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Probabilistic Bubble RoadMap

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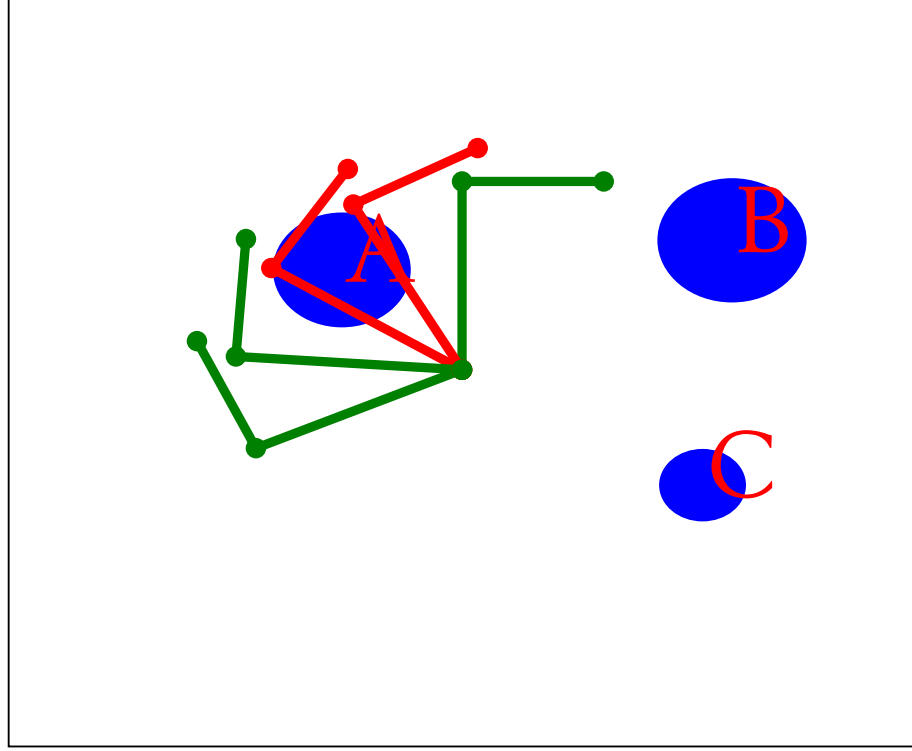
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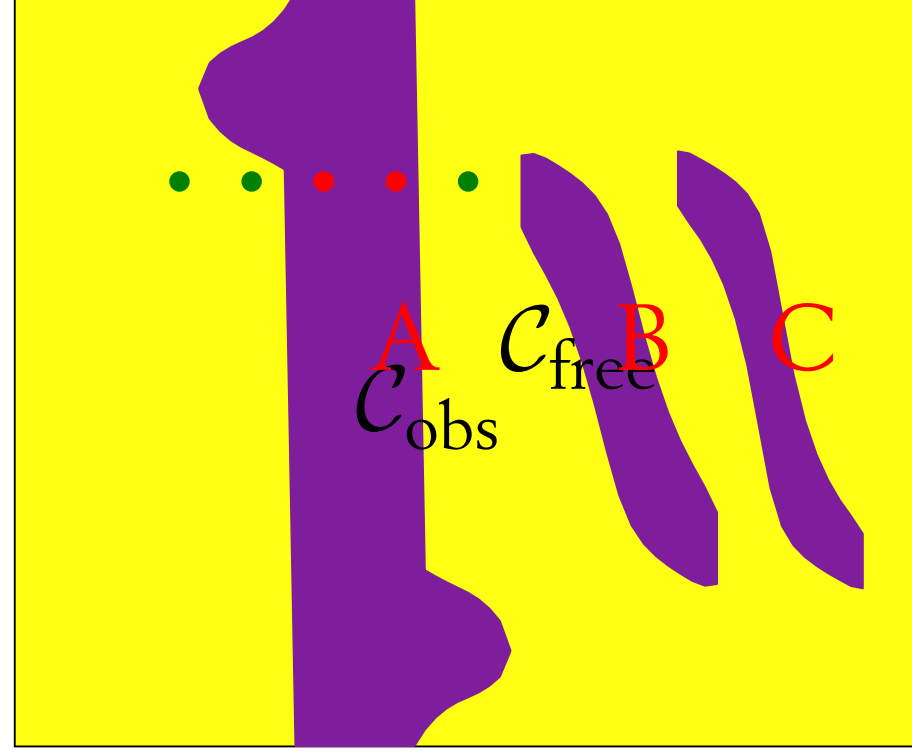
WASP | WALLENBERG AI,
AUTONOMOUS SYSTEMS
AND SOFTWARE PROGRAM

