

Sample Based Motion Planning Methods

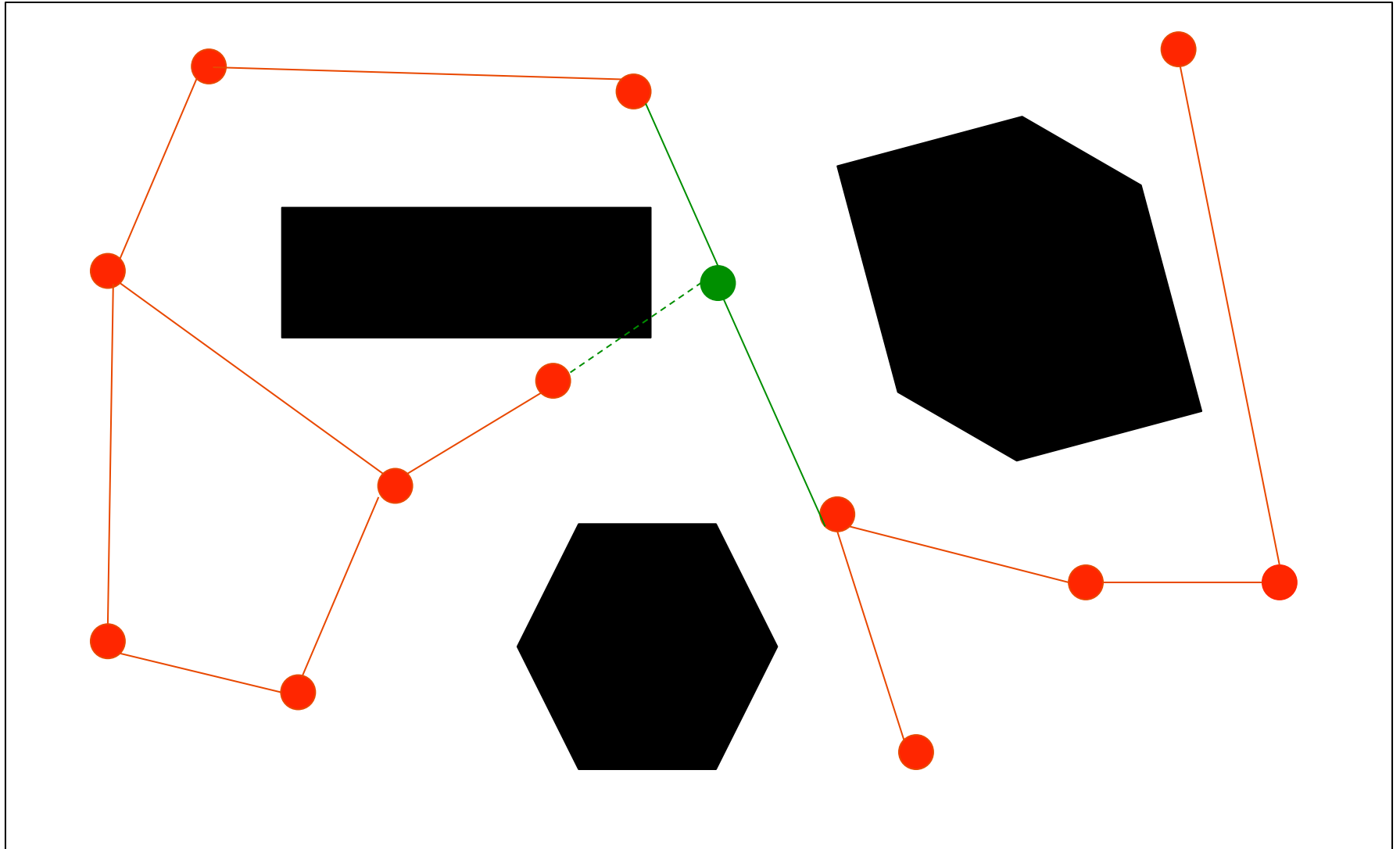
Probabilistic Road Maps

SECTION 3.1

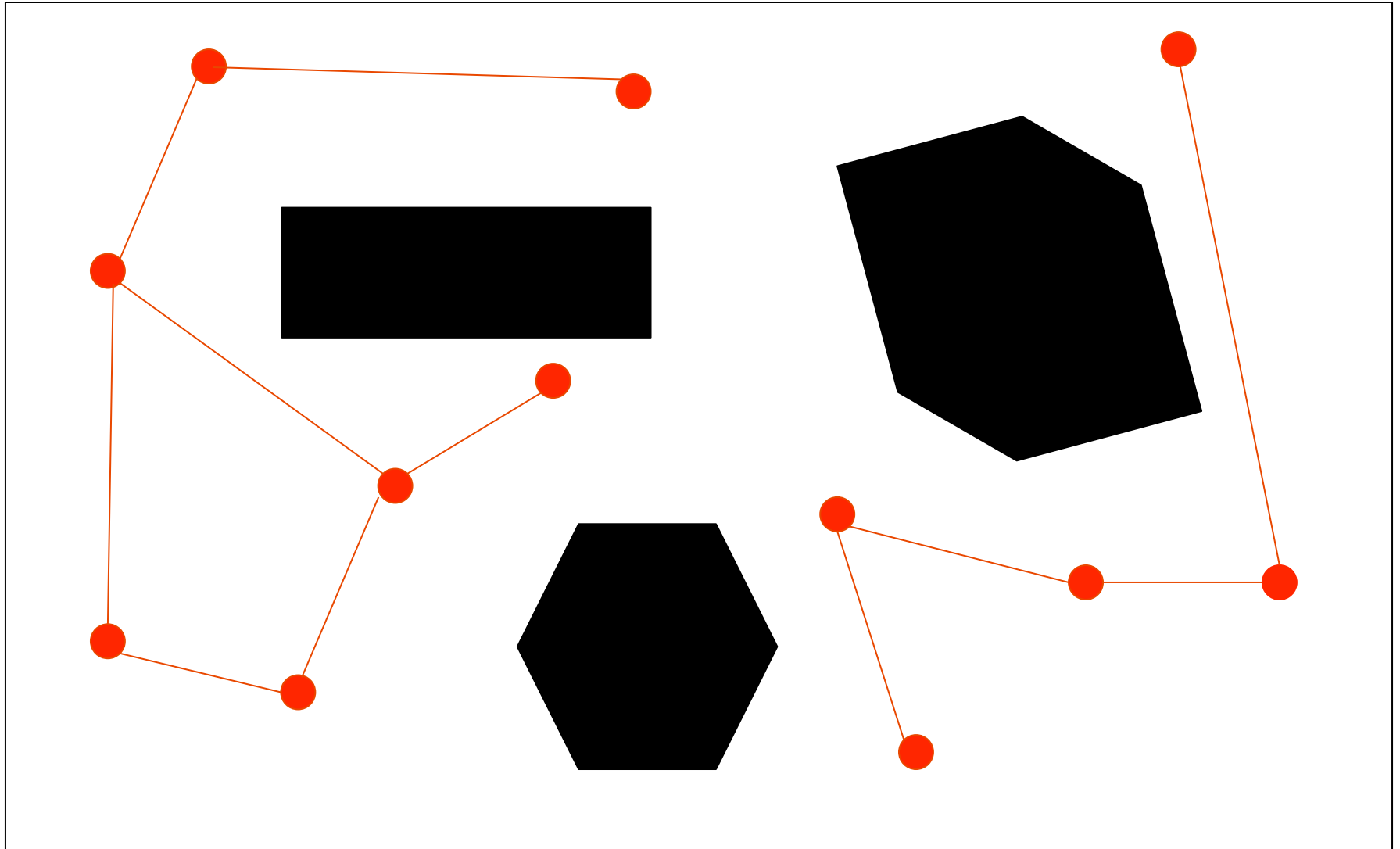
Probabilistic Road Map Pseudocode

- Repeat n times
 - Generate a random point in configuration space, \mathbf{x}
 - If \mathbf{x} is in freespace
 - Find the k closest points in the roadmap to \mathbf{x} according to the **Dist** function
 - Try to connect the new random sample to each of the k neighbors using the **LocalPlanner** procedure. Each successful connection forms a new edge in the graph.

