PHYS 310 -- Homework #1, Due Tuesday Jan 26, 2016

1. Hughes and Hase, 2.2

(i) Calculate the mean

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In[2]:= data = {5.33, 4.95, 4.93, 5.08, 4.95, 4.96, 5.02, 4.99, 5.24, 5.25, 5.23, 5.01}

Out[2]= {5.33, 4.95, 4.93, 5.08, 4.95, 4.96, 5.02, 4.99, 5.24, 5.25, 5.23, 5.01}
```

Find mean using the "Mean" function, then the old - fashioned way of adding everything and dividing by N using Total or using Sum

```
Mean[data]

5.07833

In[7]:= Total[data]/Length[data]

Out[7]= 5.07833

In[15]:= Sum [data[[i]], {i, 1, Length[data]}]/Length[data]

Out[15]= 5.07833
```

Gives the same answer, as would be expected.

(ii) standard deviation using eq. (2.3)

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In[16]:= deviations= data-Mean[data]

Out[16]= {0.251667, -0.128333, -0.148333, 0.00166667, -0.128333, -0.118333,
  -0.0583333, -0.0883333, 0.161667, 0.171667, 0.151667, -0.0683333}

In[17]:= stdev = Sqrt[Total[deviations^2]/(Length[data]-1)]

Out[17]= 0.14358

In[18]:= StandardDeviation[data]

Out[18]= 0.14358
```

Agrees with the Mathematica formula for Standard Deviation.

(iii) standard error (i.e., standard deviation of the mean)

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In[19]:= stderr = stdev/Sqrt[12]

Out[19]= 0.0414479
```

2. Hughes and Hase, 2.3

Standard error (standard deviation of the mean) is $\sigma/\sqrt{N}$,
so if you want the standard error to drop by a factor of 10,
you need to increase the number of measurements by a factor of 100,
so instead of 1 minute of data, you should take 100 minutes of data.

3. Hughes and Hase, 2.6

(i) If the mean of δ is 3.27346 and the standard error α is 0.01913, then I' d report the results as 3.27 ± 0.02, although I' d be okay with 3.273 ± 0.019 as well.

(ii) If mean is 3.26513 and standard error is 0.002506, then I' d report as 3.265 ± 0.003.

(iii) If mean is 3.26681 and standard error is 0.000270, then I' d report as 3.2668 ± 0.0003

4. Pendulum measurements

Data for pendulum swings. Standard deviation is 0.04 s.
Experiment A : 12 sets of 10 swings, average time for 10 swings = 28.39 s;
Experiment B : 1 set of 120 swings, time for 120 swings = 340.61 s.

Period for A -- Average period T = 28.39s/10 = 2.839 s. Standard error for 10 swings is 0.04s/$\sqrt{12}$ or 0.0126491 s. So uncertainty for a single swing is a tenth of this, or 0.00126491.

So, for Experiment A, T = (2.839±0.001) s

Period for B is 340.61s/120 or 2.83842. Error is simply standard deviation divided by 120: 0.04/120 or 0.000333

So, for Experiment B, T = (2.8384±0.0003) s.

5. Estimating data

One method is to look for the median. There are 15 data points. The middle value is 4.19365, meaning 7 values are larger than this and 7 are smaller. The median can be a poor estimate for the mean if the distribution is very assymetric, but these numbers go up to 4.5 and down to 3.9, so it looks like they are fairly well centered on 4.2.

Using H & H's "rough estimate" for the standard deviation, we find that the max value minus the mean is about 0.3. Taking × 2/3 of that gives a standard deviation of 0.2.