Assignment 2: Getting started with Programming

Name:

Learn about Programming Functions

1. Look over the following topics in the Mathematica documentation.
   1.1. Part help page
   1.2. “Repetitive Operations” tutorial
   1.3. Table[] help page
   1.4. Do[] help page
   1.5. Map[] help page
   1.6. “Relational and Logical Operators” tutorial
   1.7. “Conditionals” tutorial
   1.8. “Defining Functions” tutorial
   1.9. “The Structure of Graphics” tutorial page
   1.10. RandomVariate[] help page
   1.11. NormalDistribution[] help page
   1.12. “Selecting Parts of Expressions with Functions” tutorial page

Deciphering code

Attempt to decipher the code below. Explain in ordinary words what each line does. Tell me what each function contributes, what the curly brackets do, and what is stored in the variables to the left of the = (mynums and mypoints). You can execute and modify the code to help you. Remember that you can view the output by removing the semicolon or by executing the variable name on a new line. For example, if you want to peek at the first 10 items stored in mynums you would execute mynums[[1;;10]].

```mathematica
{RandomVariate[NormalDistribution[0, 1]], RandomVariate[NormalDistribution[0, 1]]}
{-0.619408, -0.422883}
```

```mathematica
mynums = Table[{RandomVariate[NormalDistribution[0, 1]],
   RandomVariate[NormalDistribution[0, 1]]}, {1000}];
```
mynums = [[1 ;; 10]]
{[1.48886, 1.15791], [0.784284, -0.154445],
{0.425746, -0.535462], [-2.38991, -0.647542], [0.425441, -0.168439],
{-0.0816064, 0.159879], [-0.380979, 0.277742],
{-1.19926, -1.50253], [-0.933942, -0.446129], [1.2338, 0.899014]}

Sqrt[100 * #] & @ mynums
{[12.2019, 10.7606], [8.85598, 0. + 3.92995 i], [6.52492, 0. + 7.31753 i],
{0. + 15.4593 i, 0. + 8.0471 i], [6.52258, 0. + 4.10413 i], [0. + 2.85668 i, 3.99849],
{0. + 6.17235 i, 5.27012], [0. + 10.9511 i, 0. + 12.2578 i],
{0. + 9.66407 i, 0. + 6.67929 i], [11.1076, 9.48164]}

If[-2 > 0, "I'm a positive number", "I'm a negative number"]
I'm a negative number

{Red, Point[{0.1, -0.2}]}
{Point[{0.1, -0.2}]}

If[#[1] > 0 && #[[2]] < 0, {Red, Point[#]}, {LightGray, Point[#]}]

mypoints = [[1 ;; 10]]
{[□, Point[{1.48886, 1.15791}], [□, Point[{0.784284, -0.154445}]],
[□, Point[{0.425746, -0.535462}], [□, Point[{2.38991, -0.647542}]],
[□, Point[{0.425441, -0.168439}], [□, Point[{-0.0816064, 0.159879}]],
[□, Point[{-0.380979, 0.277742}], [□, Point[{1.19926, -1.50253}]],
[□, Point[{-0.933942, -0.446129}], [□, Point[{1.2338, 0.899014}]]}
mypoints = If[#1[[1]] > 0 && #1[[2]] < 0, {Red, Point[#1]}, If[#1[[1]] < 0 && #1[[2]] > 0, {Orange, Point[#1]}, {LightGray, Point[#1]}]] &/@ mynums;

Graphics[mypoints, Frame -> True, AspectRatio -> Automatic]

---

**Write a short program**

Using the above code as a model, write code that generates 1000 random 3D points and plots them in a 3D graph (see `Graphics3D`) colored red if they are located in the positive end of the z-axis, but otherwise colored grey.

mynums1 = Table[{RandomVariate[NormalDistribution[0, 1]], RandomVariate[NormalDistribution[0, 1]], RandomVariate[NormalDistribution[0, 1]]}, {1000}];

mynums2 = Table[{RandomVariate[NormalDistribution[10, 10]], RandomVariate[NormalDistribution[-2, 2]], RandomVariate[NormalDistribution[0, 1]]}, {500}];
mypoints1 = If[H[[3]] > 0, {Red, Point[H]}, {LightGray, Point[H]}] &/@ mynumsl;
Graphics3D[mypoints1, Frame -> True]

MyRedPoints[mynums_] :=
Graphics3D[If[H[[3]] > 0, {Red, Point[H]}, {LightGray, Point[H]}] &/@ mynums]

MyRedPoints[mynums1]

Selecting lines that match a criterion
Using the same sample data from Caumul and Polly, write a line of code that stores the lines for samples with body mass greater than 4.5 kg in a new variable `bigmarmots`.

```math
\text{data} = \text{Import[}

  "/Users/pdavidpolly/Documents/Lectures/G562 Geometric Morphometrics/Sample Data/CaumulAndPolly2005.xls"][[2]];

\text{data} //

\text{TableForm}

\{\text{mystuff} = \text{data}\} // \text{TableForm}

\begin{tabular}{|c|c|c|c|c|}
\hline
\text{Group} & \text{Taxon} & \text{N} & \text{skull_len} & \text{Diet} & \text{Habitat} \\
\hline
A & M. baibacina & 4. & 96.6475 & A & 3. \\
B & M. c. caudata (Central Kashmir) & 9. & 100.311 & C & 2. \\
C & M. c. caudata (N Central Kashmir) & 6. & 101.636 & C & 2. \\
D & M. c. caudata (Pakistan) & 7. & 99.58 & C & 2. \\
E & M. caudata aurea & 7. & 89.6457 & C & 2. \\
F & M. h. himalayana (Ladakh) & 7. & 99.1713 & B & 1. \\
G & M. h. robusta (C. China) & 7. & 99.3627 & B & 1. \\
H & M. h. himalayana (E. Himalayas) & 7. & 89.26 & B & 1. \\
I & M. h. himalayana (Xinjiang) & 7. & 92.788 & B & 1. \\
J & M. marmota (Europe) & 7. & 88.074 & A & 1. \\
K & M. sibirica (Arvayheer) & 7. & 91.7911 & A & 2. \\
L & M. sibirica (Ulan Baator) & 7. & 89.5608 & A & 2. \\
\hline
\end{tabular}

\text{Select[\text{data}, \#[[7]] != 4.5 \&]} // \text{TableForm}

\begin{tabular}{|c|c|c|c|c|c|}
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\hline
\end{tabular}

**Define a function of your own**

- Define a function of your own that accepts a number (n) as its input parameter. The function should then generates 100 pairs of random numbers from 0 to 1 (these will be x and y coordinates of points on a graph), multiplies each random number times n, and graphs the random points using ListPlot. In your work, show the function and one plot that you create with it.

**Plot geographic locations in a graph (reprise)**

1. If you were not able to plot labels for the geographic locations from the last assignment, try again as follows...
2. Download the sample data file from the website ("Associated data from Caumul and Polly, 2005").

3. Open the file in Excel (or other spreadsheet) to understand what it contains.

4. Import the second worksheet ("by sample") into Mathematica and store its contents in a variable.

5. Create a group showing the locations of the samples plotted by latitude and longitude. Show each location as a colored point labeled with the "Group" letter. Use the Graphics[] function to do this, using Point[] for the markers and Text[] for the labels.