

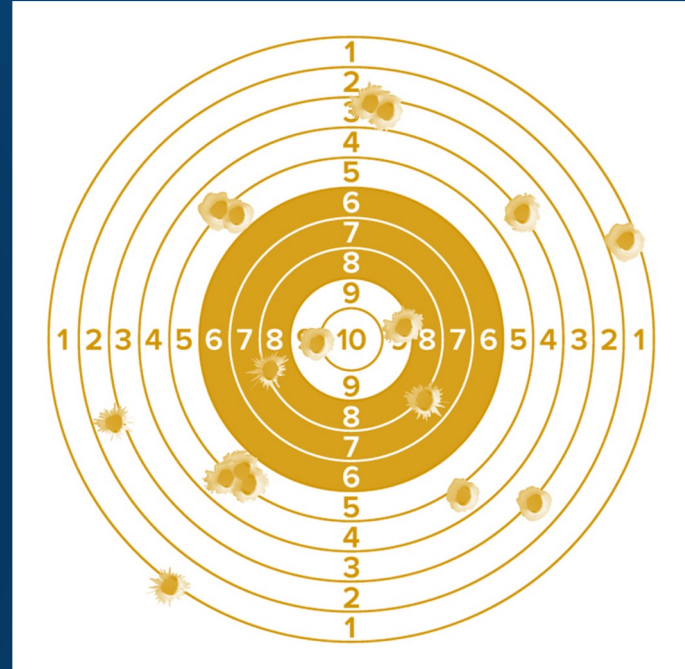
A hand is shown in the foreground, reaching out towards a complex digital interface. The interface features a large circular gauge with multiple concentric rings, some of which are highlighted in green. In the center of the gauge are three interlocking gears. The background is dark blue with various digital elements, including lines, dots, and a bar chart, suggesting a high-tech or data-driven environment.

