Navigation: Potential fields

Forming a potential function

Additive potential functions

The most common technique for constructing potential functions is to use an **additive model**:

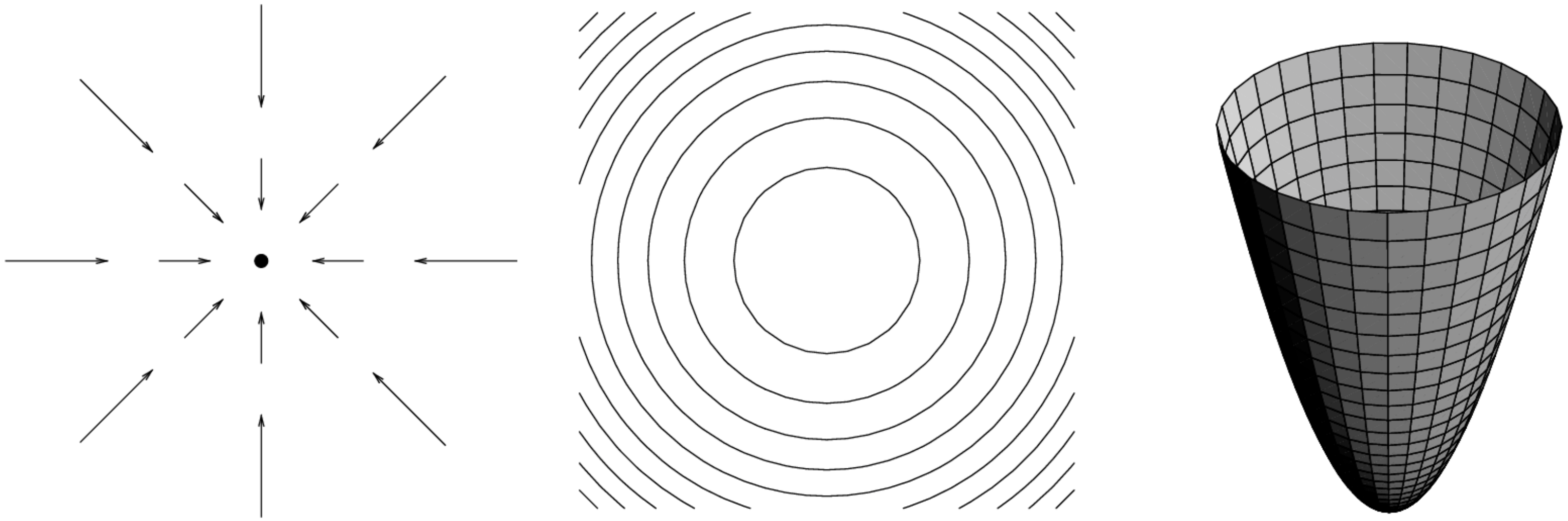
$$U(x) = U_{\mathrm{goal}}(x) + \sum_i U_{\mathrm{obst}}^{(i)}(x)$$

- U_{goal} generates an attractive force toward the goal.
- U_{obst} generates repulsive forces away from each obstacle.

Attractive potential

A simple choice for the attractive potential is based on a scaled squared distance to the goal:

$$U_{\text{goal}}(x) = \frac{1}{2}\zeta[d(x, x_{\text{goal}})]^2$$



(a) (b) (c)

Repulsive potential

We also need to define a repulsive potential for each obstacle. A common choice is

$$U_{\text{obst}}^{(i)}(x) = \begin{cases} \frac{1}{2}\eta\left(\frac{1}{d_i(x)} - \frac{1}{Q_i^*}\right)^2 & \text{if } d_i(x) \le Q_i^* \\ 0 & \text{if } d_i(x) > Q_i^* \end{cases}$$

In this setup:

- $d_i(x)$ is the distance from state x to the closest point on obstacle i.
- Q_i^* is the maximum “range of influence” for obstacle i.
- η is a scaling factor.

Repulsive potential

We also need to define a repulsive potential for each obstacle. A common choice is

$$U_{\text{obst}}^{(i)}(x) = \begin{cases} \frac{1}{2}\eta\left(\frac{1}{d_i(x)} - \frac{1}{Q_i^*}\right)^2 & \text{if } d_i(x) \le Q_i^* \\ 0 & \text{if } d_i(x) > Q_i^* \end{cases}$$