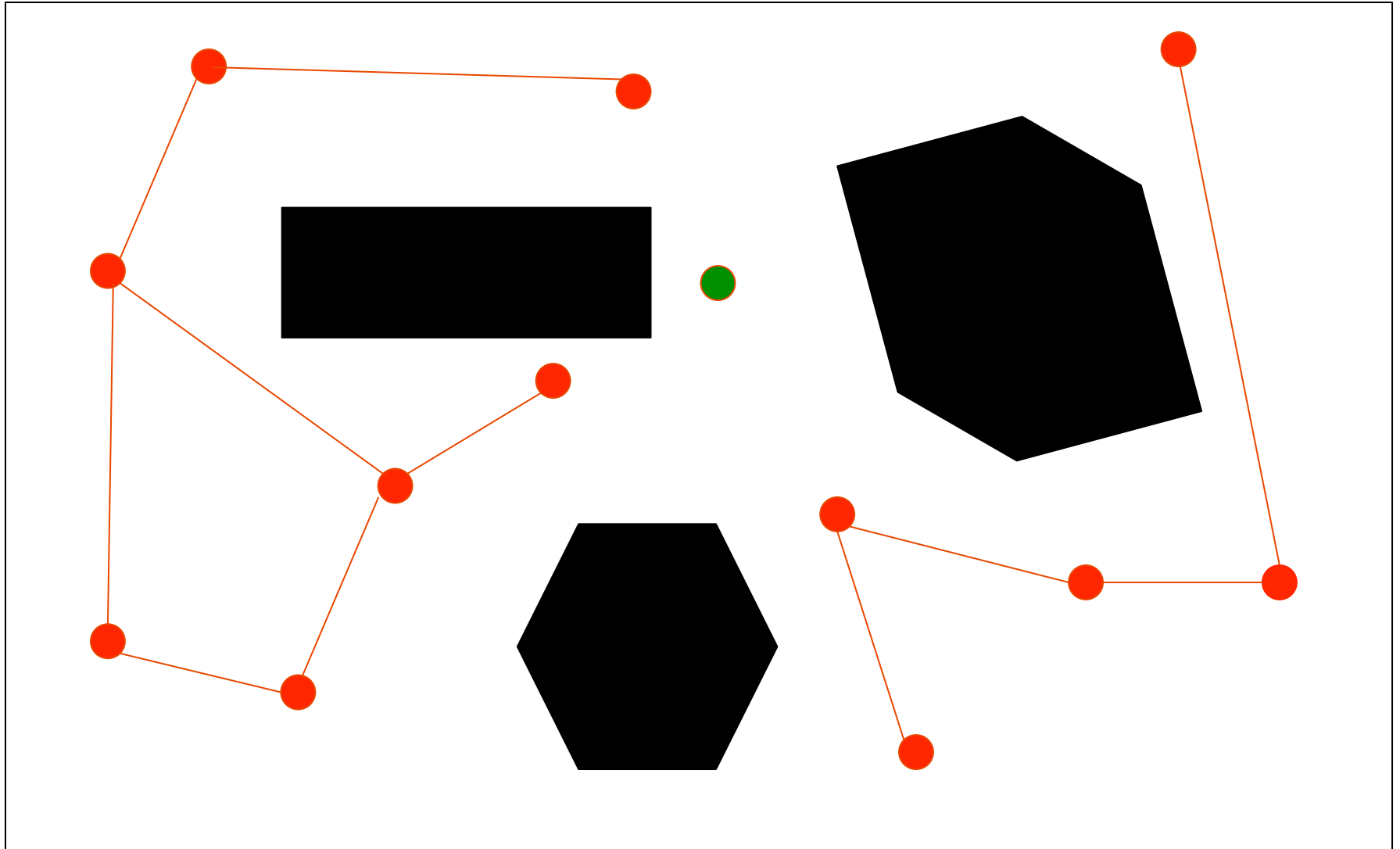
Random Graph Construction



Random Graph Construction



Random Graph Construction



The Dist function

- The PRM procedure relies upon a distance function, $Dist$, that can be used to gauge the distance between two points in configuration space. This function takes as input the coordinates of the two points and returns a real number:

