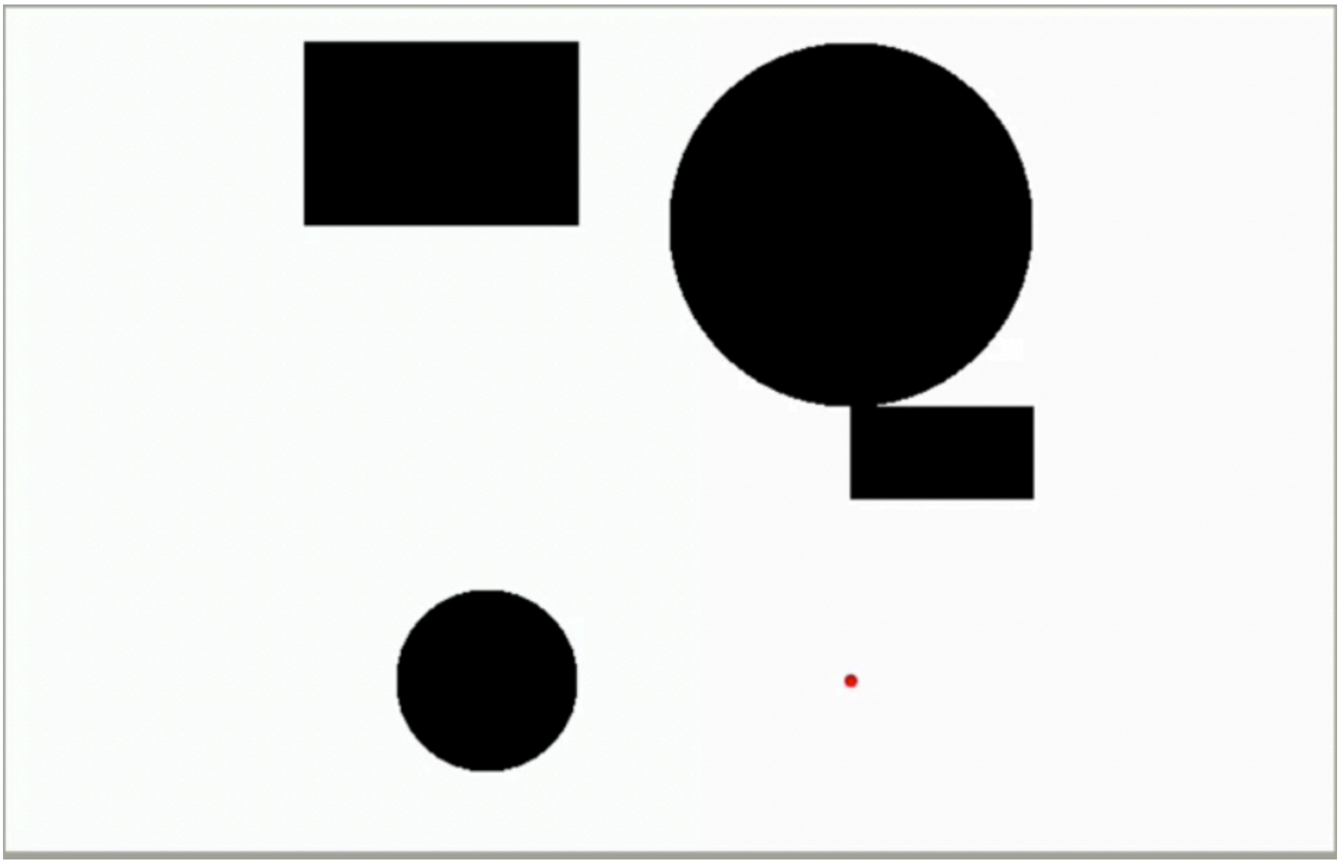
Robotics - Computational Motion Planning (Artificial Potential Field - Sensor based)

