# Benchmarking of known Path Planners against RRT-Dubins-Post-Processing method

## 1. Path Planners considered for benchmarking

1.1. POSQ controller (Source | Paper)

1.2. SST with Dubins Curves (Source)

1.3. RRT with Bezier Curves (Source)

## 2. Metrics chosen for comparison

2.1. **Average curvature**: Summation of all curvature values (1/R) divided by Path length.

2.2. **Number of curvature peaks**: If a value in the curvature array is greater than its previous and next value, it is defined as 1 peak.

2.3. **Maximum curvature**: Maximum curvature value in the curvature array.

2.4. **Average curvature variation**: Differential of the curvature array. We used diff(X) function in MATLAB

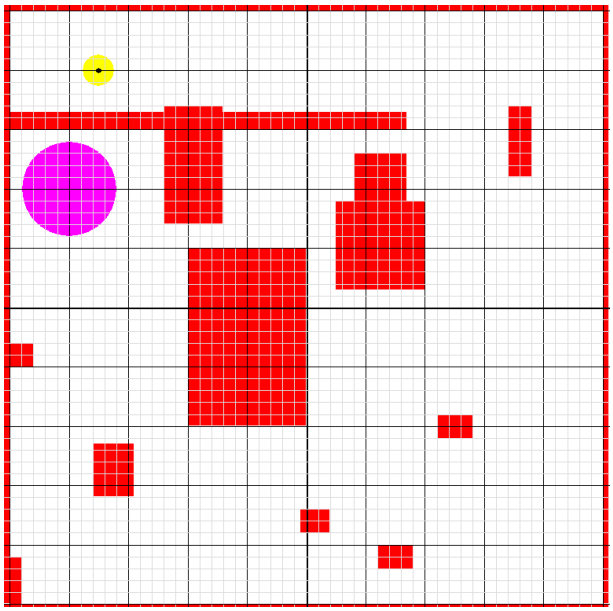
2.5. **Number of curvature variation peaks**: Implies change in direction. For example, straight-left-straight counts as 2 peaks since there are 2 direction changes.

2.6. **Path length:** Summation of the Euclidean distance between the path points.

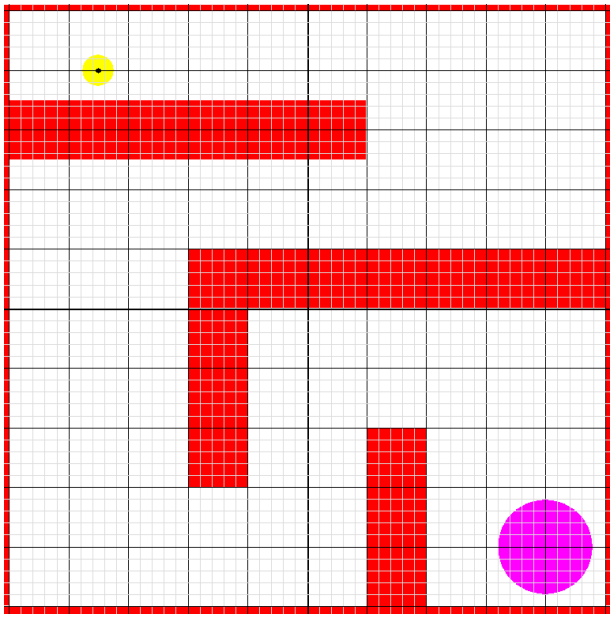
Note: *All the above metrics were recorded for 100 iterations for each map, for each controller, and the obtained distribution is shown in the form of a box and whisker plot in the results section.*

## 3. Environments (Maps) chosen for comparison

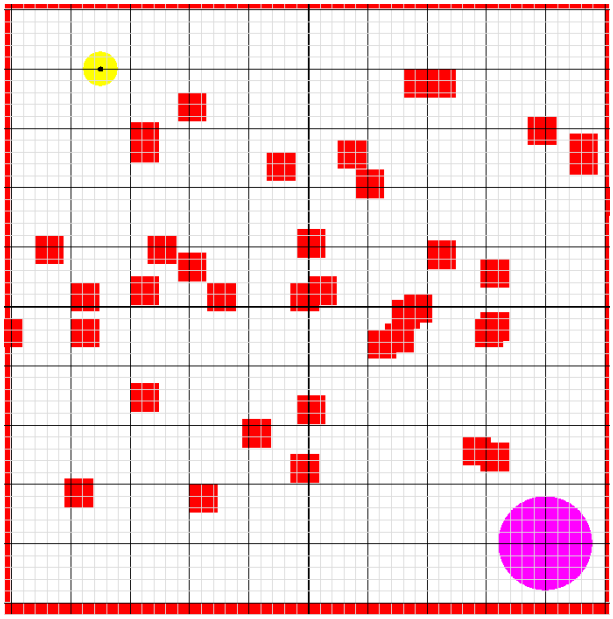
3.1. Map 1 (Named default in the results)



3.2. Map 2 (Named Maze in the results)



3.3. Map 3 (Named Scatter in the results)



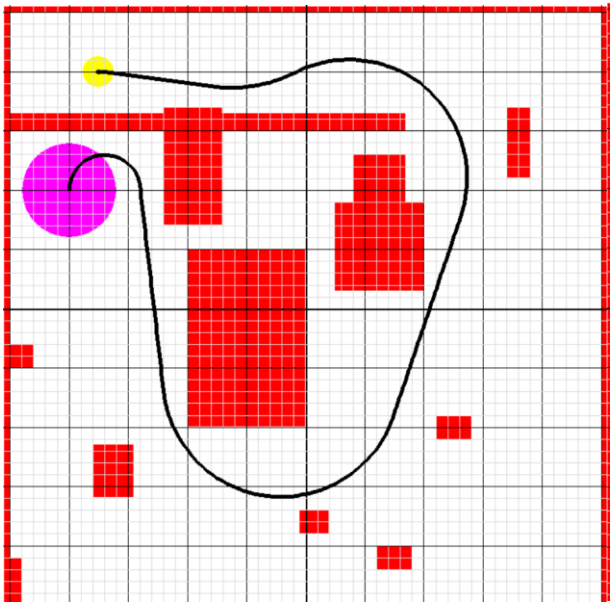
## 4. Results

Results for each map are as follows:

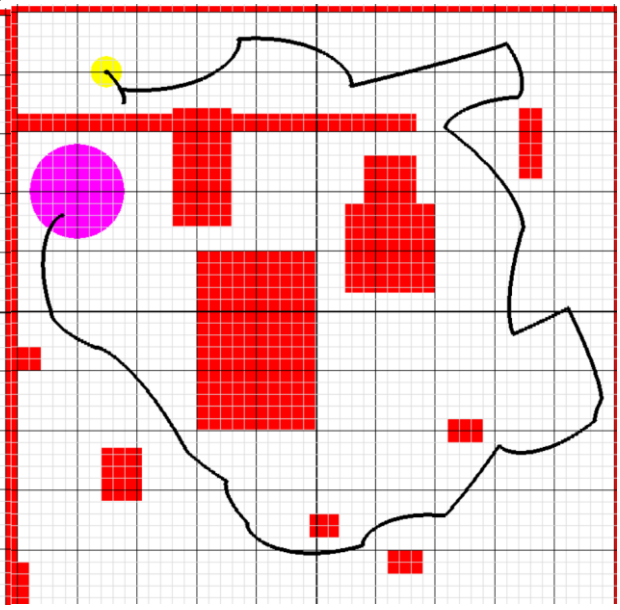
### 4.1. Map 1 plots

Sample plots for one of the 100 iterations:

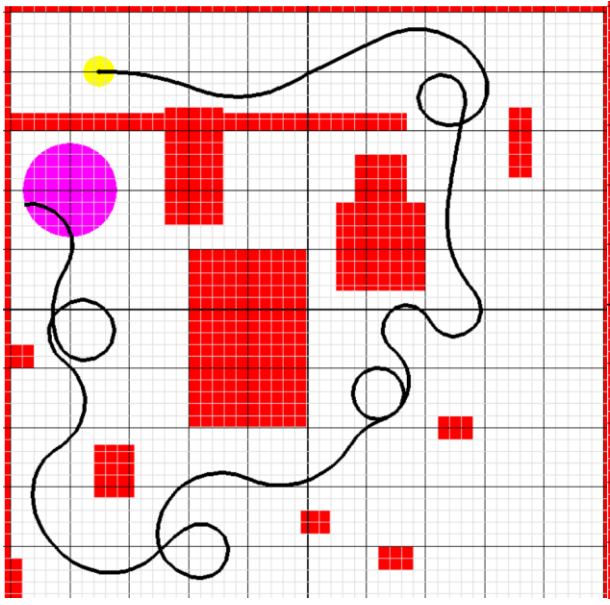
RRT with Variable Dubins and Post-processing



