Configuration Space

Cspace Intro

SECTION 2.1

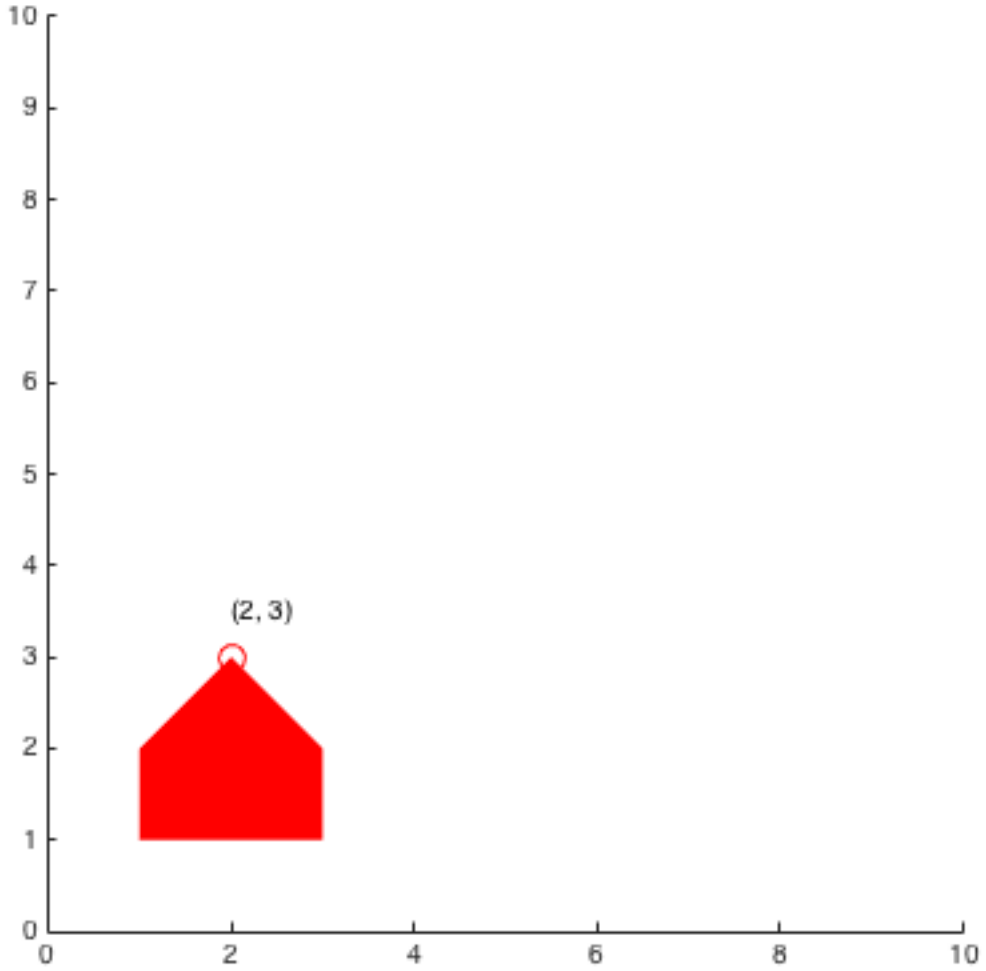
Penn

Intro

- **In the motion planning problems we have considered so far we have basically reduced the problem to planning on a graph where the robot can take on various discrete positions which we can enumerate and connect by edges.**
- **In practice most of the robots that we build can move continuously through space. Configuration space is a handy mathematical and conceptual tool which was developed to help us think about these kinds of problems in a unified framework.**