Two Main Function

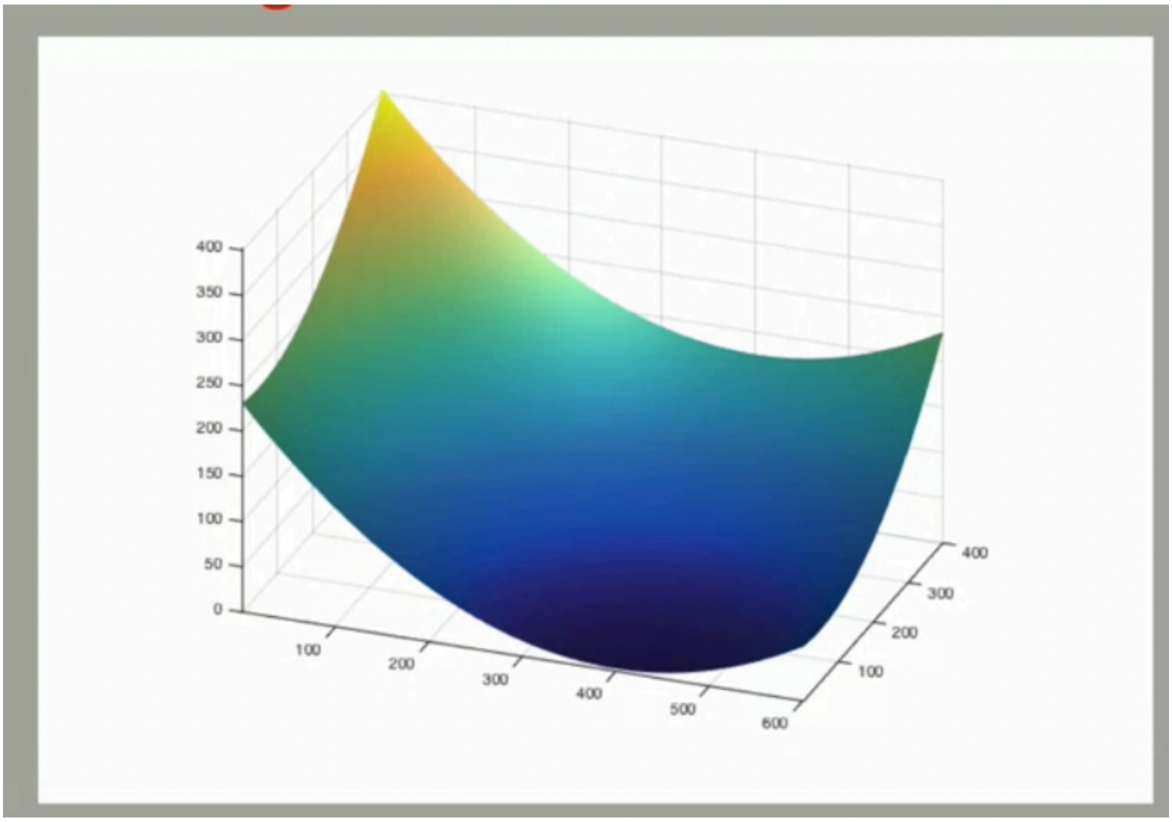


Attractive Potential Field (f_a)

- When getting far away from the goal, f_a will get larger quickly

$$f_a(x) = c(\|x - x_g\|^2)$$

- $x = \begin{pmatrix} x1 \\ x2 \end{pmatrix}$, the current position of the robot
- $x_g = \begin{pmatrix} x_1^g \\ x_2^g \end{pmatrix}$, the desired goal location
- c is simply a constant scaling parameter

