Cancer Institute

Travel time reduction in robotic stereotactic body radiation therapy (SBRT)

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Introduction

When treating a patient using a robotic device, such as the CyberKnife (Accuray Inc., Sunnyvale CA), the overall travel time between the nodes for the robot can be substantial.

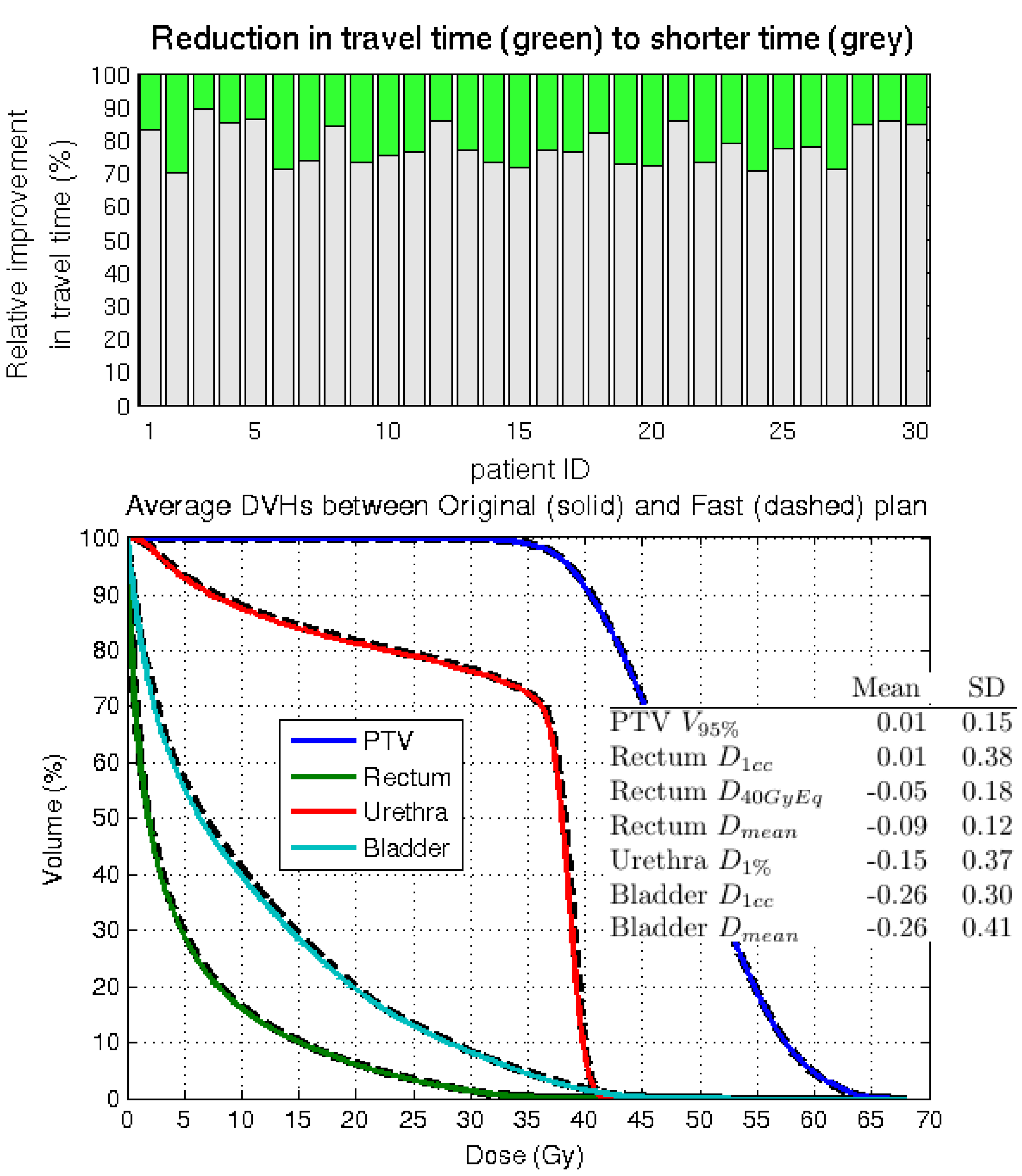
Currently, travel time is not optimised in the treatment planning process. In this study, we investigate opportunities to generate for each patient an alternative plan with similar quality but with a substantially reduced travel time.

