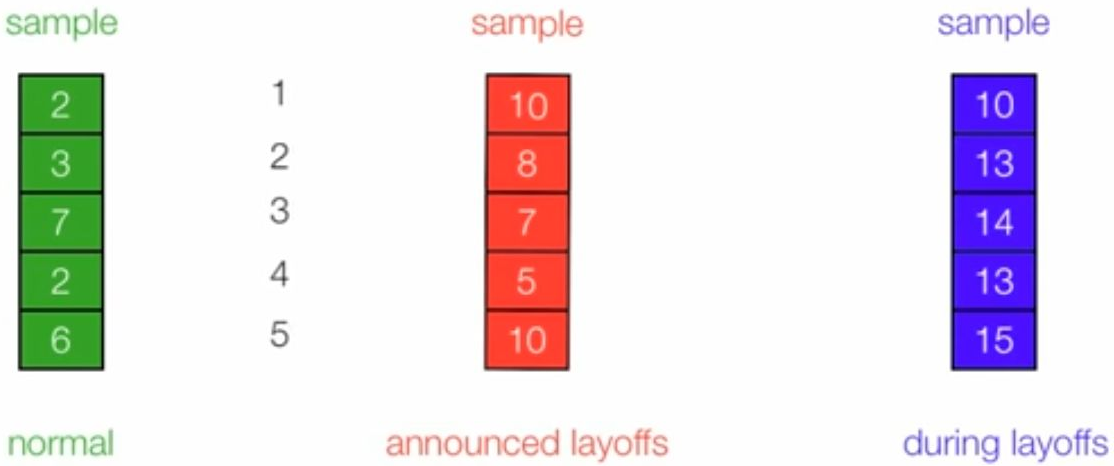
Anova example

Manishanker

Let’s say we have 3 samples of people at different situations and we are measuring the stress levels.

Analysis of Variance

levels of stress

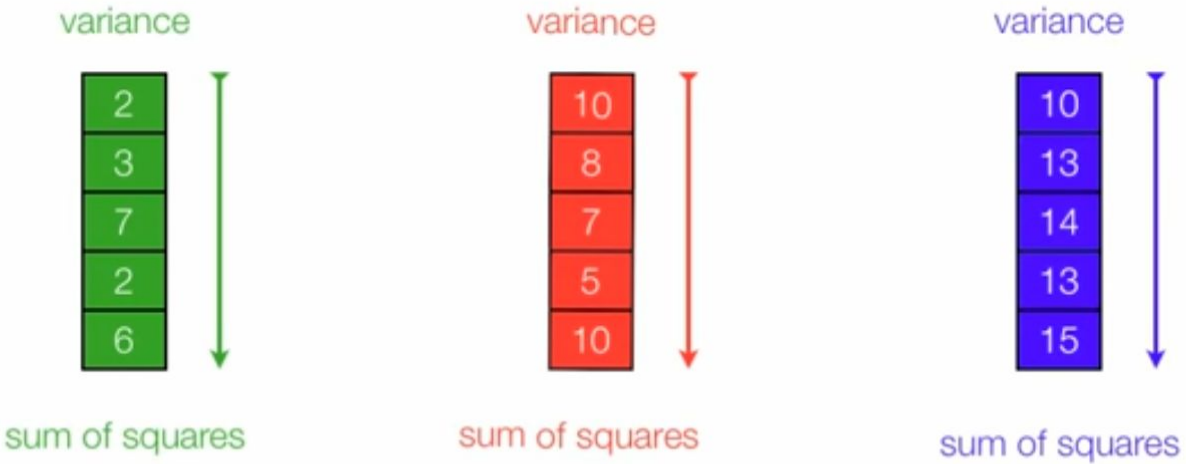


All these are same 5 people. And what we are looking for is the impact of layoff in the form of stress levels at different points of time.

