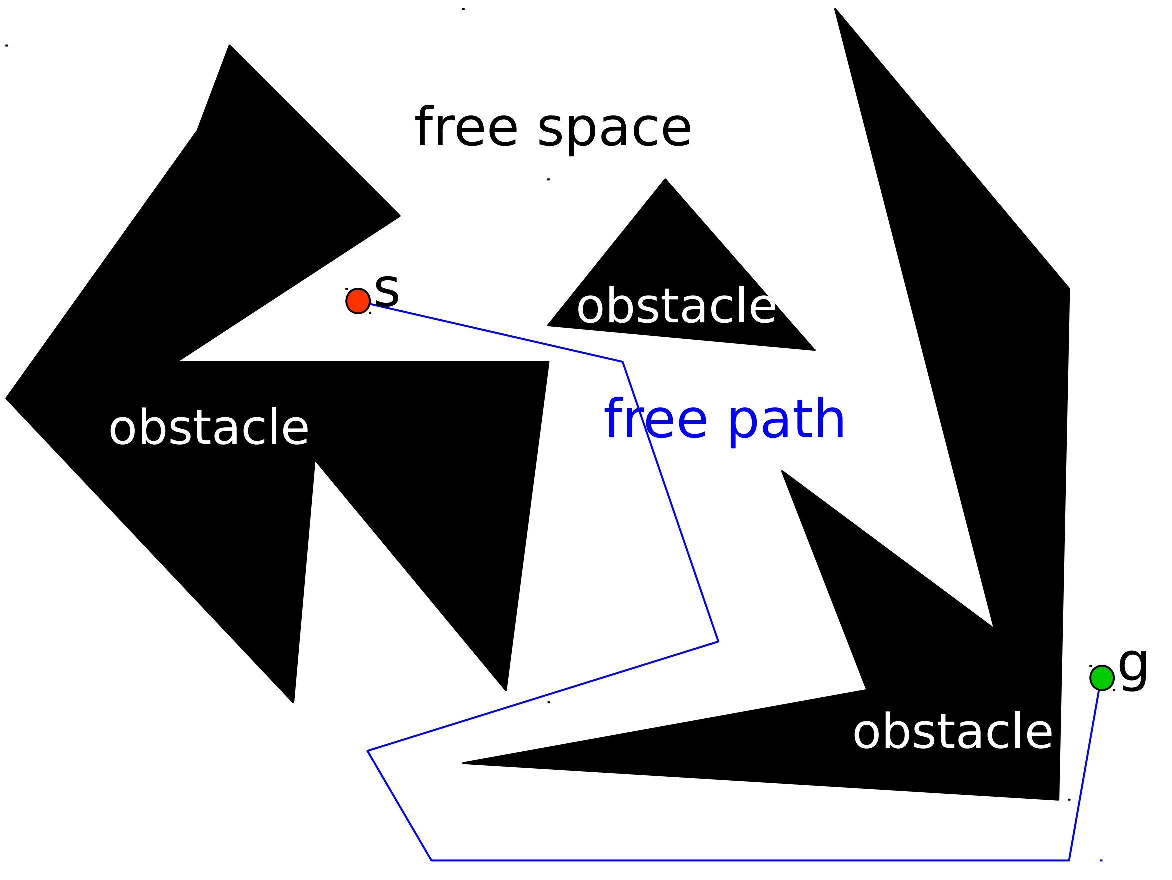
# Artificial Potential Functions

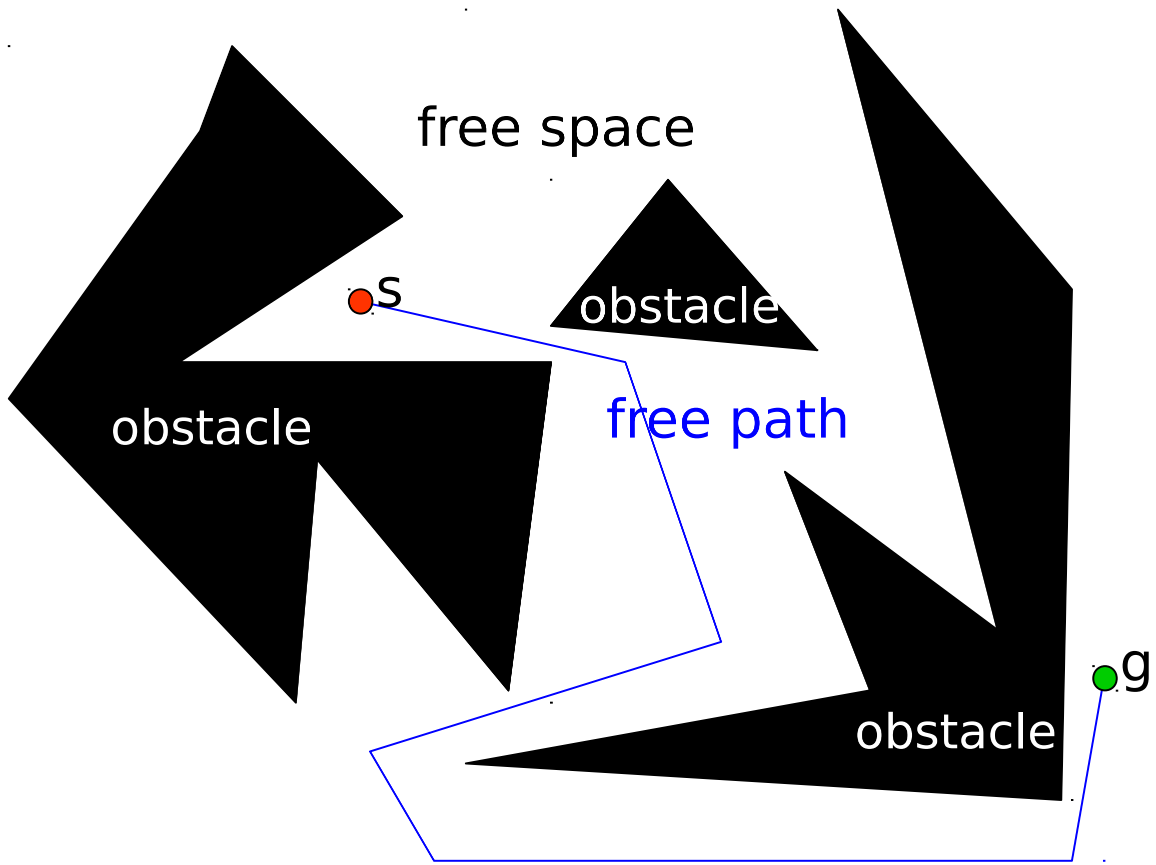



Slides borrowed from: Latombe's book and slides, Choset, Kuffner

