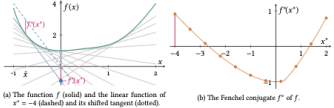
# Optimization in Machine Learning

## Other forms of duality



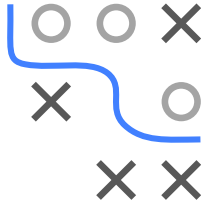

(a) The function $f$ (solid) and the linear function of $x^\star = -4$ (dashed) and its shifted tangent (dotted).

(b) The Fenchel conjugate $f^*$ of $f$.

**Learning goals**

- Dual norms
- Conjugate functions
- Fenchel duality
- Examples in statistics

# CONSTRAINED MINIMIZATION AND DUAL NORMS



Consider the problem of norm minimization under linear constraints in its primal form:

$$\begin{aligned} \min_{\mathbf{x}\in\mathbb{R}^d} \quad & \|\boldsymbol{x}\| \\ \text{s.t.} \quad & \boldsymbol{G}\boldsymbol{x} = \boldsymbol{h}\,, \end{aligned}$$

where $\|\cdot\|$ is some norm function. For instance, if the norm is the $L1$ norm, this problem is the famous ▸ basis pursuit problem.

**Question:** Is there a more straightforward way to solve constrained optimization problems involving norms?

# CONSTRAINED PROBLEMS AND CONJUGATE FUNCTIONS