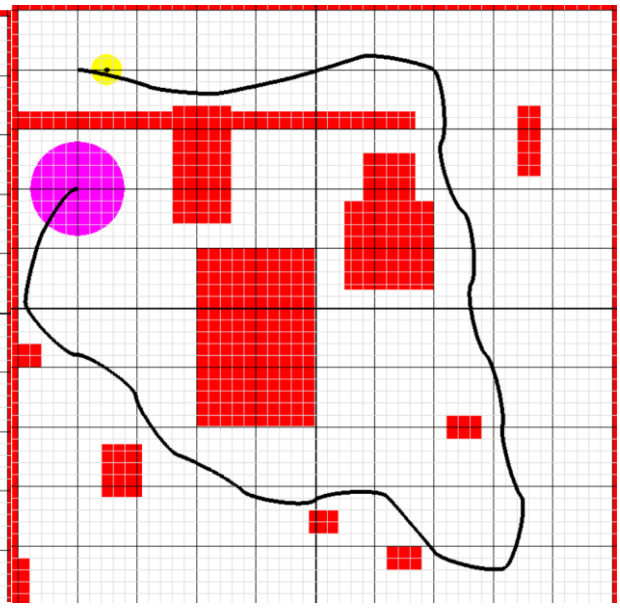
RRT + POSQ controller



SST with Dubins

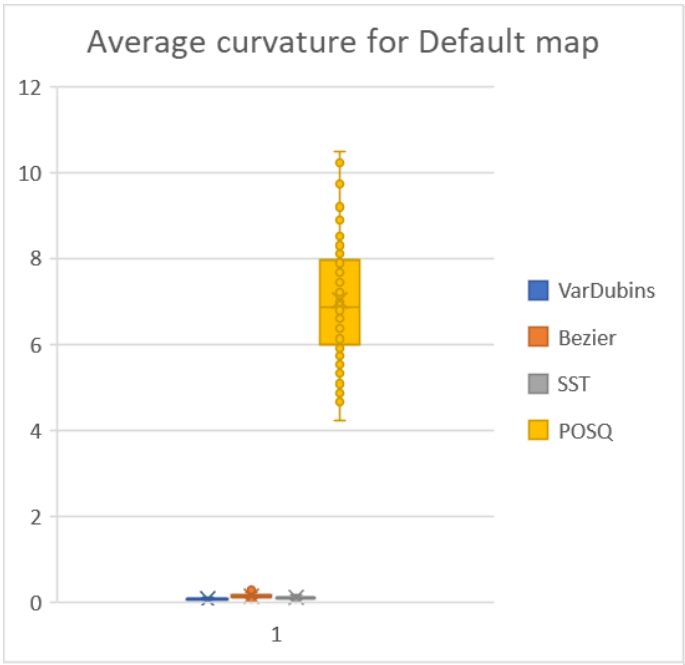


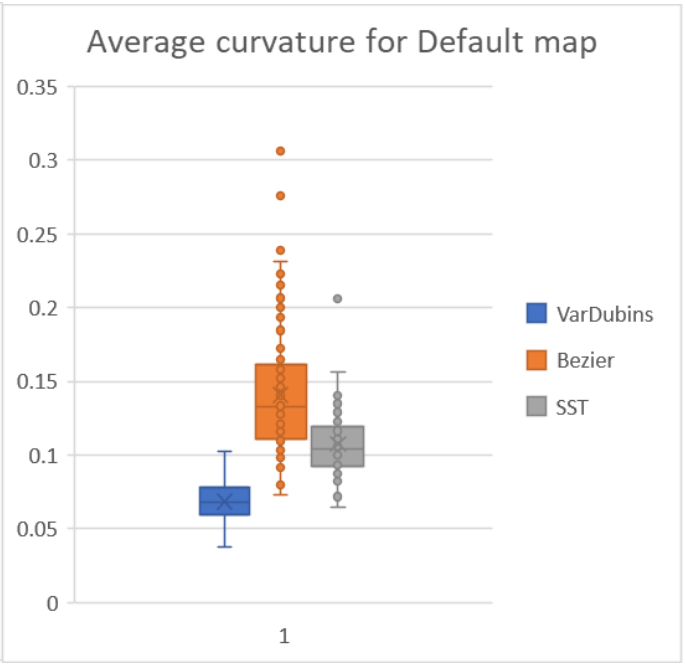
RRT with Bezier Curves



Metric 1: Average curvature

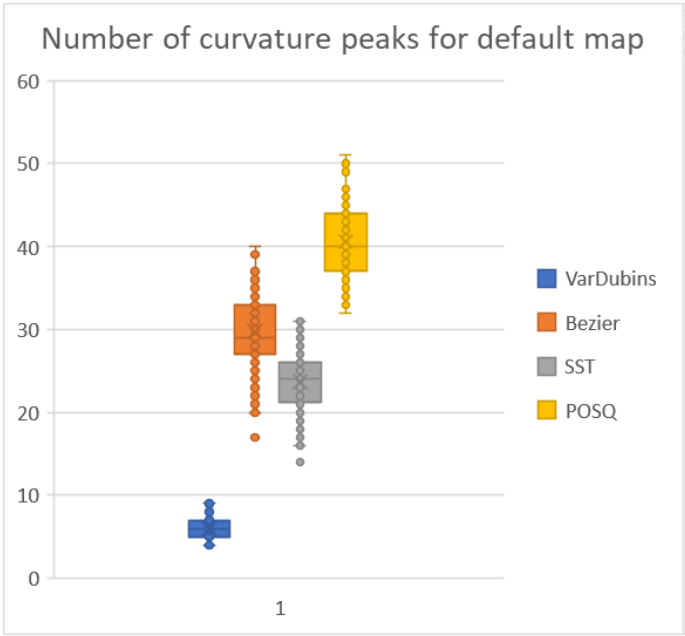
Due to large differences between the POSQ results and the rest of the methods, there are two sets of results for each plot. One shows all planners, and another one excludes POSQ for a closer comparison among the rest of the planners:

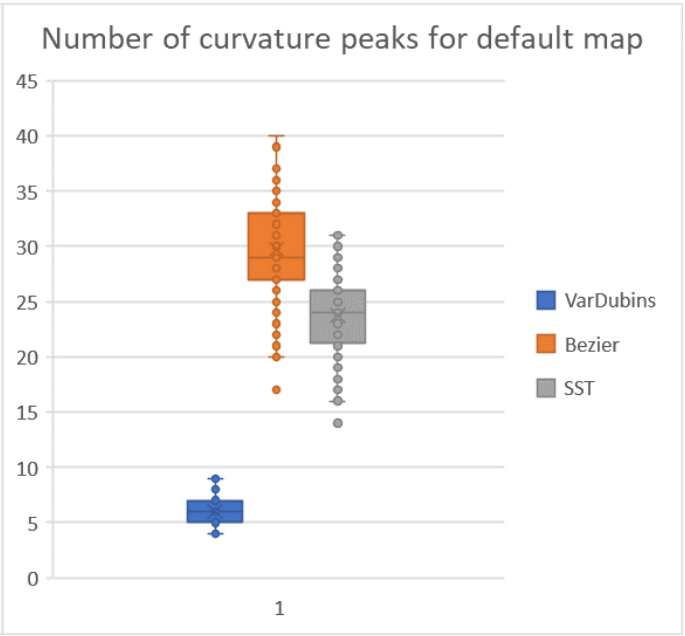


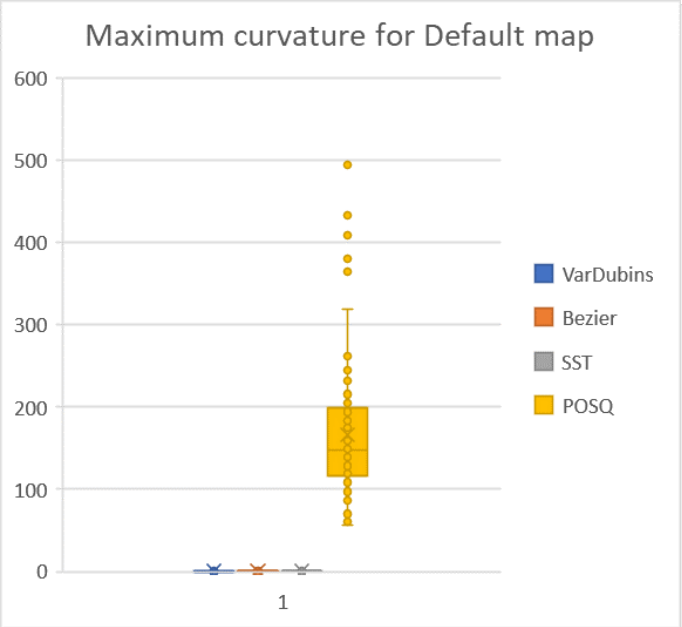

Note: *The left image shows overall comparison, while the right image offers a closer look at the better performing planners*

