Towards explicit calculation of terms in the Bias-Variance Decomposition (BVD).

Symposium on Data Science and Statistics

June 2-4, 2021

Neil A. Hamlett, D.Sc., MBA

Strategic Consulting Data Scientist, Uncertainty Research, LLC

neil.hamlett@uncertainty-research.science

https://www.linkedin.com/in/neil-hamlett-strategic-quant/

https://hamlett-neil-ur.github.io/

"Uncertainty is a key source of competitive advantage."

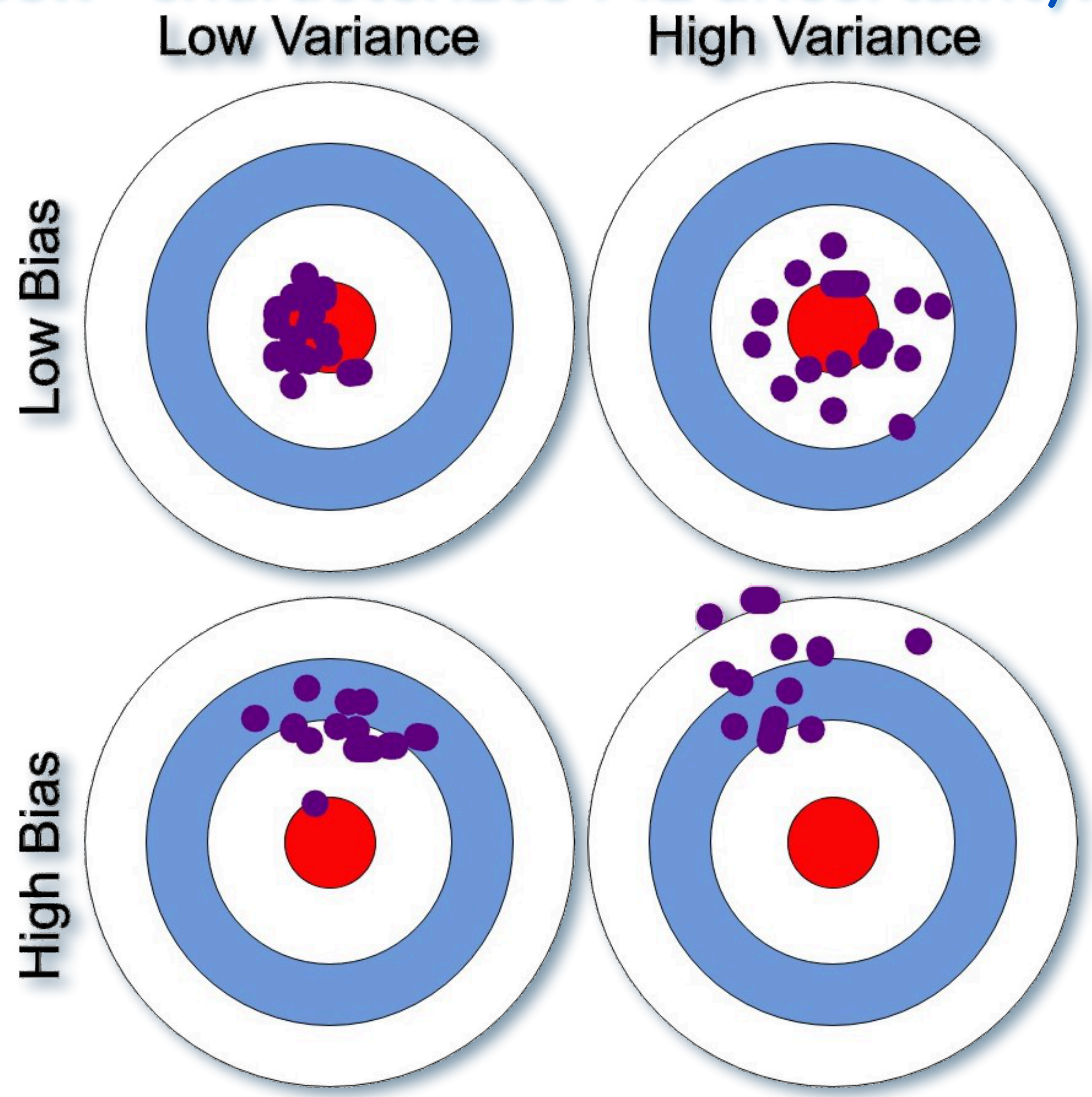
The *Bias-Variance Decomposition** characterizes ML uncertainty.

Irreducible Error. The extent to which variation in the data defies explanation by any model.

Bias. The extent to which a given model fails to explain the phenomenologically-based structure of the data.

Variance. The extent to which a given model explains the "structure" of the idiosyncratic error of a given sample. (Overfitting.)

$$\begin{aligned} Err(x_0) &= \sigma_\varepsilon^2 \\ &+ \left[\mathcal{E}\hat{f}(x_0) - f(x_0)\right]^2 \\ &+ \left[\hat{f}(x_0) - \mathcal{E}\hat{f}(x_0)\right]^2 \end{aligned}$$



* T. Hastie, R. Tibshirian, J. Friedman, *Elements of Statistical Learning*, Springer, 2009, https://bityl.co/5qZD.