Calculate sum of squares for each sample individually, i.e. the variance

Analysis of Variance

levels of stress

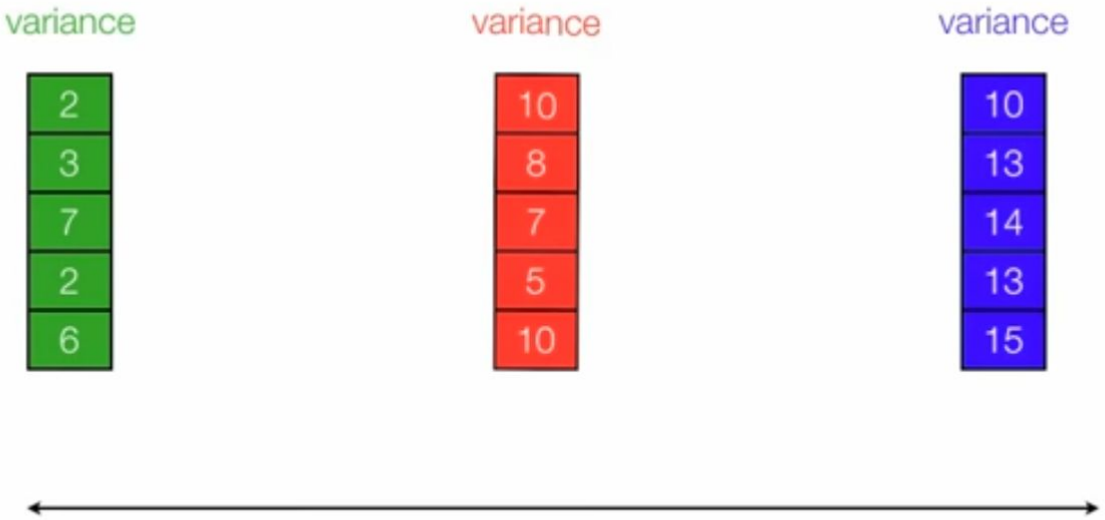


Sum of Squares Within Groups

Next calculation is sum of squares between groups. This would consider all the values

Analysis of Variance

levels of stress



variance between groups

sum of squares

Sum of Squares Between Groups

Also consider all these samples combined as one large big sample and calculate Total sum of squares