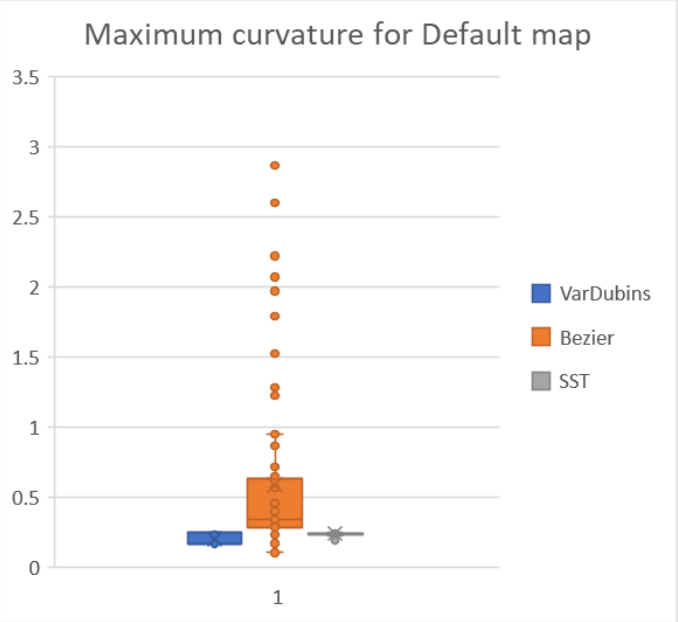
Metric 2: Curvature peaks



Metric 3: Max Curvature

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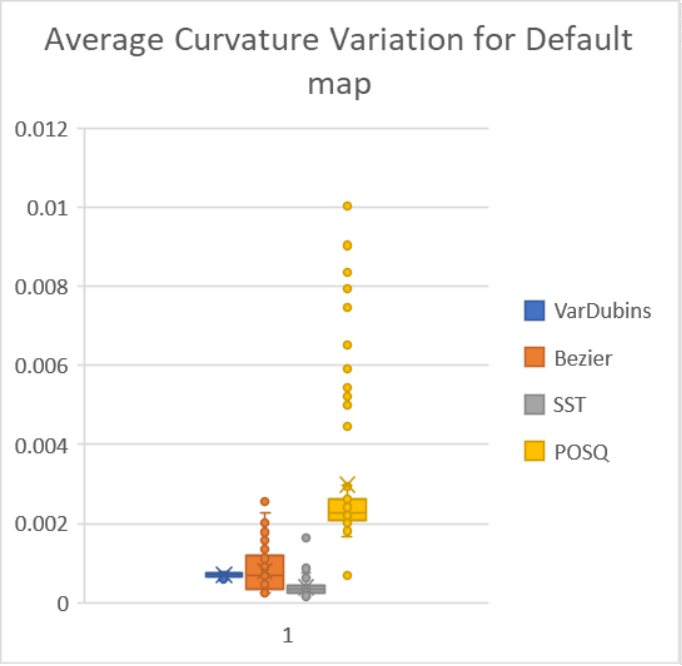
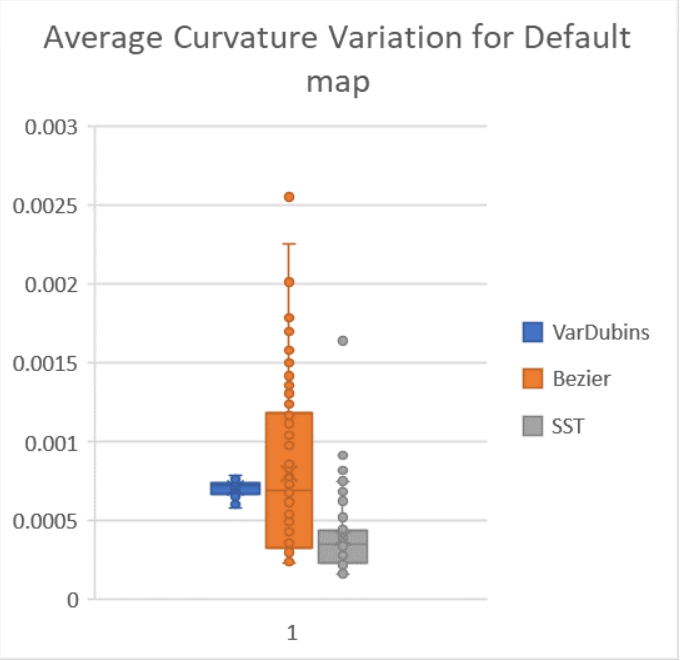
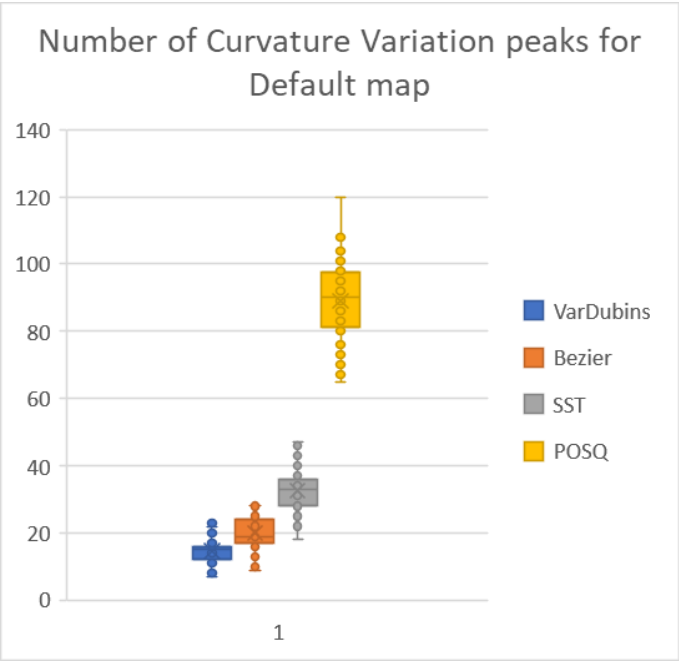
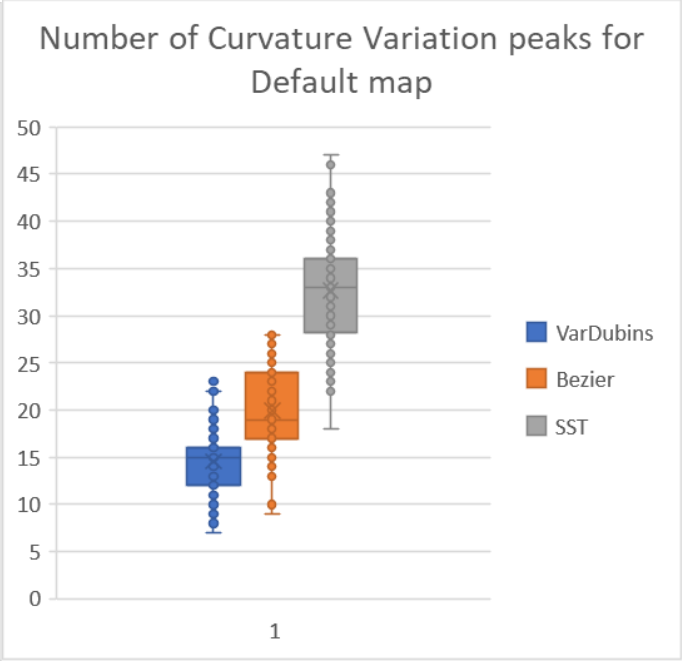
Metric 4: Average curvature variation



