Supplementary Material: Exponential Convergence of Infeasibility Proofs for Kinematic Motion Planning

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A   Appendix: Comparing PRM and RRT-connect

Below is an example comparing PRM and RRT-connect in a 2D configuration space with disconnected $\mathcal{C}_{\text{rest}}$ regions. PRM's samples form two classes, the samples connectable to the goal configuration, and the samples not connectable to the goal configuration. RRT-connect's samples also form two classes, the start tree samples and the goal tree samples. The example configuration space's $\mathcal{C}_{\text{rest}}$ in Figure 1 has two disconnected components, the region outside of obstacle region 1, and the region in between obstacle region 1 and 2. PRM samples all $\mathcal{C}_{\text{free}}$, so with disconnected $\mathcal{C}_{\text{rest}}$, the trained manifold is in $\mathcal{C}_{\text{obs}}$ (Figure 1a). RRT-connect samples are connected to either the start configuration or the goal configuration, which is nor guaranteed to cover the entire $\mathcal{C}_{\text{free}}$ if there are disconnected regions, thus the learned manifold may not converge into $\mathcal{C}_{\text{obs}}$ (Figure 1b). In our proof, if $\mathcal{C}_{\text{rest}}$ has disconnected regions, then we need to use PRM planner. If $\mathcal{C}_{\text{rest}}$ is connected, then PRM and RRT-connect are the same.

(a) PRM training result   (b) RRT-connect training result
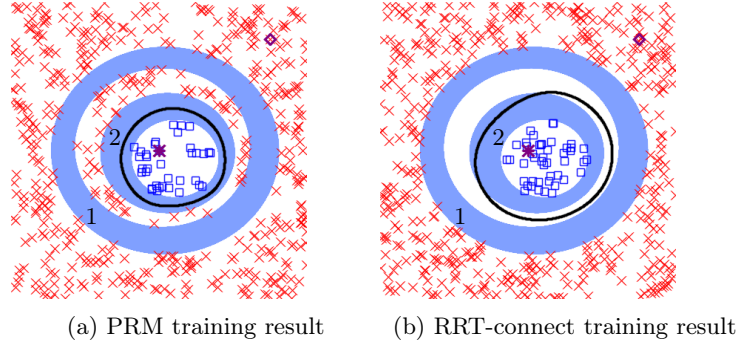
Fig. 1: Comparing PRM and RRT-connect in disconnected $\mathcal{C}_{\text{rest}}$ configuration space. Manifold trained from PRM samples are gaurenteed to converge, while manifold trained from RRT-connect samples may not converge. For this reason, we switch to use PRM for the proofs in this paper to cover the general case.