Error and Overfitting

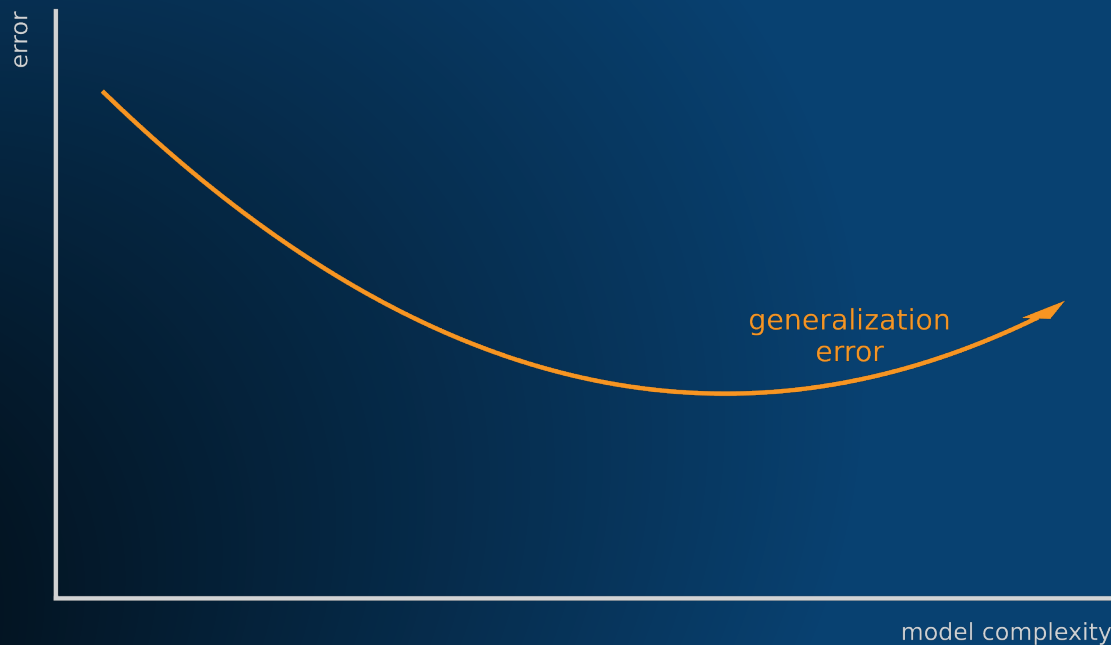
ERROR MINIMIZATION



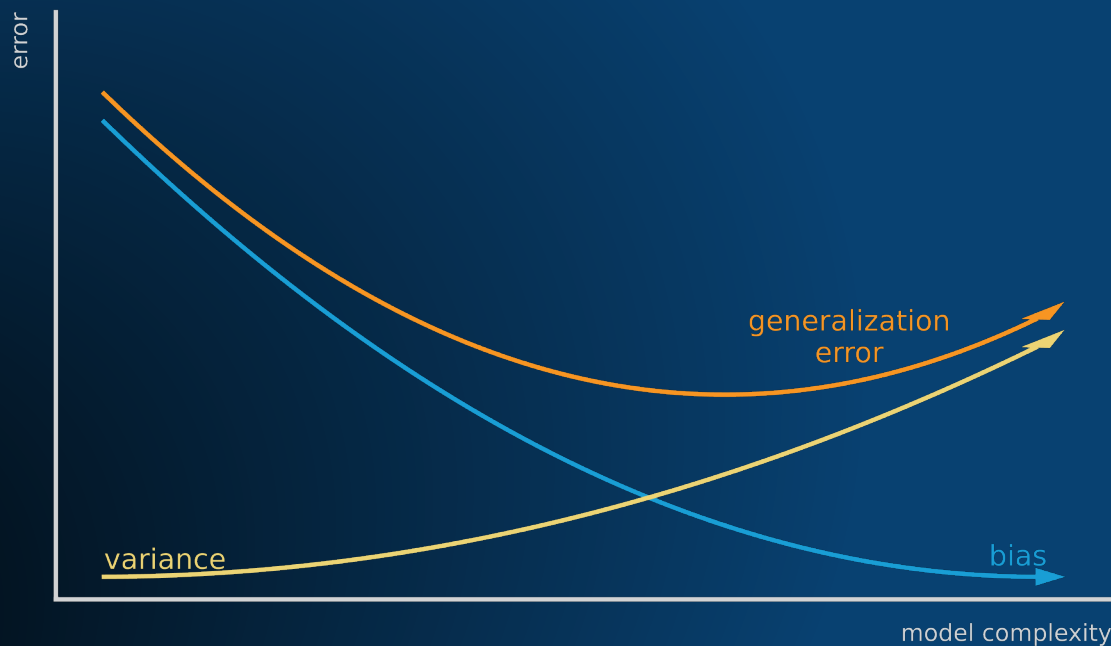
$$M^* \leftarrow \operatorname{argmin}_{M_i} \operatorname{error}(M_i)$$