$$Dist(\mathbf{x}, \mathbf{y}) \in \mathbb{R}$$

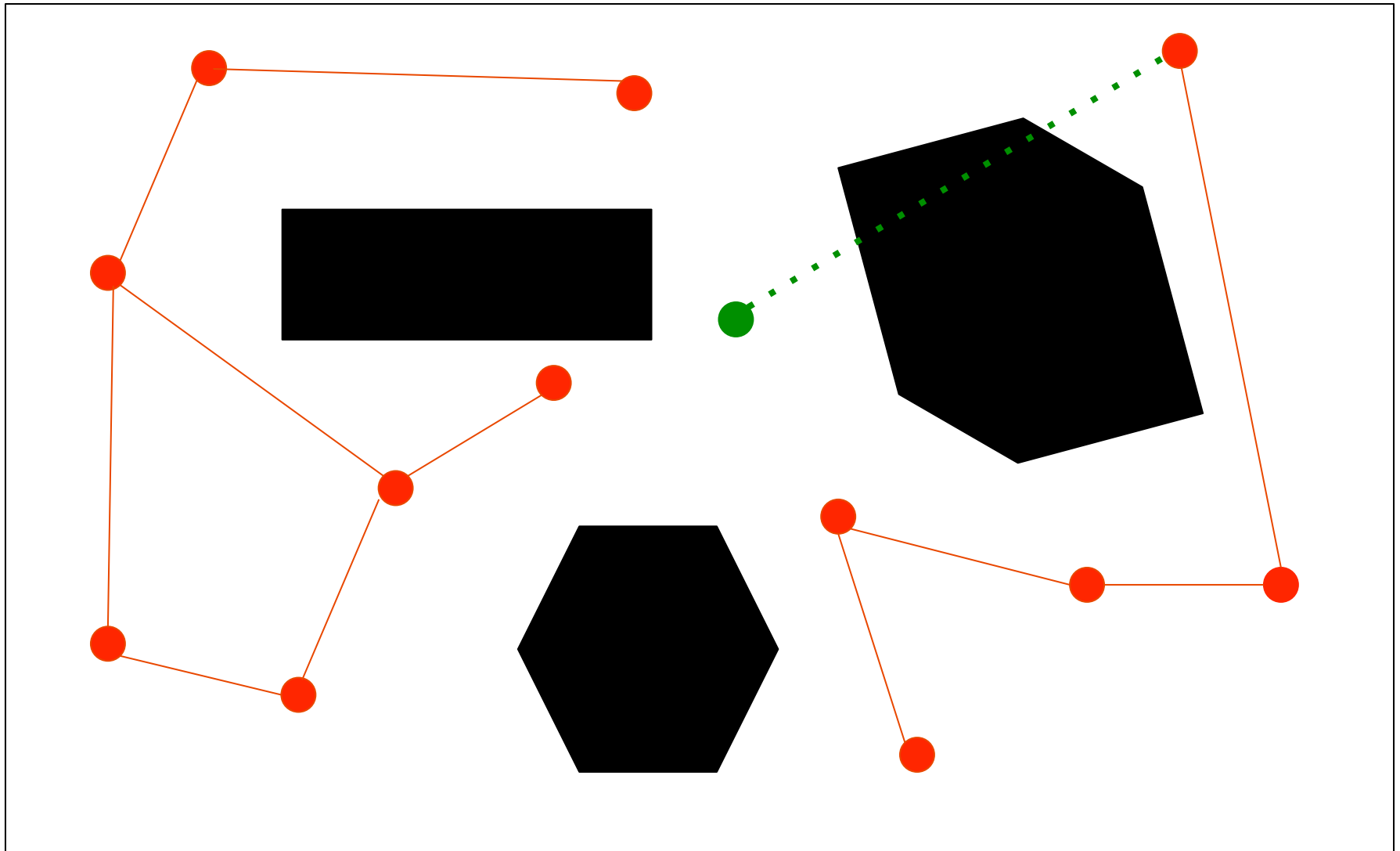
- Common choices for distance functions include:
 - The L1 distance : $Dist_1 = \sum_i |\mathbf{x}_i - \mathbf{y}_i|$
 - The L2 distance : $Dist_2 = \sqrt{(\sum_i (\mathbf{x}_i - \mathbf{y}_i)^2)}$

Handling angular displacements

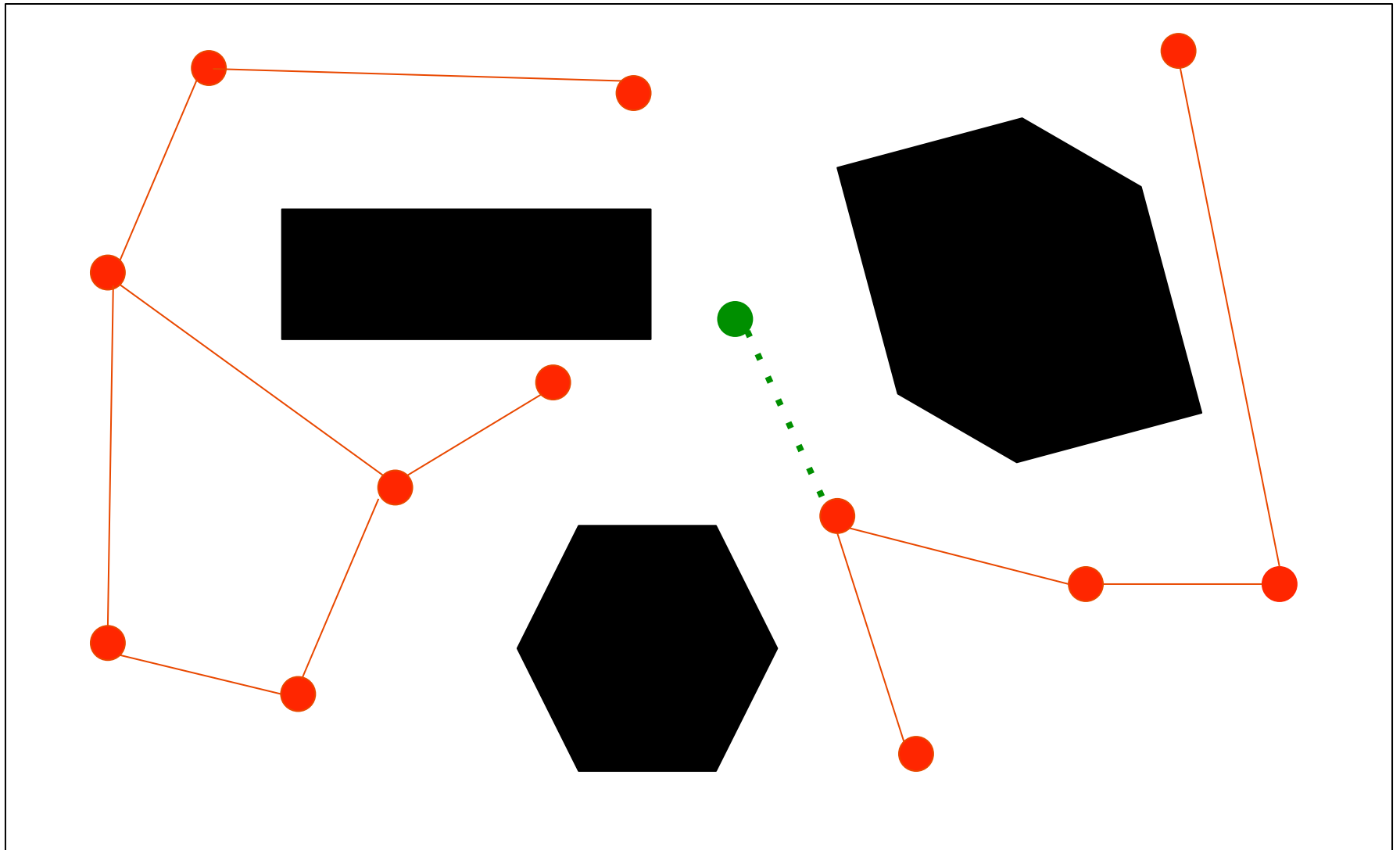
- There are often cases where some of the coordinates of the configuration space correspond to angular rotations. In these situations care must be taken to ensure that the *Dist* function correctly reflects distances in the presence of wraparound.
- For example if θ_1 and θ_2 denote two angles between 0 and 360 degrees the expression below can be used to capture the angular displacement between them.

