Homework 10: Applications of the Metropolis Algorithm

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1 Question 1: Metropolis Algorithm

In this question I used metropolis algorithm to sample $2x$.
I proposed the values of x from 0 to 1 using drand function.
The immediate next path values was taken in the range plus minus 0.1 about current x.
We can see the xvalues lies between 0 and 1 in the file xvalues.dat.
I used 20 bins of 25 time steps and created 4 data segments. There is also initial bin values and initial xvalues data file. I chose 1000 walkers and nstep is 100.

I plotted the graph of sample points in the bins which is hw10qn1a.eps.
The animated pictures (gif files) of sample paths and xvalues was also created.
Executing the program hw10qn1.f90 gives output data files hw10qn1.dat and xvalues.dat.
Running xvalues.gp gives 4 png images and using website gifmaker.me I created the gif file xvalues.gif. And I did similar for the samplePath.gif.

The solution directory is :

```
location             : hw10/qn1/
source code          : hw10qn1.f90
datafiles            : hw10qn1.dat,initial.dat,xvalues.dat,initialbinvalues.dat
gnuplot file         : xvalues.gp, samplePath.gp
plots                : hw10qn1a.eps
animated graphics    : samplePath.gif, xvalues.gif
```

The figures are shown below:

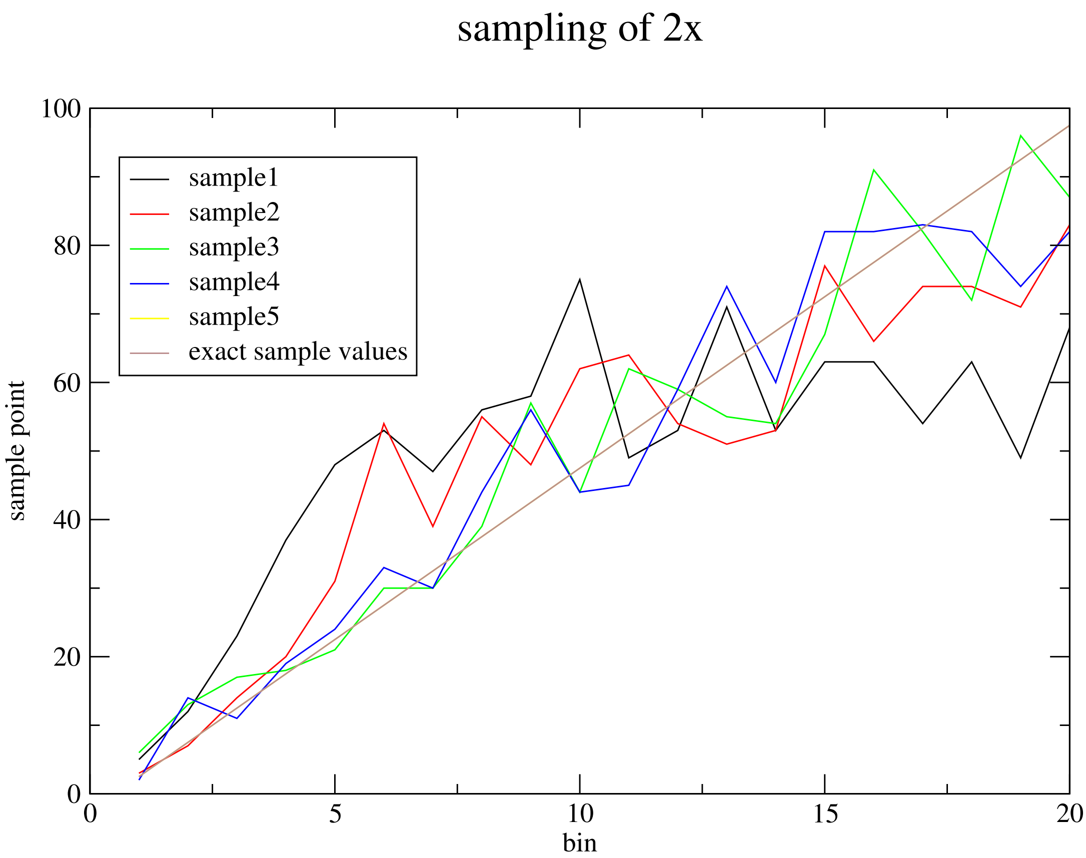

Figure 1: sampling of $2x$

2 Question 2: Lattice Path Integration

In this part I solved the ground state probability for the $1D$ Harmonic Oscillator via Feynman path integration using the Metropolis algorith.
Here, I translated the code qmc.java into hw10qn2.f90 and variables and paramter names are same as in the given book.
I examined some of the actual space-time paths in the simulation. While comparing with classical trajectory, the path was found similar. Here in the code I chose max value is 250000. We can get a more precise value of wavefunction by taking this value larger.

The plot shows wavefunction is gaussian and is similar to classical trajectory.

The solution directory is :

```
location            : hw10/qn2
source code         : hw10qn2.f90
datafiles           : hw10qn2a.dat,hw10qn2b.dat
plots               : hw10qn2a.eps,hw10qn2b.eps
hints               : qmc.java (Landau 2E , chap 28.1.3)
```

The figures are shown below:

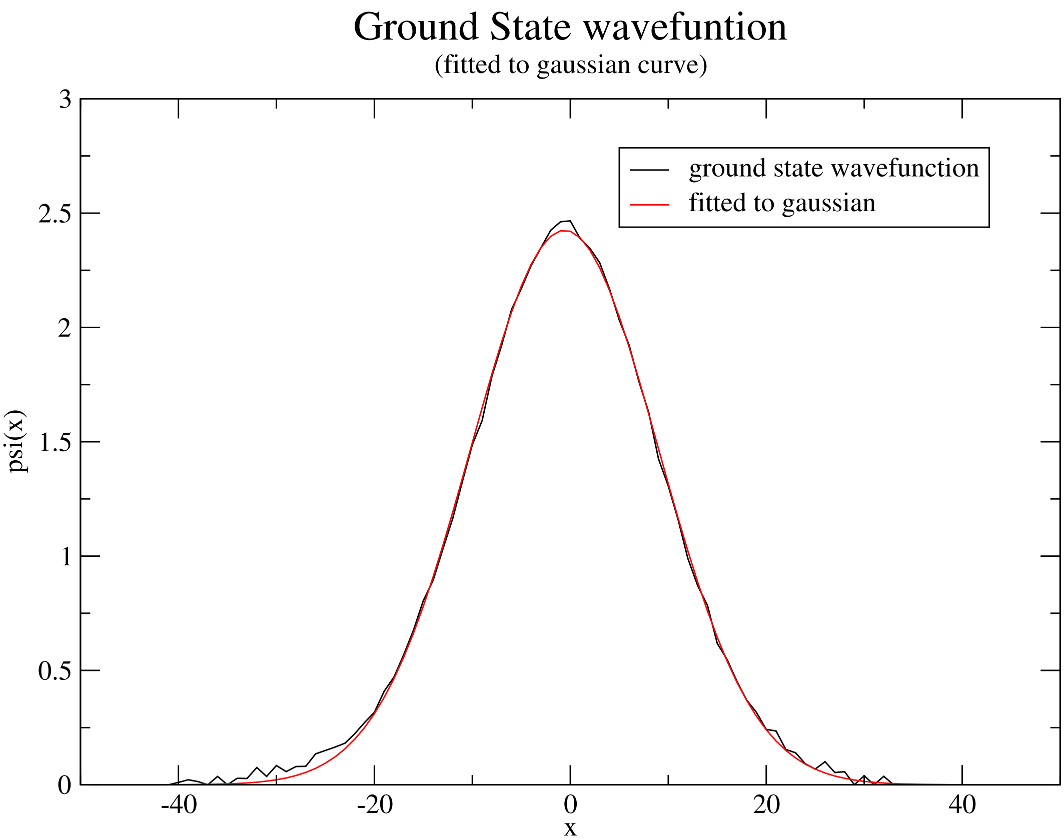

Figure 2: ground state wavefunction

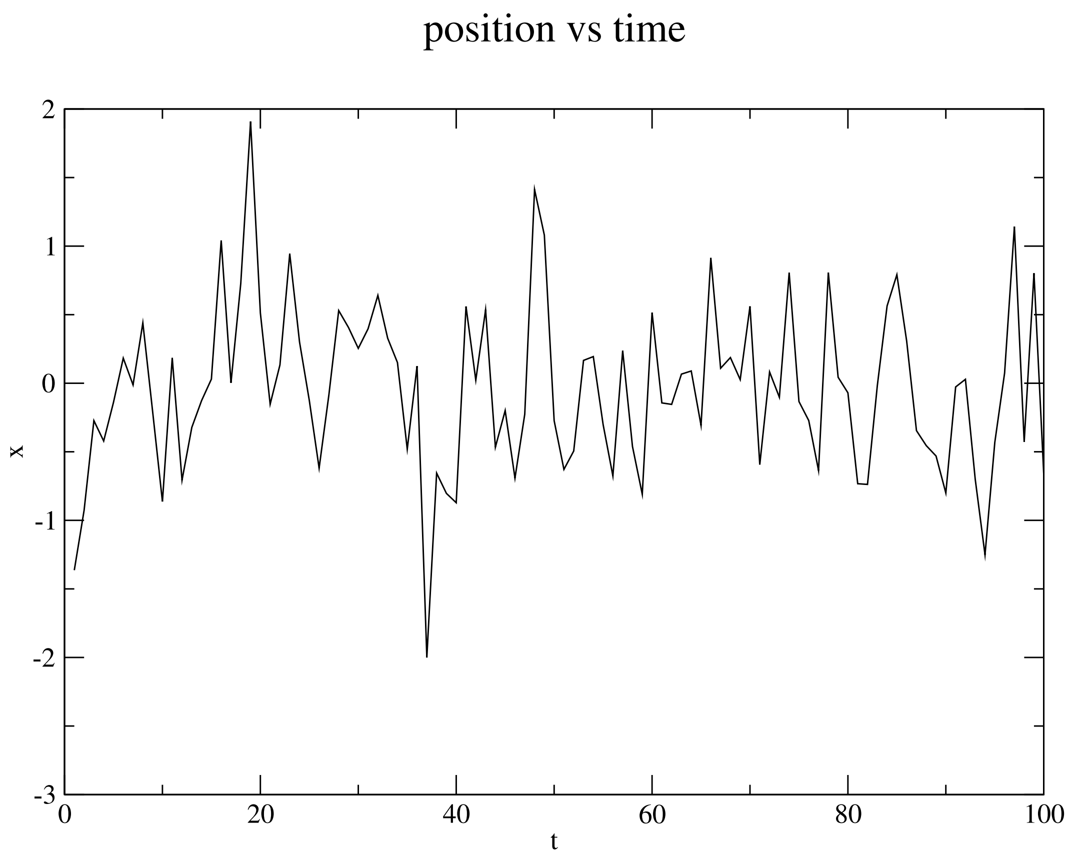

Figure 3: position vs. time

3 Question 3: Gravitational Potential

In this question I tested the wave function computation for the gravitational potential. Here, I modified the energy value of the code hw10qn2.f90 and got the appropriate energy value. I plotted the graph for wavefunction and position-time. Which can be seen below. The solution directory is :

```
location            : hw10/qn3
source code         : hw10qn3.f90
datafiles           : hw10qn3.dat
```

The figures are shown below:

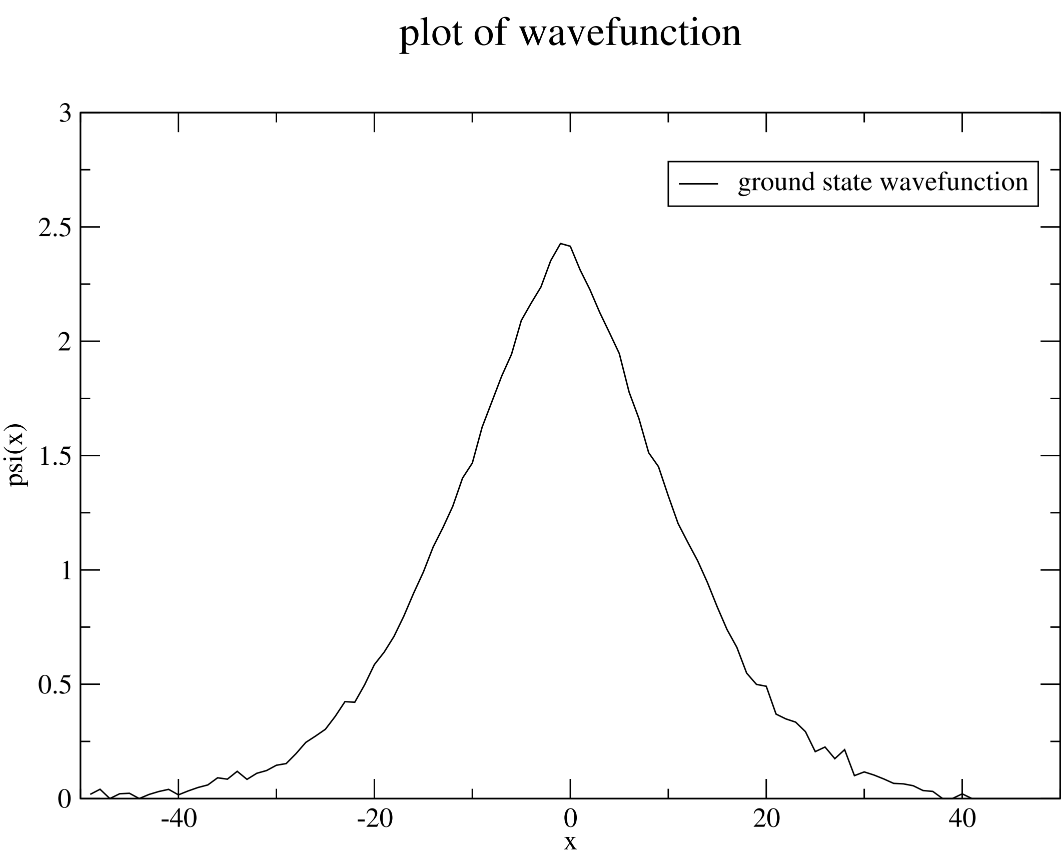

Figure 4: ground state wavefunction

The figures are shown below:

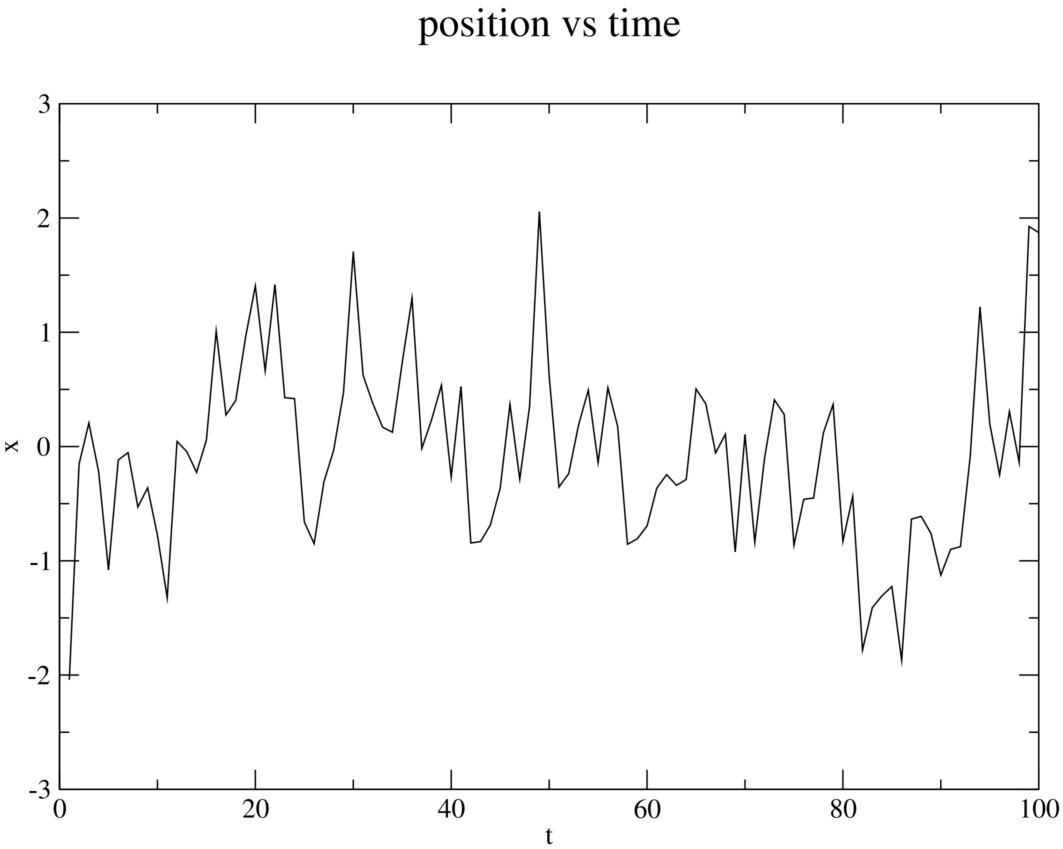

Figure 5: position vs. time