Background

World space $\mathcal{W}$

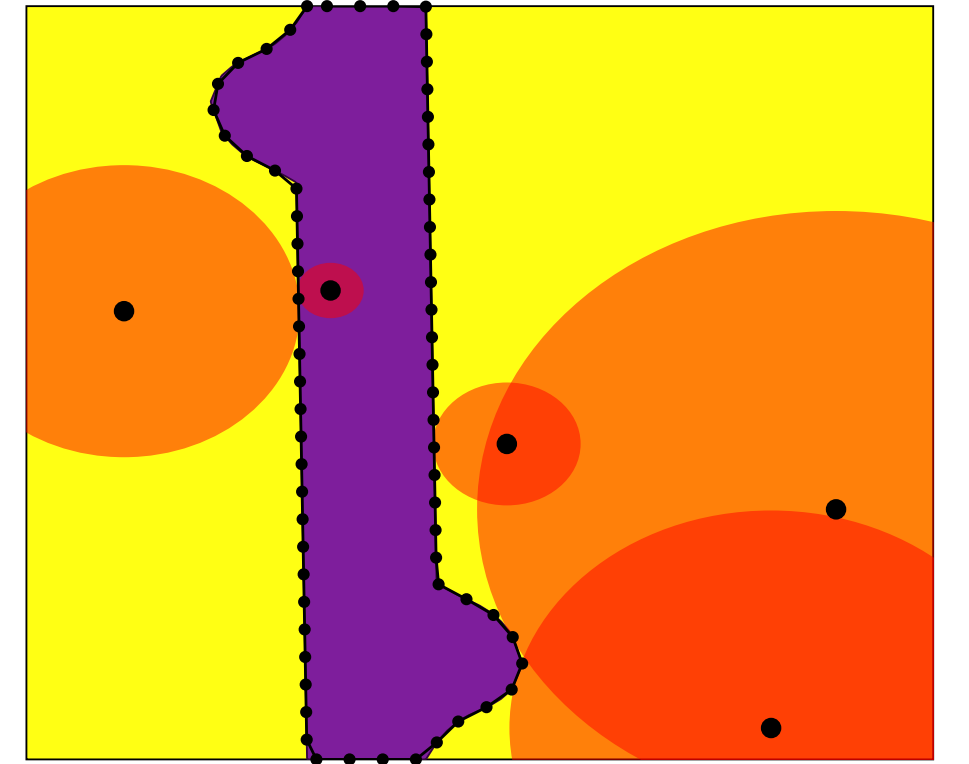


Configuration space $\mathcal{C}$