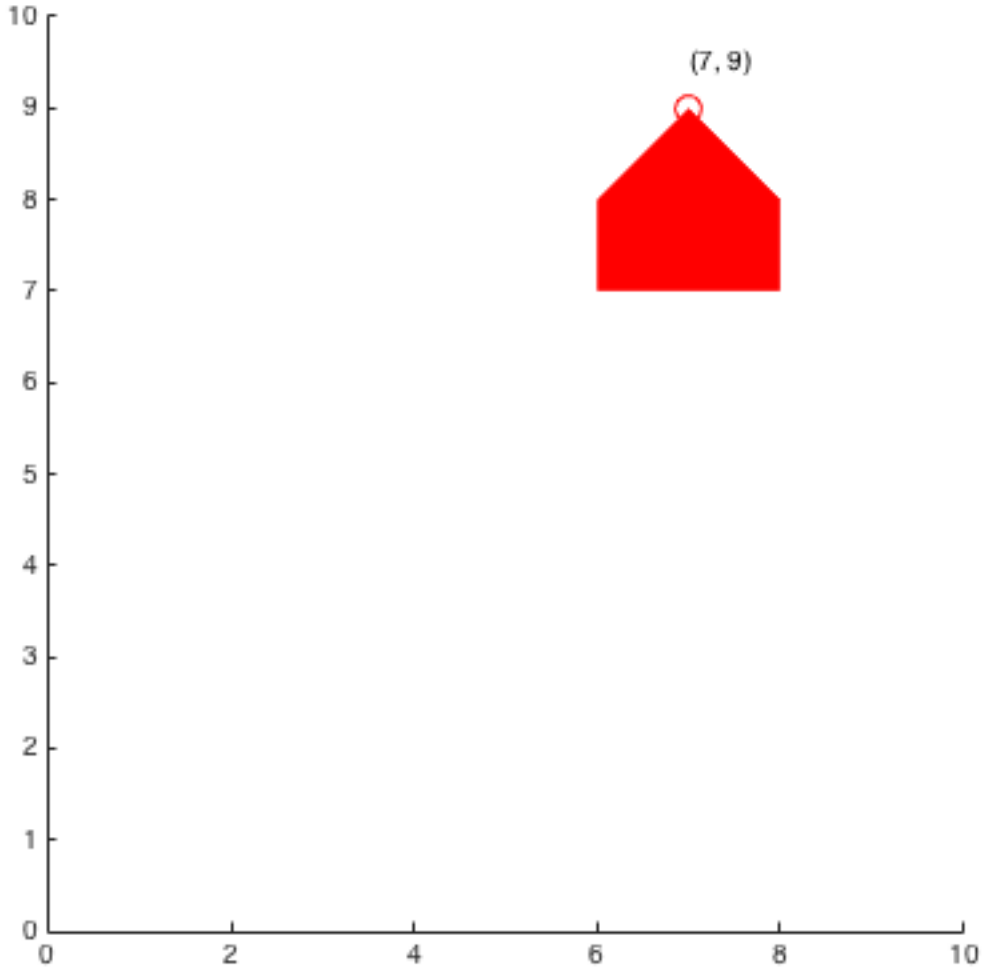
- **Basically the configuration space of a robot is the set of all configurations and or positions that the robot can attain.**
- **This slide shows a simple example of a robot that can translate freely in the plane. Here we can quantify the positions that the robot can take on with a tuple (tx, ty) which denotes the coordinates of a particular reference point on the robot with respect to a fixed coordinate frame of reference.**

