Module 3E: ANOVA & Correlation

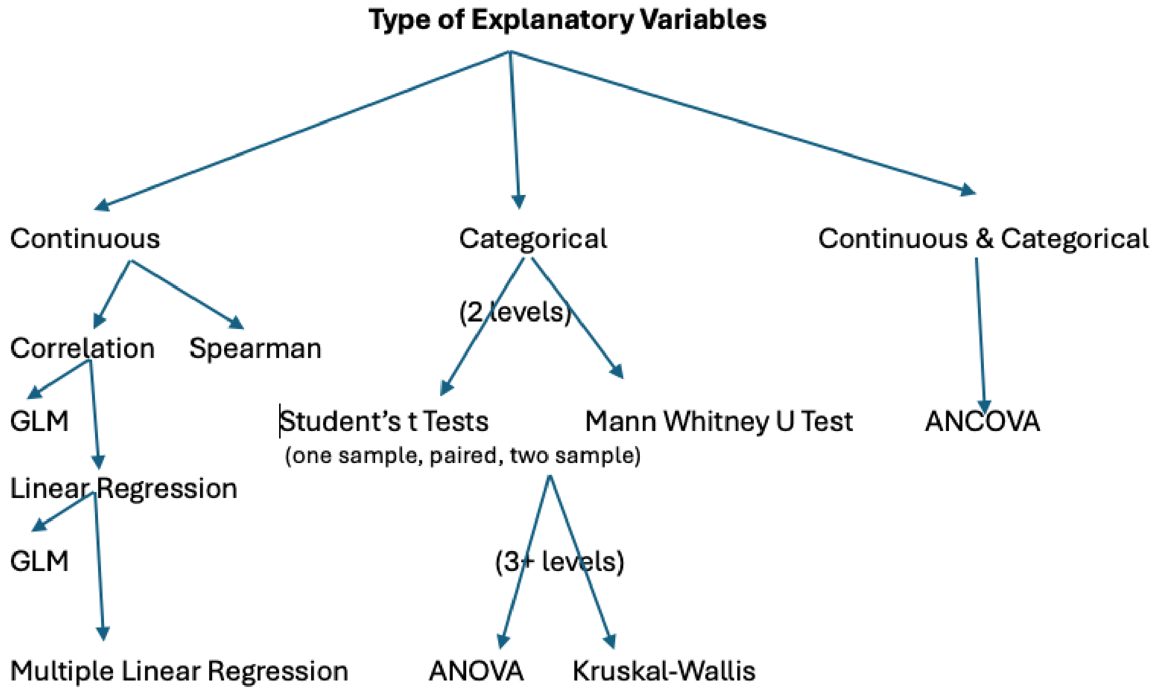
Assigning signal and noise to variation

Agenda:

1. ANOVA: Nuts & Bolts

2. Worked Example
   A. One way ANOVA
   B. Post-hoc tests: Tukey-Kramer
   C. Kruskal-Wallis (nonparametric)

3. Linear Correlation
   A. Spearman's rank



Testing for no correlation:

Step 1: declare null and alternate hypotheses

H_0: Zero correlation ($\rho = 0$)

H_A: Some correlation ($\rho \neq 0$)

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Step 2: test statistic

$$t = \frac{r - \rho}{SE_r}$$

$$\boxed{SE_r = \sqrt{\frac{1-r^2}{n-2}}}$$

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Step 3: P-value/Critical value

- Null distribution has a **sampling distribution** of Student's t-distribution with d.o.f. = *n – 2* → *use a Student's t table!*
- *Why n - 2? Use two summaries of data,* $\overline{X}$ *and* $\overline{Y}$

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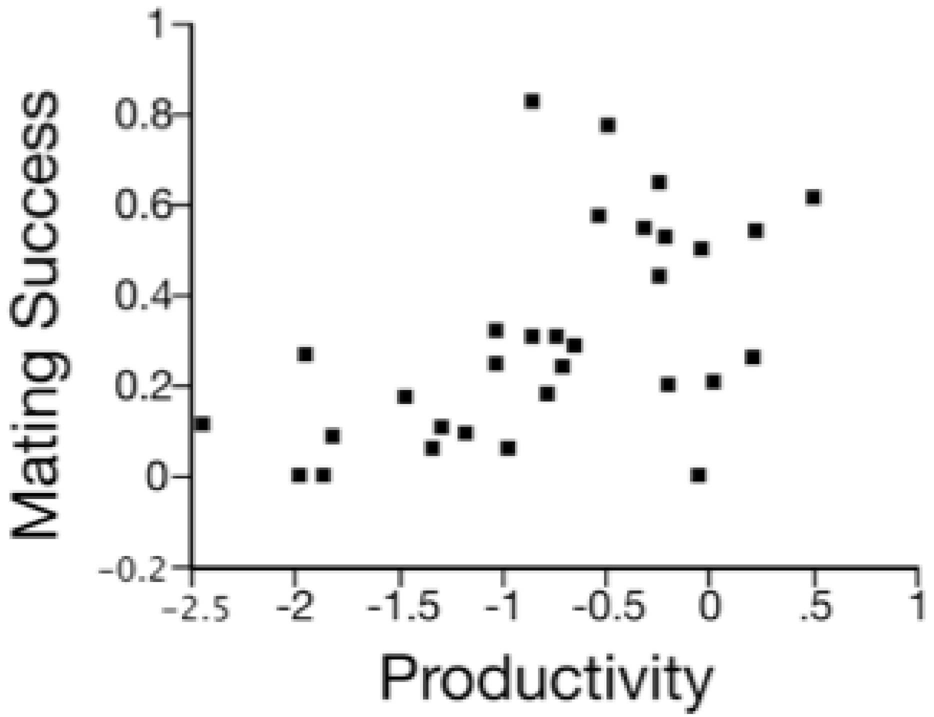
Step 4: State conclusion and Confidence interval