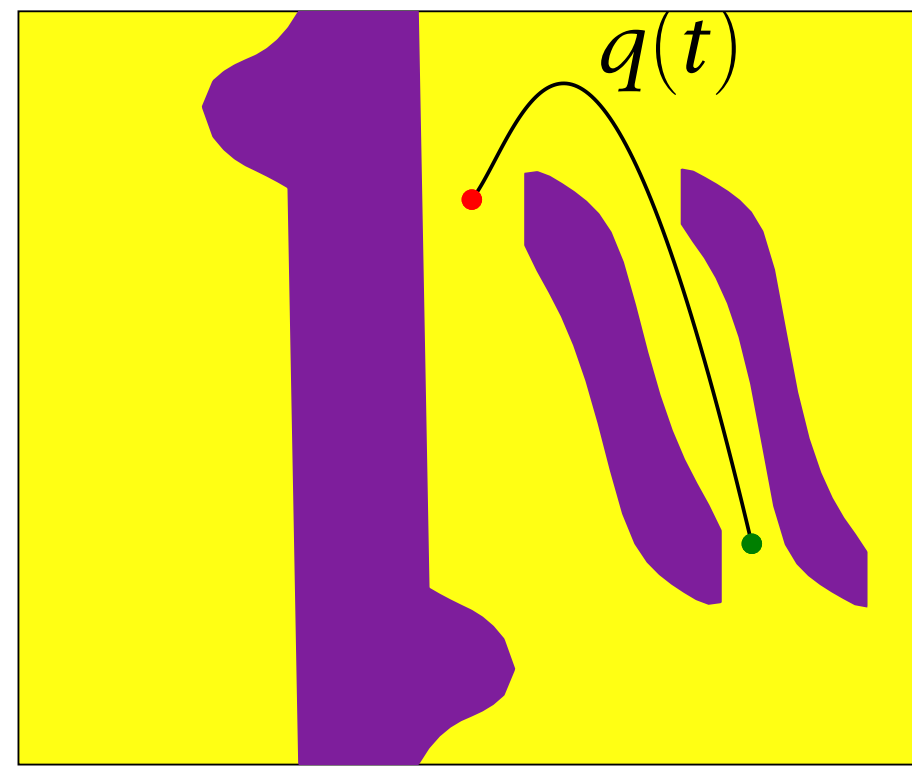
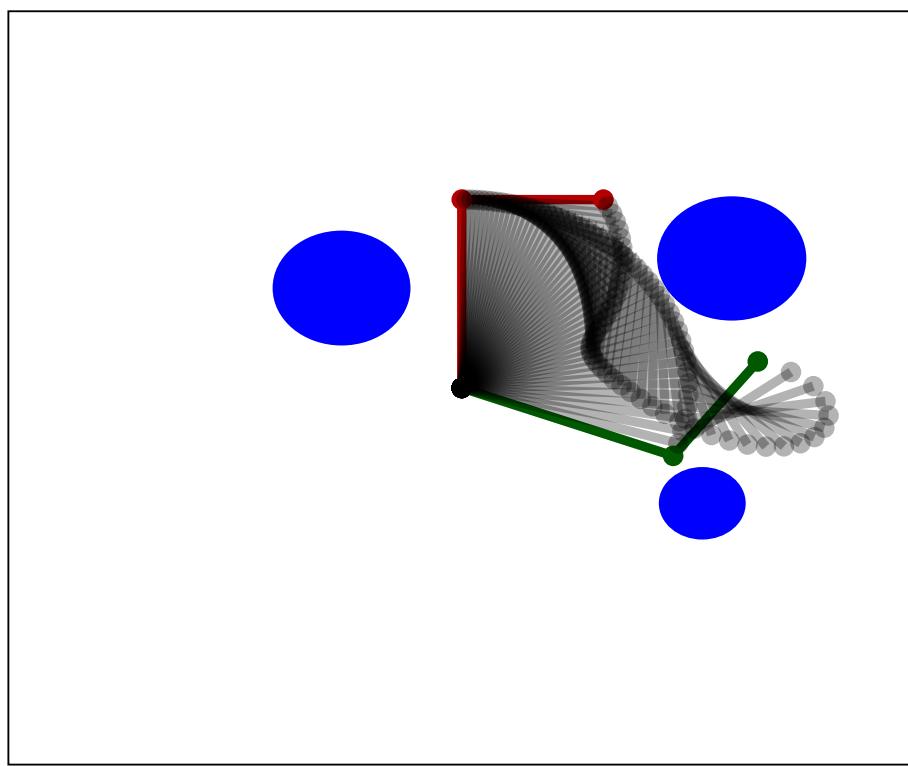


Neural Signed Configuration Distance Function (neural SCDF)