Metalog distributions provide a highly-flexible approach to analysis of residual errors from ML-model fits.

Metalog distributions' formulations are based on the quantile function $M_n(y)$ defined as

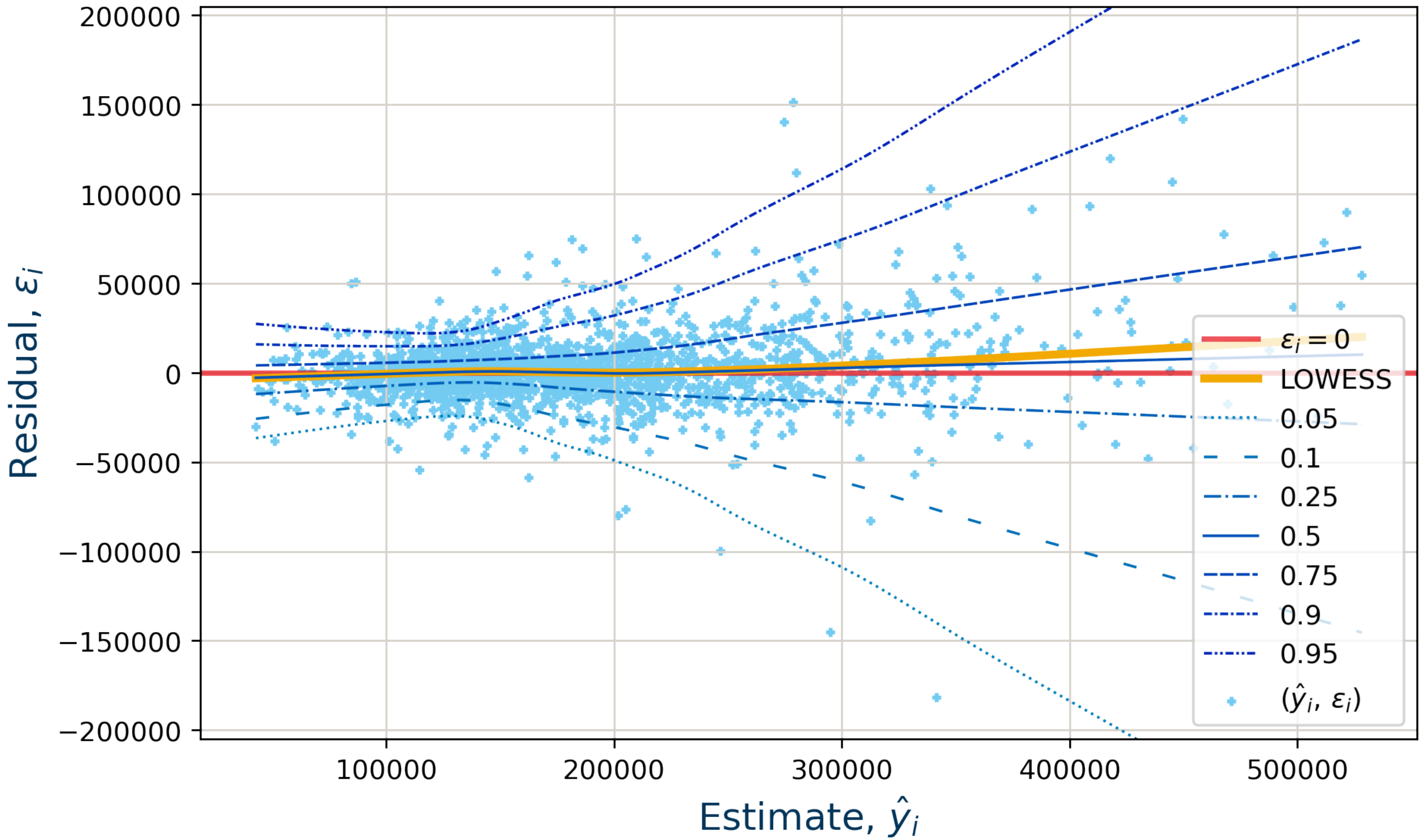
$$x = M_n(y) \Leftrightarrow y = Pr\{\mathscr{X} \le x\} = P_{\mathscr{X}}(x)\,.$$

The quantile function is estimated using a series

$$\hat{M}_n(y) = \sum_{\nu=1}^{\frac{n}{2}} \left(a_{2\nu-1}\left(y - \frac{1}{2}\right)^{2\nu-1} \right.$$
$$\left. + a_{2\nu}\left(y - \frac{1}{2}\right)^{2\nu-1} \ln\left(\frac{y}{1-y}\right) \right)\,.$$

* T. W. Keelin, "The metalog distributions", *Decision Analysis*, December 2106, https://t.ly/WSTG.

Local metalog fits to ML residuals produce conditional probability distributions.



Uncertainty Research, LLC

Neil A. Hamlett, D.Sc., MBA

Strategic Consulting Data Scientist, Uncertainty Research, LLC

neil.hamlett@uncertainty-research.science

https://www.linkedin.com/in/neil-hamlett-strategic-quant/

https://hamlett-neil-ur.github.io/