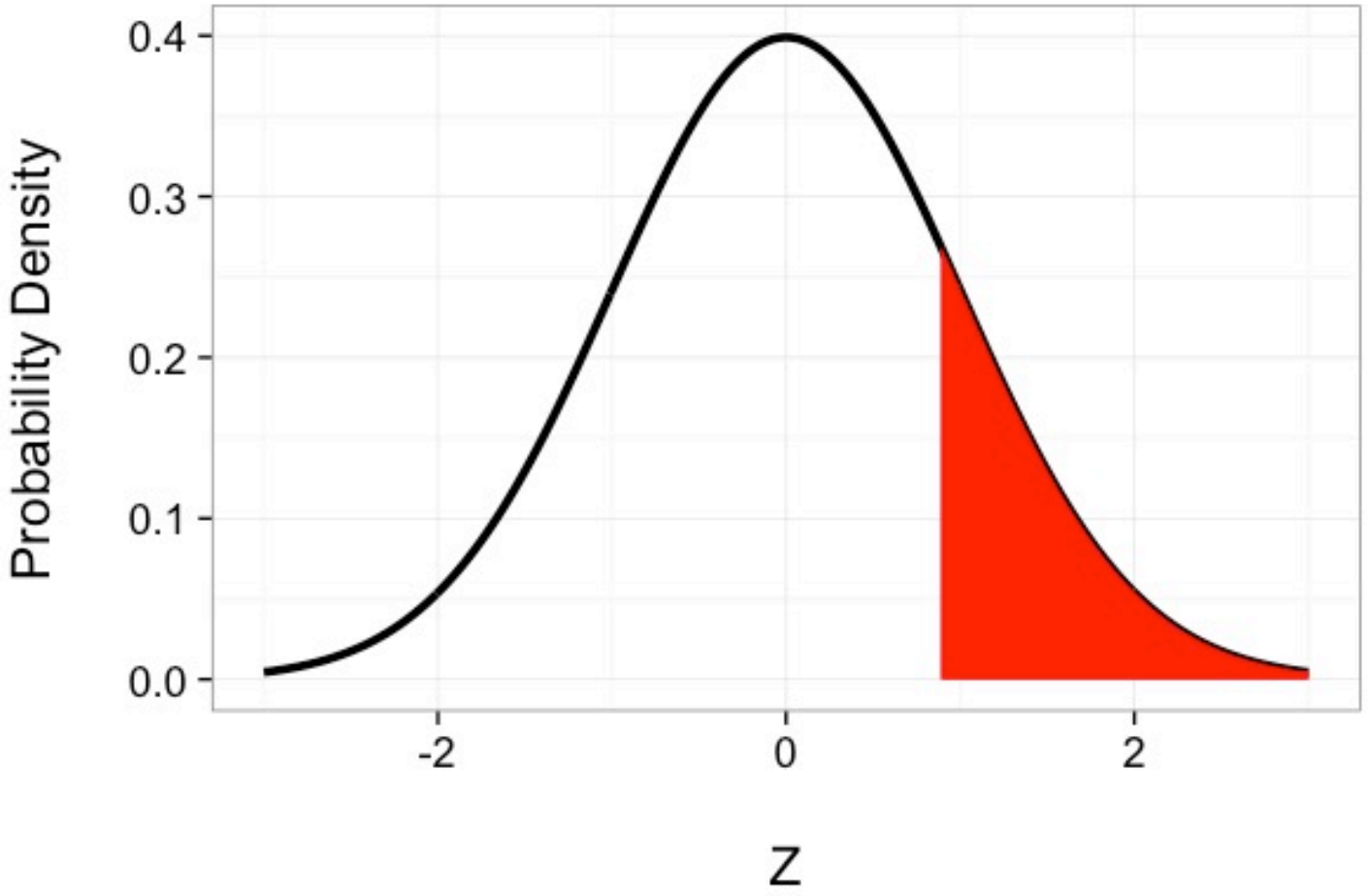
Differences Between Two Groups

Statistical Golems

(sensu Richard McElreath)

This is a Golem

- What is my data generating process?
- What is my error generating process?



What Drives My Golem?

