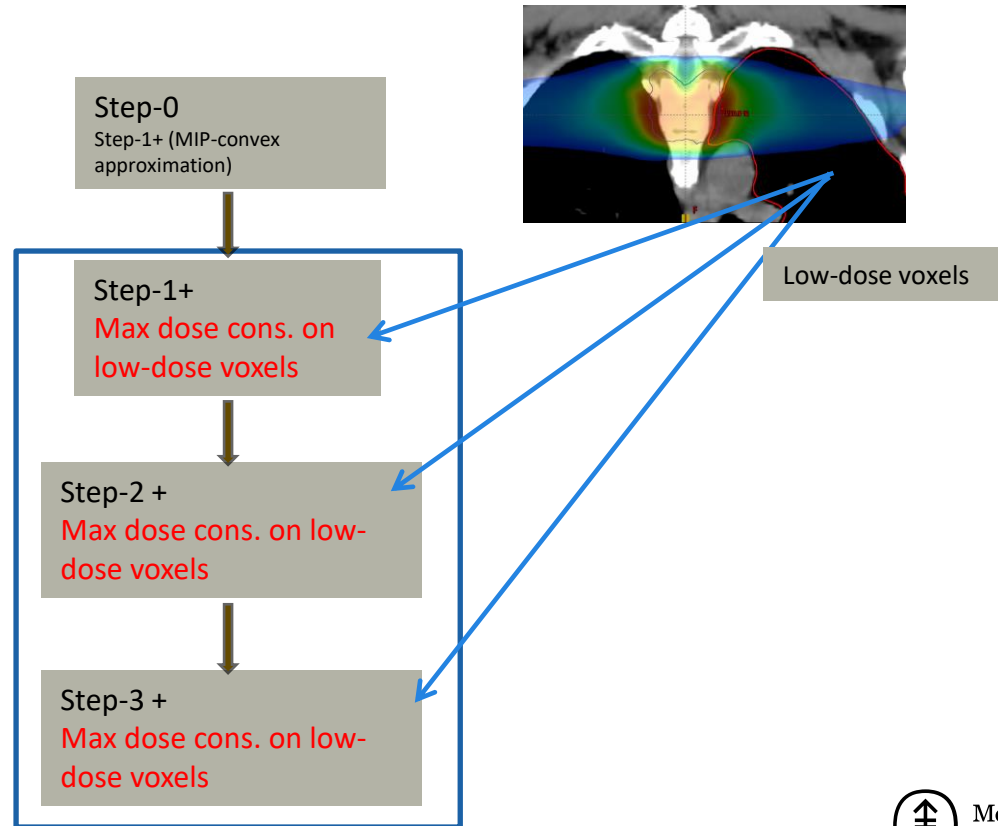
❖ Convex relaxation

- ❖ Computationally tractable
- ❖ No guarantee
- ❖ Encourage DVH constraints

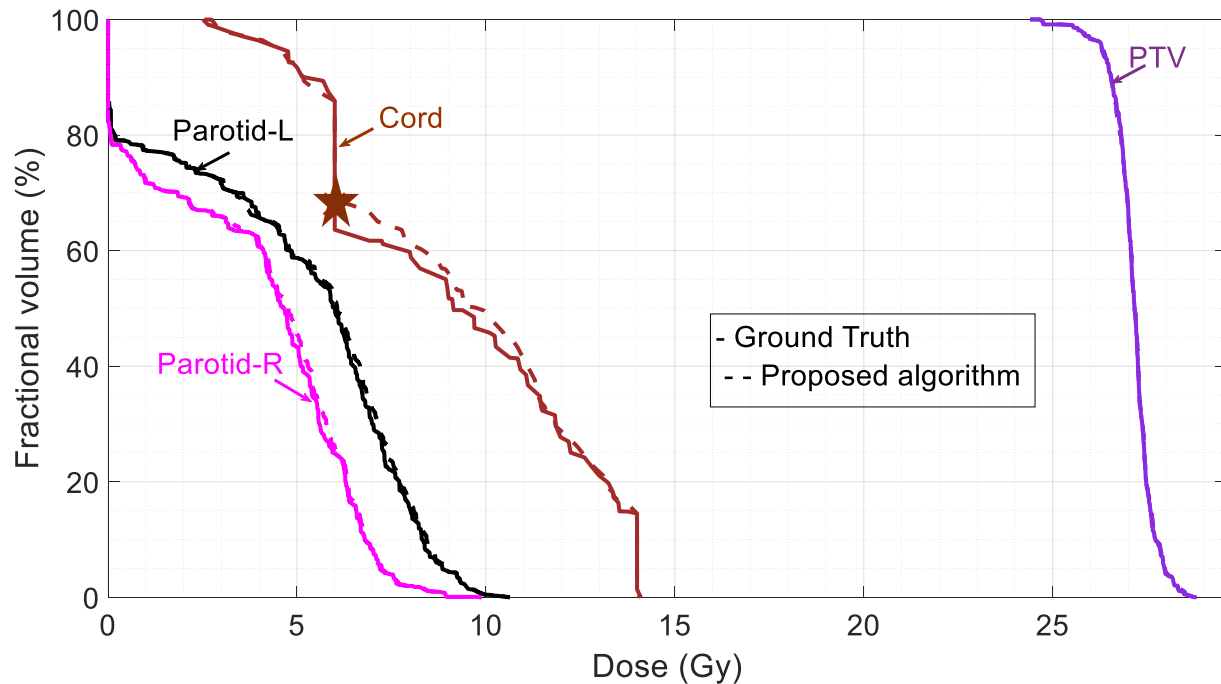
$$b_i \in \{0,1\} \quad \longrightarrow \quad b_i \in [0,1]$$



