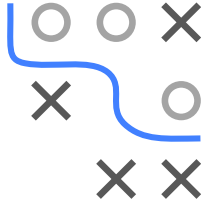
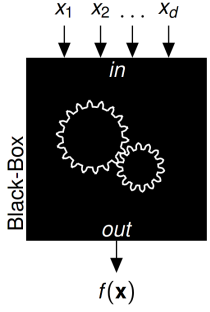
Optimization in Machine Learning



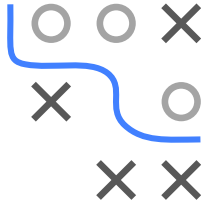
Bayesian Optimization
Black Box Optimization



Learning goals

- Definition and properties
- Examples
- Naive approaches

STANDARD VS. BLACK-BOX OPTIMIZATION



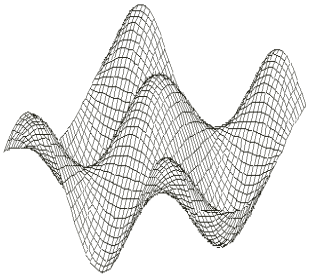
Optimization: Find

$$\min_{\mathbf{x}\in\mathcal{S}} f(\mathbf{x})$$

with objective function

$$f: \mathcal{S} \to \mathbb{R},$$

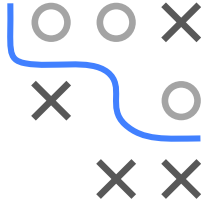
where $\mathcal{S}$ is usually box constrained.



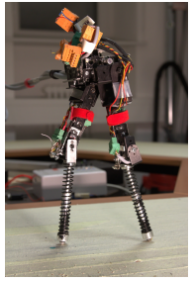
If we are lucky ...

- ... we have an analytic description of $f: \mathcal{S} \to \mathbb{R}$
- ... we can calculate gradients and use gradient-based methods (e.g. gradient descent) for optimization

EXAMPLES FOR BAYESIAN OPTIMIZATION



1. Robot Gait Optimization: The robot's gait is controlled by a **parameterized controller**



- **Goal:** Find parameters s.t. average velocity (directional speed) of the robot is maximized
- Parameters of the gait control e.g. joints of ankles and knees
- *Calandra et al. (2014). An Experimental Evaluation of Bayesian Optimization on Bipedal Locomotion*

NAIVE APPROACHES

1. Empirical knowledge / manual tuning
   - Select parameters based on “expert” knowledge
   - **Advantages:** Can lead to fairly good outcomes for known problems
   - **Disadvantages:** Very (!) inefficient, poor reproducibility, chosen solution can also be far away from a global optimum