Drawn from Data

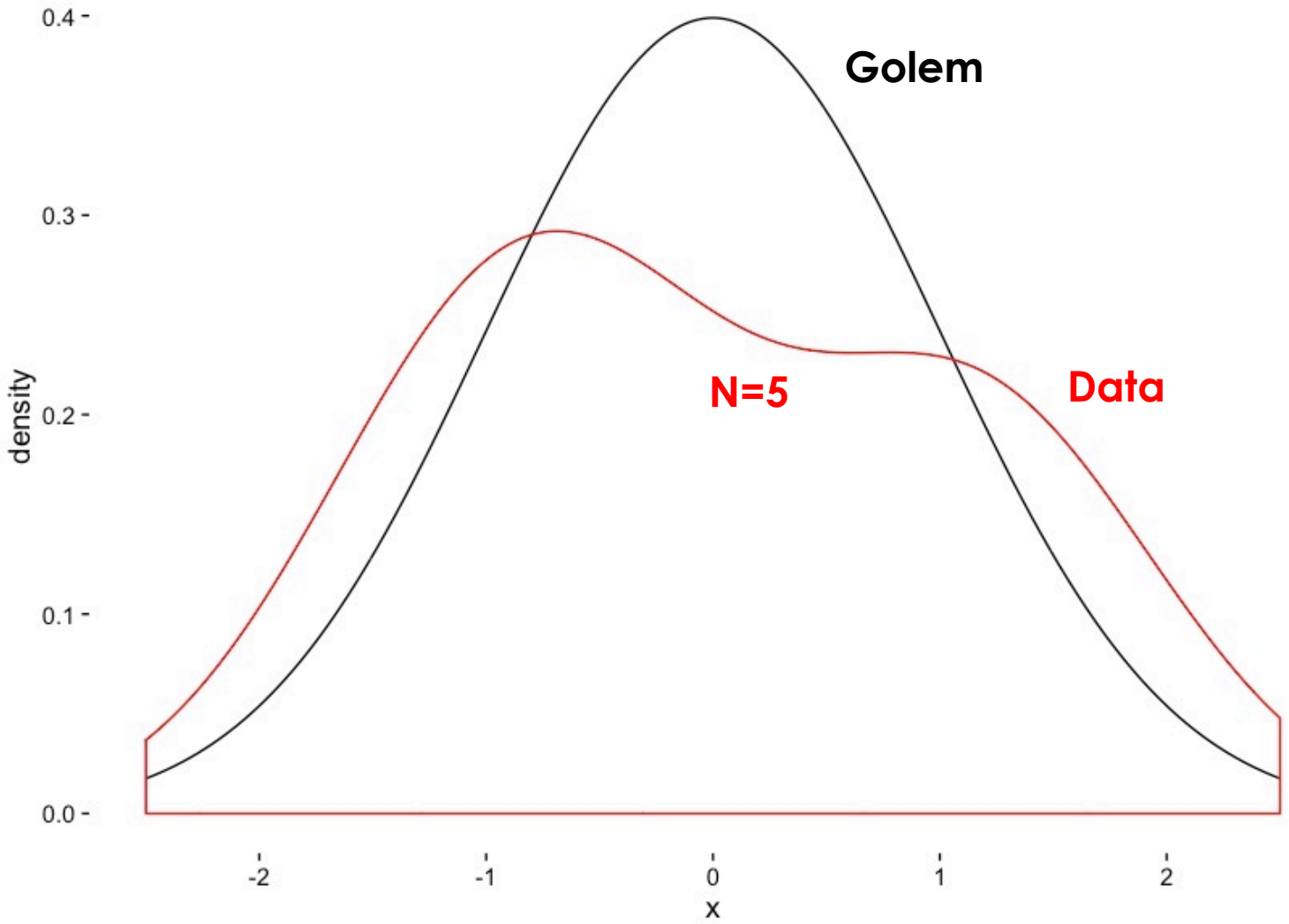
Assumption about Population

$$z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

Assumption about Population

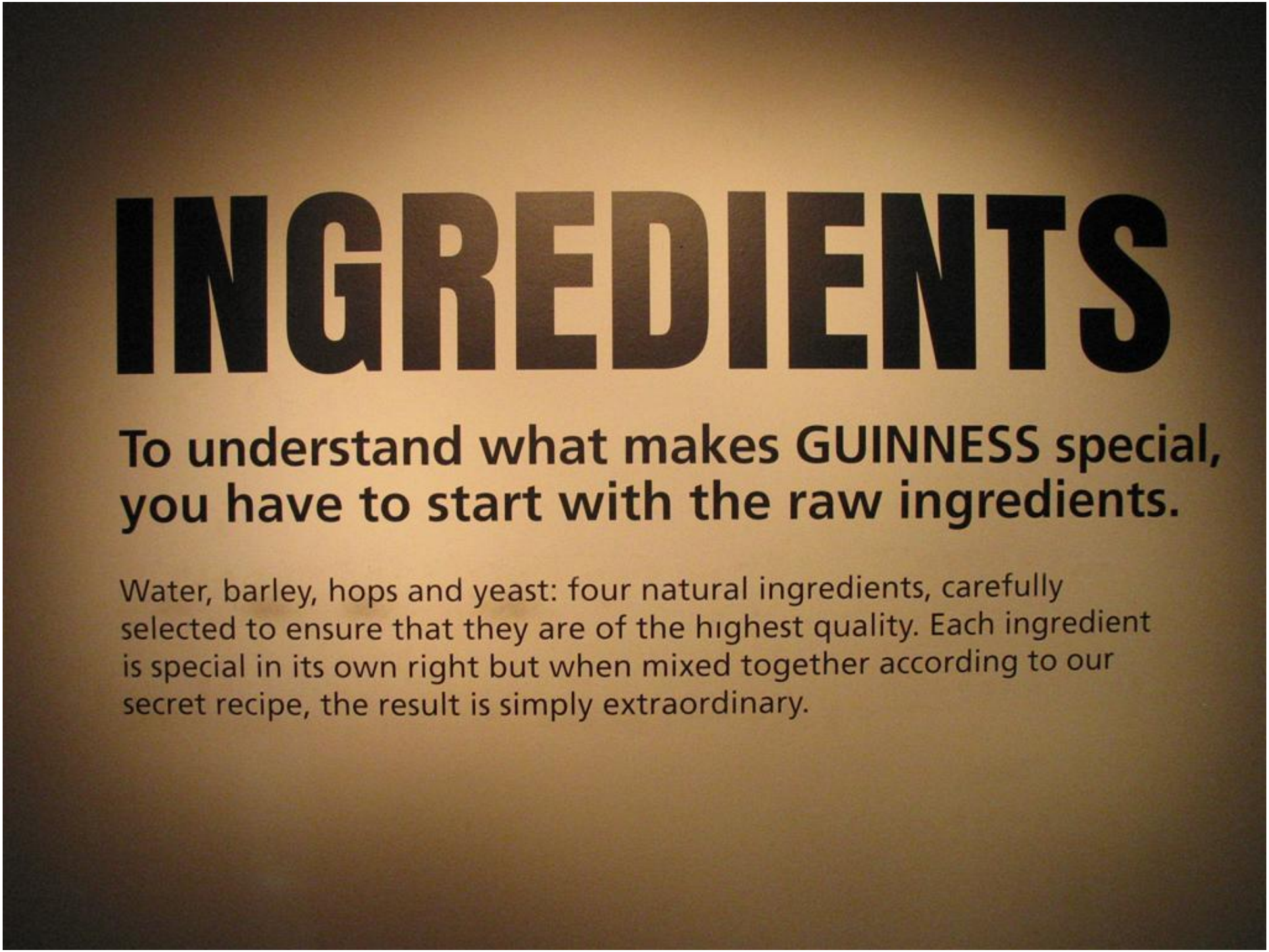
Drawn from Data

Is this a Good Golem for Realistic Sample Sizes?

