PHY 423/623: Computational Techniques & Programming languages

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Problem Set 2: Due Feb 06, 2018

Note: Name the programs as 'qnxx_yourname.py' where 'xx' is the question number and 'yourname' is your own name. Put all the files a folder named as your name and upload it in the shared google drive folder.

1. The Gaussian function is given by,

$$f(x) = \frac{1}{2\pi a} \exp\left[-\frac{1}{2}\left(\frac{x-m}{a}\right)^2\right]$$

   Write a python function to evaluate it and call the function to find its value for $m = 0$, $a = 2$ and $x = 1$.

2. Write a Python program that prints out a table with Fahrenheit degrees $0, 10, 20, \ldots, 100$ in the first column and the corresponding Celsius degrees in the second column.

3. Write a program that generates all odd numbers from 1 to n. Set n in the beginning of the program and use a while loop to compute the numbers.

4. Write a program that prints a nicely formatted table of t and $y(t)$ values, where

$$y(t) = ut - \frac{1}{2}gt^2$$

   $u = 10$ m/s and g is acceleration due to gravity. Use 20 equally spaced t values through the interval $[0, 2u/g]$.

5. Given $n+1$ roots $r_0, r_1, \ldots, r_n$ of a polynomial $p(x)$ of degree $n+1$, $p(x)$ can be computed by

$$p(x) = \prod_{i=0}^{n}(x - r_i) = (x - r_0)(x - r_i)\ldots(x - r_n)$$

   Write a function *poly(x, roots)* that takes x and a list *roots* of the roots as arguments and returns $p(x)$. Construct a test case for verifying the implementation.

6. Write a program that asks the user to enter the number of seconds as an integer value (use type long, or, if available, long long) and that then displays the equivalent time in days, hours, minutes, and seconds.

7. The Ising model is defined as,

$$\mathcal{H} = -J \sum_{\langle i,j \rangle} S_i S_j$$

where the sum runs over nearest neighbour sites i and j. S_i-s are classical spin variable which can take values ± 1. J is the exchange interaction. Here assume $J = 1$. The thermal average of a quantity A at inverse temperature β $(1/k_B T)$ is given by,

$$\langle A \rangle = \frac{\sum_s A_s e^{-\beta E_s}}{Z}, \quad Z = \sum_s e^{-\beta E_s}$$

where s denote a basis state configuration of spins and the sum is over all possible states. A_s is the value of the physical quantity corresponding to state s and E_s is the energy of the state. **Consider a one dimensional lattice with periodic boundary condition**.

Write a Python program to evaluate avarage values of energy and absolute net magnetization ($|m|$) at a given $\beta \in (0,\ 1.0)$.

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