Conclusion

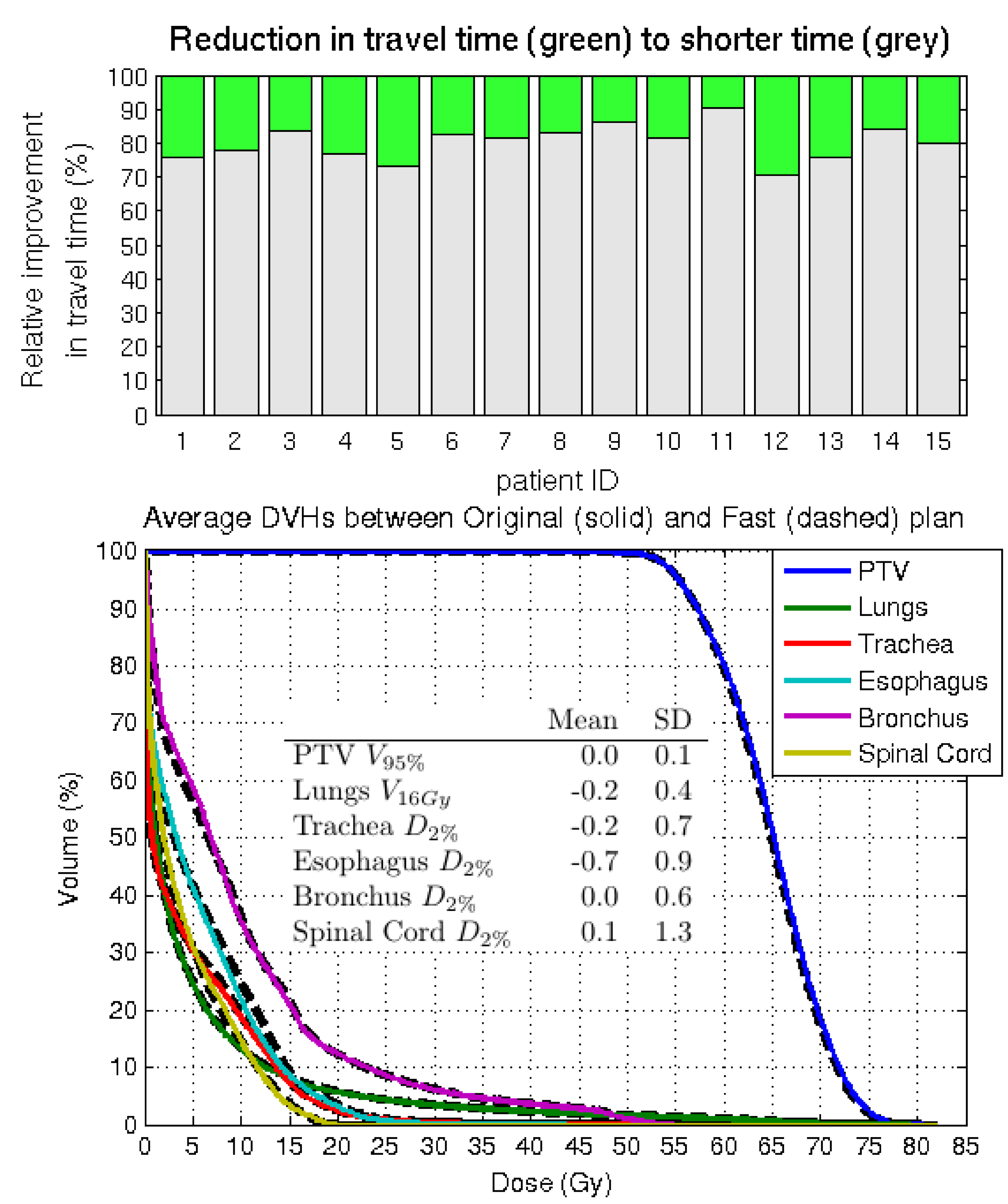
A strategy has been developed to establish for each patient a fast robot travel path with minimal loss in plan quality relative to the original treatment plan.

Overall, the travel time reduced by more than 20% per patient: 22% (range 11%-30%) for prostate and 20% (range 10%-30%) for lung. Computation time to find the faster node-set was 21 seconds on average.

