

# Bootstrapping

## Bootstrap Process

  
**Original Data**

N samples



  
**Sample with Replacement**

Create B bootstrap samples



  
**Train Models**

One model per sample



  
**Aggregate**

Mean & confidence interval

## Sampling with Replacement (Example)

Original (N=10)

1	2	3	4	5
6	7	8	9	10



Bootstrap Samples

Sample 1: 

3	3	7	1	9	2	2	5	10	8
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Sample 2: 

5	6	1	1	4	8	9	9	3	7
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Sample B: 

...
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 **Key Feature**

 **Statistical Power**

Samples with replacement: same data point can appear multiple times in a bootstrap sample

Provides confidence intervals and variance estimates for model performance

### Common Uses

Estimate model uncertainty

Build ensemble methods (Bagging)

Small dataset validation