Metric 5: Curvature variation peaks

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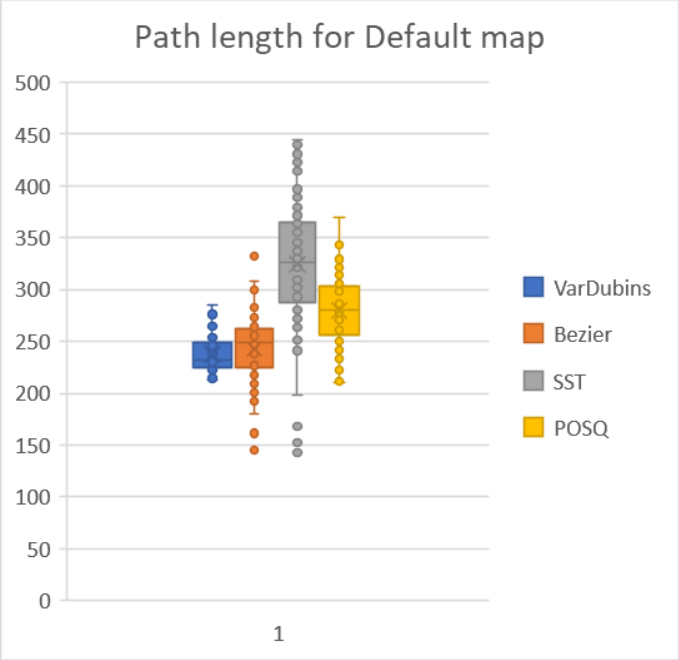
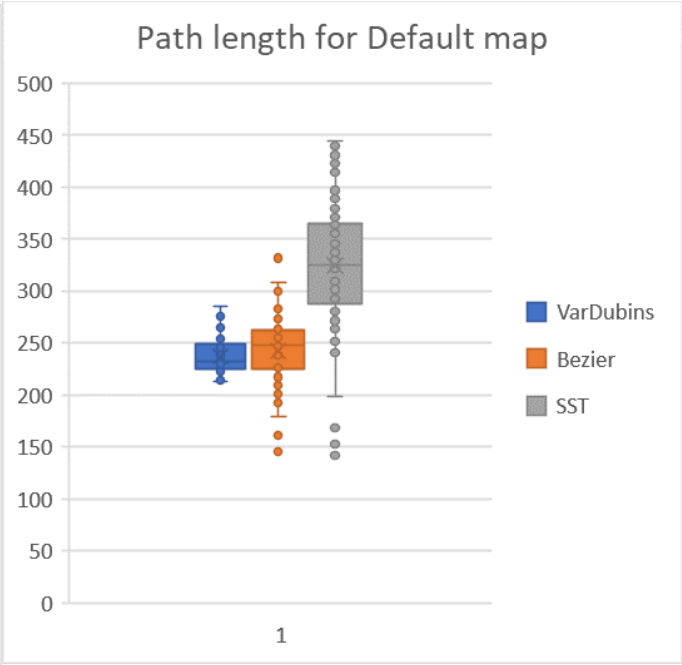
Metric 6: Path length

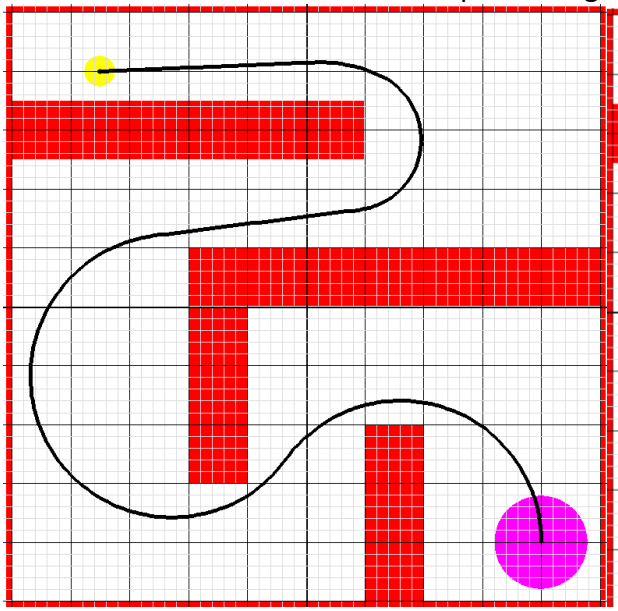


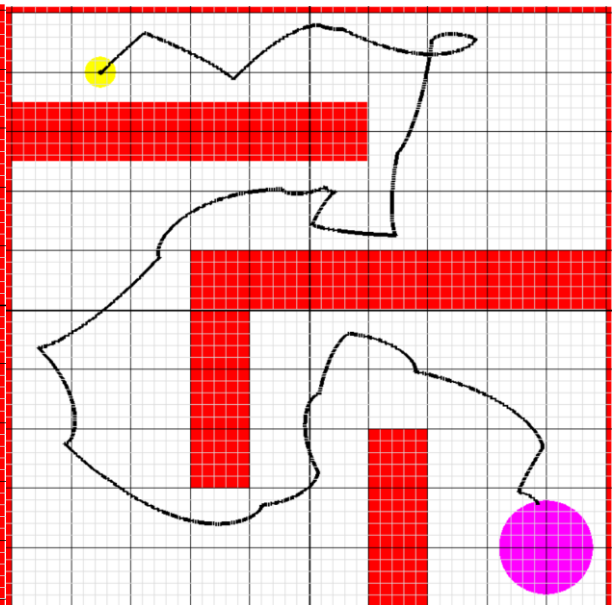
4.2. Map 2 (Maze):

Sample plots for one of the 100 iterations:

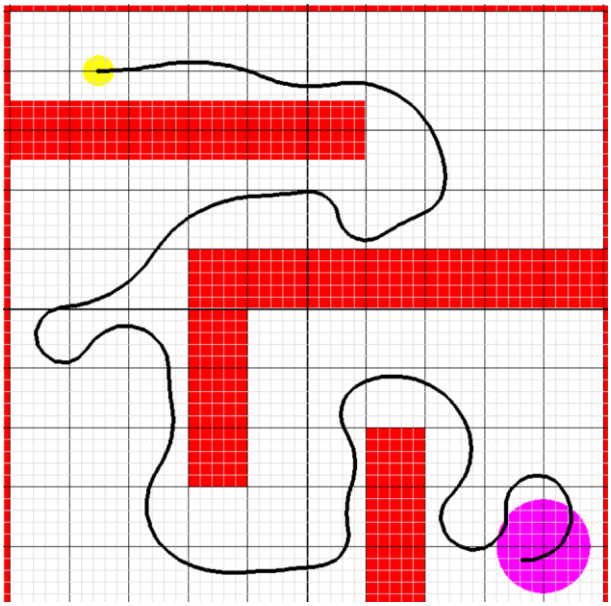
RRT with Variable Dubins and Post-processing



RRT + POSQ controller

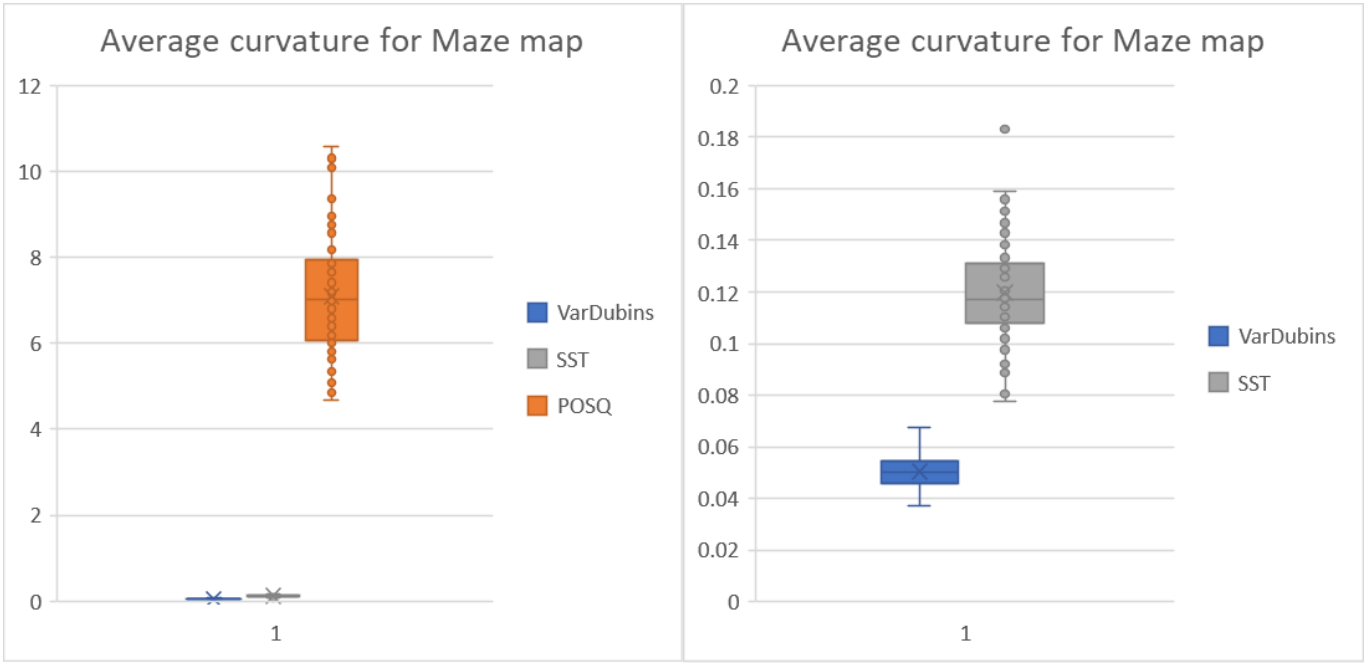


SST with Dubins



Note: Since the Bezier curves planner was unable to generate any paths for this map, there are no available results or images.