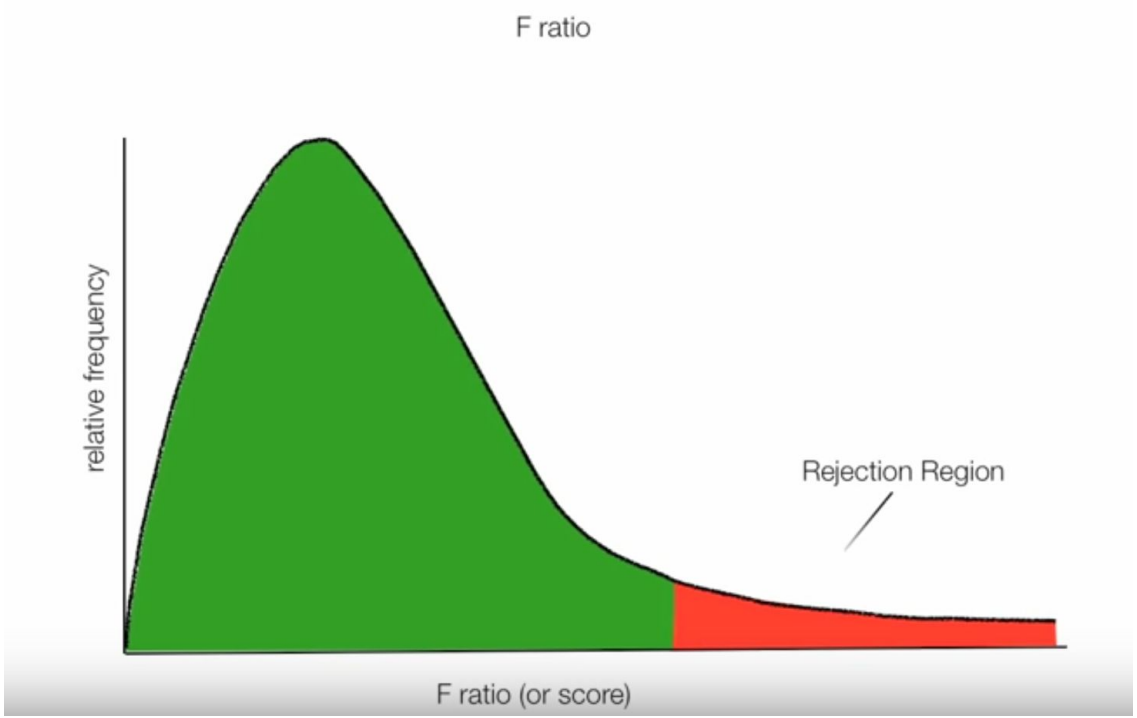
Analysis of Variance

levels of stress

variance from the mean

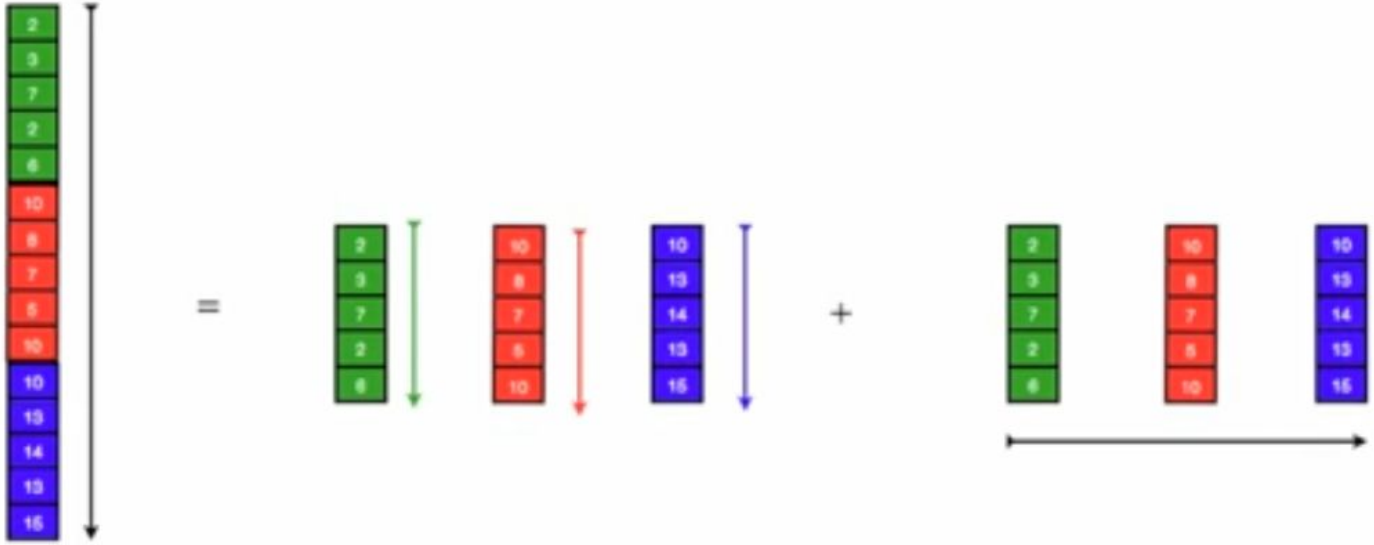
Total Sum of Squares

Calculate the F-ratio and see where it falls.



Analysis of Variance

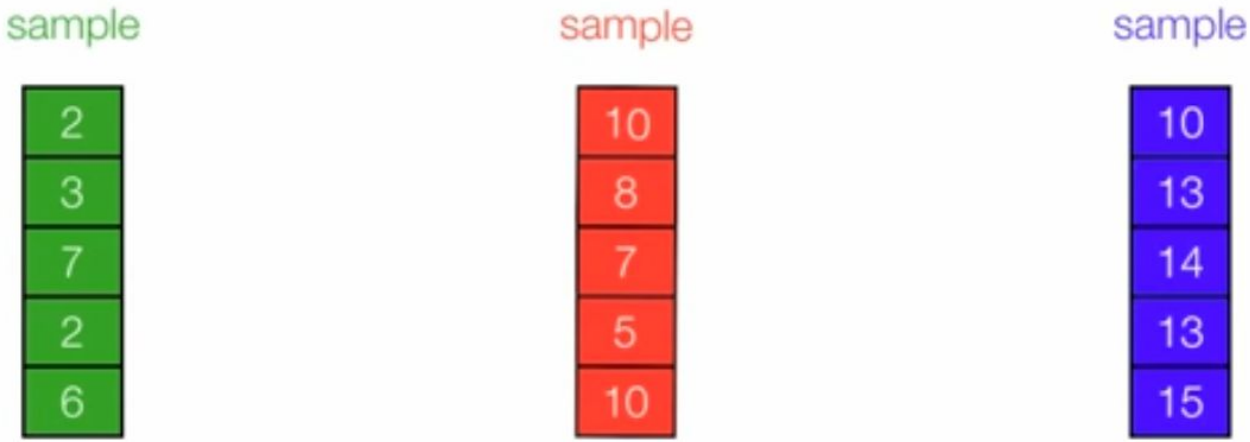
F Ratio



Total Sum of Squares = Sum of Squares Within Groups + Sum of Squares Between Groups

257.3 = 54 + 203.3

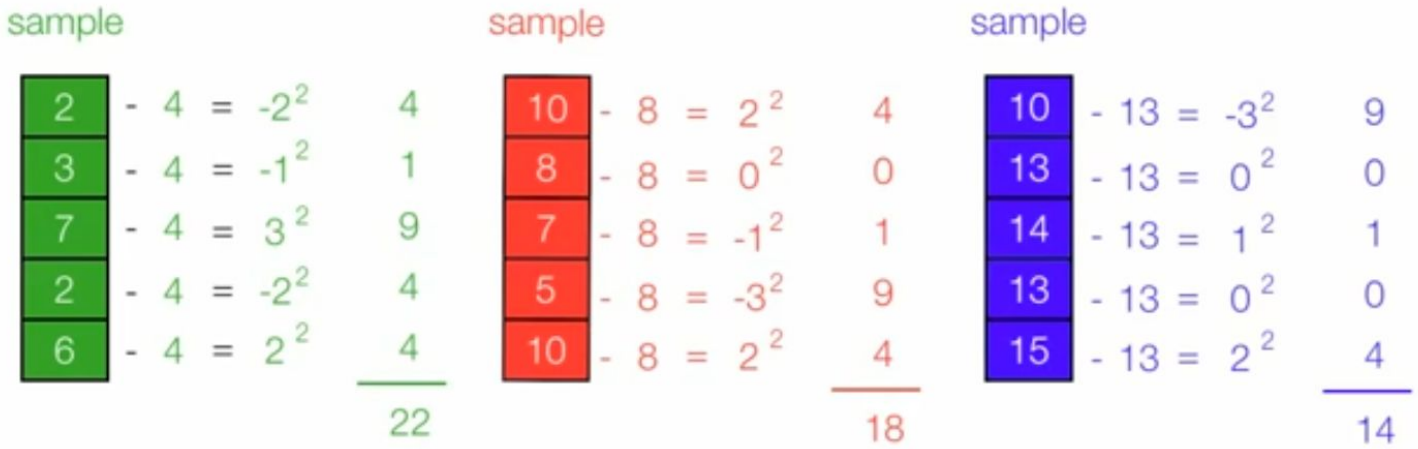
Analysis of Variance



Total Sum of Squares = Sum of Squares Between Groups + Sum of Squares Within Groups

Analysis of Variance

Sum of Squares Within Groups



Sum of **S**quares **W**ithin Groups = 22 + 18 + 14 = 54

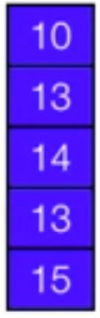
observation		mean	observation - mean	(observation - mean) ^{2}
2	-	8.3	= -6.3	40.1
3	-	8.3	= -5.3	28.4
7	-	8.3	= -1.3	1.8
2	-	8.3	= -6.3	40.1
6	-	8.3	= -2.3	5.4
10	-	8.3	= 1.7	2.7
8	-	8.3	= -0.3	0.1
7	-	8.3	= -1.3	1.8
5	-	8.3	= -3.3	11.1
10	-	8.3	= 1.7	2.8
10	-	8.3	= 1.7	2.8
13	-	8.3	= 4.7	21.8
14	-	8.3	= 5.7	32.1
13	-	8.3	= 4.7	21.8
15	-	8.3	= 6.7	44.4

Total **S**um of **S**quares

SST = 257.3

Analysis of Variance

Sum of Squares Between Groups



1. mean - mean mean - mean mean - mean
2. $(\text{mean} - \text{mean})^2$ $(\text{mean} - \text{mean})^2$ $(\text{mean} - \text{mean})^2$
3. $(\text{mean} - \text{mean})^2 + (\text{mean} - \text{mean})^2 + (\text{mean} - \text{mean})^2$
4. $(\text{mean} - \text{mean})^2 + (\text{mean} - \text{mean})^2 + (\text{mean} - \text{mean})^2 \times 5$

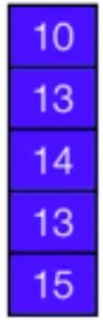
Analysis of Variance

Sum of Squares Between Groups

mean 8.3

$4 - 8.3 = (-4.3)^2$

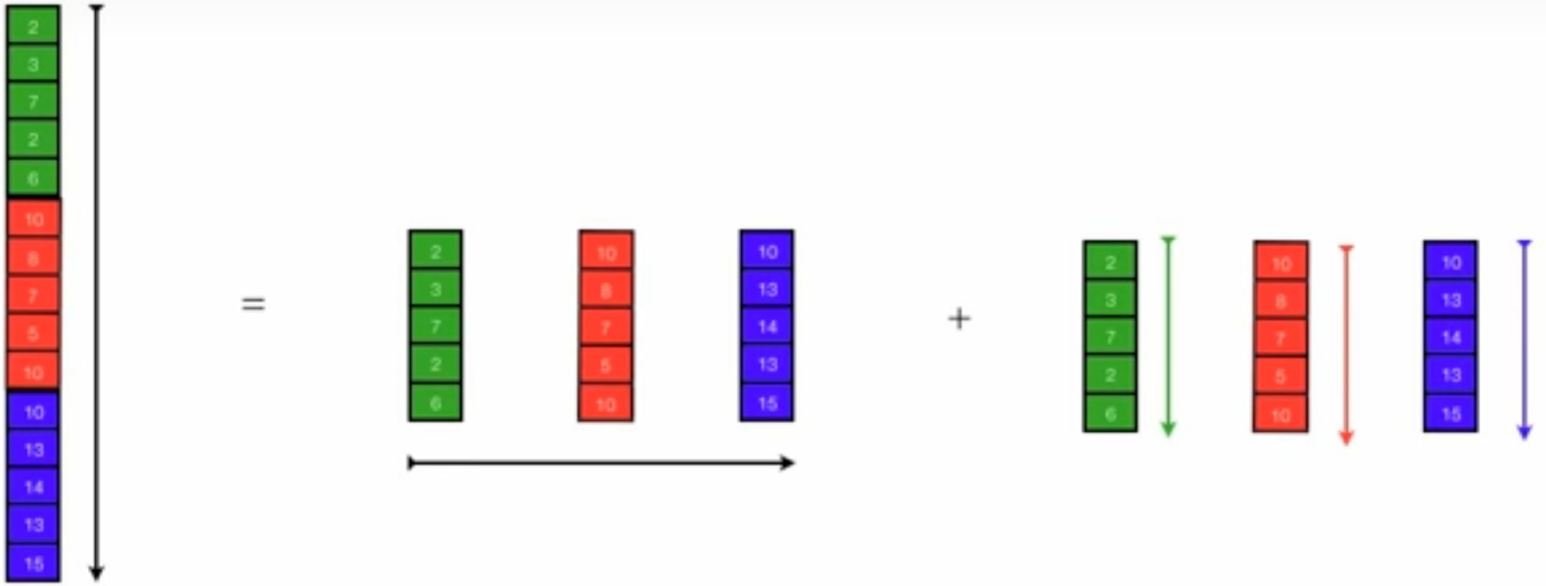
$8 - 8.3 = (-.3)^2$



$13 - 8.3 = (4.7)^2$

$18.8 + .1 + 21.8 = 40.7$

$40.7 \times 5 = 203.3$



Total Sum of Squares = Sum of Squares Between Groups + Sum of Squares Within Groups

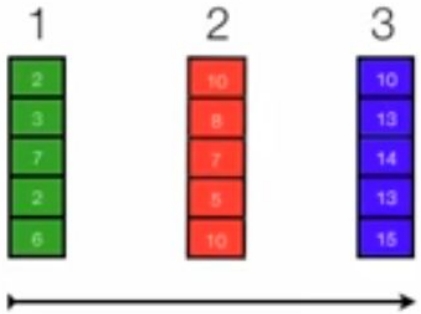
257.3 = 203.3 + 54

Final Calculations

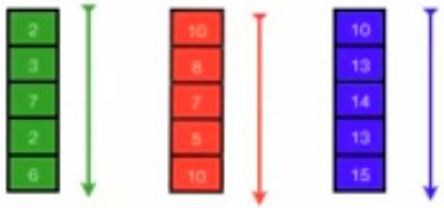
$$\frac{\text{Sum of Squares Between Groups}}{\text{degrees of freedom}} = \frac{203.3}{2}$$

Groups - 1

3 - 1 =



Final Calculations



$$\frac{\text{Sum of Squares Within Groups}}{\text{degrees of freedom}} = \frac{54}{12}$$

Final Calculations

$$\frac{\text{Sum of Squares Between Groups}}{\text{degrees of freedom}} = \frac{203.3}{2} = 101.667$$

$$F = \frac{101.667}{4.5} = 22.59$$

$$\frac{\text{Sum of Squares Within Groups}}{\text{degrees of freedom}} = \frac{54}{12} = 4.5$$

Final Calculations

$$F(2,12) = 22.59,\ p<.05$$

$$\frac{\text{Sum of Squares Between Groups}}{\text{degrees of freedom numerator}} = \frac{203.3}{2} = 101.667$$