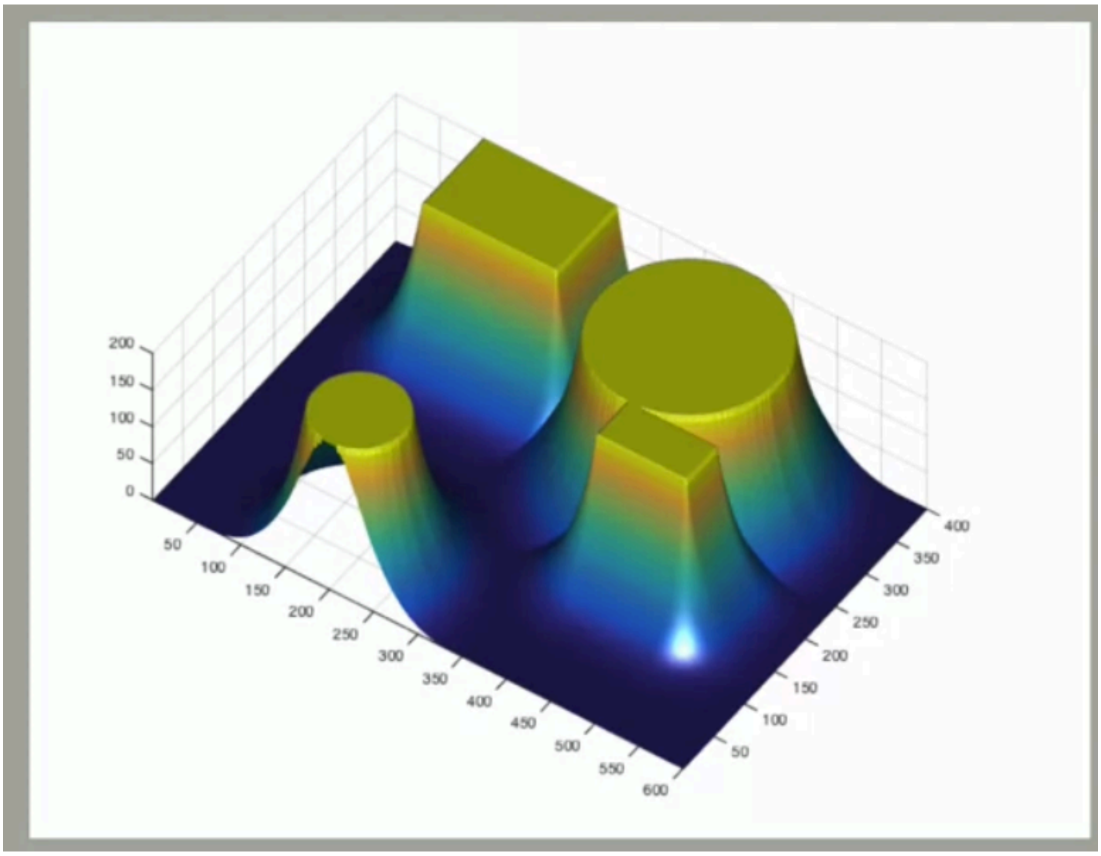


Repulsive Potential Field (f_r)

- When getting close to the obstacle, f_r will get larger quickly.

$$f_r(x) = \{ \begin{matrix} \eta(\frac{1}{\rho(x)} - \frac{1}{d_0})^2 \text{ if } \rho(x) \leq \ d_0 \\ 0 \text{ if } \rho(x) > d_0 \end{matrix}$$