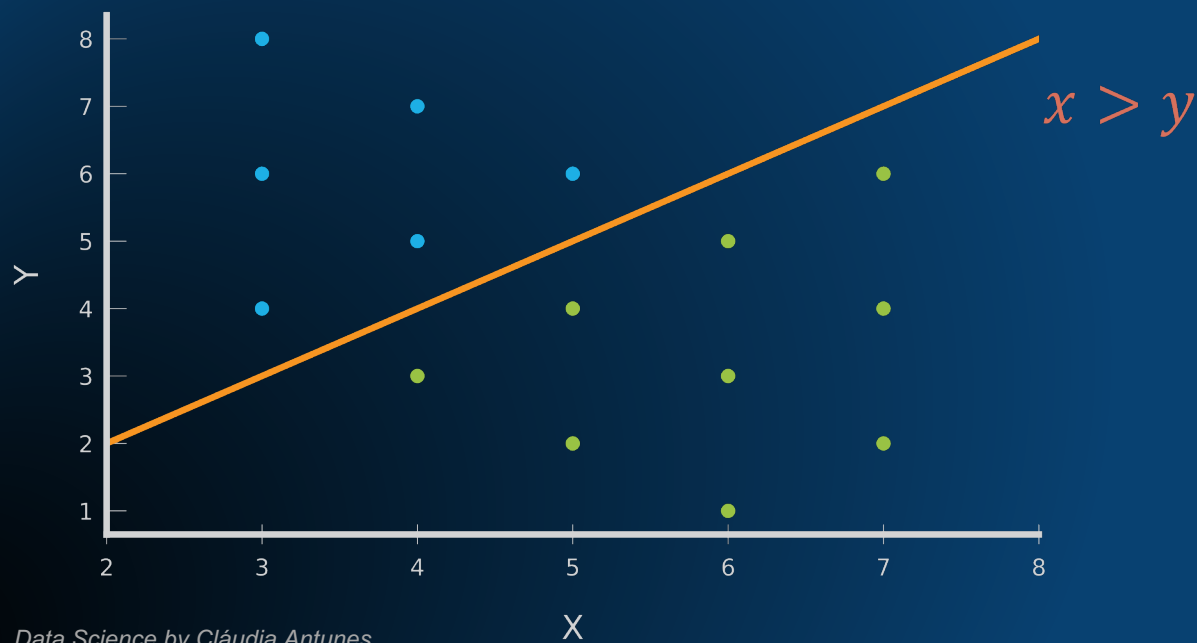
GENERALIZATION ERROR



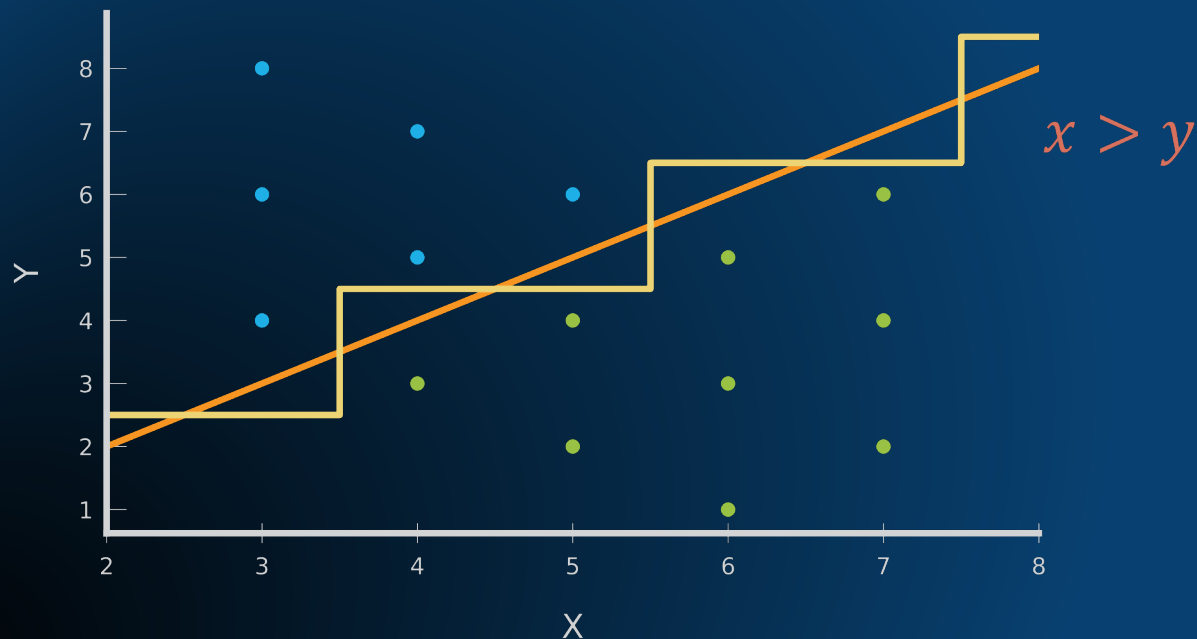
BIAS AND VARIANCE



BIAS

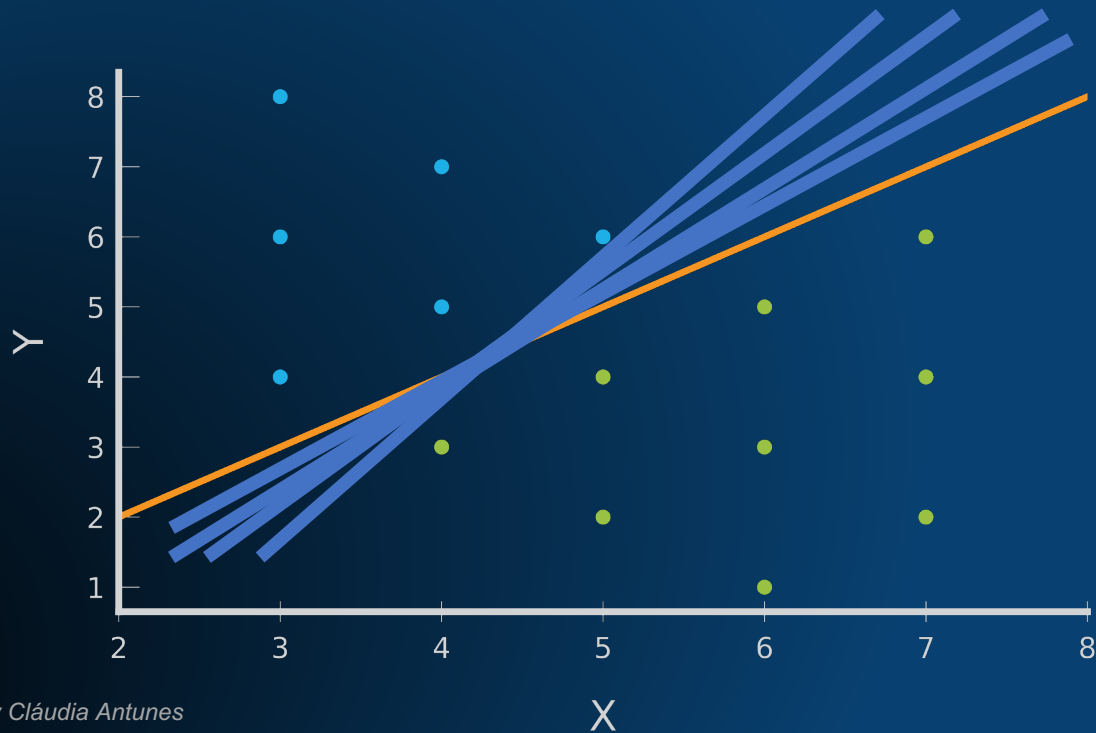


BIAS

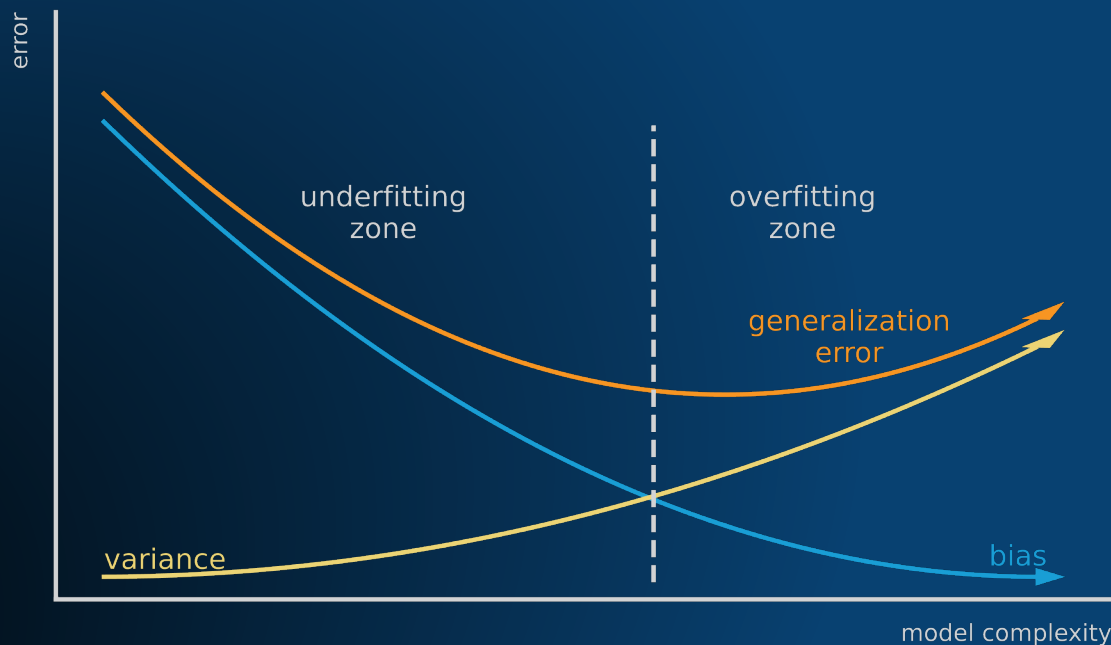


$$\begin{aligned} &(x \leq 3.5 \wedge y \leq 3.5) \\ &\vee \\ &(3.5 < x \leq 5.5 \wedge y \leq 5.5) \\ &\vee \\ &(5.5 < x \leq 7.5 \wedge y \leq 6.5) \\ &\vee \\ &\dots \end{aligned}$$

VARIANCE



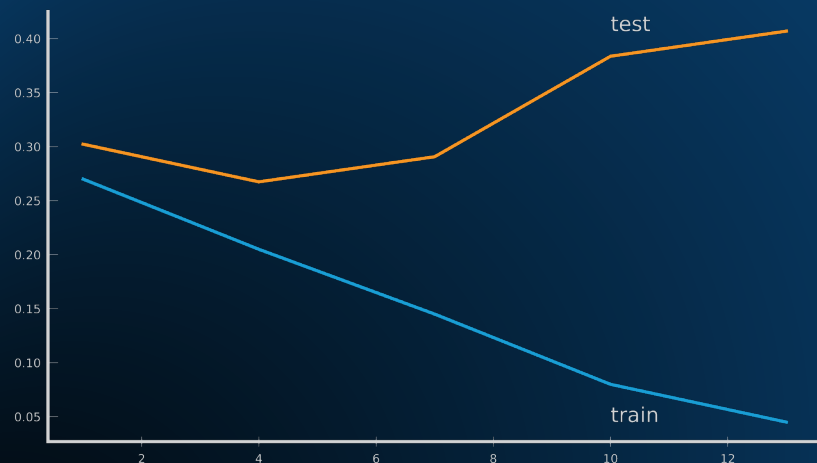
BIAS AND VARIANCE



OVERFITTING