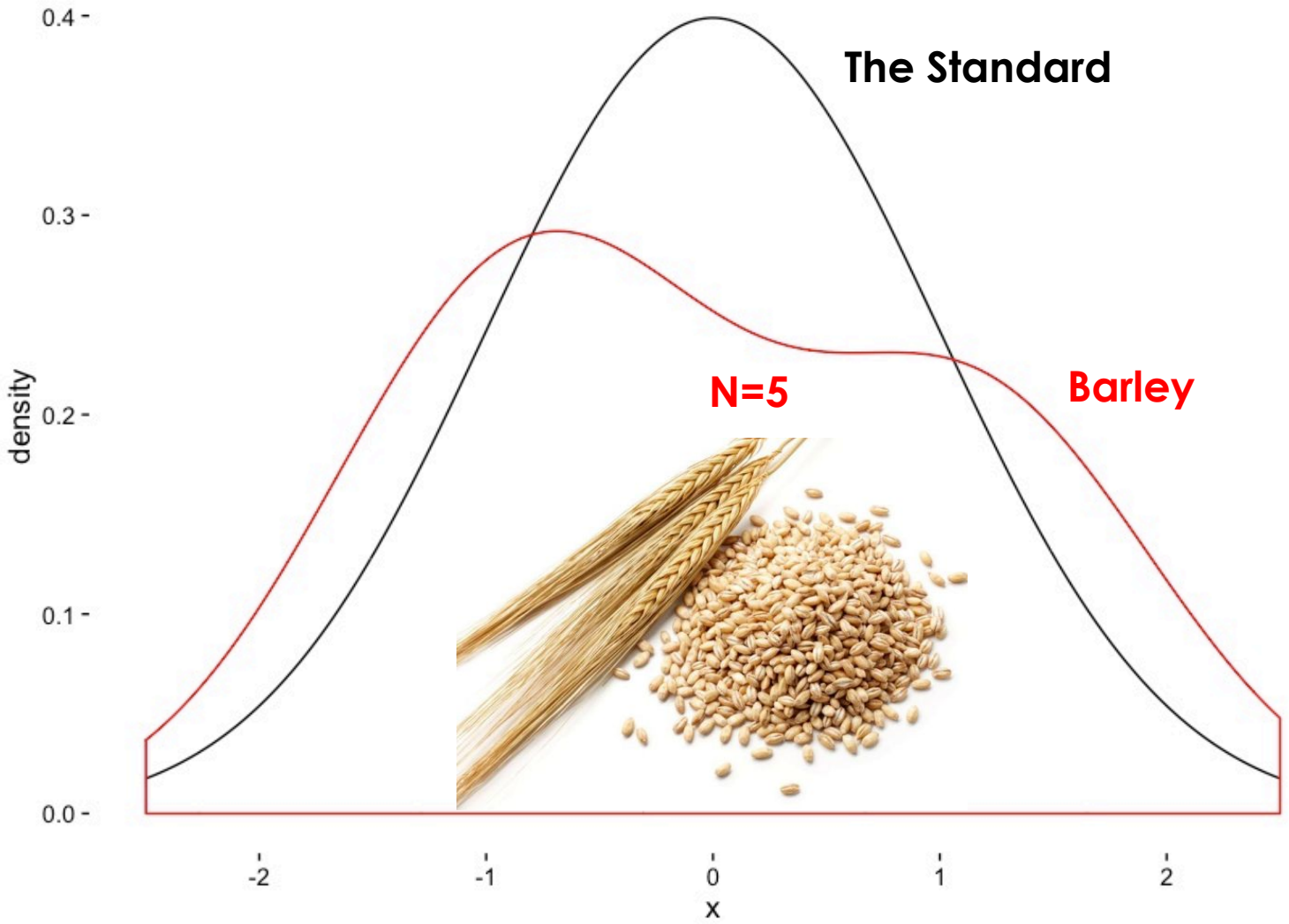



ESTD 1759
GUINNESS®

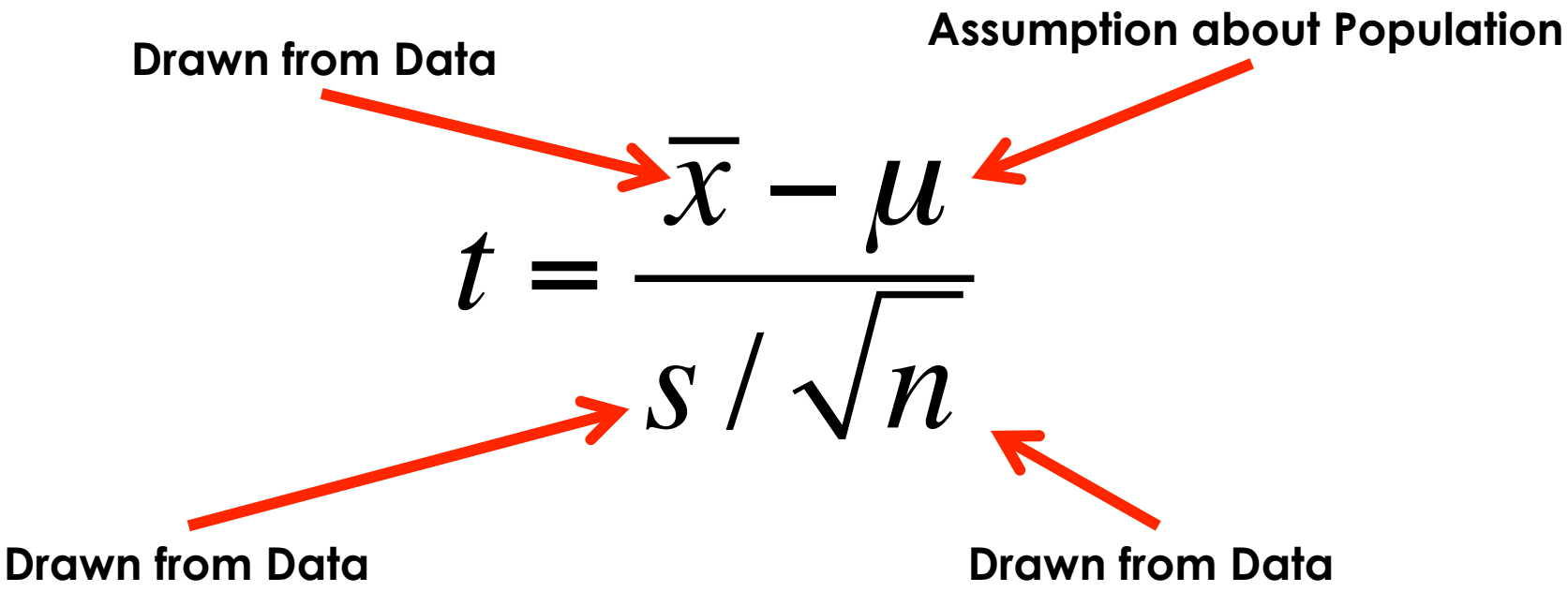

Chemist & Statistician
WILLIAM SEALY
GOSSET
1876-1937
Chief Brewer
Student 't' test


INGREDIENTS
To understand what makes GUINNESS special, you have to start with the raw ingredients.
Water, barley, hops and yeast: four natural ingredients, carefully selected to ensure that they are of the highest quality. Each ingredient is special in its own right but when mixed together according to our secret recipe, the result is simply extraordinary.

Does This Farm Produce Barley at the Right Moisture?



What Does My Golem Know?



Evaluate against T Distribution with n-1 Degrees of Freedom

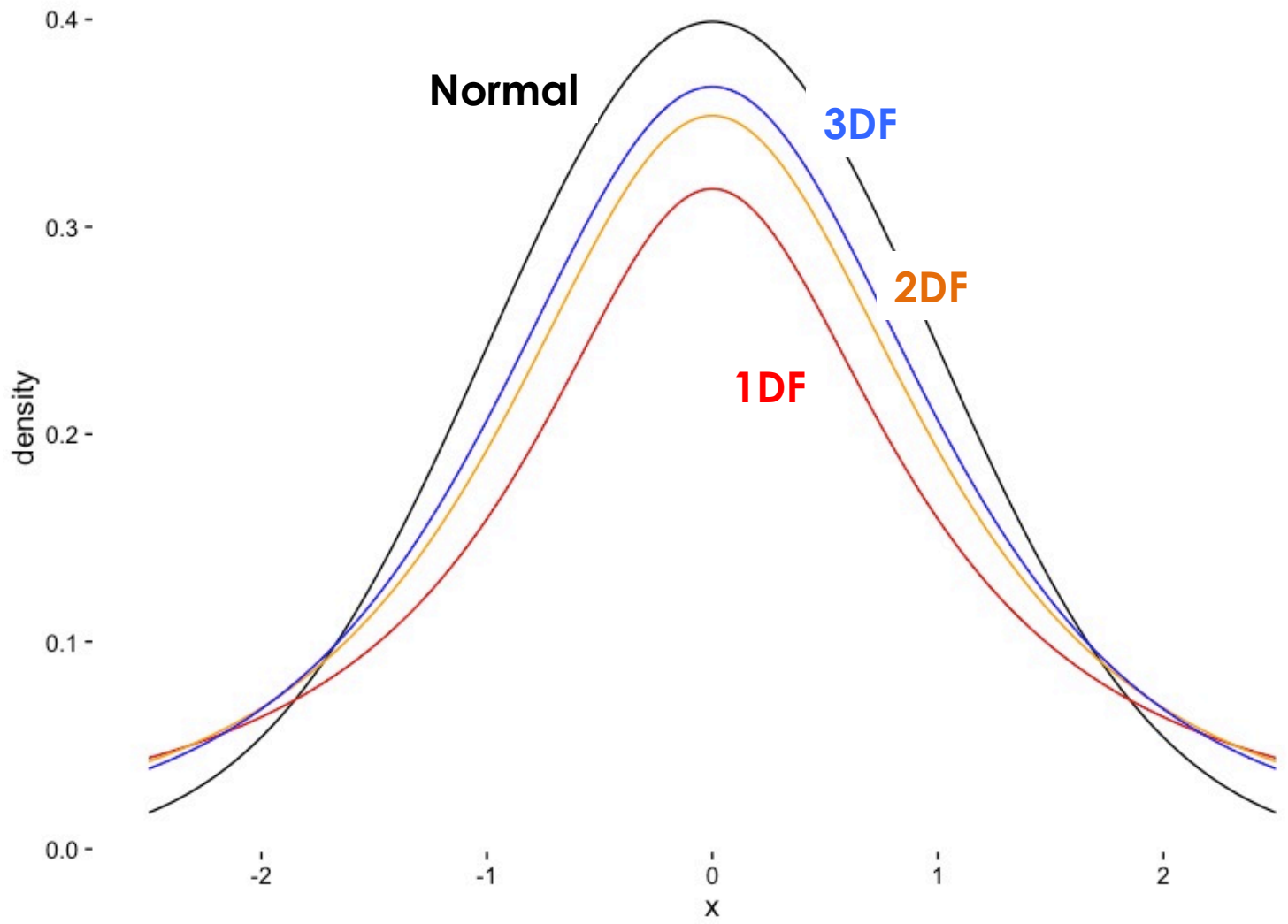
T Versus N

- A Normal Distribution is defined by a mean and a SD
- A T-Distribution assumes a mean of 0, a SD of 1, but changes shape based on its Degrees of Freedom

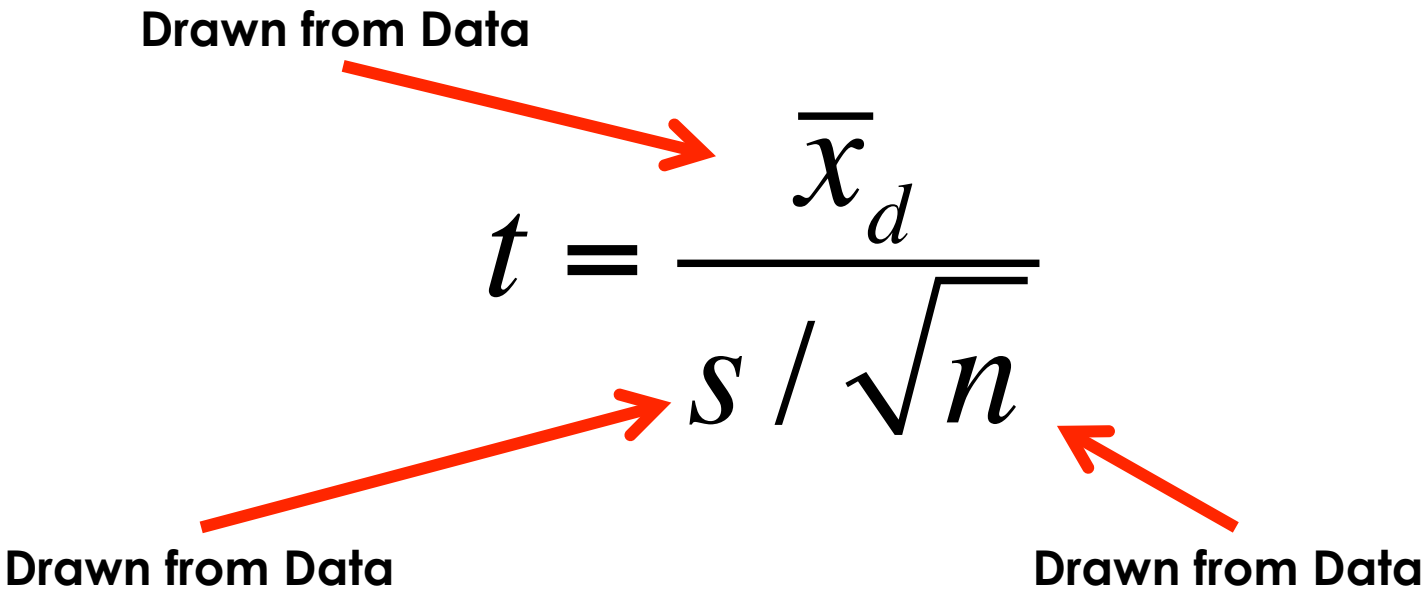
Degrees of What?

- Let's say you ***estimate*** a mean
- Mean = (x1 + x2 + x3)/3
- If you know the mean, x1, and x2, you can calculate x3
- How much unique information is there in calculating a parameter?