Simple Robot – Translation in the Plane

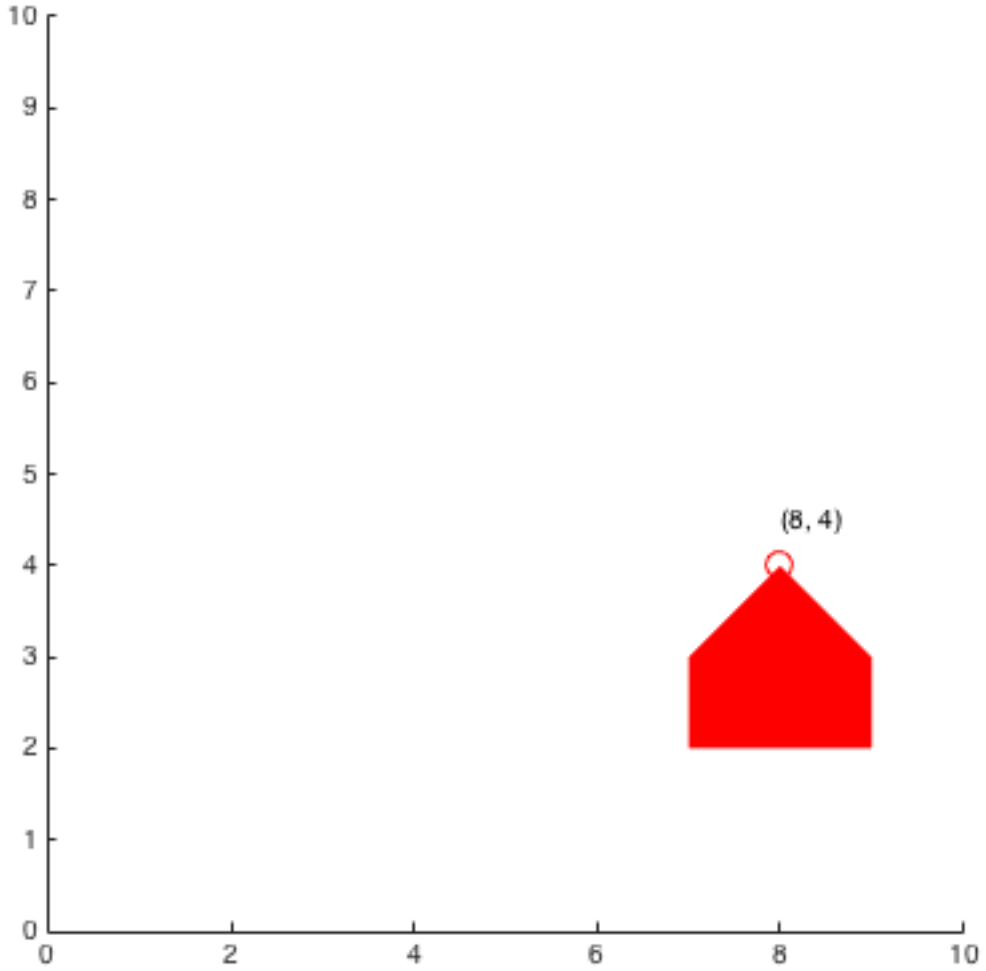


- **Here are a couple of configurations that this translating robot can take on along with the associated coordinates.**