OVERFITTING



M_2 is in **overfitting** iff

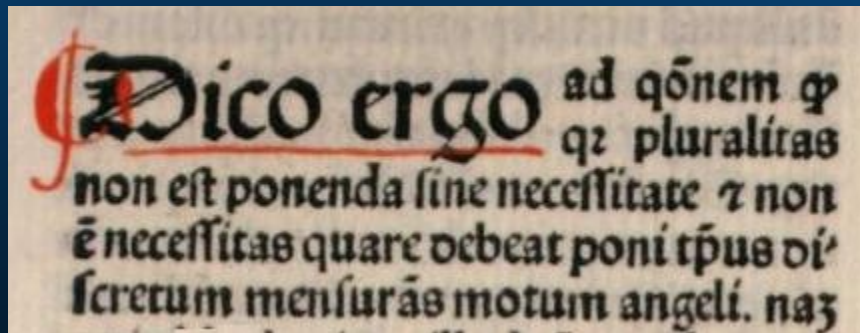
$\exists M_1: M_2$ is a specialization of M_1
 $error_{M_2}(train) < error_{M_1}(train)$
 $error_{M_2}(test) > error_{M_1}(test)$



A conceptual image featuring a human hand on the left, reaching towards a complex, futuristic digital interface on the right. The interface is composed of concentric circles, gears, and various data-like elements, all rendered in shades of blue and teal. The word "Simplicity" is prominently displayed in the center, contrasting the complex background with a message of ease and clarity.

Simplicity

OCCAM'S RAZOR



*Pluralitas non est ponenda
sine necessitate*



William of Ockham
1285–1349

OCCAM'S RAZOR



**all other things being equal,
the simplest model is
the most likely to be true**

TECHNIQUE-SPECIFIC APPROACHES



- **early stopping** for iterative methods
- **pruning** for decision trees
- **dropout** of neural networks' units





*Thank
you!*