- $\rho(x)$, return distance to the closest obstacle from a given point in configuration space, x.
- η and d_0 are a parameters that control the influence of the repulsive potential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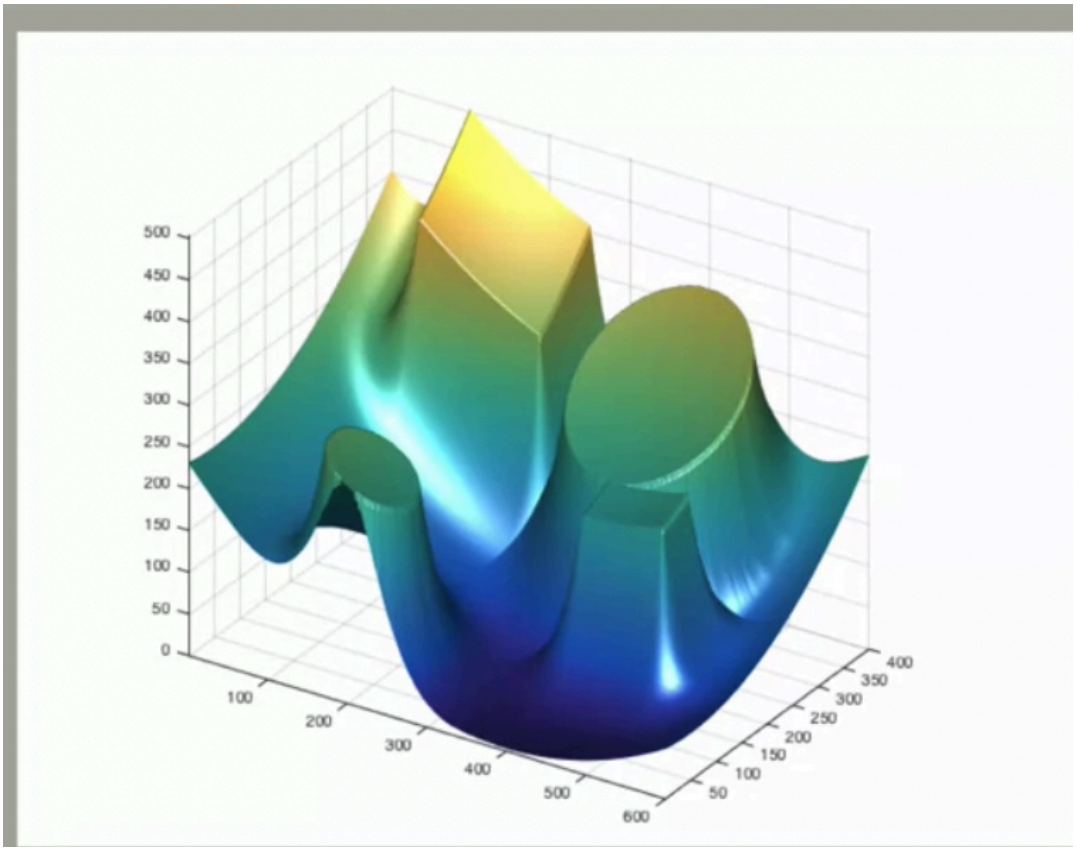
Add them up !!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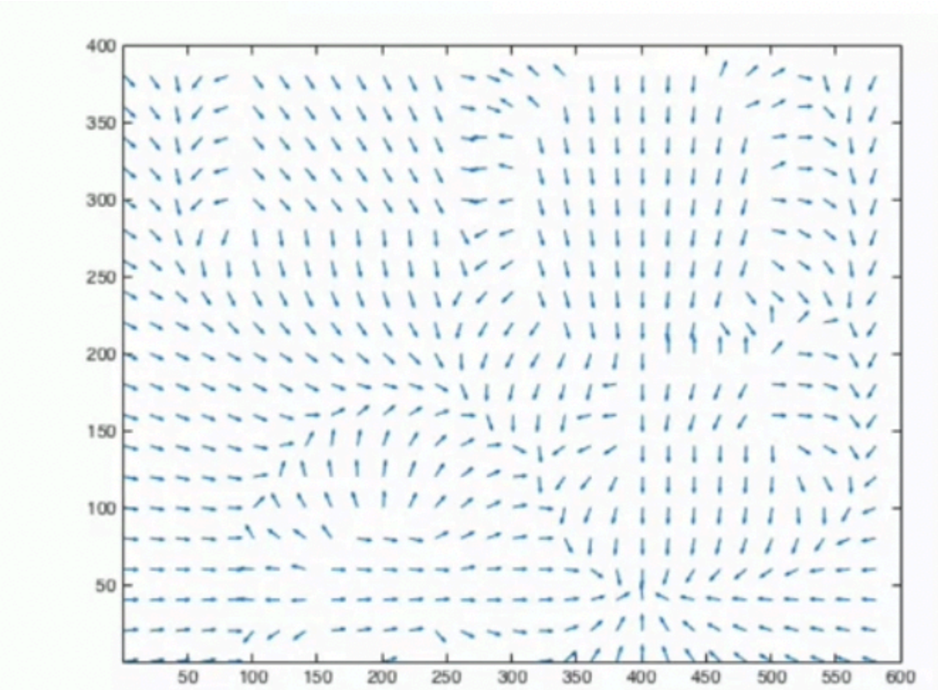
Gradient Based Control Strategy