Metric 1: Average curvature

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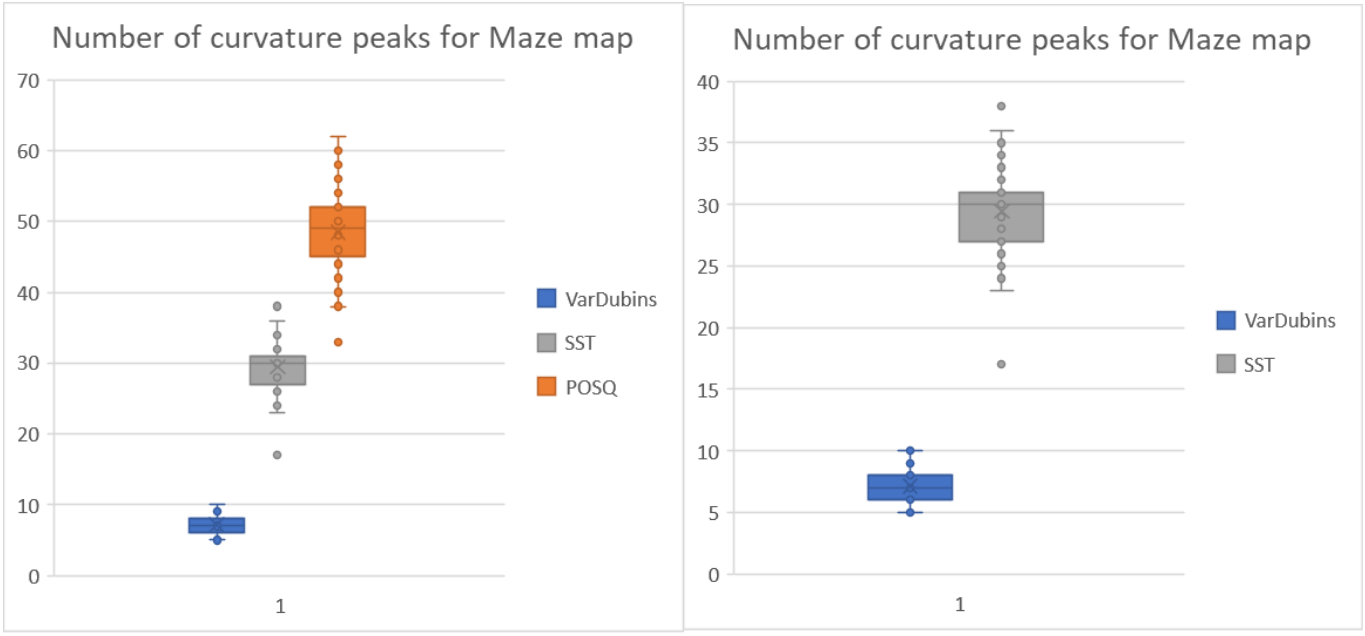
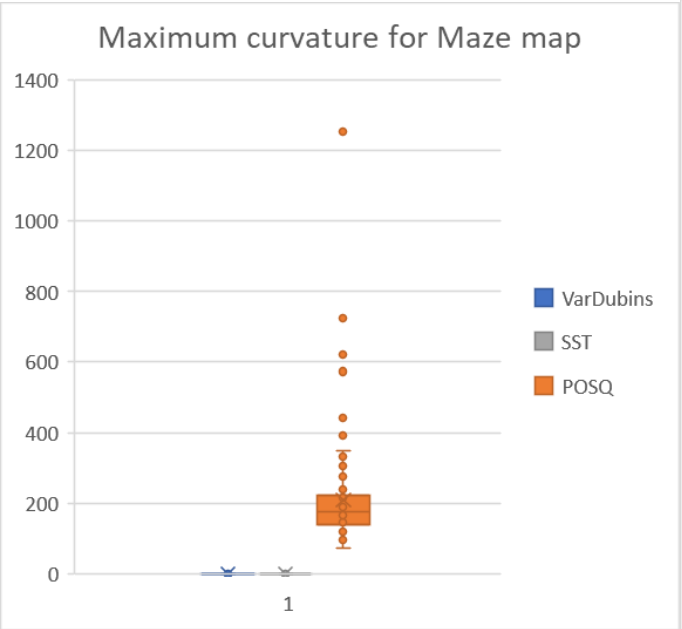
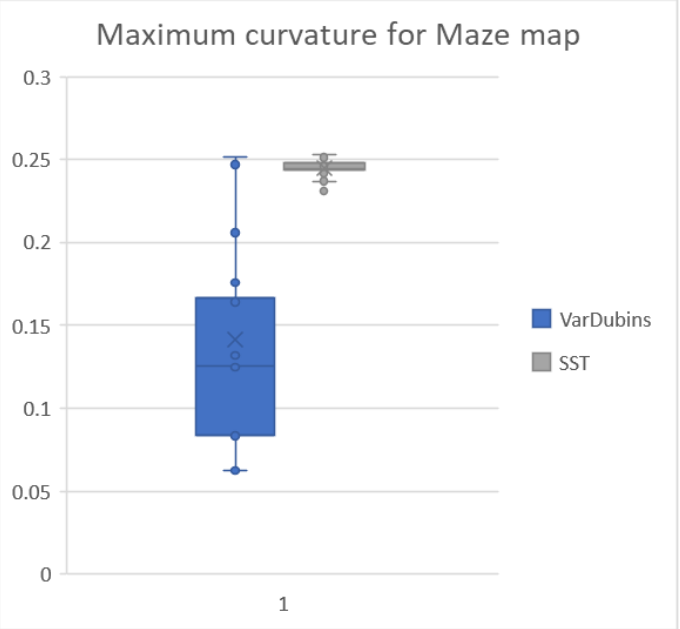
Metric 2: Curvature peaks



Metric 3: Max Curvature

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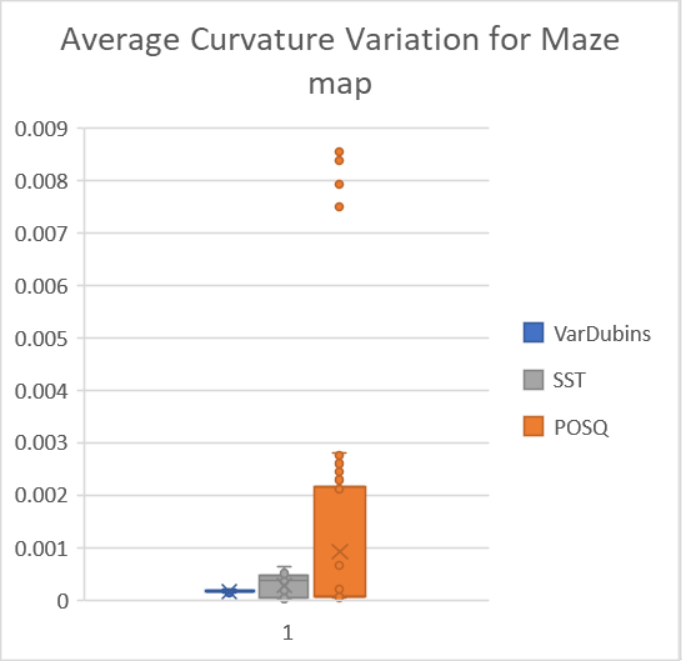
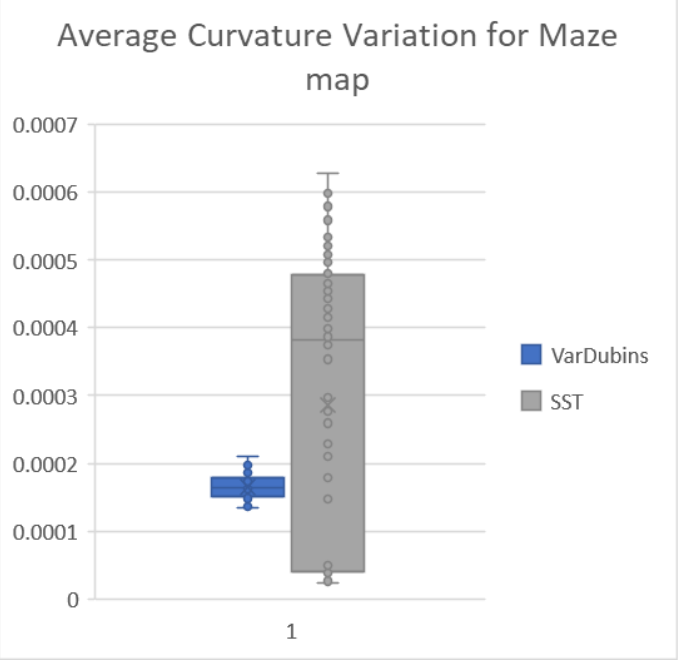
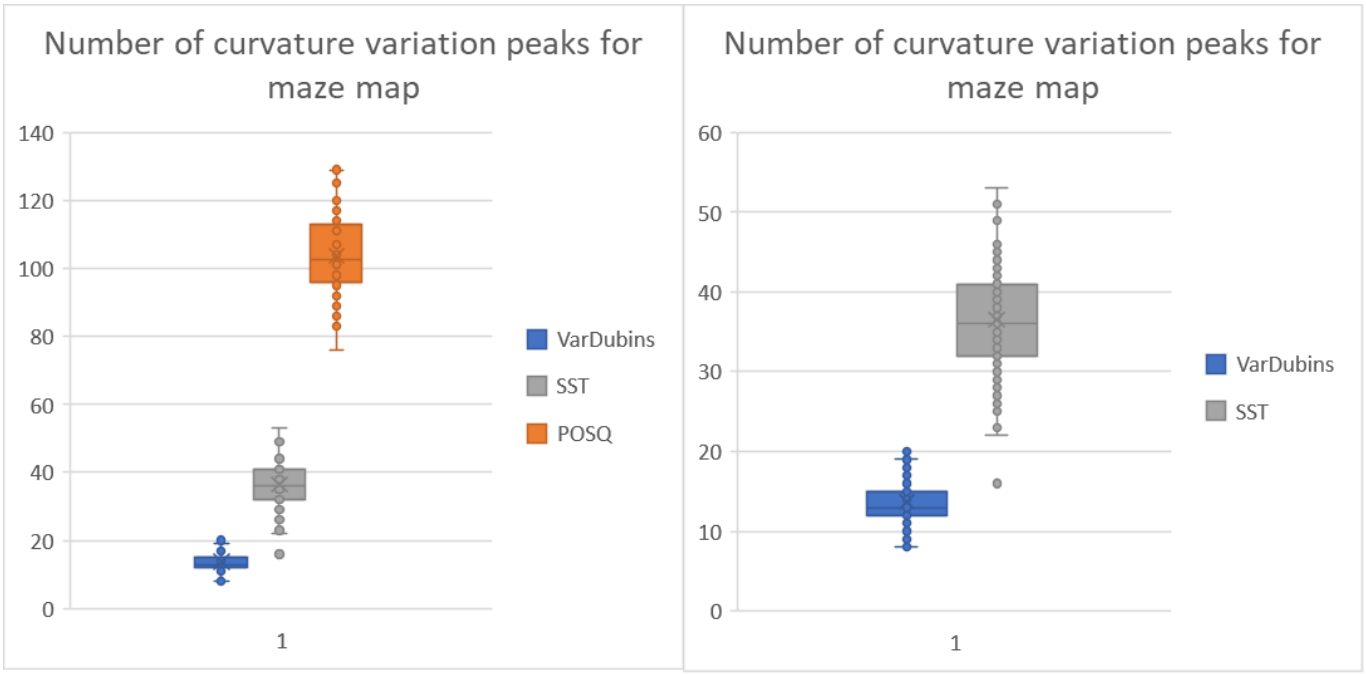
Metric 4: Average curvature variation