Correlation?

Confidence Interval needs to use transformation since SE_r is not normally distributed

Example: Are the effects of new mutations on mating success and productivity correlated? 31 data points from various visible mutations in *Drosophila melanogaster*.



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X is productivity, Y is the mating success

$$r = \frac{2.796}{\sqrt{(16.245)(1.6289)}} = 0.535$$

$\sum X = -24.228$ $\sum Y = 9.498$

$\sum X^2 = 35.1808$ $\sum Y^2 = 4.5391$

$\sum XY = -4.62741$ **n = 31**

$$SE_r = \sqrt{\frac{1-r^2}{n-2}} = \sqrt{\frac{0.7045}{29}} = 0.1558$$

$$t = \frac{0.5435}{01558} = 3.49$$

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t = 3.49

df = 29

This is greater than $t_{0.05(2),\,29} = 2.045$, so we can reject the null hypothesis and say that productivity and male mating success are correlated ($\rho \neq 0$).

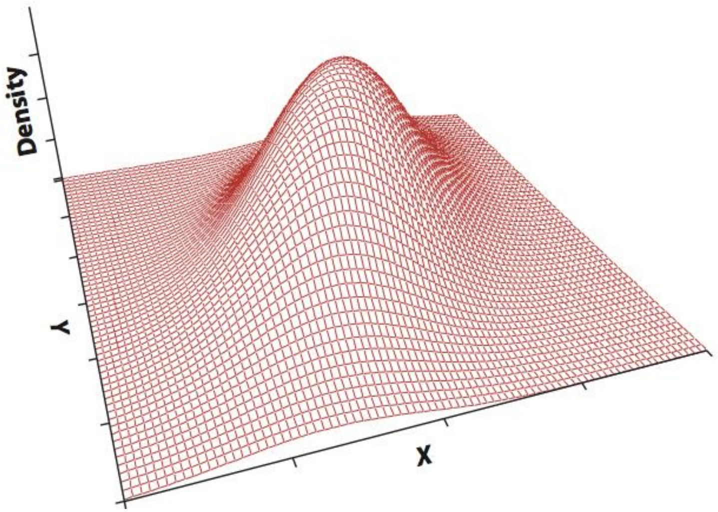
The 95% confidence interval for this parameter is:

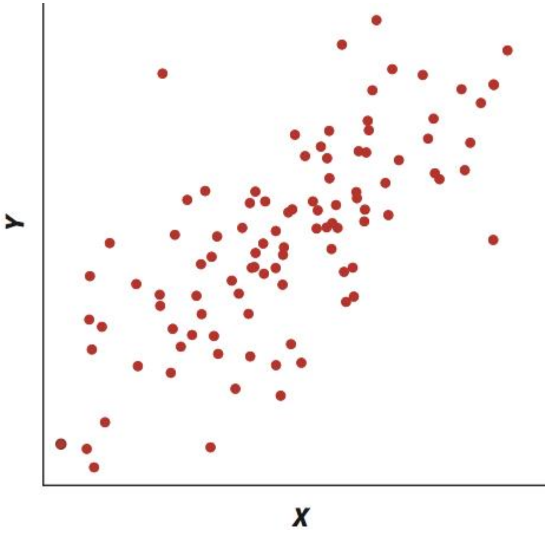
$$0.22 < \rho < 0.747$$

* I used a horrible conversion (Fisher's Z transformation) to get this confidence interval that is not intuitive at all.