T Distribution Versus Normal



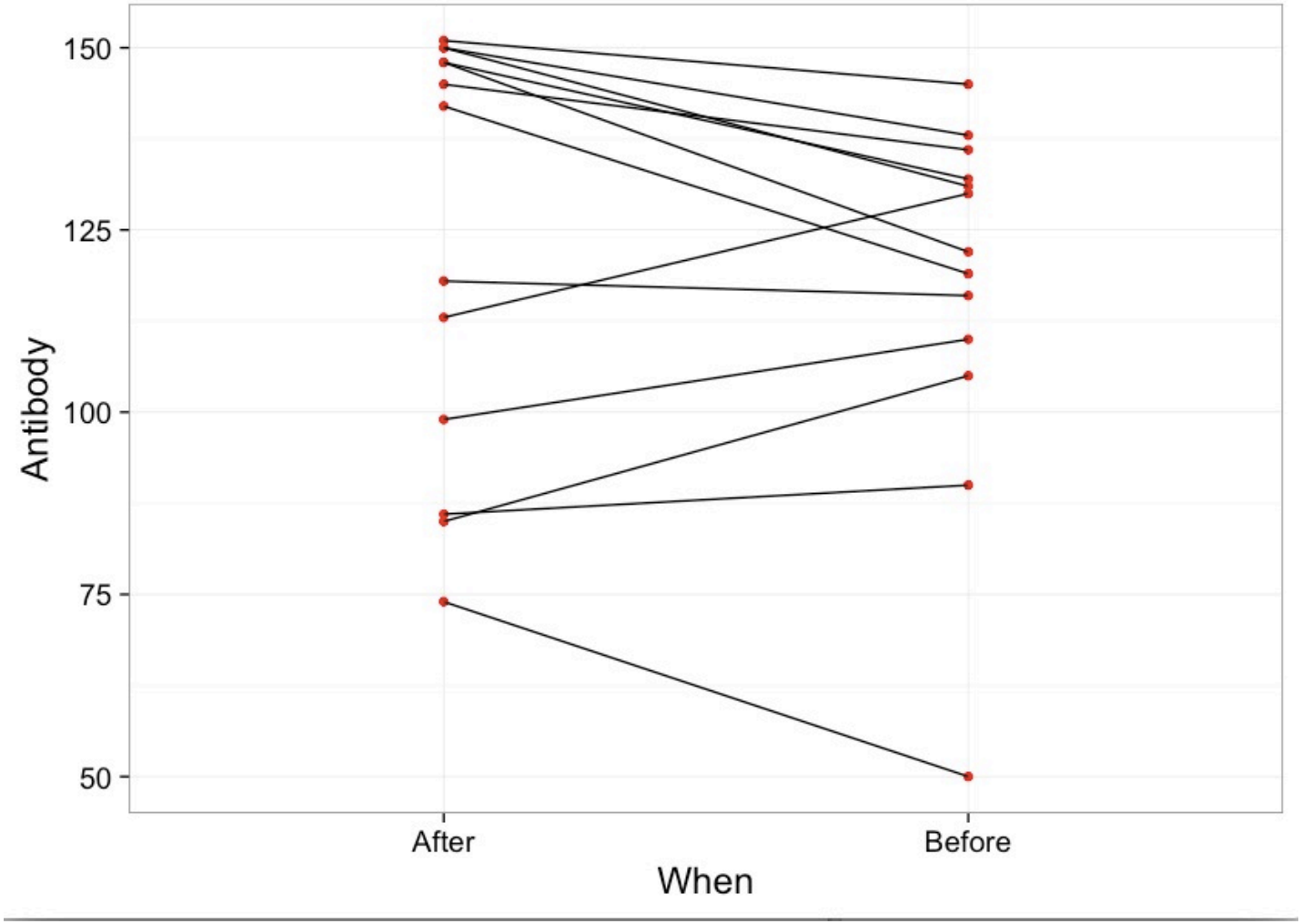
Comparing Paired Groups
H_0: Difference = 0