Metric 5: Curvature variation peaks

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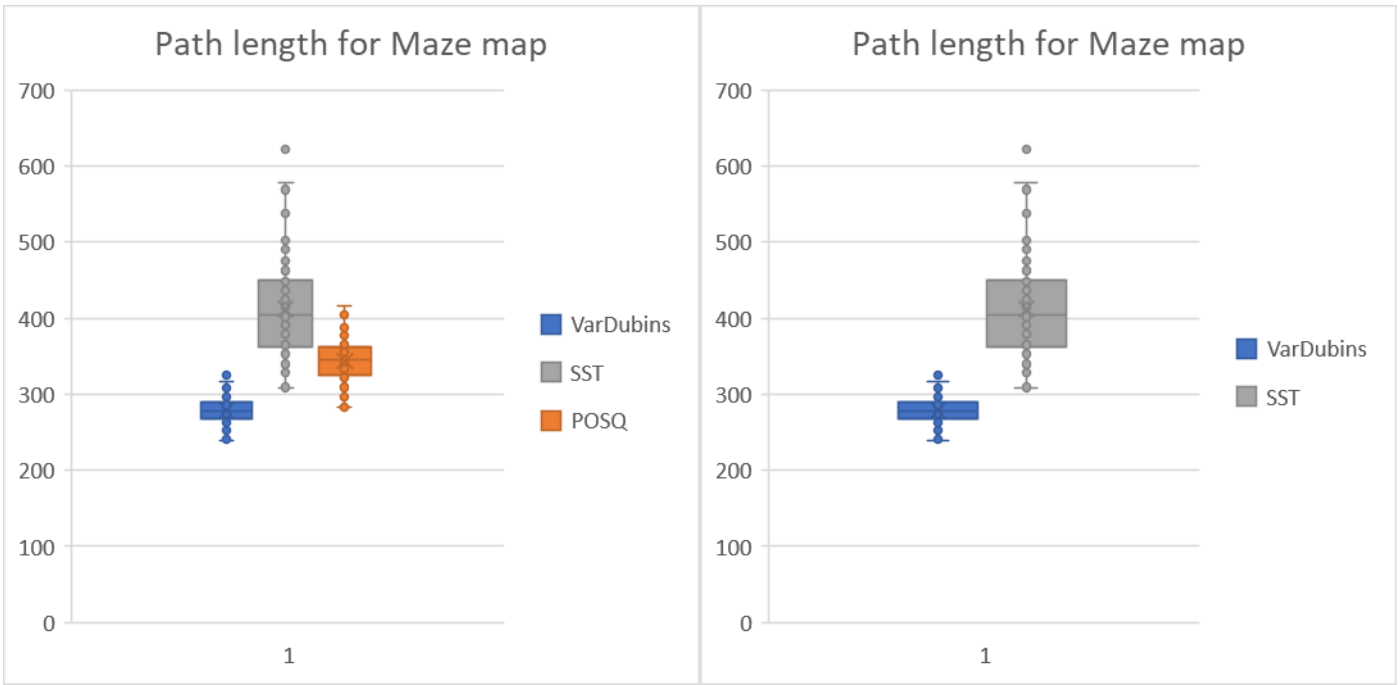
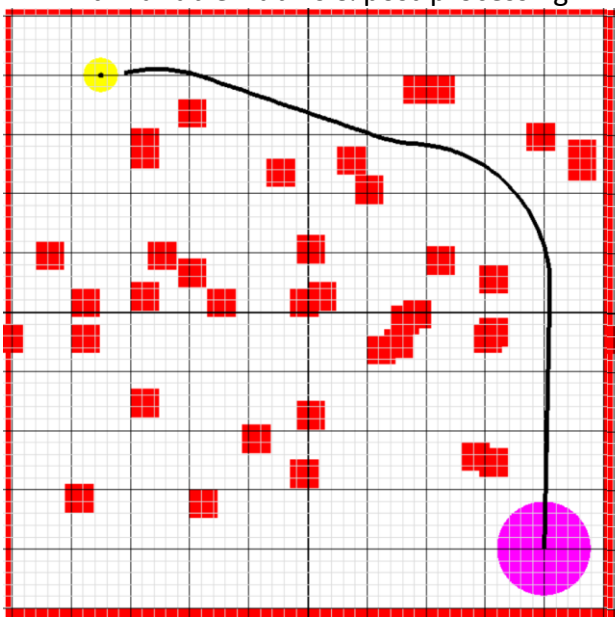
Metric 6: Path length



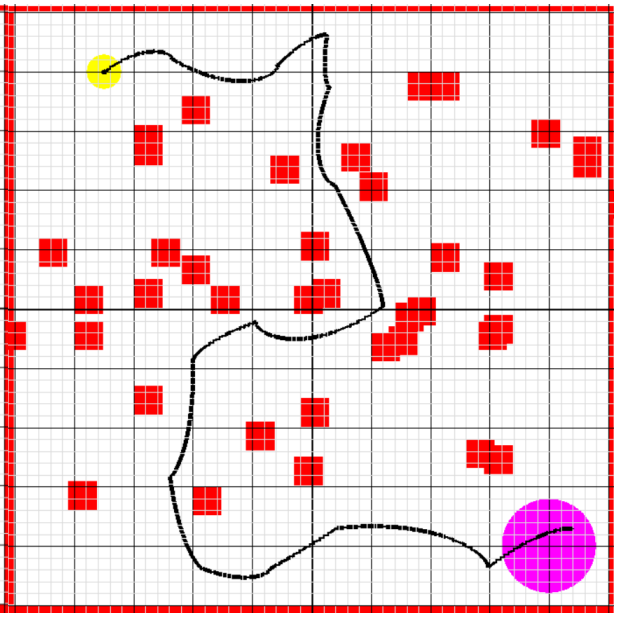
4.3. Map 3 (Scatter):

