Computational Physics **Problem Set 9** **Due 2019/12/17**

Your solutions should include your source codes (without *.exe files), results, and discussions, all in a gzipped tar file, with a file name containing your student number and the problem set number (e.g., r05202043_ps9.tar.gz). Please send your homework from your NTU email account to twchiu@phys.ntu.edu.tw before 24:00 of the due date.

1. **Simulation of 1D real scalar field with Metropolis algorithm**
   Write a C/C++ program to perform the Monte Carlo simulation of one dimensional real scalar field using Metropolis algorithm. In the free field limit, compare your result with the exact solution. With $L = 1000$ and $ma = 0.01$, perform MC simulation and discard the initial 1000 sweeps for thermalization, then generate and save 1000 configurations, with 10 sweeps separation between successive configurations. Using the saved 1000 configurations, measure the scalar propagator for $x = 0$ to 100, and estimate the errors by binning.

2. **Simulation of 1D real scalar field with Hybrid Monte Carlo**
   Write a C/C++ program to perform the hybrid Monte Carlo simulation of one dimensional real scalar field. Repeat the same measurement as in problem 1.

3. **1D real scalar field with $\lambda\varphi^4$ interaction**

   Repeat problems 1 and 2 with $\frac{\lambda\varphi^4}{4!}$ interaction term for $\lambda = 0.4$. Now the exact solution does not exist. Convince yourself that your results are indeed correct.