STAT 598Z: Homework 3

Due: 26th February 2013

1. This homework will contribute 10 points towards your final score.
2. Attempt as many problems as possible.
3. Only neatly handwritten solutions will be accepted. Alternatively you may use LaTeX to typeset your solutions.
4. Hand in your HW (including print outs of your source code) at the beginning of the class on 26th of February 2013. Additionally source code (if any) should be emailed to `stat598z@gmail.com` **before** the assignments are submitted in the class. No late submissions will be accepted!
5. Program files should be named after the problem (e.g. solution to problem 1 should be problem1.py etc).

Problem 1 (2 pt) Write a Python function `median(b)` which takes as input an unsorted list of integers `b` and returns the median. Test your code on various inputs to ensure correctness. What is the time complexity of your algorithm? Hint: Think about whether you can adopt a quicksort like divide and conquer technique for this problem.

Problem 2 (2 pt) Review the numpy documentation.

- Create a numpy array `x` which contains $(1, \ldots, 15)$ and print it.
- Reshape `x` into the following 5×3 matrix

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \\ 10 & 11 & 12 \\ 13 & 14 & 15 \end{bmatrix}$$

  and print `A`.
- Extract the 1st, 2nd, and 4th row and 1st and 3rd column of `A` into a matrix `B` and print `B`. Multiply `B` by the vector $(3, 5)$ and print the result.
- Reshape `x` into the following 5×3 matrix

$$C = \begin{bmatrix} 1 & 6 & 11 \\ 2 & 7 & 12 \\ 3 & 8 & 13 \\ 4 & 9 & 14 \\ 5 & 10 & 15 \end{bmatrix}$$

and print **C**.

Problem 3 (2 pt) Write Python code using numpy to calculate the mean, std, var, max, and min of an array with shape $(4, 3, 8, 6)$ containing floats drawn from a Gaussian distribution with mean 0 and standard deviation 1.

Problem 4 (2 pt) Write a Python function `f(x)` to compute the value of $f(x) = 2x + 3x^2 + 3\cos x$. Using `fmin_bfgs` from the scipy package `optimize`, compute the minimum of $f(x)$. Using `matplotlib`, produce a plot of the function for $x \in [-10, 10]$. State whether the minimum visible on the plot agrees with the result of `fmin_bfgs`

Problem 5 (2 pt) Write Python functions `f(x)`, `g(x)`, `h(x)` to compute $f(x) = \sin(x)$, $g(x) = \cos(x)$, $p(x) = \tan(x)$. Use `matplotlib` to plot them for $x \in [-10, 10]$. Set the ylimits on all three plots to $y \in [-1, 1]$. Arrange the plots as subplots in a single figure on a single row. Label the x-axes as 'x' and the y-axes as 'sin(x)', 'cos(x)', 'tan(x)' respectively. Give the three subplots the titles, 'sin wave', 'cosine wave', and 'tan wave', respectively. Use `set_position` to adjust the positions and size of the subplots so as to eliminate any overlap between axes and labels from neighboring subplots.