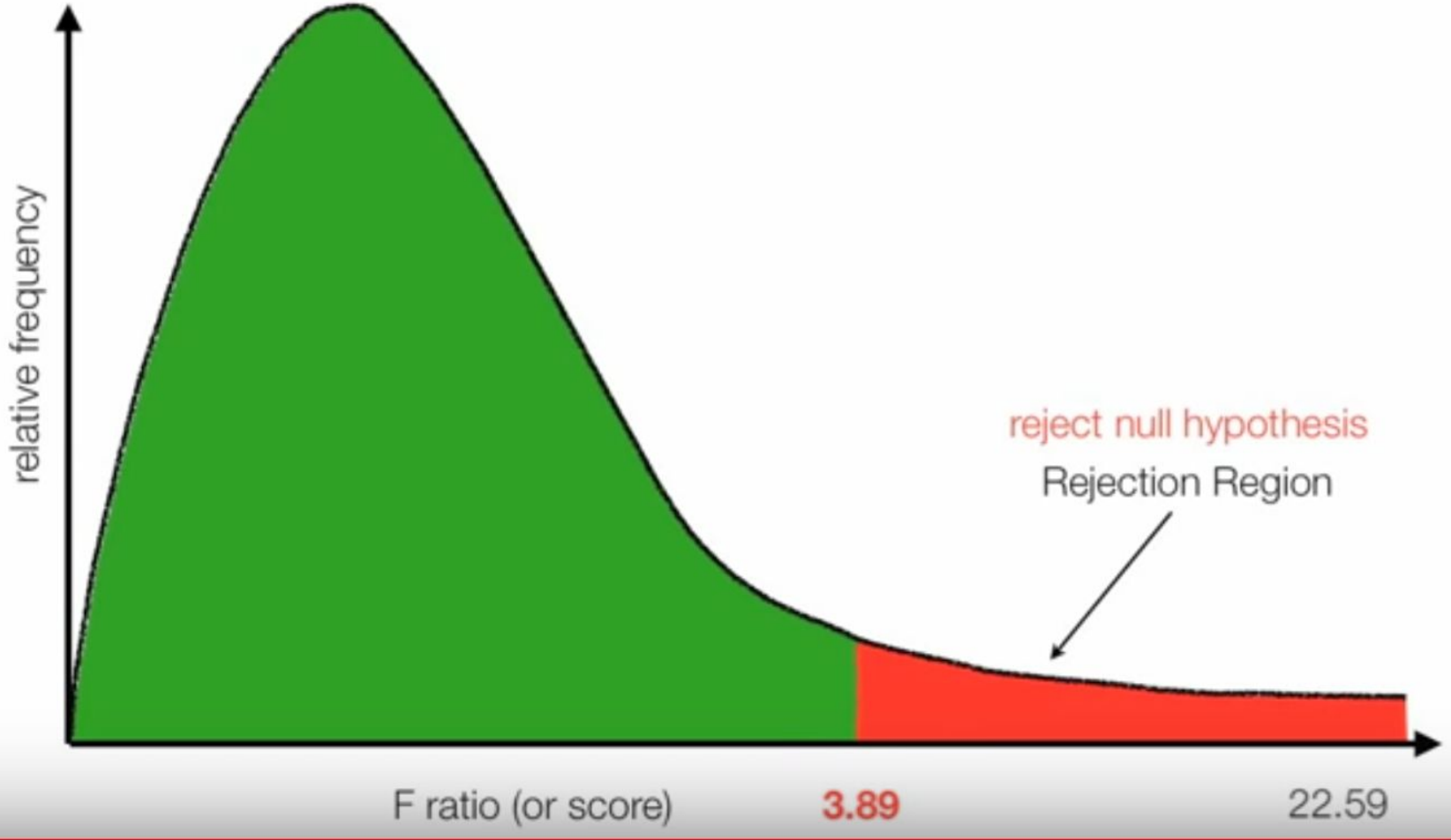
$$F = \frac{101.667}{4.5} = 22.59$$

$$\frac{\text{Sum of Squares Within Groups}}{\text{degrees of freedom denominator}} = \frac{54}{12} = 4.5$$

F Distribution F (2,12) = 22.59, $p<.05$

degrees of freedom numerator

degrees of freedom denominator	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	161.5	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5	241.9	243.9	246.0	248.0	249.1	250.1
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.45	19.46
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25


relative frequency
reject null hypothesis
Rejection Region
F ratio (or score)
3.89
22.59