Project2 (Out of 100)

- Copy the directory "Project2" from /export/home/thf272/ME5013/Fall2014/Project2 into your home directory: $HOME/ME5013/Fall2014/Exercises/InClass.

Task1 - 40 Points: In the Project2 directory there are couple of FORTRAN codes: vecdot.f, sqrmatmul.f. **vecdot.f** takes two 1D arrays (i.e. vectors) and returns "Dot Product" between these vectors. **sqrmatmul.f** performs matrix multiplication between two square matrices $[A]$ and $[B]$. Use Numpy module F2PY to interface these two codes with python. Use 1D and 2D square **random** arrays with different sizes and use these fortran SUBROUTINES from you python code to perform dot product $C = A \cdot B$ and matrix multiplication $C = A * B$. Compare the computational time between this F2PY-Python code and a pure python code (**Without numpy**) by tabulating and plotting the data (example: plotting computational time vs. matrix size, screen shots of code execution from command line etc.).
Hint: Look at the f2py documentation.[1]

Task2 - 40 Points: Solve 2D Laplace's equation $\nabla^2\psi(x,y) = 0$ with BC's: $\psi(x,0) = \psi(x,1) = \sin x$ and $\psi(0,y) = \psi(1,y) = 0$ using Finite Difference Method. Write a **parallel python code** using **MPI**. Plot and tabulate the computational times against different number of processors. Show the $\psi(x,y)$ distribution in the 2D domain using **Gnuplot** or **matplotlib**. Use grid size: 100×100.

Task3 - 20 Points: Write a maximum **2 PAGE** report. Email the PDF file to rezwanur.rahman@utsa.edu with title of email: Project2 by **5 pm, Friday, November** 21^{st}**, 2014**. [2]

Bonus task - 30 Points: Evaluate the integral $I = \int_{-20}^{20} e^{-x^2} dx$ using the function "quad" from **scipy.integrate** and "MPI" . Tabulate your data as follows:

```
#of_processors  #of_slices  #computational_time  #error(%)
```

The $\%error$ is the difference between the analytical value and the numerical value of the integral: $\frac{\|I_{Analytical} - I_{Numerical}\|}{I_{Analytical}} \times 100$.
Add **one page** with the report for the bonus task. So, the PDF file with bonus task **will not** exceed **3 pages**. [3]

[1] http://docs.scipy.org/doc/numpy/user/c-info.python-as-glue.html
[2] Late submissions will not be considered.
[3] Number of processors can be varied between $2 \sim 16$.