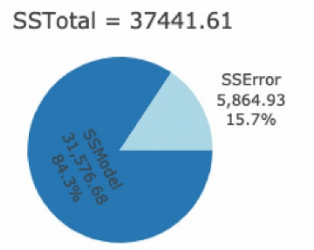
Chapter 1

Exploration 1.2

1. Do dung beetles use celestial objects as guidance when rolling their balls of dung?
2. The dung beetles were randomly assigned a clear or dark cap making this procedure an experiment.
   Explanatory Variable – type of cap
   Response Variable – time to reach the edge of the platform (seconds)
   Treatments – black cap and clear cap.
3. Same species, identical platform size, clear night with stars (not overcast)
4. No, although the difference in means of 84.4 seconds seems quite large, we must first get an understanding of what kind of variation in times is reasonable/expected naturally and through the random assignment process.
5. *predicted time* = 84.66 seconds
   Standard Error of residuals = 46.93 seconds (SD from mean time of 84.66 seconds)
6. $(n-1)\times(SD\ of\ times)^2 = 17\times(46.93)^2 = 37,441.22\ (\text{calculated}) \approx 37,441.61\ (\text{applet})$
   SSTotal = 37,441.61
7. Yes, the longest clear cap time is quicker than the shortest black cap time. Furthermore, the means of black cap = 126.55 sec and clear cap = 42.78 sec are quite different.
8. $predicted\ time = \begin{cases} 126.55\ if\ black\ cap \\ 42.78\ if\ clear\ cap \end{cases}$
   SE of residuals = 19.416 seconds.
   This is a substantial improvement from the single mean model's standard error of residuals equal to 46.93 seconds.
9. $(n-2)\times(SE\ residuals)^2 = 16\times(19.416)^2 = 5,865.11(calculated) \approx 5,864.93\ (applet)$
   SSError = 5,864.93
10. $Black\ cap\ effect = 126.55 - 84.66 = 41.89$ seconds
    $Clear\ cap\ effect = 42.78 - 84.66 = -41.89$ seconds
11. $predicted\ time = 84.66 + \begin{cases} 41.89\ if\ black\ cap \\ -41.89\ if\ clear\ cap \end{cases}$
12. $9\times(126.55-84.66)^2 + 9\times(42.78-84.66)^2 = 9\times(41.885)^2 + 9\times(-41.885)^2 = 31,578.36\,(\text{calculated})$
    $\approx 31,576.68$ (applet)
    SSModel = 31,576.68
13. *SSModel* + *SSError* = 31,576.68 + 5,864.93 = 37,441.61 = *SSTotal*
    df model + df error = 1 + 16 = 17 = df total
14. $\frac{SSModel}{SSTotal}\times 100\% = \frac{31576.68}{37441.61}\times 100 = 84.3\%$
15. The type of cap worn by the beetle accounts for 84.3% of the variation in times.

16.



17. *Difference in group means* = 126.55 – 42.78 = 83.77 seconds
    83.77/19.146 = 4.38 standard errors
    The large result of the effect (over 4 times larger than the residual SE) indicates practical significance for the difference in means.
18. The difference in times for each treatment group is quite impressive, beetles with the black cap took nearly three times as long as those with a clear cap. There should be no confounding variables as a result of the random assignment in the study design.
19. Increase sample size, use different sized platforms, use a middle darkness cap, etc.