Sample plots for one of the 100 iterations:

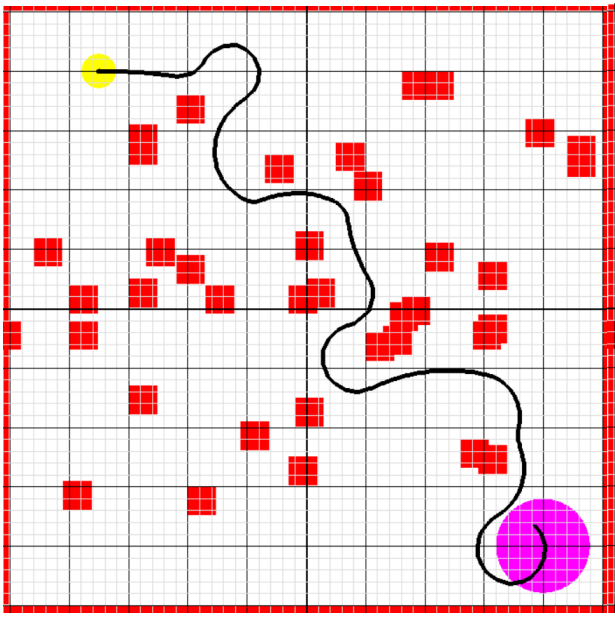
RRT with variable Dubins & post-processing



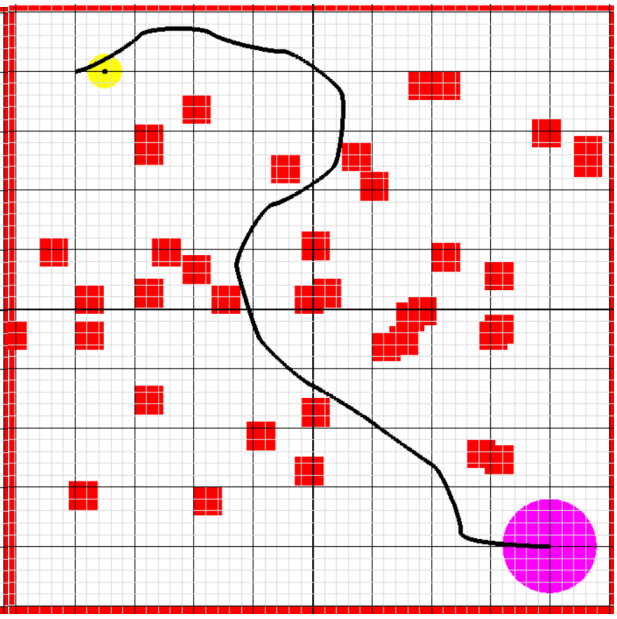
RRT + POSQ Controller



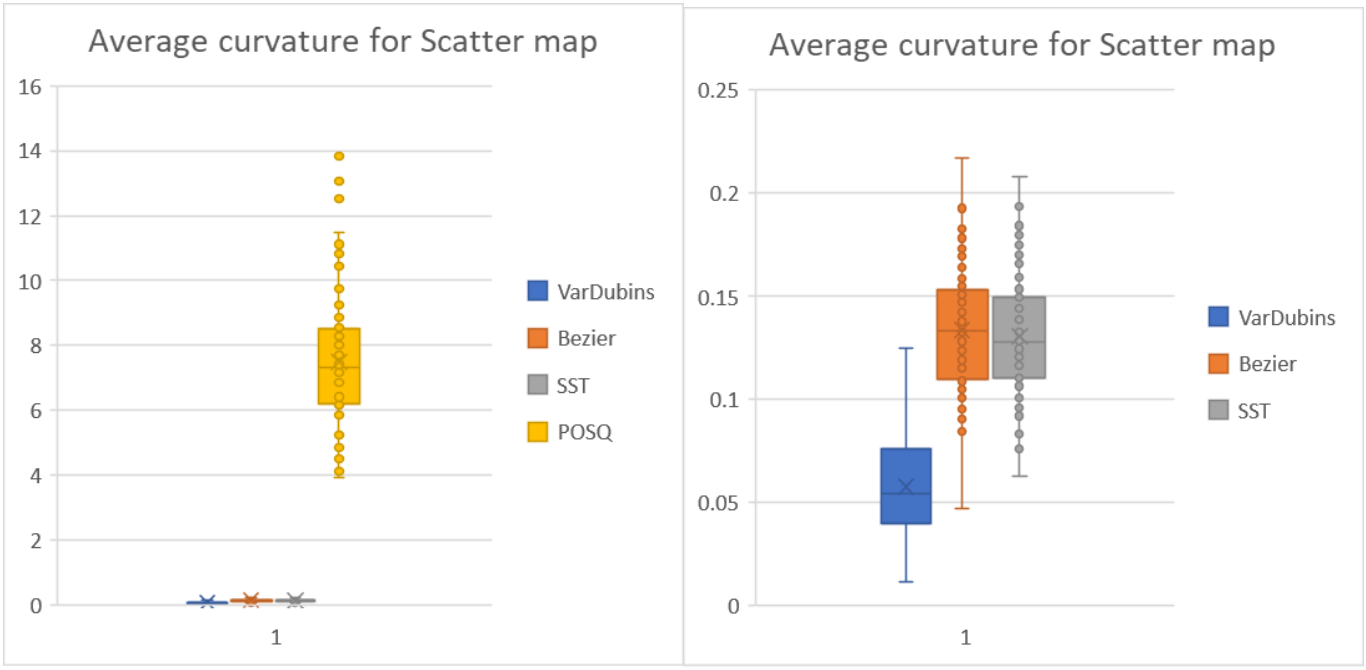
SST with Dubins



Bezier Curves



Metric 1: Average curvature

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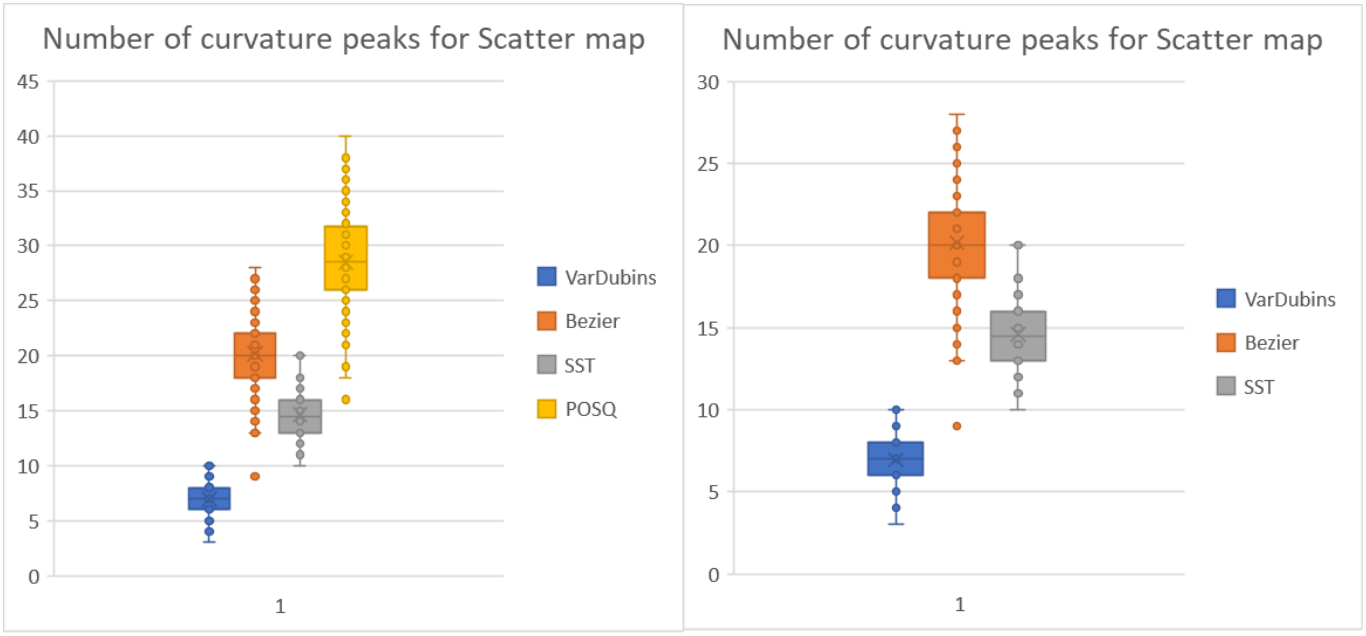
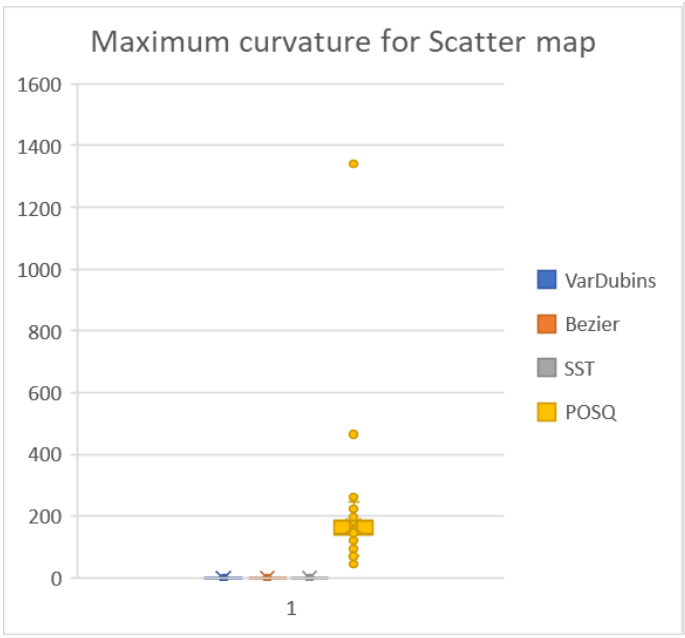
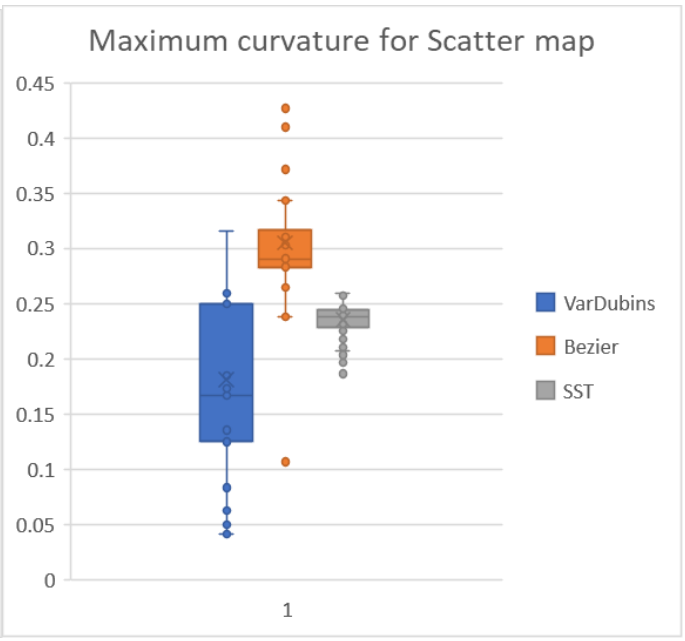
Metric 2: Curvature peaks