- While robot position is not close enough to goal
  - Choose direction of robot velocity based on the gradient of the artificial potential field

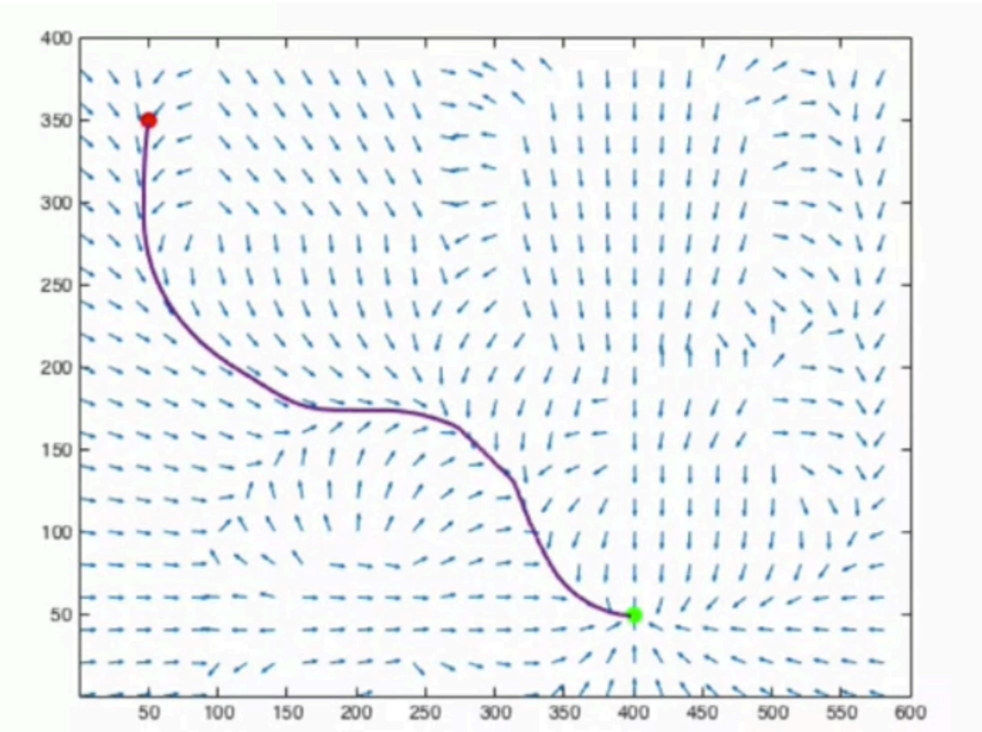
$$v \propto -\nabla f(x) = -\begin{pmatrix} \frac{\partial f(x)}{\partial x_1} \\ \frac{\partial f(x)}{\partial x_2} \end{pmatrix}$$

  - choose an appropriate robot speed, $||v||$

Quiver Plot



- The arrows denote the direction of the gradient vector at various points in the configuration space

- 

NOTE

- May produce local minima -> cannot find the destination -> use back tracking procedure to detect these situations and switch to different planning strategy.
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