$$Dist(\theta_1, \theta_2) = \min(|\theta_1 - \theta_2|, (360 - |\theta_1 - \theta_2|)) \quad (1)$$

Checking for collision along a path

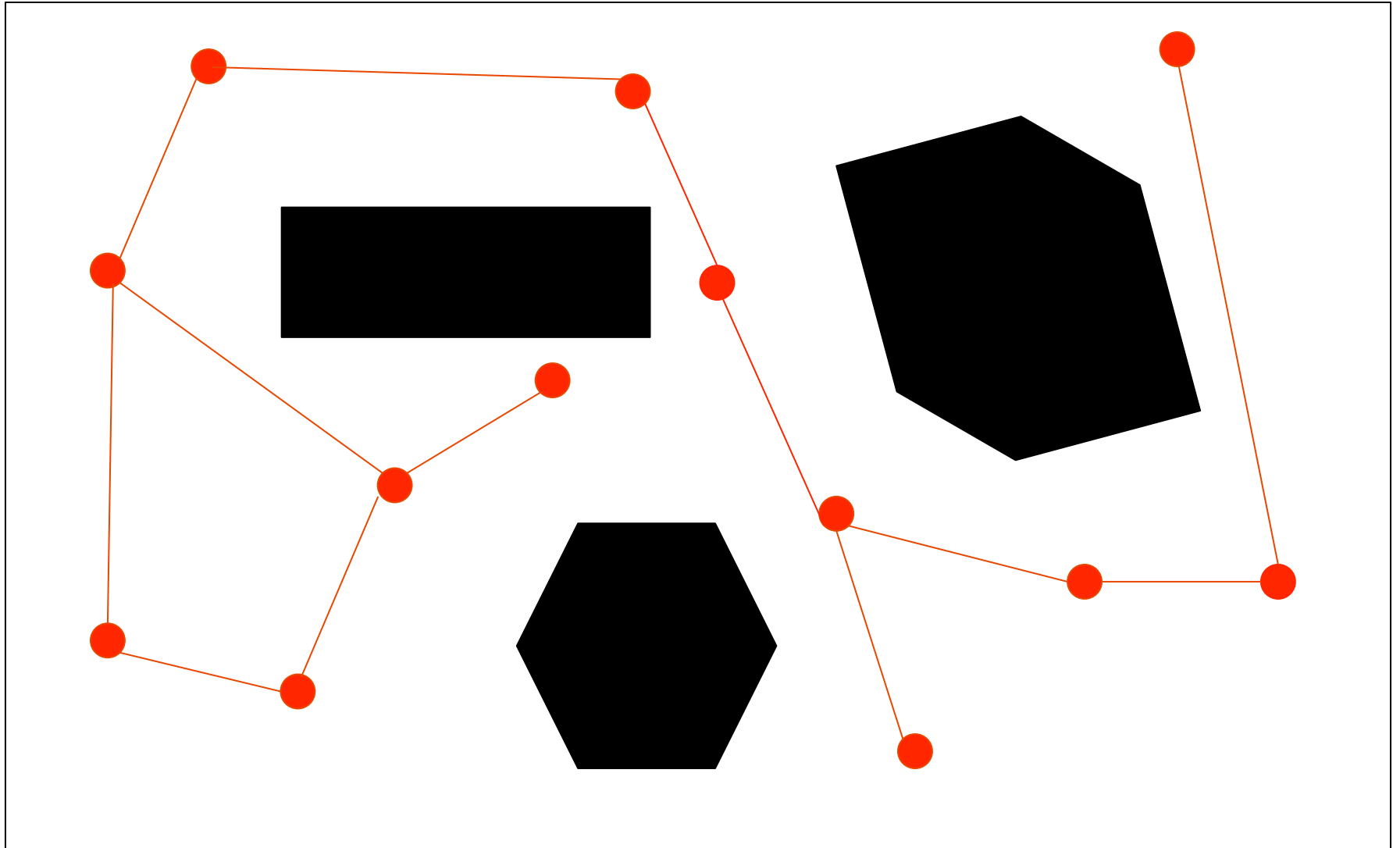


Checking for collision along a path

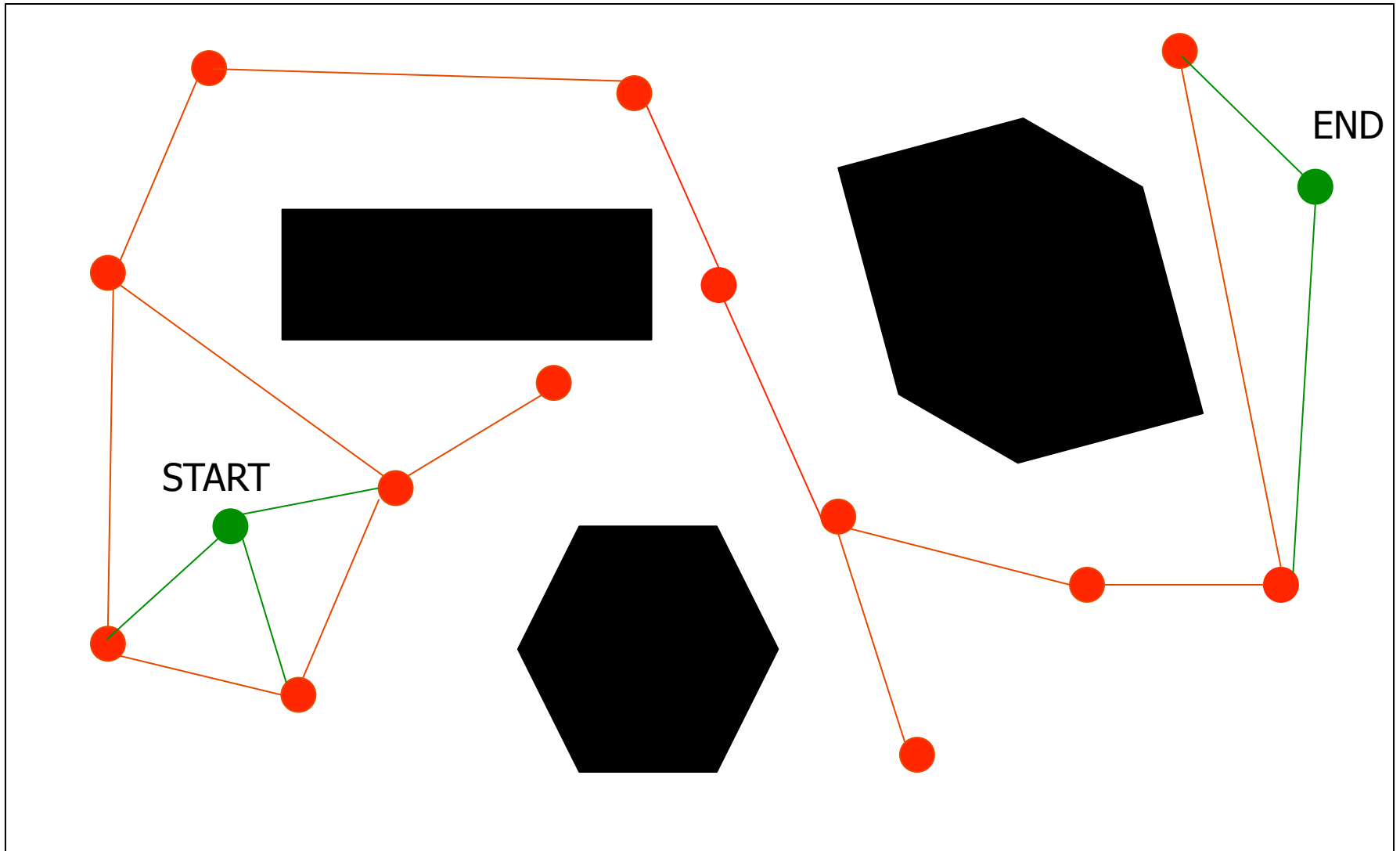


- This first slide shows the original Probabilistic roadmap constructed via random sampling.
- This second slide shows the roadmap augmented with the start and end nodes which are attached to the roadmap using the green edges
- This final version shows the path planned through the augmented graph