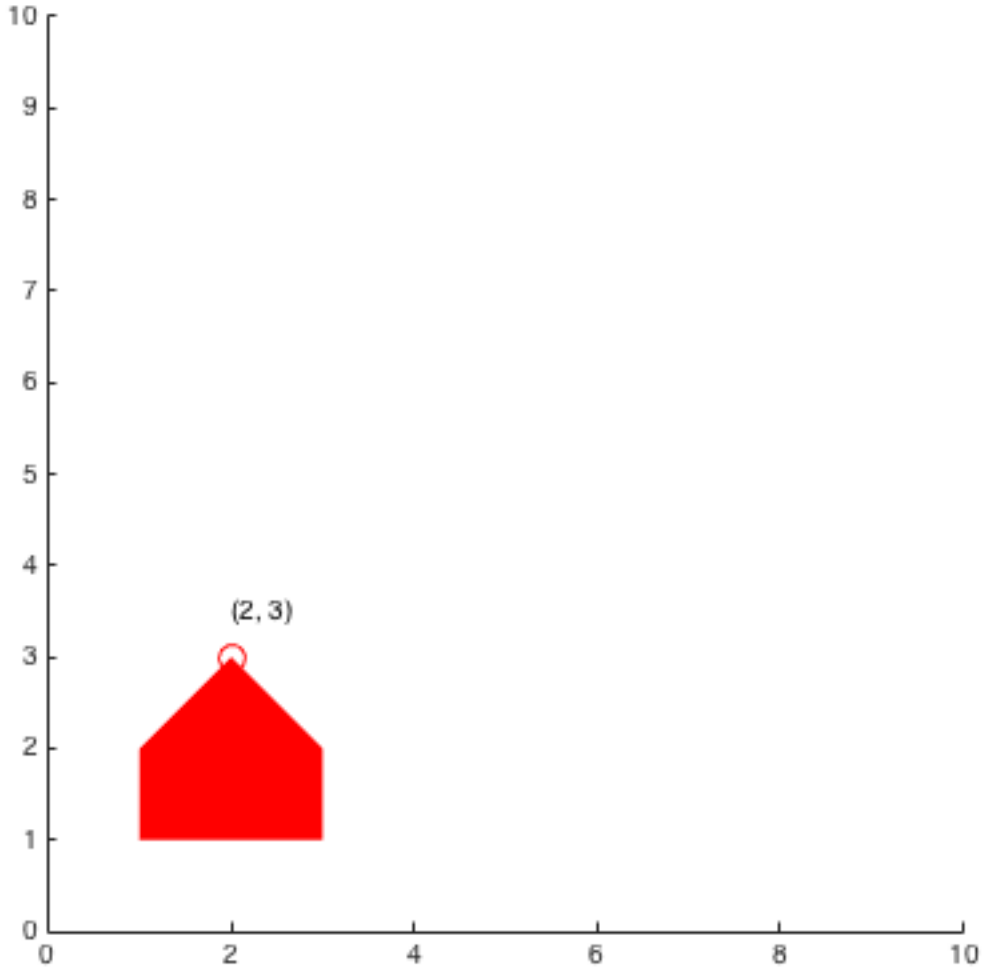
Simple Robot – Translation in the Plane



Simple Robot – Translation in the Plane

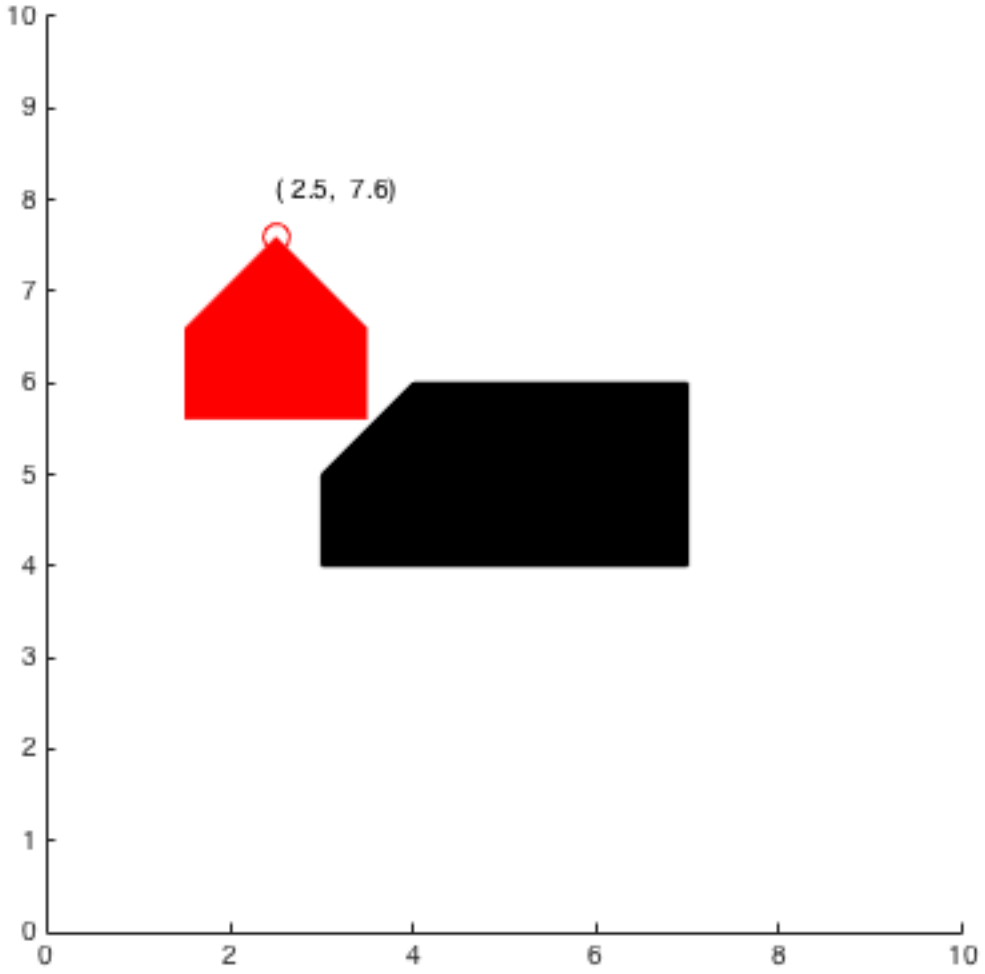


Simple Robot – Translation in the Plane



- **In this case we would say that our robot has two degrees of freedom and we can associate the configuration space of the robot with the points on the 2D plane – namely these (tx,ty) coordinates.**

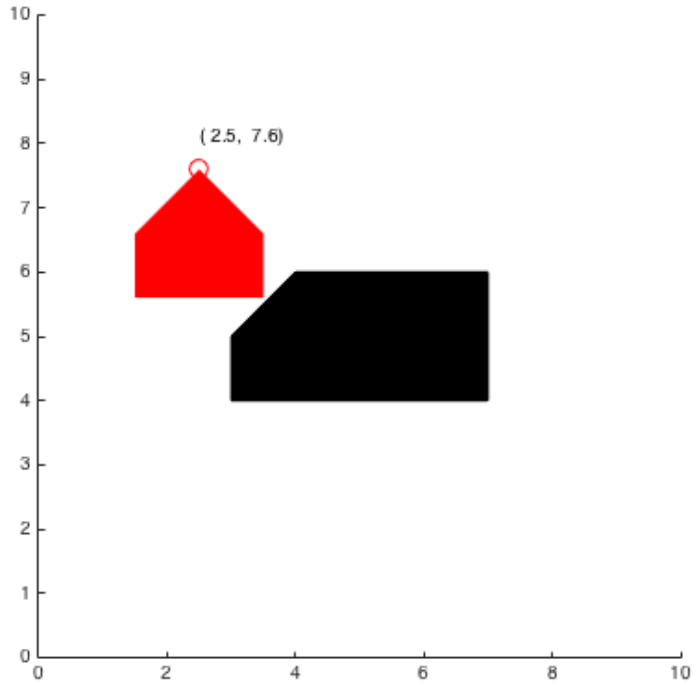
Adding an Obstacle

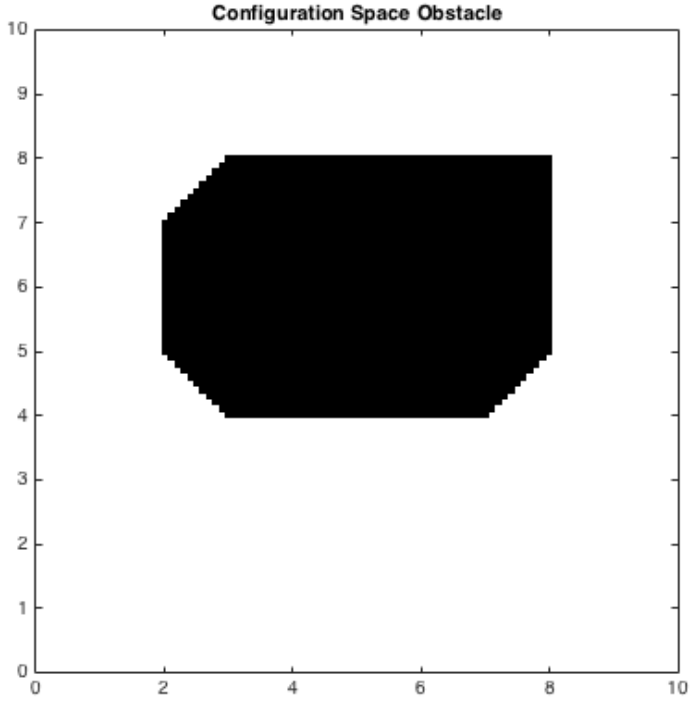


- Now we will make the story a little bit more interesting by introducing fixed obstacles into our model.
- What these obstacles do is make certain configurations in the configuration space unobtainable. This figure shows the (tx,ty) configurations that the robot CANNOT attain because of the obstacle
- This set of configurations that the robot cannot inhabit is referred to as a CONFIGURATION SPACE OBSTACLE.
- Conversely the region of configuration space that is outside of the configuration space obstacle is termed freespace.