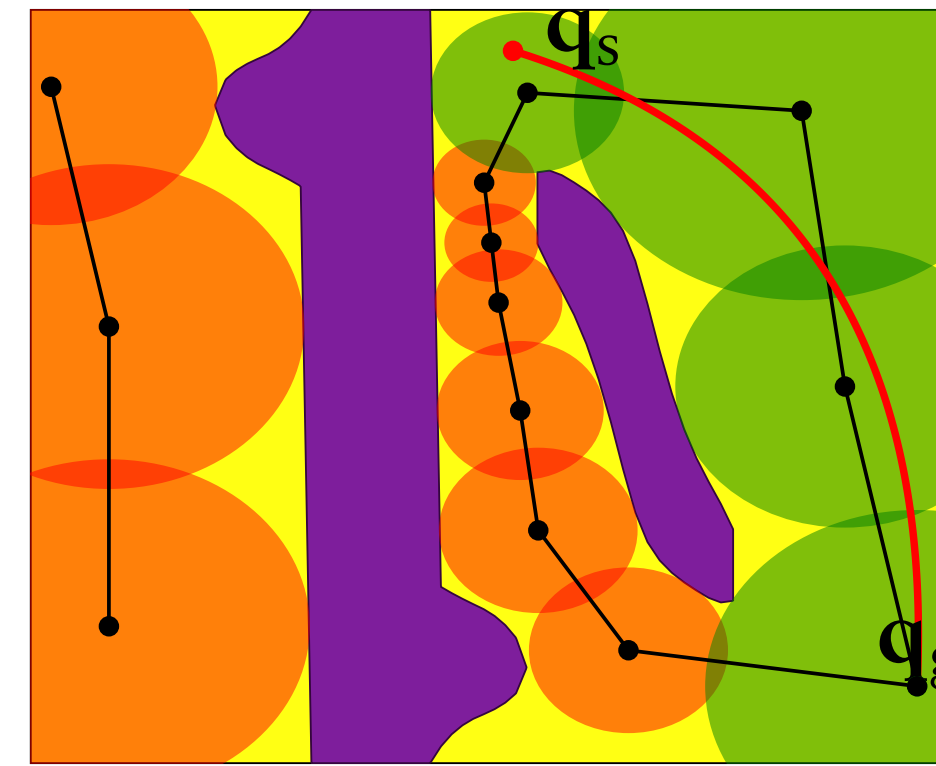
- Obstacle shape $\mathbf{g}$
- Compute mesh representing $\partial\mathcal{C}_{\text{obs}}$ (costly!)
- Sample configurations, $\mathbf{q}_{i,j}$, compute distance, d_i , from $\partial\mathcal{C}_{\text{obs}}$, and collision-status, $s_{i,j}$
- Compile data-set $\mathcal{D} = \{(\mathbf{q}_{i,j}, i, r_i, s_{i,j}, d_{i,j})\}_{i=1, j=1}^{M, N}$
- Learn $\tilde{\rho}(\mathbf{q}, \mathbf{g} | \theta)$