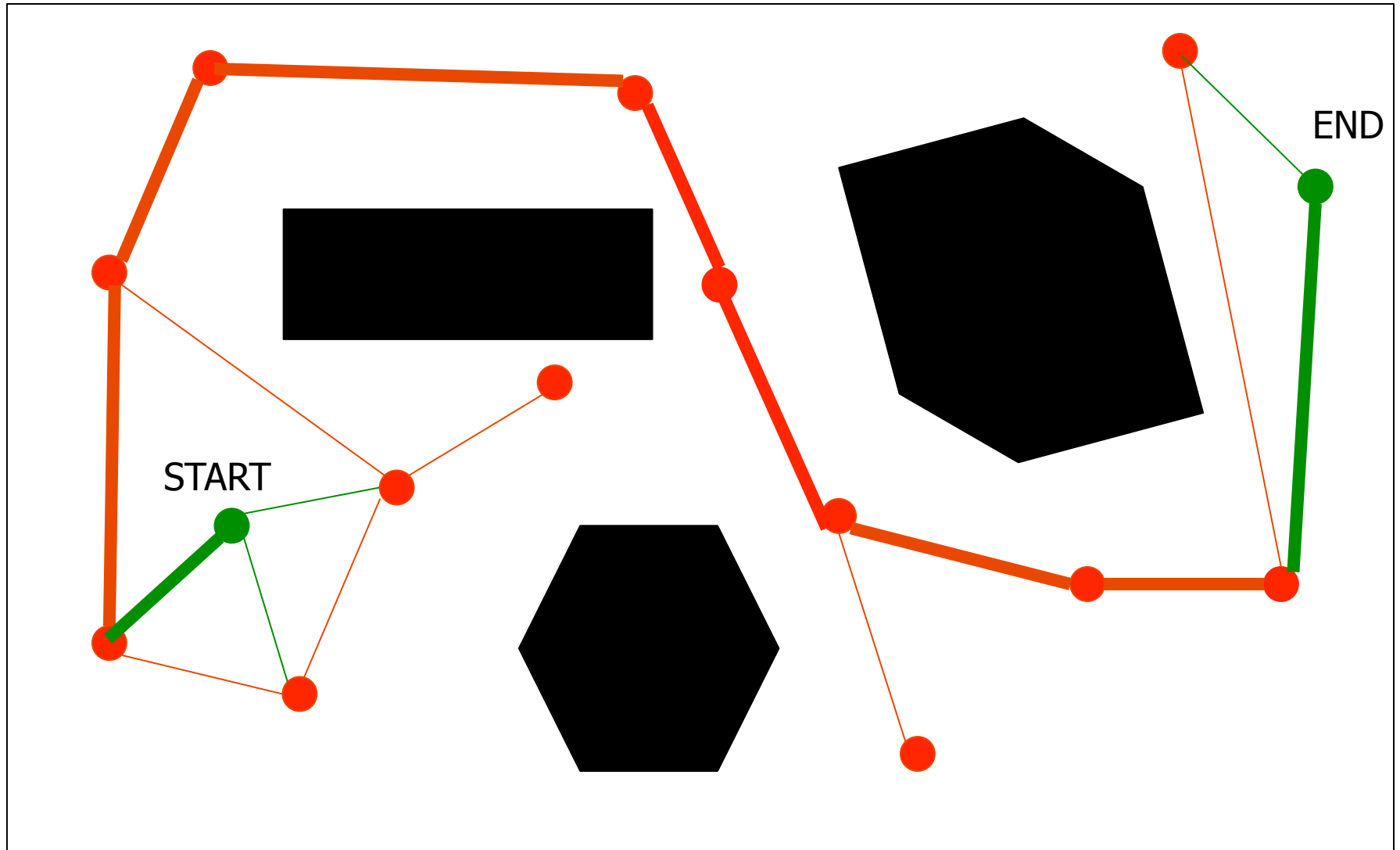
Initial Road Map



Road Map with Start and End added



Final Route



- **Note that once the roadmap has been constructed it can be used to answer various path planning problems so the cost of constructing the roadmap graph can be amortized over multiple queries. This is great if you are going to be running the your robot back and forth through the same environment.**