- On the right hand side of this figure we plot the configuration space obstacle corresponding to the geometric obstacle shown in the left half.
- Again the C-space obstacle denotes the set of configurations that the robot CANNOT attain because of collision with the obstacle.

Configuration Space Obstacle

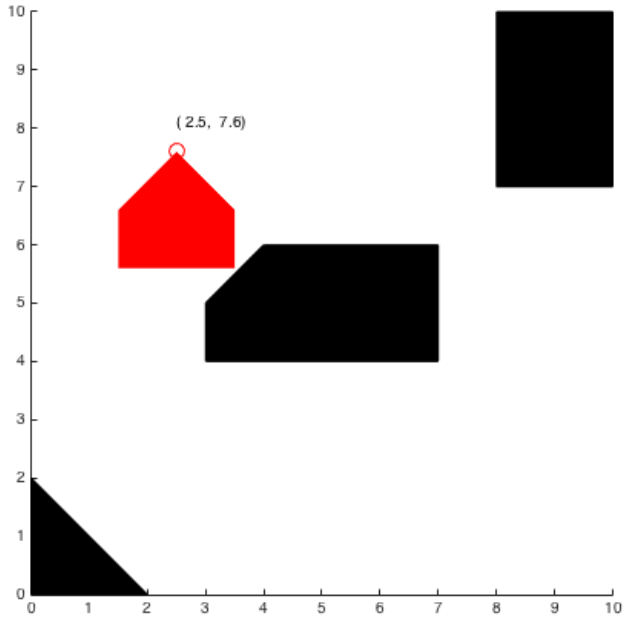


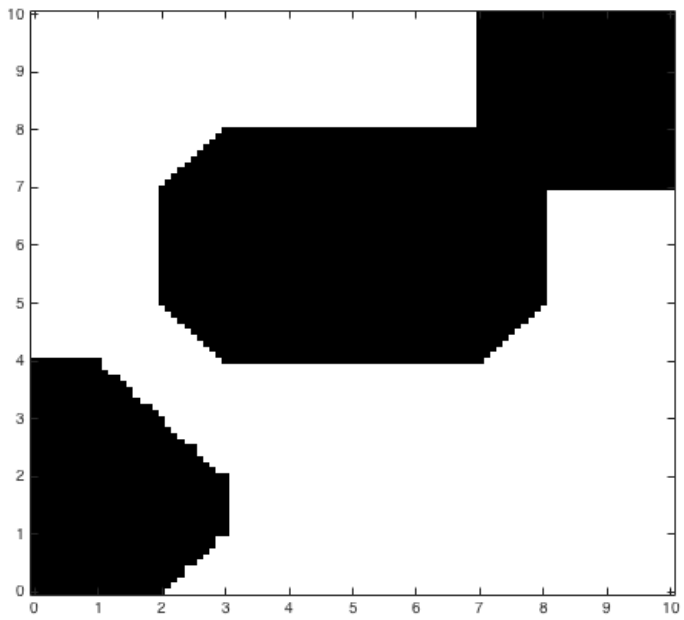


- **Note that the dimensions and shape of the configuration space obstacle are obtained by considering both the obstacle and the shape of the robot.**
- **More formally the configuration space obstacle in this case is the Minkowski sum of the obstacle**

- **If we have multiple obstacles in space we can visualize the union of all of the configuration space obstacles and we get a picture like this.**
- **Again the configuration of the robot corresponds to a point in the space and the dark areas correspond to configurations that the robot cannot attain.**

Configuration Space Obstacles





- **In this setting the task of planning a path for our robot correspond to planning a trajectory through configuration space from the starting configuration to the end configuration.**