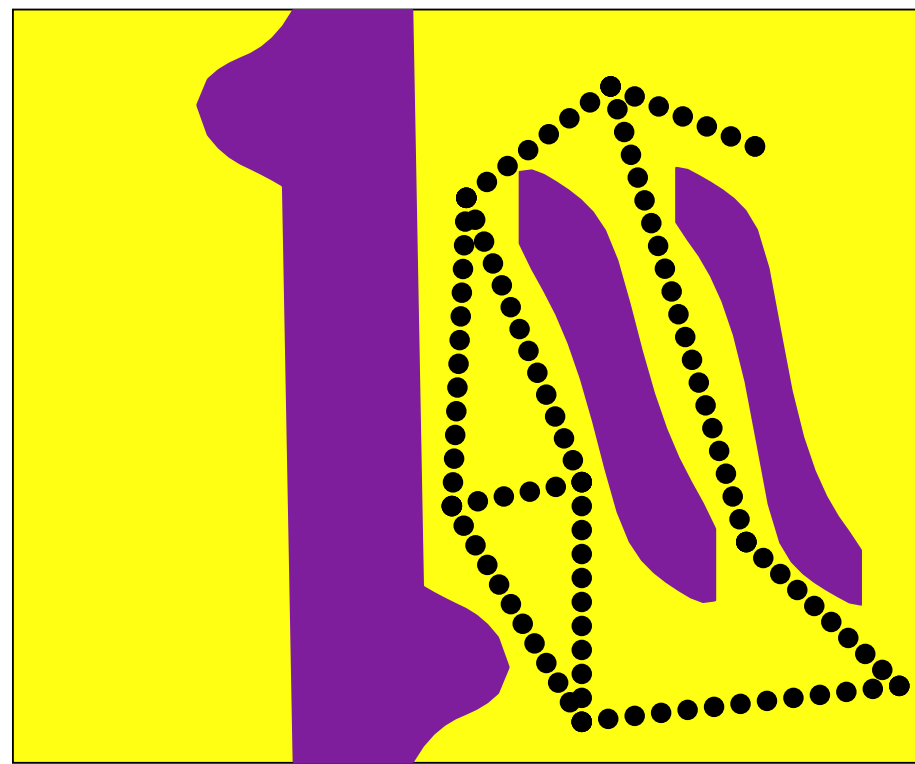
Motion planning problem



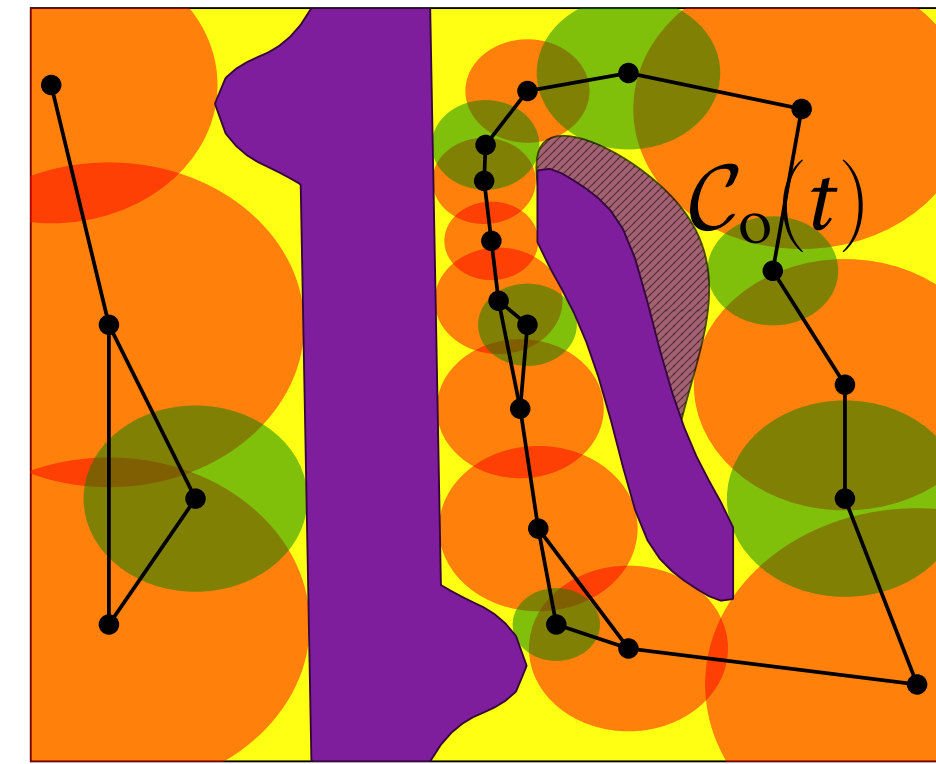
Probabilistic Bubble RoadMap (PBRM)



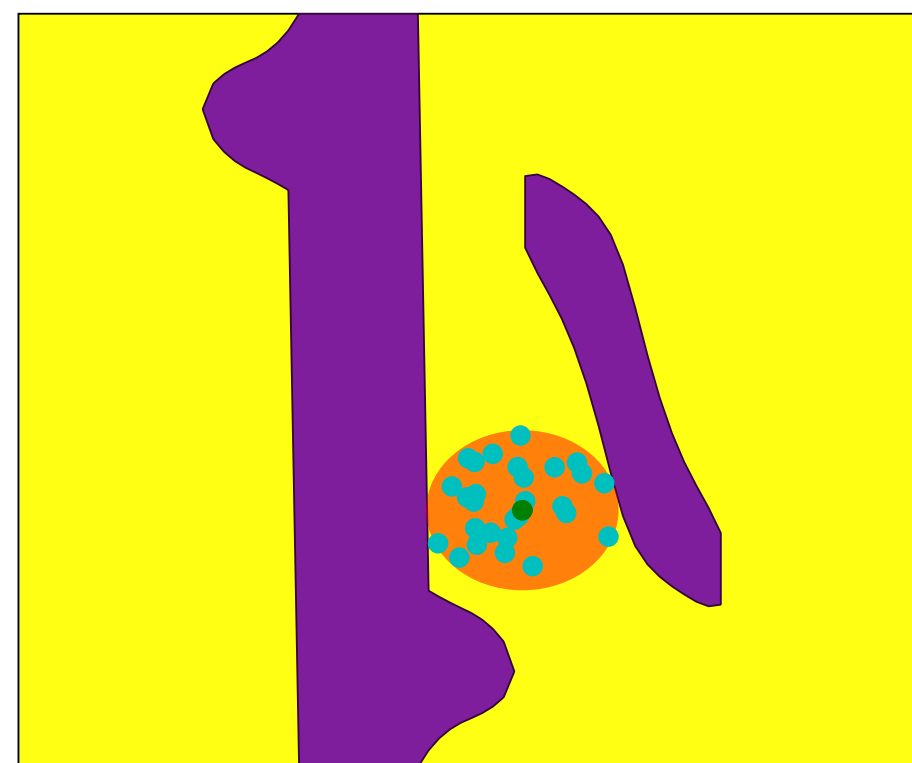
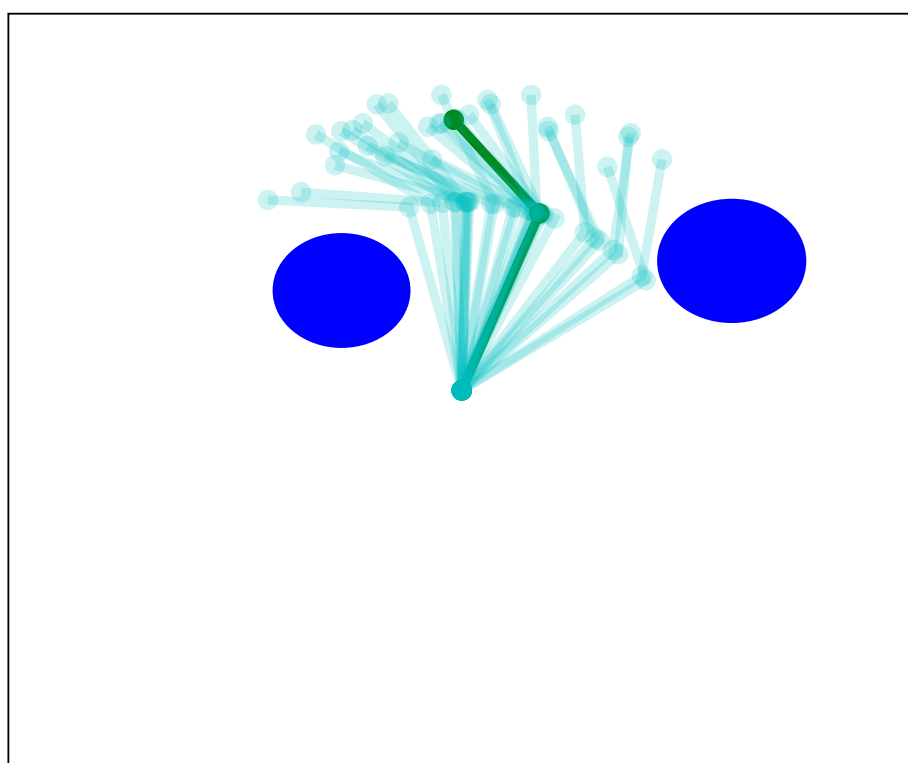
State of the art: Probabilistic RoadMap (PRM)