Result: Prostate



Result: Lung



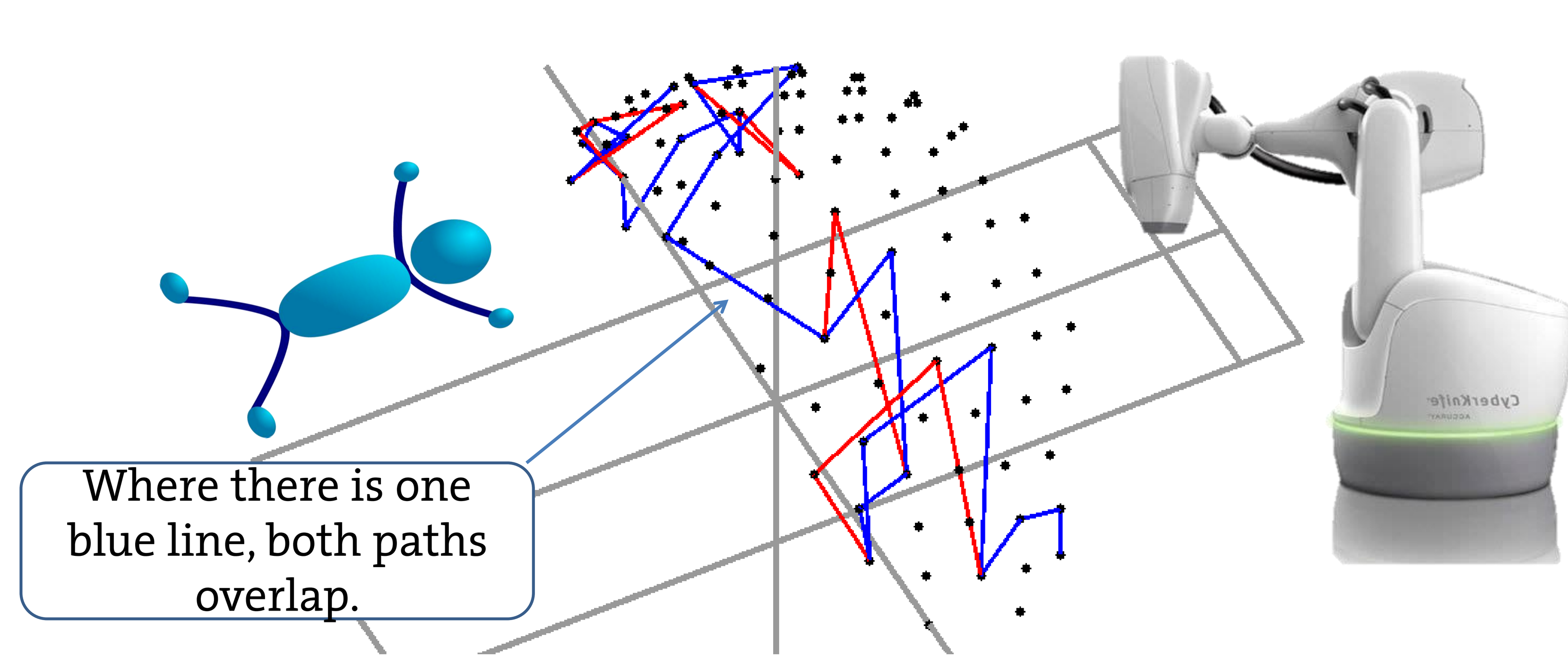
Method

For this study, 25-node treatment plans were first generated for each patient using our in-house developed TPS for automated multi-criterial plan generation. An alternative (fast) plan was then generated with a minimised travel time. For all plans (original and fast), a Travelling Salesman Problem (TSP) approach was used to establish the order of the 25 selected nodes for a minimal travel time, consistent with the commercial CyberKnife software.

The travel time reduction strategy investigated for each node if a nearby node (angle < 15 degrees) leads to a significantly shorter travel time. Per node, 3-7 nearby nodes were explored. If the travel time could be reduced by more than 3.5 seconds, the original node was replaced with the faster alternative. This was sequentially repeated for each node. For the new node-set, the TSP is solved again.

Finally, a new plan optimisation was performed for the alternative, faster travel path using the automated multi-criteria treatment planning system.

Example



Example of a prostate case. Depicted is the couch with corresponding patient orientation. Black dots indicate the fixed node positions from which the CyberKnife can irradiate the patient.

The **RED** line is the fastest path (234.9 secs) using the original nodes resulted from the plan optimisation. The **BLUE** line is the reduced travel time path (189.2 secs), with only 6 differently selected nodes.