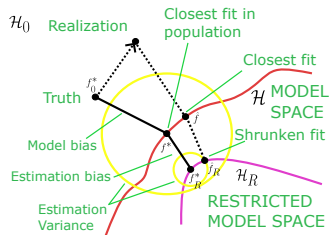# Introduction to Machine Learning

Regularization
Bias-variance Tradeoff

Learning goals

- Understand the bias-variance trade-off
- Know the definition of model bias, estimation bias, and estimation variance

BIAS-VARIANCE TRADEOFF

In this slide set, we will visualize the bias-variance trade-off.

We consider a DGP $\mathbb{P}_{xy}$ with $\mathcal{Y} \subset \mathbb{R}$ and the L2 loss L. We measure the distance between models $f : \mathcal{X} \to \mathbb{R}^g$ via

$$d(f, f') = \mathbb{E}_{\mathbf{x} \sim \mathbb{P}_{\mathbf{x}}} \left[L(f(\mathbf{x}), f'(\mathbf{x}) \right] .$$

We define f_0^* as the risk minimizer such that

$$f_0^* \in \underset{f \in \mathcal{H}_0}{\arg\min} \, \mathbb{E}_{(\mathbf{x}, y) \sim \mathbb{P}_{xy}} \left[L(y, f(\mathbf{x})) \right]$$

where $\mathcal{H}_0 = \{ f : \mathcal{X} \to \mathbb{R} \mid d(\underline{0}, f) < \infty \}$ and $\underline{0} : \mathcal{X} \to \{0\}$.