Probabilistic Bubble RoadMap (PBRM) Dynamic Environment



Idea: Spherical collision-free sets



Signed Distance Function

Definition

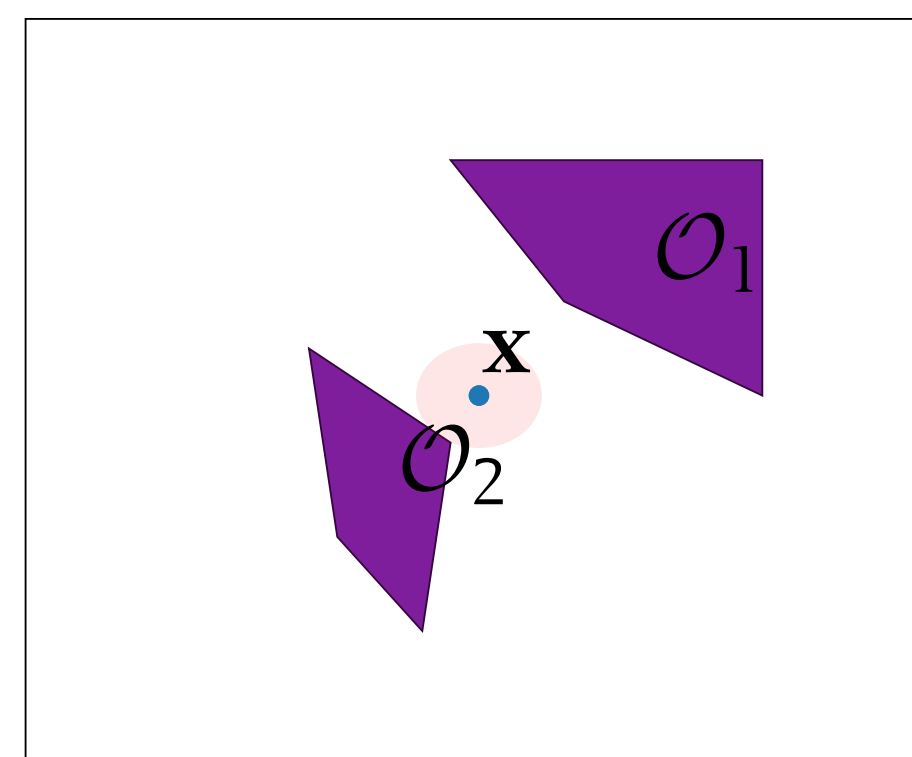
$$\rho(\mathbf{x}, \mathcal{O}) = \begin{cases} -\phi(\mathbf{x}, \mathcal{O}) & \text{if } \mathbf{x} \in \mathcal{O}, \\ \phi(\mathbf{x}, \mathcal{O}) & \text{otherwise,} \end{cases}$$

