Lab 1: Plotting with Mathematica

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- Sign on to an iMac with your username and password.
- When you open *Mathematica*, click **New Document** and a blank screen will appear. This is known as a notebook. If you need to open a new notebook, go to **File**, choose **New** and choose **Notebook** or simply hit `Command + N` (or `Ctrl + N` for **Windows**).
- Make the Untitled window bigger if necessary by dragging the lower right corner. Choose at least 125% from the lower left of the Untitled window for a comfortable viewing size.
- Do not forget to **Save** the notebook periodically. Save new notebooks on the **Desktop**. The **Save** command is under the **File** menu. Give your file a name in the following format:

  `Lab0_Name1_Name2.nb`

- Follow the instructions in the paper copy of the handout.
- At the end of Lab session, save and quit Mathematica. **Do not delete your file or any calculation you did.** Then log off or restart the computer. Do NOT click **Shut Down**.

Lists

Exercise 1: List of values

1. To create a list of numbers we use $\{num1, num2, \ldots\}$. Type

   ```
   list1={10,12,14,16,18,20}
   ```

   to create a list called `list1` that has 6 entries.

2. Type

   ```
   list2={30,40,50,40,30,20}
   ```

   to create another list.

3. Type

   ```
   First[list1]
   ```

   to get the first entry of `list1`. How do you get the *last* entry of `list2`?

4. Type

   ```
   list1[[4]]
   ```

   to get the fourth entry of `list1`. What's the command to get the 5th entry of `list2`?

5. What's the difference between a *list* and a *set*?

Exercise 2: List of points on a plane

6. To create a list of points on a plane we will use $\{\{x_1, y_1\}, \{x_2, y_2\}, \{x_3, y_3\}, \ldots\}$. Type

   ```
   points={{2,3},{4,5},{6,7},{8,9}}
   ```

   to create a list of 4 points on the plane with coordinates $(2,3), (4,5), (6,7)$ and $(8,9)$.

7. Type

   ```
   ListPlot[points]
   ```

   to plot the list of points above.

Exercise 3: Table of points

8. Suppose we want to create a list containing the points (n, n^2) for $n = 1, 2, \ldots, 40$. Of course we wouldn't want to type out all of them. We can use the `Table` command to make our life easier.

   Type the following and observe the differences.

   ```
   Table[x^2,{x,1,9}]
   Table[x^2,{x,{1,3,5,7,9}}]
   Table[{n,n^2},{n,1,40}]
   ```

9. Now define a table containing points of the form (n^2, n^3) for $n = 1, 2, 3, \ldots, 10$, and plot the points using `ListPlot`.

10. We can give the output pictures names. Type

    ```
    pic1=%
    ```

    to name the last plot `pic1`.

Exercise 3: Plotting the graph of a function

11. Type

    ```
    Plot[Sin[x],{x,0,2*Pi}]
    ```

    to plot $\sin x$ from $x = 0$ to $x = 2\pi$.

12. Plot $\tan x$ from $-\pi/3$ to $\pi/4$.

13. Draw the plot of $y = x^{3/2}$ for $1 \leq x \leq 100$. Name the plot `pic2`.

14. Type

    ```
    Show[pic1,pic2]
    ```

    to show both plots on the same graph.

15. Plot the graphs of the following functions from $x = -2$ to $x = 2$. Give them names as `plot1`, `plot2`, and `plot3`.

    (a) x^3
    (b) 2^x
    (c) e^x

16. Find the inverse functions of above four examples and draw their plots as well. Name these respectively `invplot1`, `invplot2` and `invplot3`. Show each plot of the inverse function with the original function in the same picture. There should be 3 pictures in total.

17. What can you say about the graphs of a function and its inverse? Can you guess how they are related?

Exercise 4: Defining custom functions

18. To define a function $f(x)$ we write

    ```
    f[x_]:=definition
    ```

    Note the 'underscore' after `x` in the left hand side. Type

    ```
    f[x_]:=x^2
    ```

    to define $f(x) = x^2$.

19. Type `f[5]` to check that it gives the correct output of 25. Find $f(345)$ using Mathematica. Remember to use brackets and not parentheses.

20. Define g to be the function $g(x) = x^3 - 2x - 5\sin x$. Calculate $g(2.31)$.

21. Plot the function $g(x)$ from $x = 0$ to $x = \pi$.

22. Make a table of values of $g(n)$ for $n = -10$ to $n = 10$.