



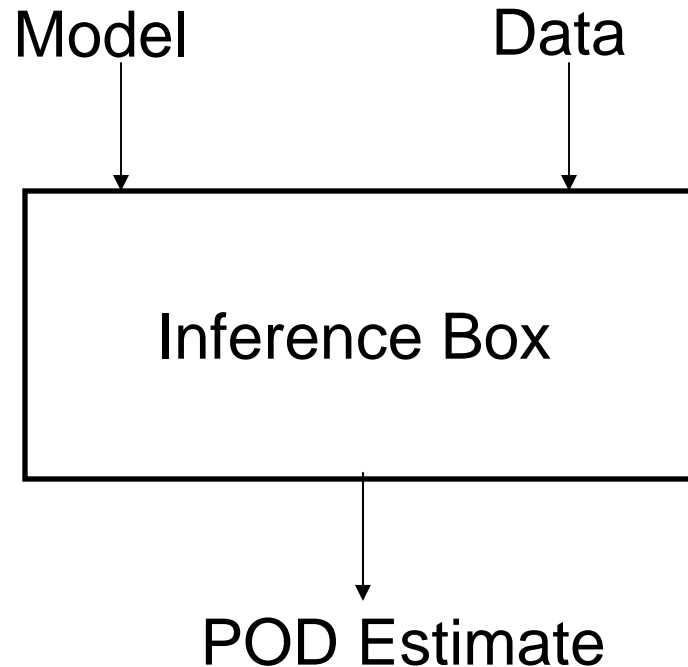
Confidence Bounds on Model-Based Data

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Statistical Confidence-Intervals

- Sometimes described as “uncertainty interval”
- Quantifies **only** statistical uncertainty (due to limited data)
- Width of the interval shrinks to zero as sample size increases
- Confidence intervals do not quantify
 - model uncertainty
 - process variability
- The 90/95% POD point is commonly used in NDE (a 95% upper confidence bound on the smallest flaw size that can be detected with .90 probability).

A Schematic View



- Different data samples will lead to different POD estimates
- Confidence interval quantifies uncertainty in estimate due to limitations in available data

More On Confidence Intervals

- Multiple methods to compute; approximations may be required; computations may be complicated
- Likelihood-based and Monte Carlo (aka bootstrap) methods are state-of-the-art
- Easy-to-compute “Normal Approximation” intervals use Taylor series approximation and an ellipse to approximate the likelihood and are adequate in “large sample” situations
- 95% is the standard confidence limit, but users are free to choose other values (e.g. 99%, 90% or even 50%)

Different Kinds of Statistical Intervals

- Confidence intervals quantify the statistical uncertainty in estimating the characteristic of a population or a process (e.g. the 90% point of a POD curve).
- Tolerance intervals quantify process variability (e.g. the range of amplitude values that might arise from inspecting a #2 flat bottom hole for a given inspection system).
- Prediction intervals attempt to capture a single future value of a random quantity.
- For more details, see Hahn and Meeker (1991) ***Statistical Intervals: A Guide for Practitioners***, John Wiley and Sons.

Uncertainty Bounds

- When using a model, can generate large number of data points
- Therefore, statistical uncertainty, as traditionally measured by confidence bounds, can be driven to zero
- However, uncertainty in model predictions will affect predictions of POD
- As an example, in the FAA ETC program, the ultrasonic simulation models were taken to be accurate to ± 3 dB, believed to be on the order of the reproducibility of typical ultrasonic experiments

Example of Uncertainty Bounds

