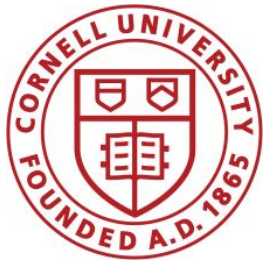


DSFA

Spring 2018

Lecture 16

Estimation

Announcements

Terminology

Statistic

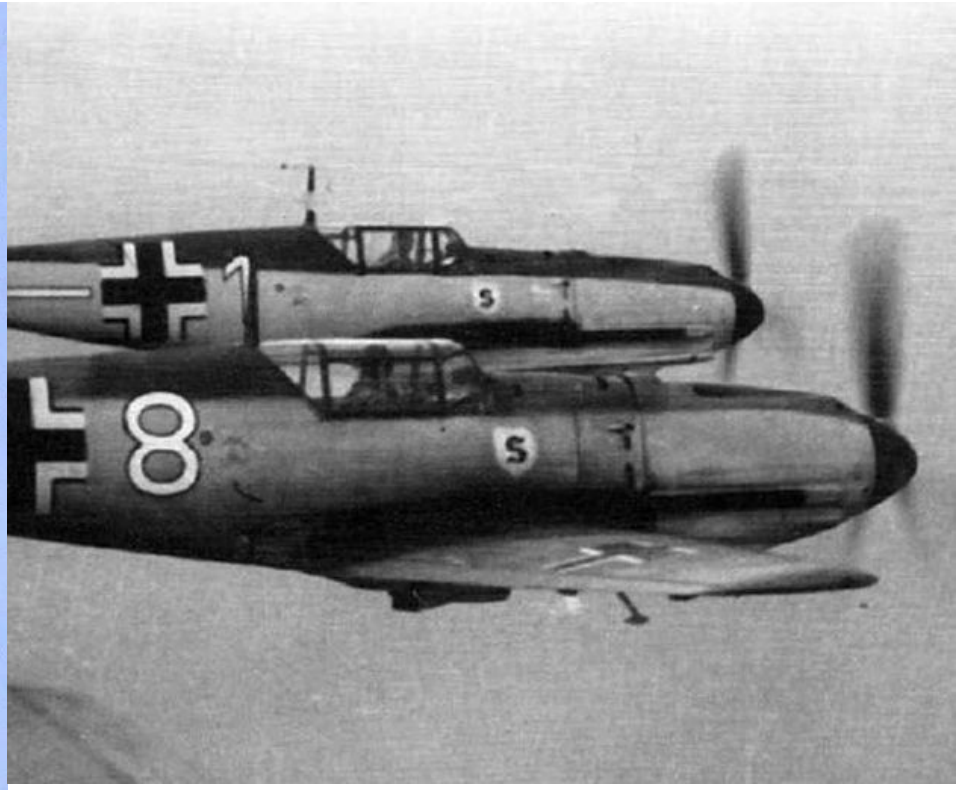
A number associated with the sample

Parameter

A number associated with the population

A statistic can be used as an **estimate** of a parameter

How many enemy planes?



Estimating enemy planes

- Population: planes with serial numbers 1, 2, 3, …, N.
- Parameter: N, which we don't know
- Sample: planes spotted by our troops
- Statistic: ???

Assumption: The serial numbers of the planes that are spotted are a uniform random sample drawn with replacement from 1, 2, 3, …, N.

Discussion question

If you saw these serial numbers, what would be your estimate of N?

```
170   271   285   290   48
235    24    90   291   19
```

One idea: 291. Just go with the maximum.

(Demo)

Is max a good estimator?

Is it likely to be close to N?

- How likely?
- How close?

Option 1. Calculate the probabilities and draw a *probability histogram*.

Option 2. Simulate and draw an *empirical histogram*.

(Demo)

Verdict on max

- The largest serial number observed is likely to be close to N.
- But it is also likely to underestimate N.

New idea

- Maybe the average of the sample resembles the average of the population
- Average of population is about N/2

New statistic: 2 * average(samples)

(Demo)

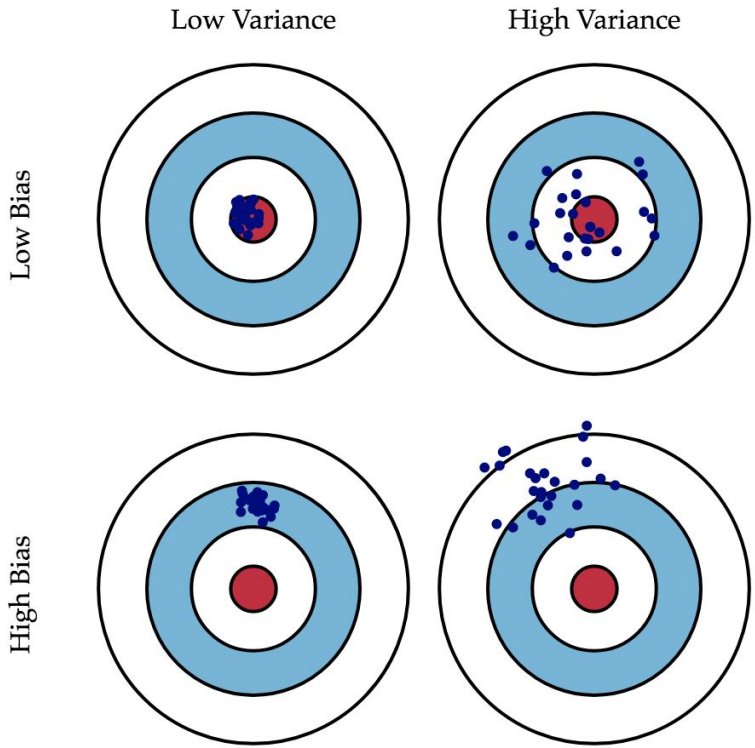
Bias

- **Biased estimate:** On average across all possible samples, the estimate is either too high or too low
- Bias creates a systematic error in one direction
- Good estimators have low bias

Variance

- Value of an estimate **varies** from one sample to another
- High variability makes it hard to estimate accurately
- Good estimators have low variance

Bias vs Variance



http://scott.fortmann-roe.com/docs/BiasVariance.html

Bias-Variance Tradeoff

- **max** has low variability, but is biased
- **2*average** has little bias, but is highly variable
- Life is tough!