with

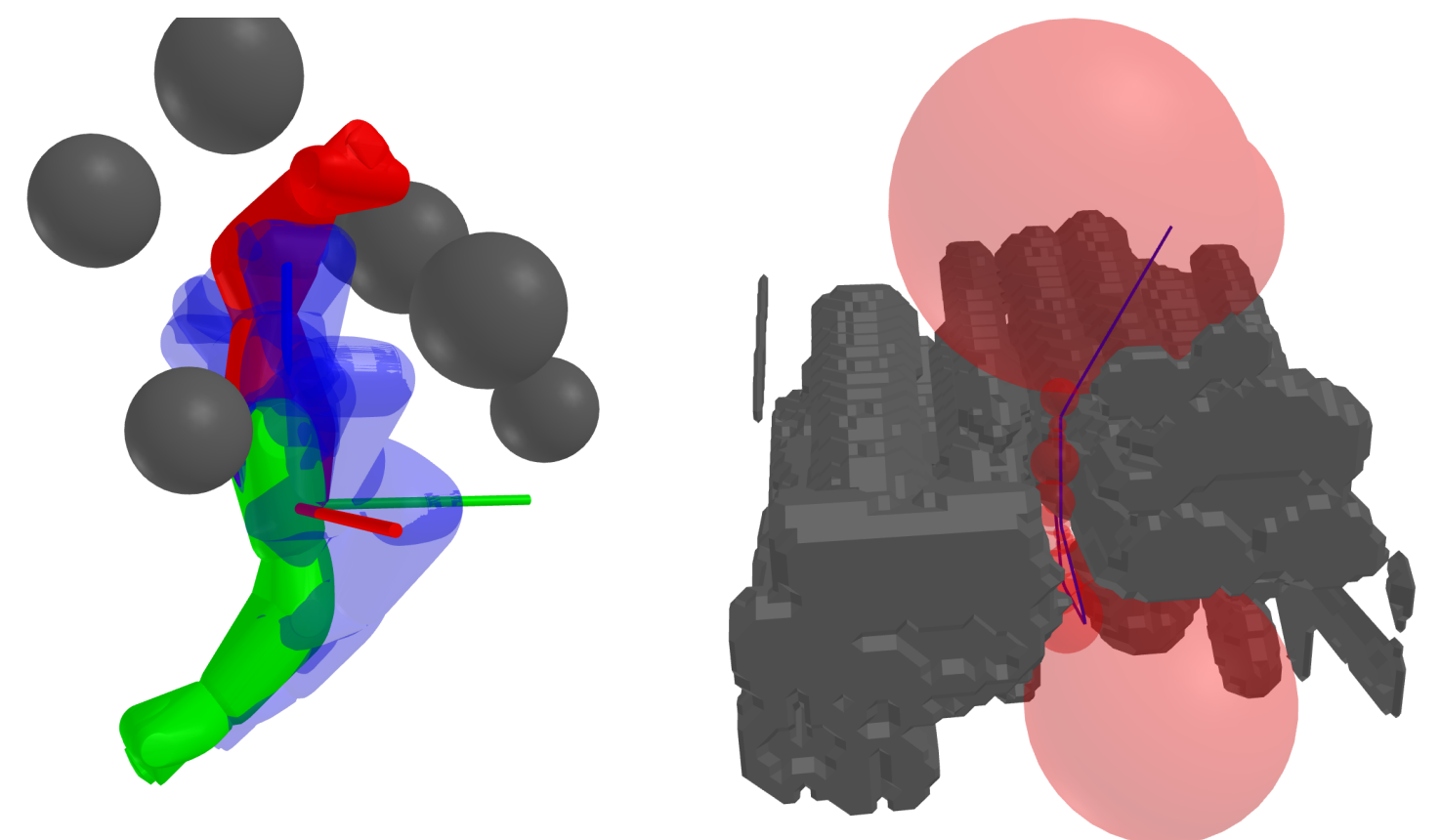
$$\phi(\mathbf{x}, \mathcal{O}) = \min_{\mathbf{x}_c \in \partial\mathcal{O}} \|\mathbf{x} - \mathbf{x}_c\|.$$

Min property:

$$\rho(\mathbf{q}, \mathcal{O}) = \min(\rho(\mathbf{q}, \mathcal{O}_1), \dots).$$



Experiments: Setup



Experiments: Results

	Graph		Paths	
	Vertices [-]	Edges [-]	Length [rad]	Time [ms]
PBRM	214	327	7.1	3
PRM	540	2425	7.4	171