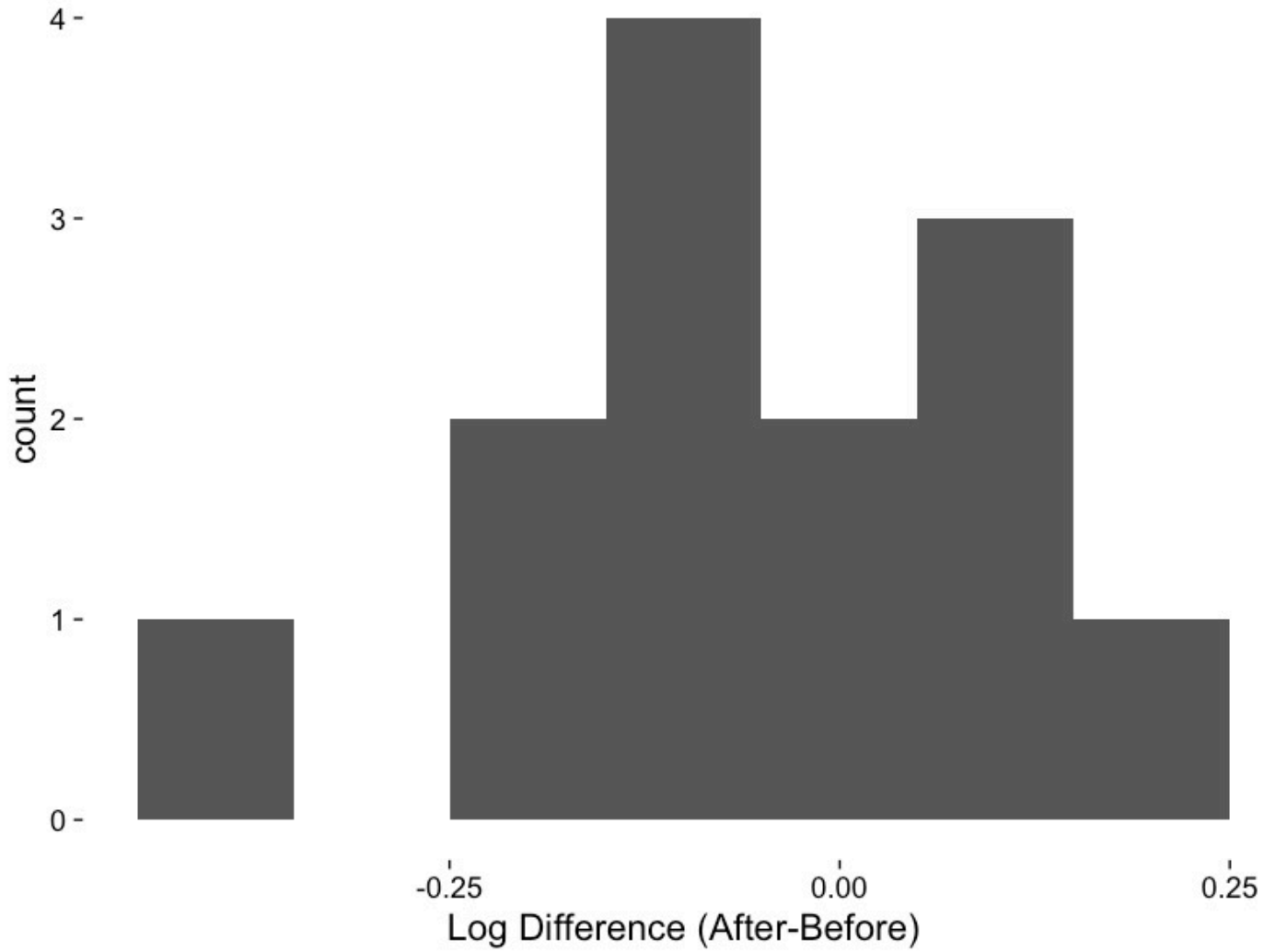
Evaluate against T Distribution with n-1 Degrees of Freedom
N is the sample size per group