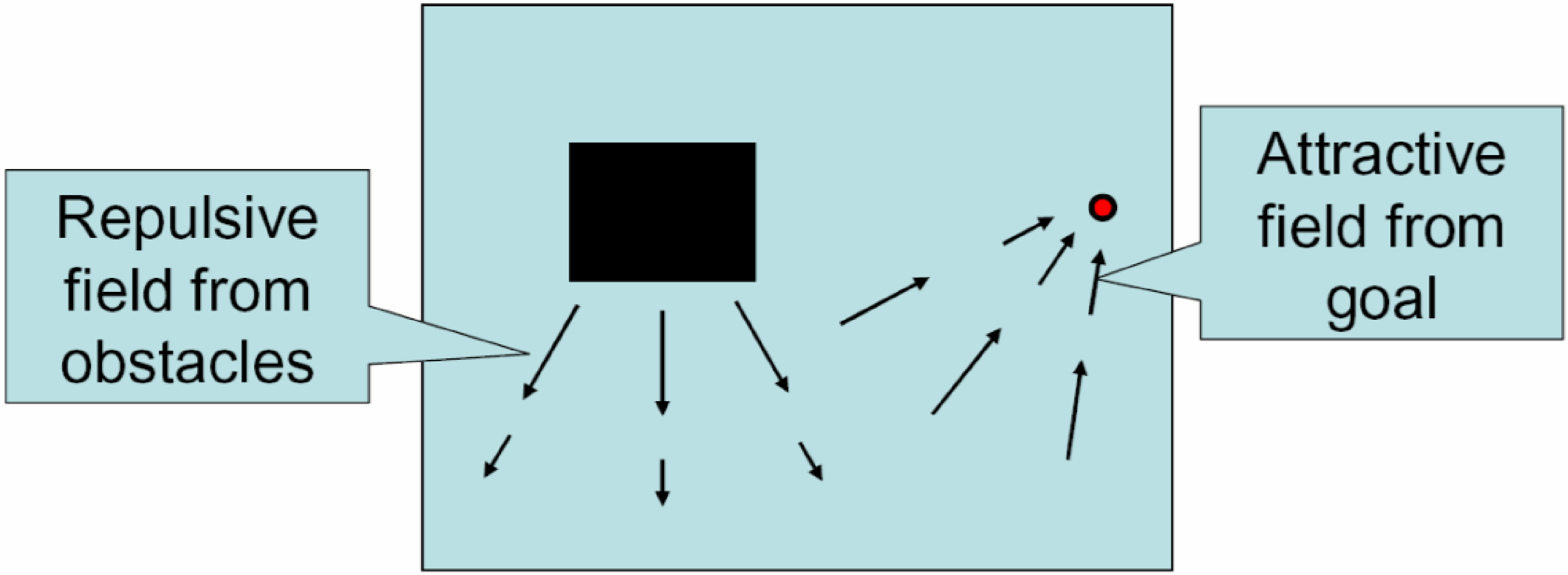
# Problem

<u>Given</u>:
– a point-robot (robot is a point in space)
– a start and goal configuration