Metric 3: Max Curvature

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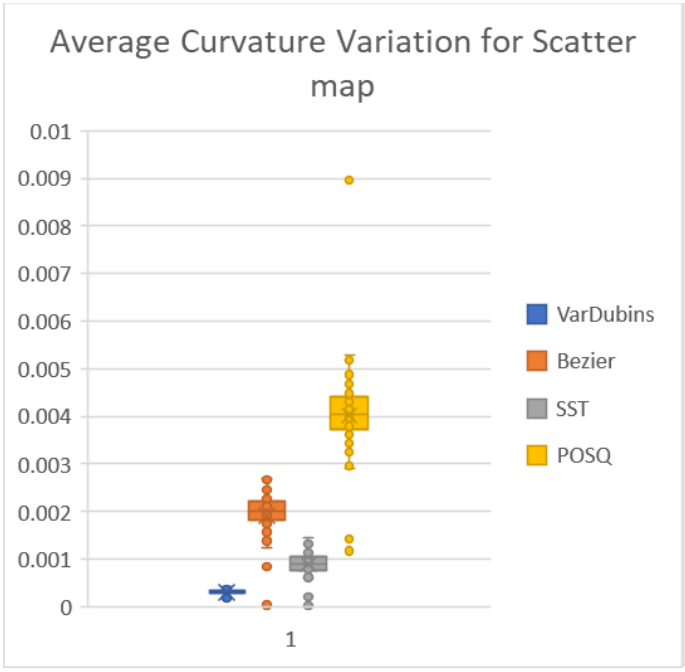
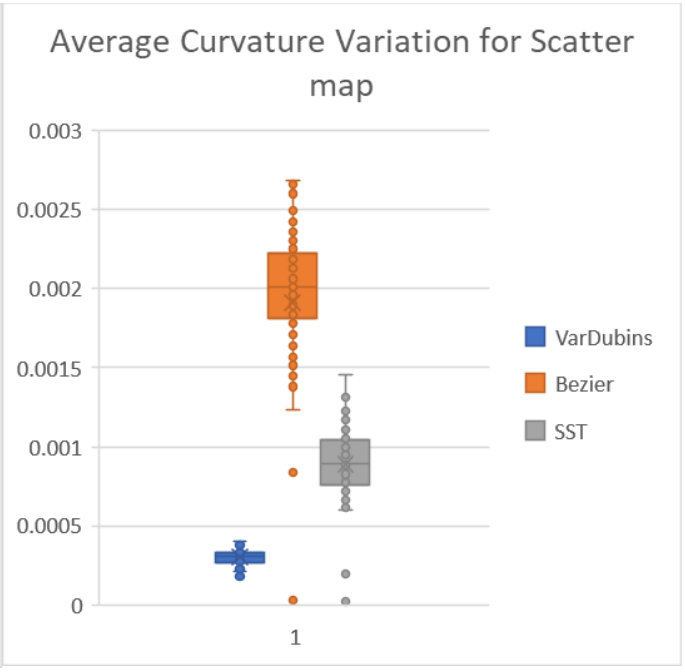
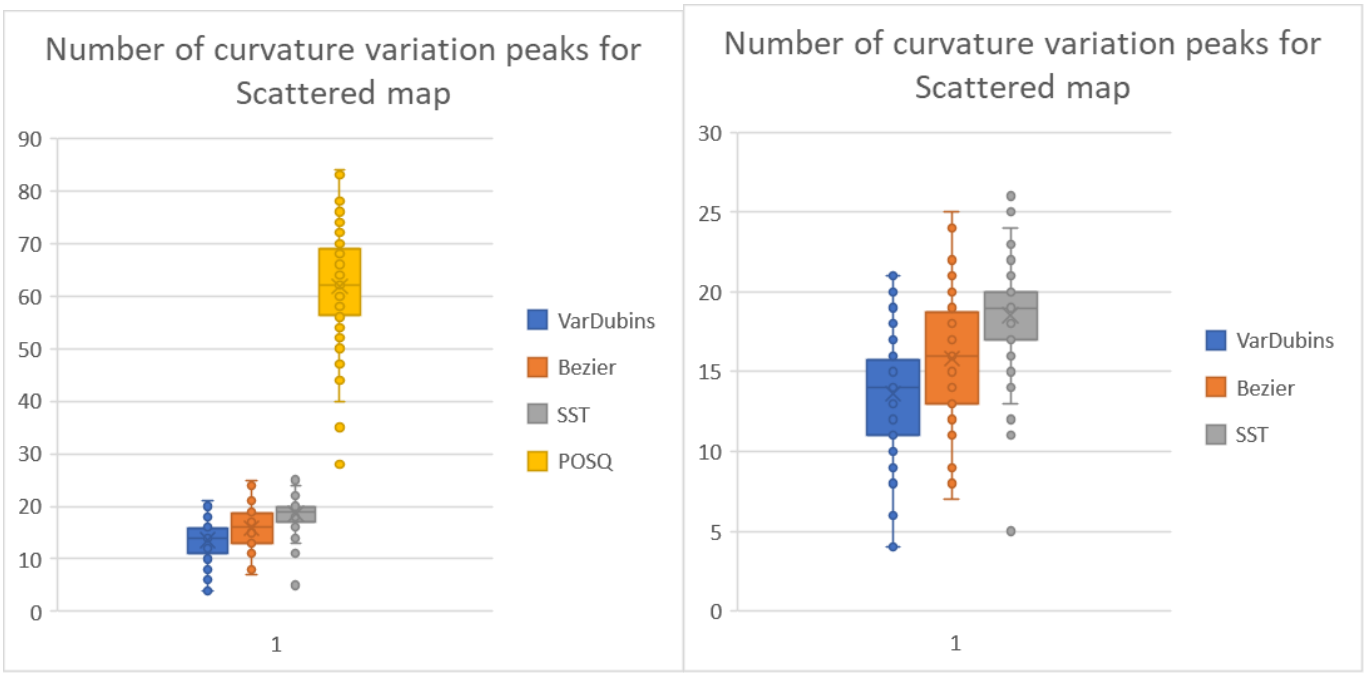
Metric 4: Average curvature variation



Metric 5: Curvature variation peaks

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Metric 6: Path length