Testosterone and Birds

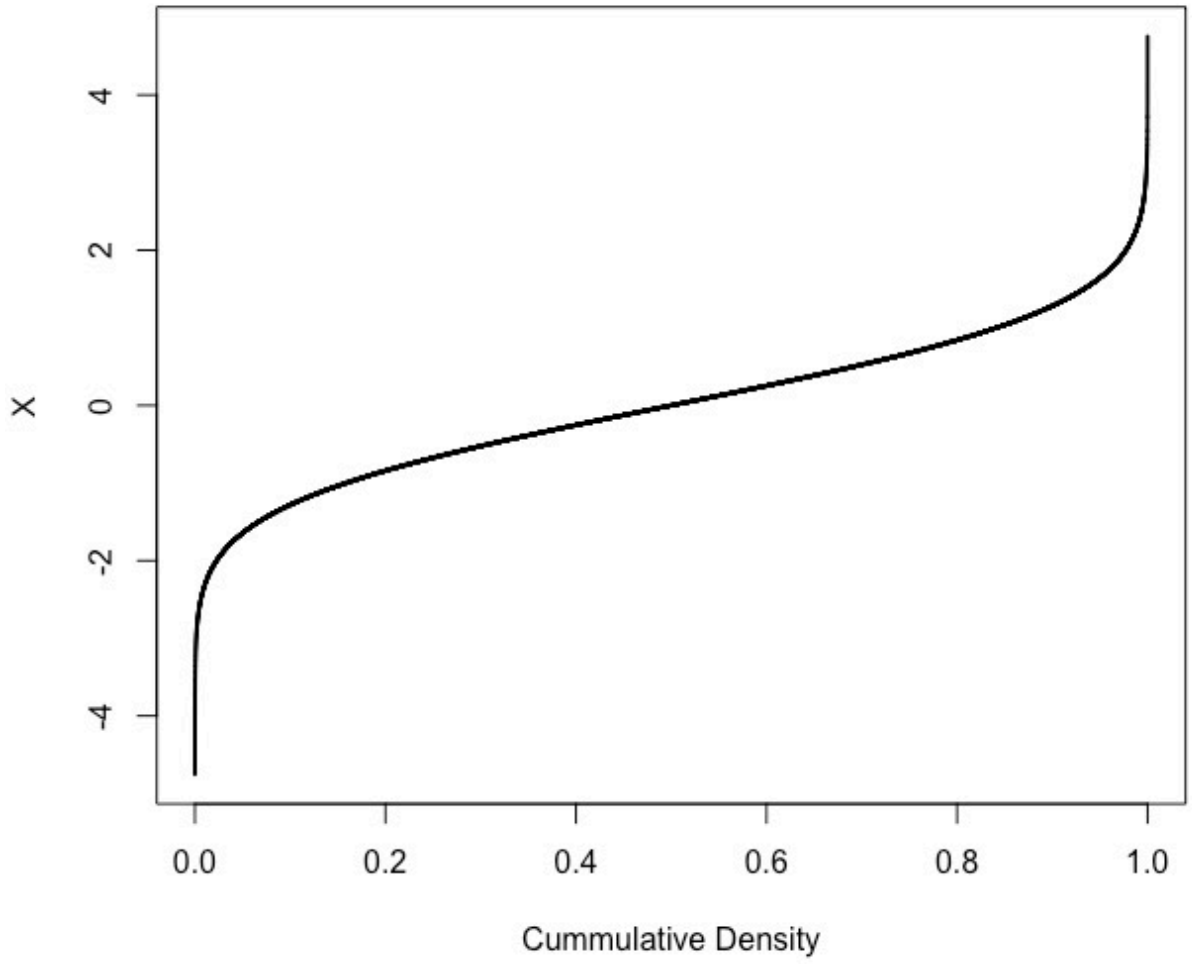
Differences in Antibody Performance



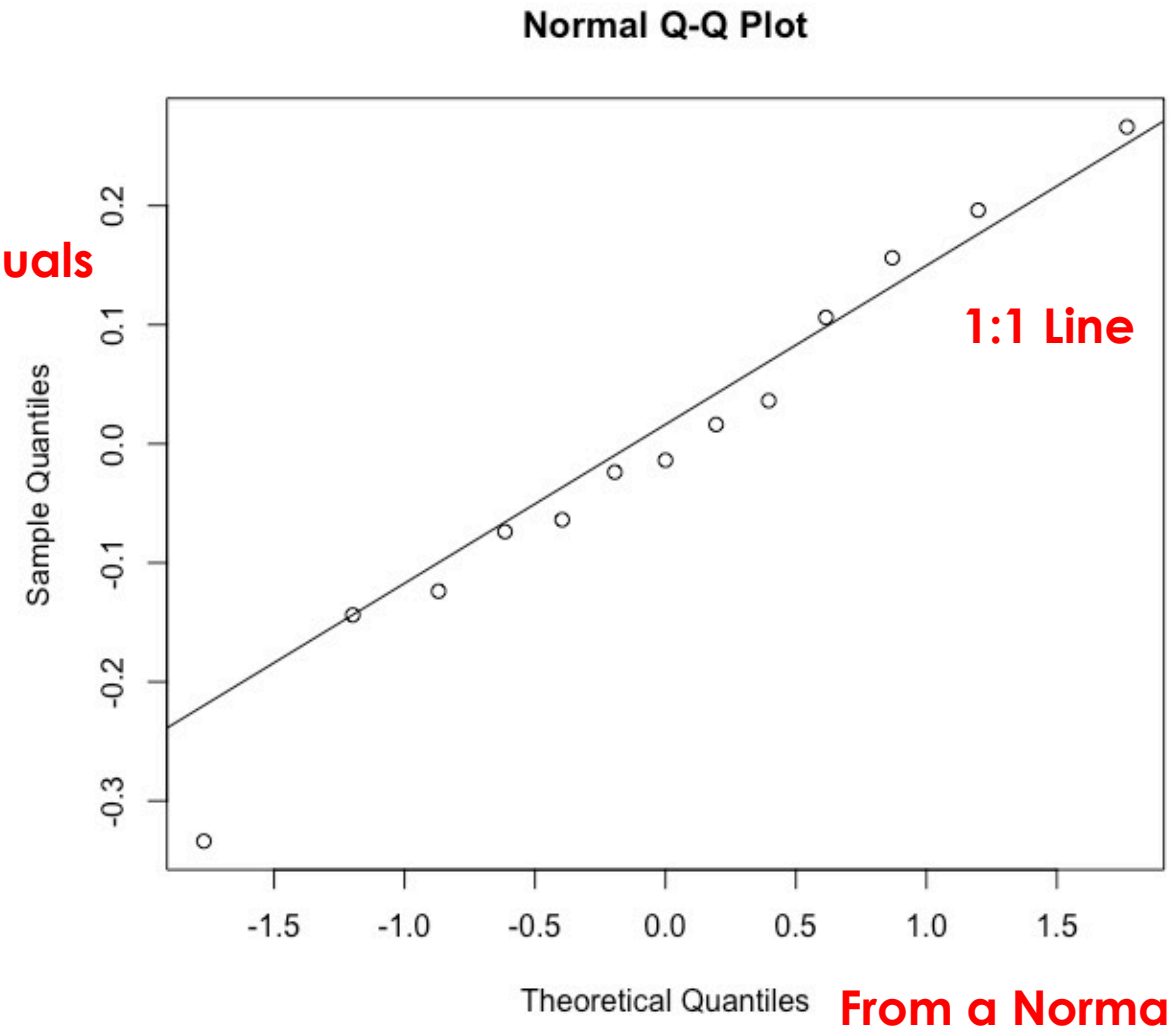
Is the Log Difference Different from 0?



One Way to Evaluate If Your Golem is Good: Quantiles



QQ Plot to Evaluate If Residuals are Normal



From Residuals

1:1 Line

From a Normal Distribution

General Testing Workflow

1. Build a Test
2. Evaluate Assumptions of Test
3. Evaluate Results
4. Visualize Results

Comparing Groups
H_0: Difference = 0

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_{12} / \sqrt{1/n}}$$

Pooled Sample SD = $\sqrt{(s_1 + s_2)}$

Evaluate against T Distribution with n-1 Degrees of Freedom
N is the sample size per group
Assumes equal sample size and equal variance of populaitons

Troubleshooting Your Golem

1. Unequal Sample Sizes
   – Alternate Formula for Denominator

2. Unequal Population Variances
   – Welch's T-Test (different denominator and DF)

3. Residuals Not Normal
   – Transform
   – Non-Parametric Test
   – Golem with a different error structure