ECHO with DVH Constraints



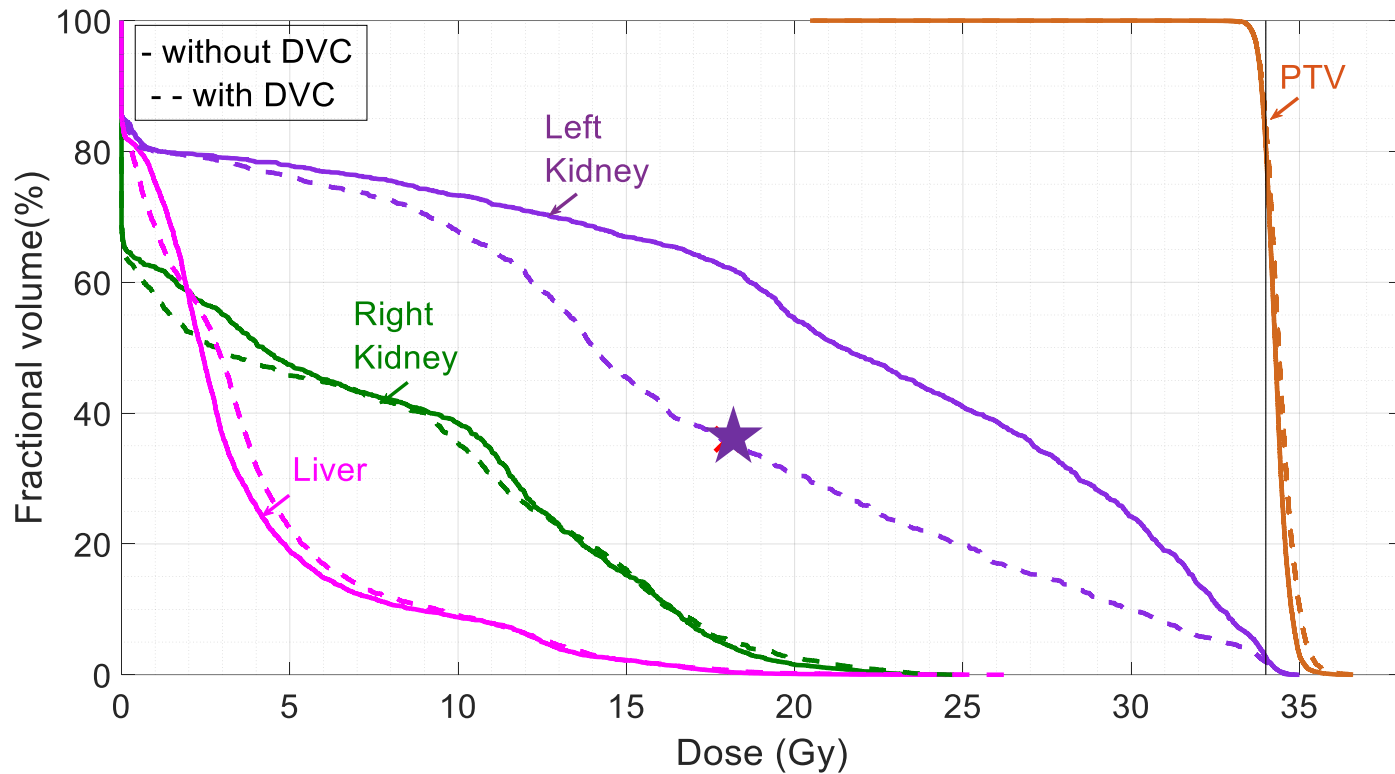
Ground-truth Comparison



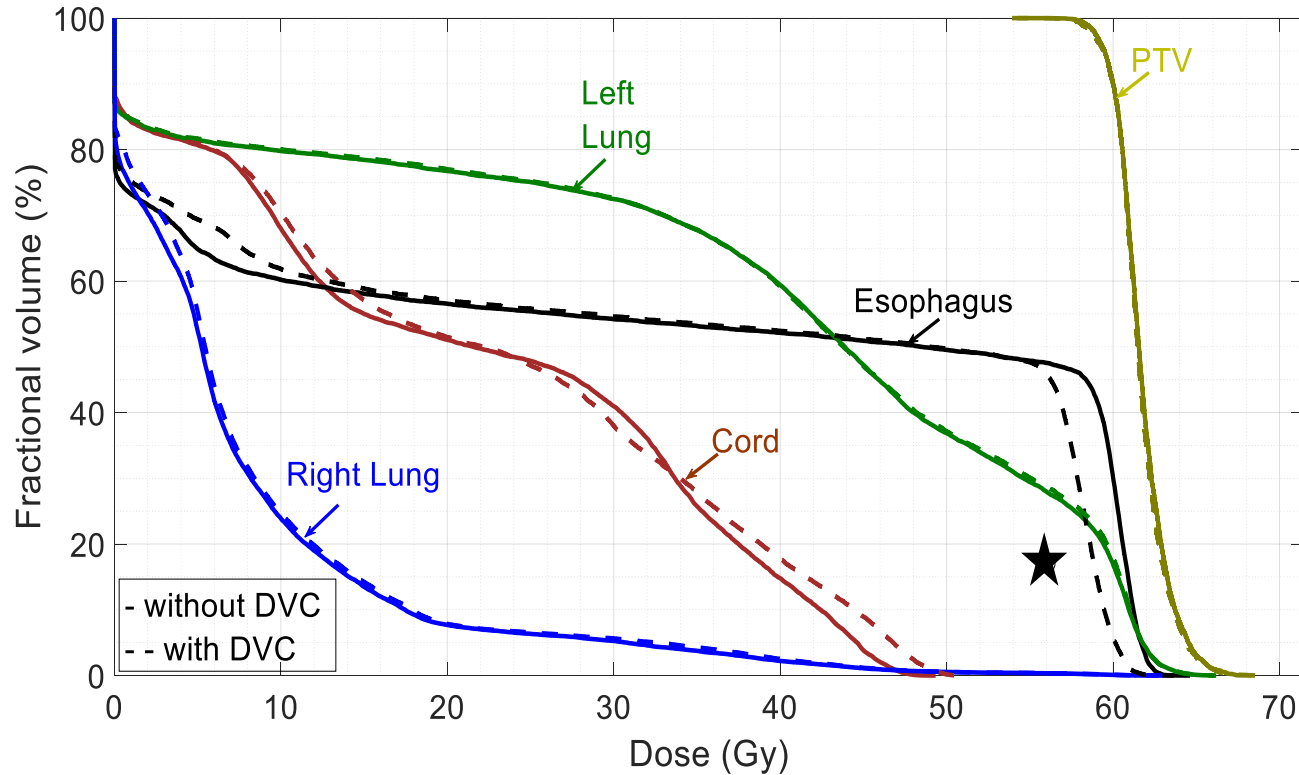
Ground-truth	Proposed algorithm
~15 hrs	3 minutes



Paraspinal Case



Soft DVH Constraint (Lung case)



Summary

- **ECHO:**

- In-house automated treatment planning system
- Integrated with Eclipse using scripting capabilities
- Part of our daily clinical practice (treated > 1000 cases)

- **DVH Constraints:**

- Computationally tractable algorithm (adds 20-30% to the computational time)
- Can handle both hard and soft DVH constraints

