Doing an ANOVA by hand, in Excel

Let's do an ANOVA by hand

- Open the file
- For this, let's assume that you have 3 groups ($m = 3$) with 10 participants each ($n_{group} = 10$) and that your data are in `A2:A11` for Group 1, `B2:B11` for Group 2, and `C2:C11` for Group 3. `A12`, `B12`, and `C12` contain your group means (`=AVERAGE(A2:A11)` etc.) and `A13`, `B13`, and `C13` contain your group standard deviations (`=STDEV.S(A2:A11)` etc.)

Calculate sums of squares in Excel

- $SS_{model} = n_{group} \cdot \sum_{j=1}^{m} (\bar{A}_i - \bar{x})^2$
  - In Excel: `=10*((A12-AVERAGE(A2:C11))^2+(B12-AVERAGE(A2:C11))^2+(C12-AVERAGE(A2:C11))^2)`
- $SS_{error} = \sum_{j=1}^{m} \sum_{i=1}^{n_{group}} (x_{ij} - \bar{A}_j)^2$.
  - Excel has a useful function called `DEVSQ` which gives you the sum of squares of deviations of data points from their sample mean
  - So: `=DEVSQ(A2:A11)+DEVSQ(B2:B11)+DEVSQ(C2:C11)`
- $SS_{total} = \sum_{j=1}^{m} \sum_{i=1}^{n_{group}} (x_{ij} - \bar{x})^2$
- Thanks to DEVSQ, this is really easy: `=DEVSQ(A2:C11)`

Calculate degrees of freedom and mean squares

- $df_{model} = m - 1 = 3 - 1 = 2$
- $df_{error} = m \cdot n_{group} - m = 10 \cdot 3 - 3 = 27$
- $df_{total} = m \cdot n_{group} - 1 = 10 \cdot 3 - 1 = 29$
- Let's assume that your sums of squares are in `B20`, `B21`, `B22` for model, error, and total, respectively. Then your mean squares are
  - $MS_{model} = \frac{SS_{model}}{df_{model}}$; `=B20/2` in Excel.
  - $MS_{error} = \frac{SS_{error}}{df_{error}}$; `=B21/27` in Excel.
  - MS_{total}: We don't actually need that!

Compute your F-value and the corresponding p-value

- Our F-value: $F_(df_{model}, df_{error}) = \frac{MS_{model}}{MS_{error}}$
- Assuming that you've stored MS_{model} in `D17` and MS_{error} in `D18`: `=C=D17/D18`
- Easy!
- Assuming that you put the F-value in `E17`, we can get the p-value using `=F.DIST.RT(E17,2,27)`, where 2 is df_{model} and 27 is df_{error}.

Example data set

- If you don't have Excel handy to generate your own or if you want to compare your calculations to mine.

BU	Soton	Oxford
101.37080	112.28569	105.39426
98.90038	92.33469	102.64322
99.35124	110.97803	85.54996
110.41595	121.00897	85.18428
113.22132	114.35717	121.77122
95.67537	126.07178	95.09605
113.69695	110.15121	86.46963
114.53939	96.40311	77.37942
98.88912	126.64088	111.85448
55.56055	114.37858	94.99734

ANOVA table

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Group	2	619.283	309.6415	1.329495	0.2813843
Error	27	6288.342	232.9015	NA	NA
Total	29	6907.625	NA	NA	NA