<u>Find</u>:
– path from start to goal that does not result in a collision

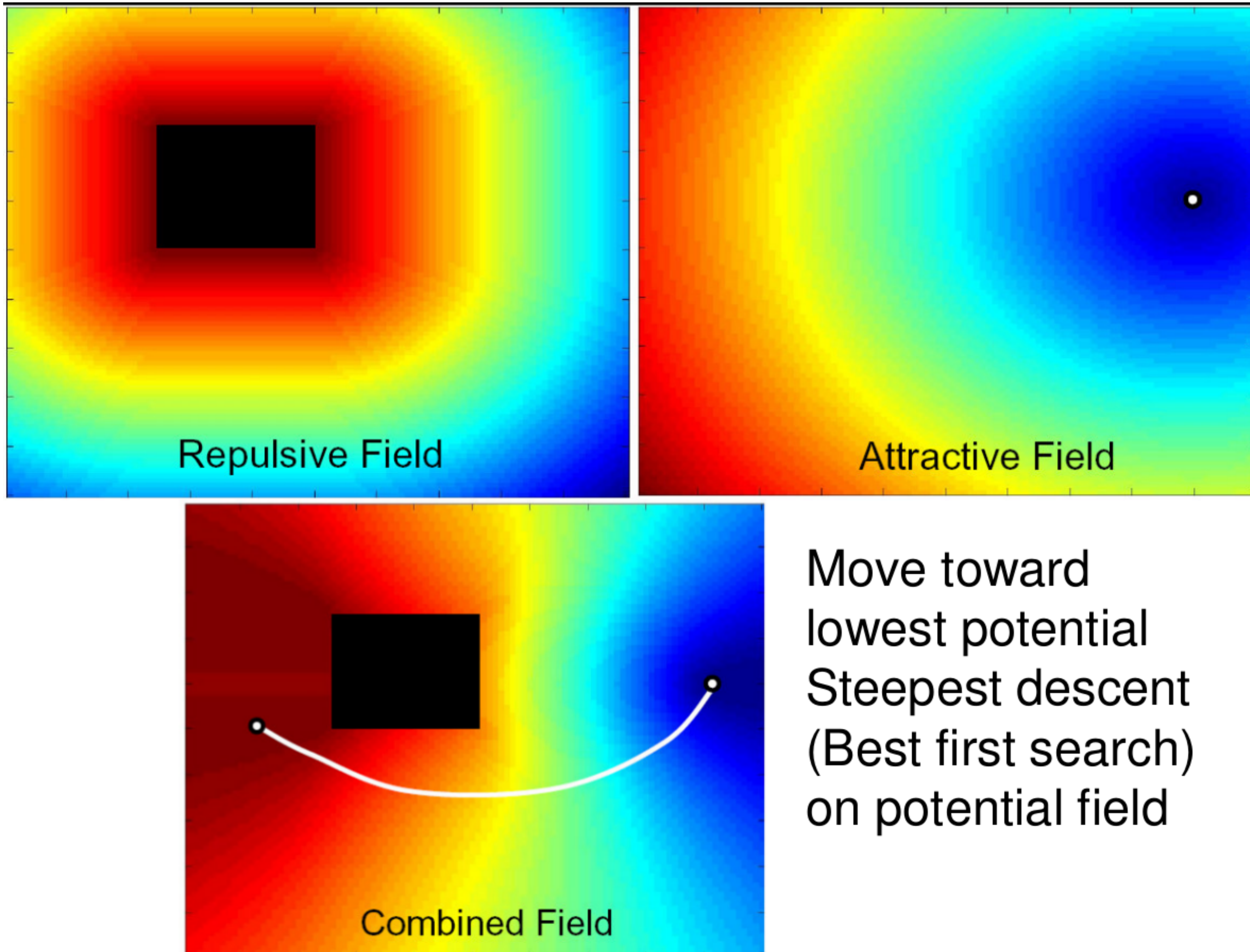


# Potential Functions




- Stay away from obstacles: Imagine that the obstacles are made of a material that generate a *repulsive* field
- Move closer to the goal: Imagine that the goal location is a particle that generates an *attractive* field

# Potential Functions




Move toward lowest potential
Steepest descent
(Best first search)
on potential field

# Potential Functions

$$U_g(\mathbf{q}) = d^2(\mathbf{q}, \mathbf{q}_{goal})$$

Distance to goal state

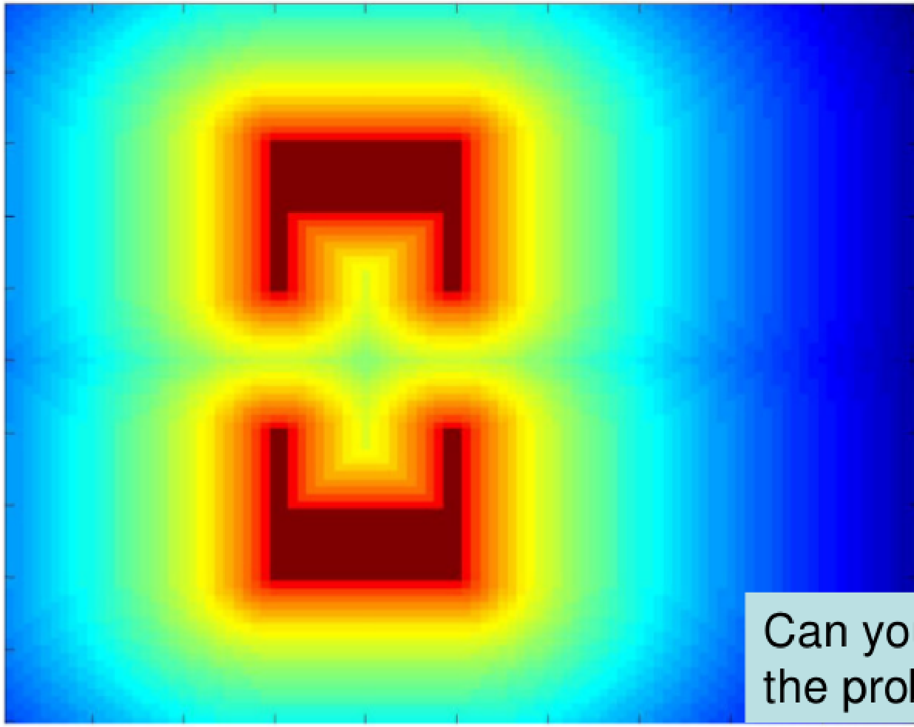
$$U_o(\mathbf{q}) = \frac{1}{d^2(\mathbf{q}, Obstacles)}$$

Distance to nearest obstacle point.
Note: Can be computed efficiently by using the *distance transform*

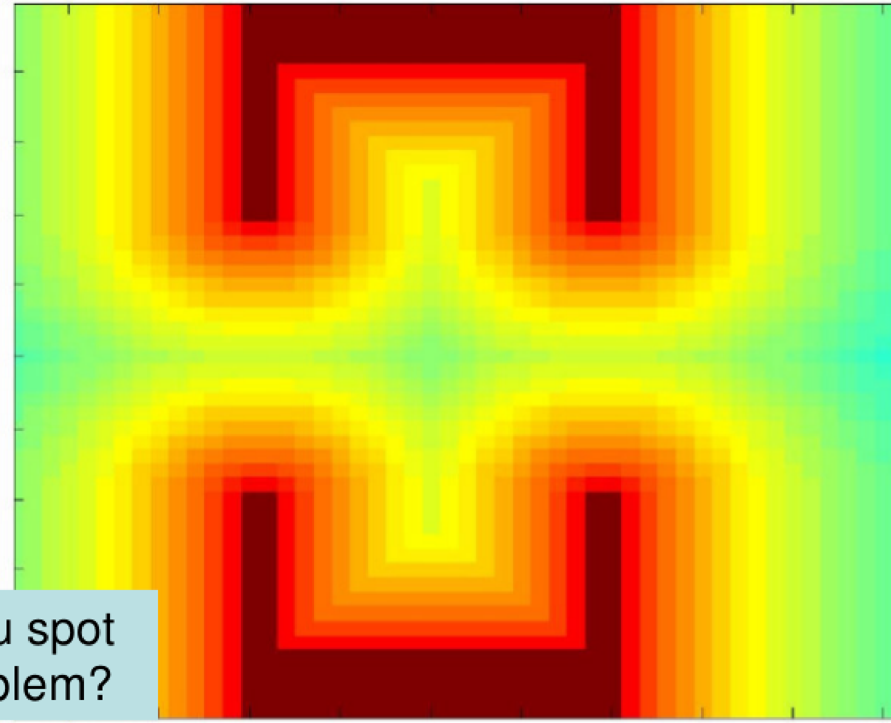
$$U(\mathbf{q}) = U_g(\mathbf{q}) + \lambda U_o(\mathbf{q})$$

$\lambda$ controls how far we stay from the obstacles

# Potential Function Limitations



Potential field

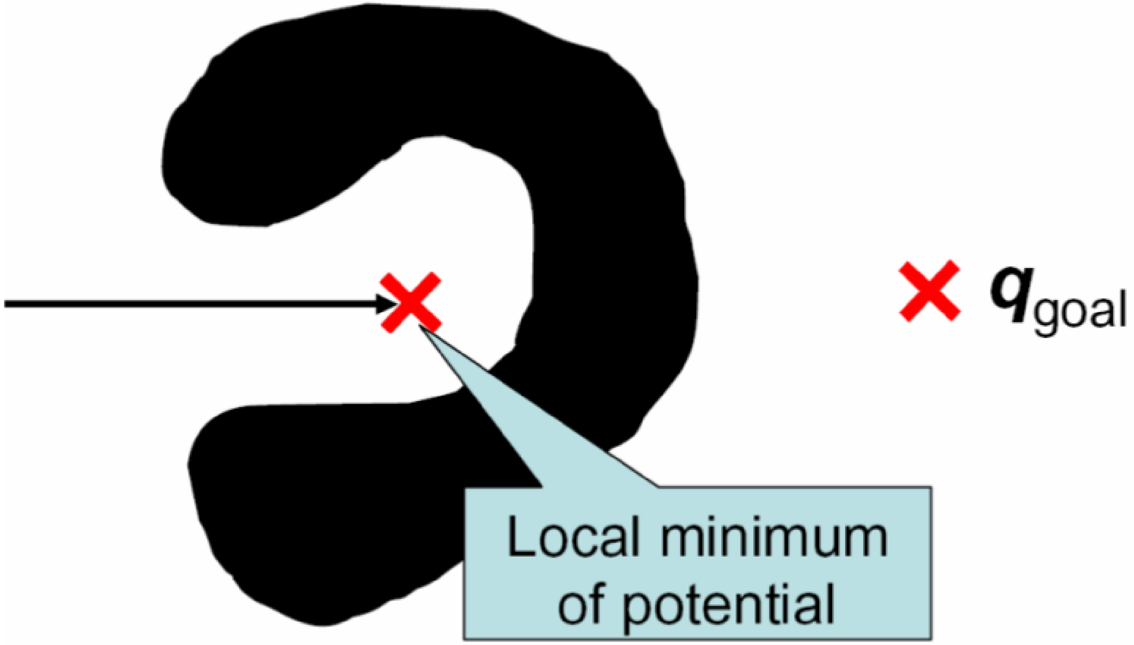


Zoomed in view

Can you spot the problem?

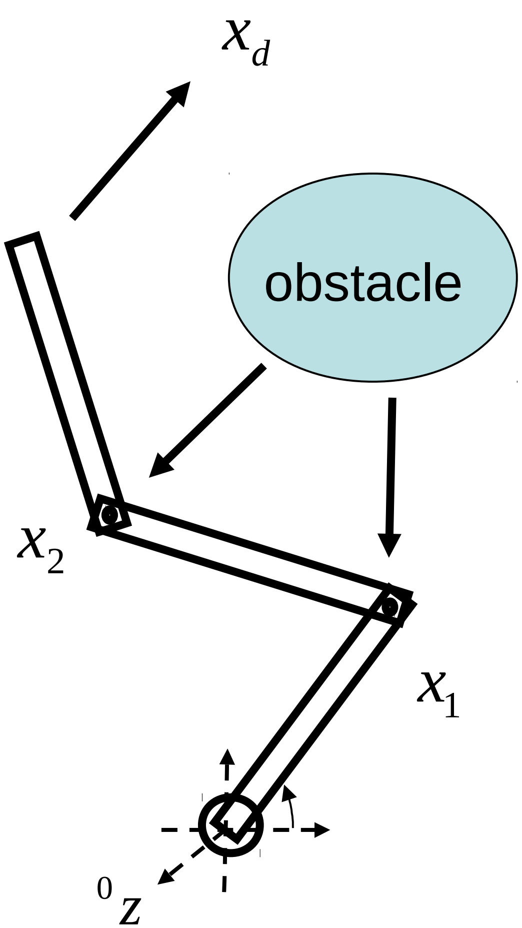
- Completeness?
- Problems in higher dimensions

# Potential Function Limitations




- Potential fields in general exhibit local minima

# Application to manipulators




$$\dot{q} = \underbrace{J_{ee}^T \dot{x}_d}_{U_g} + \underbrace{J_2^T \dot{x}_2 + J_1^T \dot{x}_1}_{U_o}$$