2411 Project 6

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1 Analytical Solution

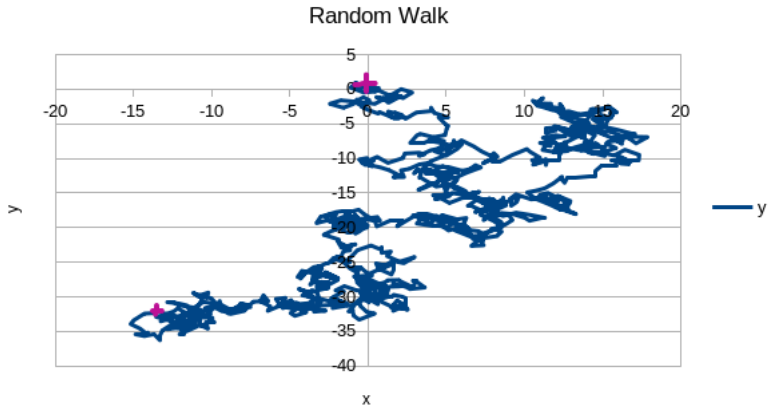
It is expected that a simple stochastic process like this will have radial displacement at step i of $\overline{\Delta r}\sqrt{i}$.

2 Numerical Method

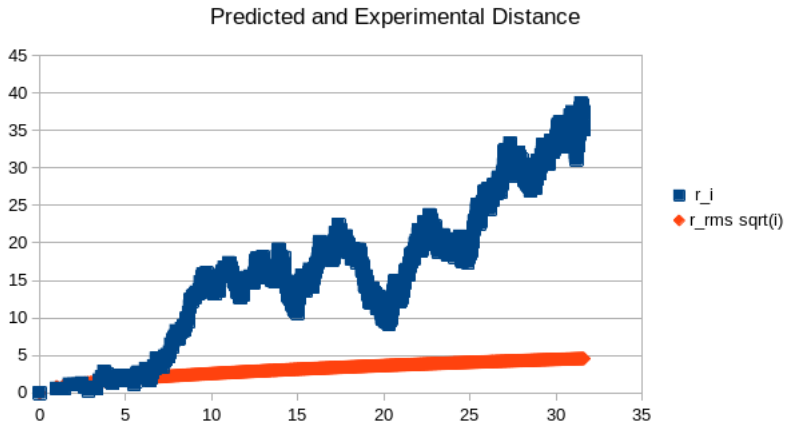
We use the Linux `drand48()` fuction seeded with the value 42 to compute the step for a walk of length 1000, implemented in C++.

3 Program Analysis

The program written appears in the script files. The resulting plot of the random walk appears below, showing precisely the standard Brownian motion qualitative behavior.



A plot of the real displacement versus the expected value appears below. It is evident it is followed approximately initially, and eventually diverges from it.



After the program has completed, the average displacement is 0.815 meters on each step. This corresponds to an approximate total distance travelled of $r_{rms}N = 815$ meters. The actual distance away from the origin, on the other hand, is 19 meters. The first is clearly much larger, and so this is clearly not a terribly efficient form of travel.

4 Script Files

```
Script started, file is dwilk14_proj6p1.txt
[dwilk14@tigers ~/Project6]$ cat dwilk14_proj6p1.cpp
#include <fstream>
#include <iostream>
#include <cmath>
#include <cstdlib>

using namespace std;

int main() {
  ofstream out1, out2;
  out1.open("output1.txt");
  out2.open("output2.txt");

  int n = 1000;
  double x = 0, y = 0, stepsum = 0;
  srand48(42);

  out1 << "x, y" << endl;
  out2 << "sqrt(i), r_i" << endl;
  cout << "Average step size: " << endl;
```

```
  for (int i = 0; i < n; i++) {
    out1 << x << ", " << y << endl;
     out2 << sqrt(i) << ", " << sqrt(pow(x, 2) + pow(y, 2)) << endl;

    double stepx = 2 * drand48() - 1;
    double stepy = 2 * drand48() - 1;
    stepsum += pow(stepx, 2) + pow(stepy, 2);
    x += stepx;
    y += stepy;
  }

  cout << sqrt(stepsum / n) << endl;

  return 0;

}
[dwilk14@tigers ~/Project6]$ g++ dwilk14_proj6p1.cpp -o dwilk14_proj6p1
[dwilk14@tigers ~/Project6]$ ./dwilk14_proj6p1
Average step size:
0.815514
[dwilk14@tigers ~/Project6]$ cp dwilk14_proj6p1.txt /home3/kristina/phys2411/.
[dwilk14@tigers ~/Project6]$ exit
exit
Script done, file is dwilk14_proj6p1.txt
```