https://www.statology.org/fisher-z-transformation/

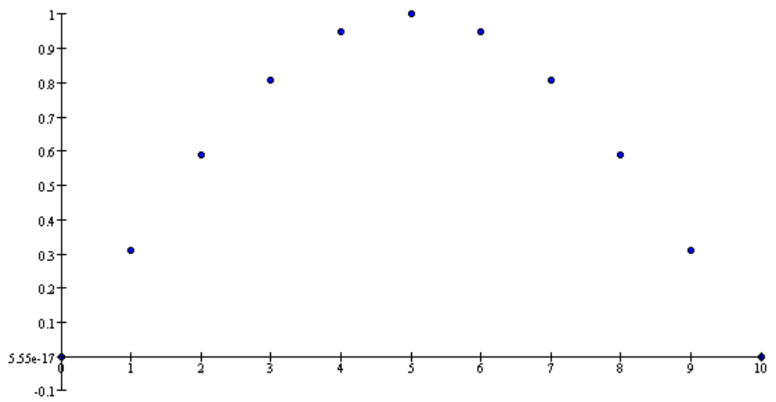
<u>Assumptions:</u>

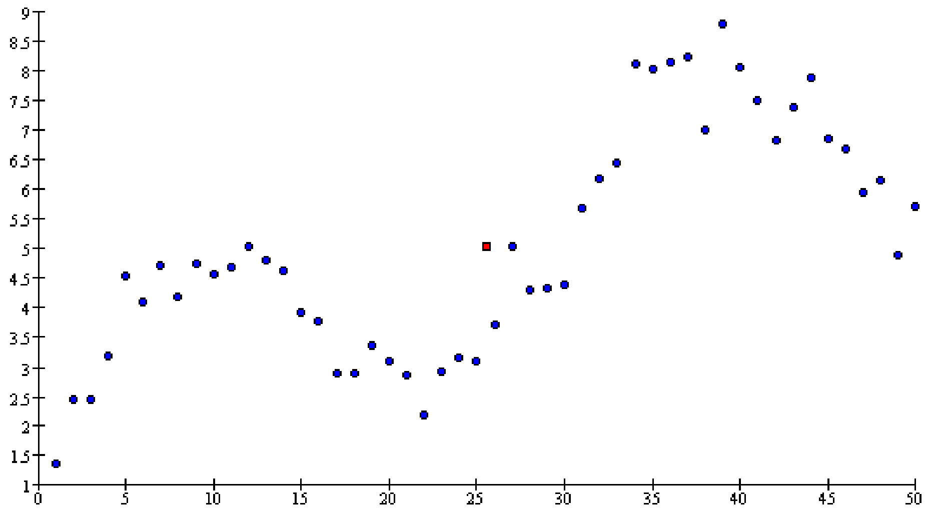




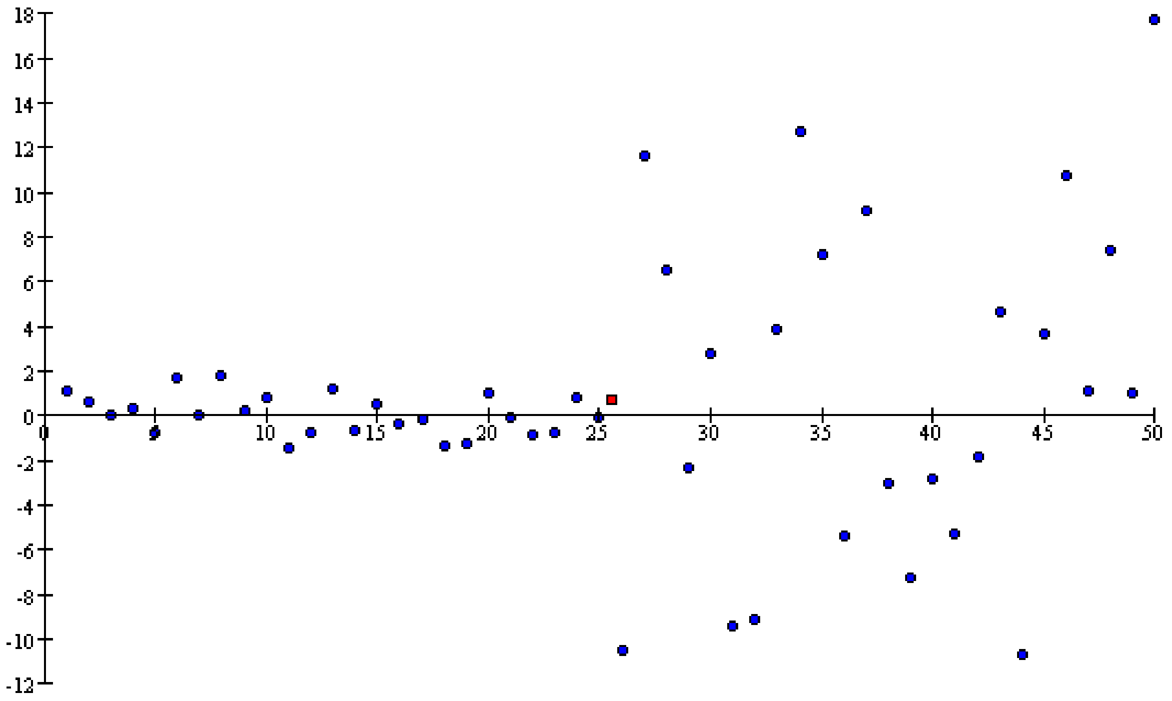
- Random sample
- Linearity
- Correlation <u>depends on range of values</u>
- Homoscedastic variances
- **Bivariate Normal Distribution**
    - X is normally distributed
    - Y is normally distributed
    - X and Y have linear relationship

Non-linearity





Heteroscedascity



Outliers: