Computational Physics Homework 3

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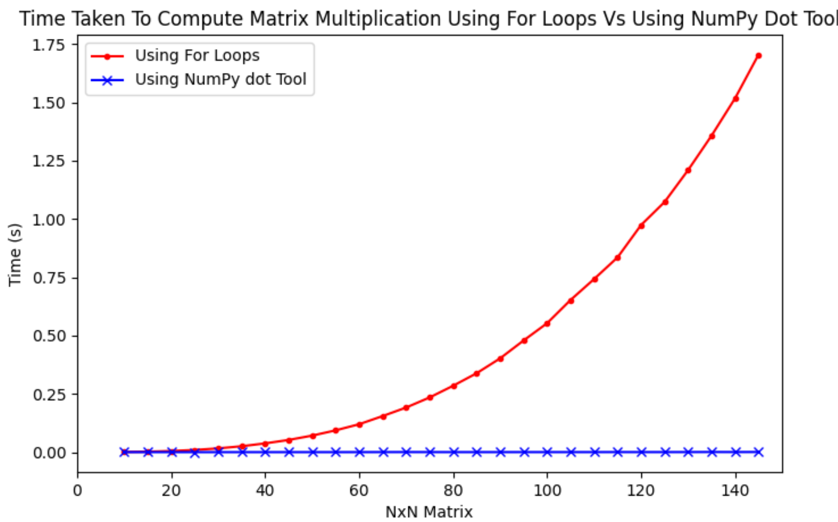
1 Abstract

This problem set looks at more types of mathematical and physical problems and how to solve them in ways that optimise computation, illustrated by computing derivatives, matrix multiplication and radioactive decay. errors.

2 Problem 1

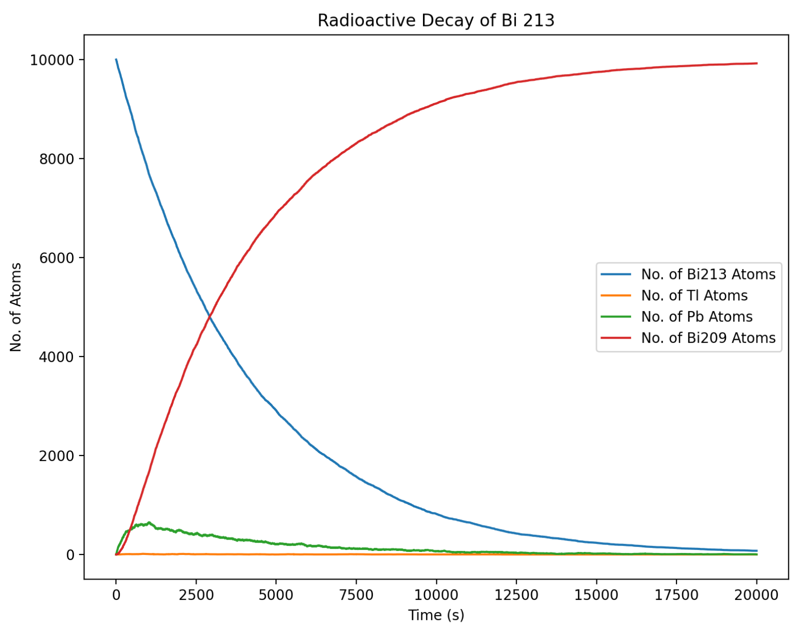
This problem uses the case of matrix multiplication to show how much better different methods can be at optimizing computind speed and efficiency. Using a for loop then the NumPy dot tool to do the computation and measuring the time each takes at varying matrix sizes shows a stark difference in computation time for each method.



The time taken using for loops rises proportionally to N^3 whereas the computational time using NumPy's dot tool is negligible.

3 Problem 2

Problem 3 was more tricky than it initially appeared. The problem looks at the radioactive decay of Bi 213 into its decay products using the radioactive decay equation, using their half-lives to create a probability that an atom has decayed at a given time. My first approach was to just create a function that models the decay of each particle based on the decay equation and each particles respective half life and plotting the function, however, keeping track of the decay products and mapping where they go at a given time made it tricky given that there is always the same number of particles at any time and they do not just disappear as a function alone makes it look. To get past this I had to make a number of arrays that would be appended each time a decay occurred, either increasing or deceasing in value as a particle decayed to or from the isotope at any time.

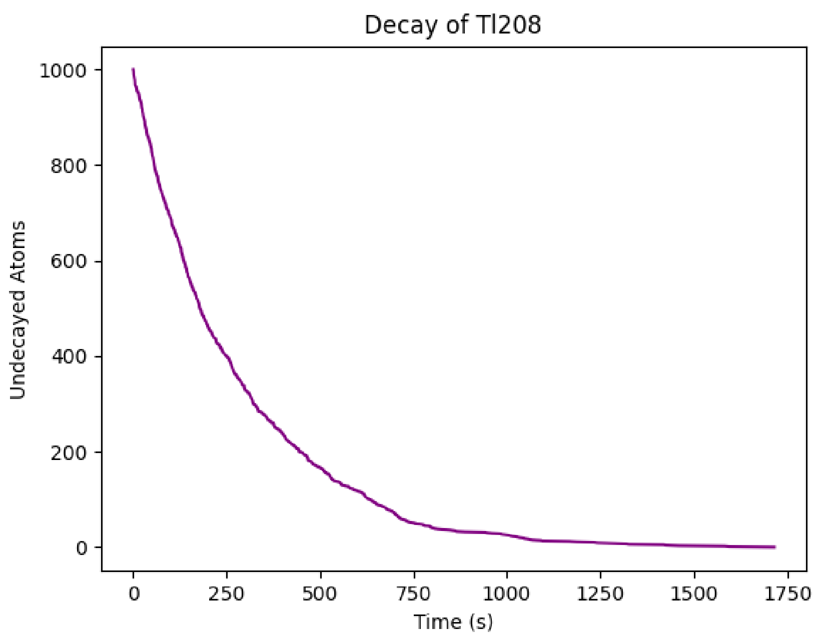


4 Problem 3

This problem looked at another way of modelling radioactive decay computationally. By creating an array of uniformly distributed random numbers, then using the transformation method to turn them into a non-uniform distribution, distributed exponentially using the equation

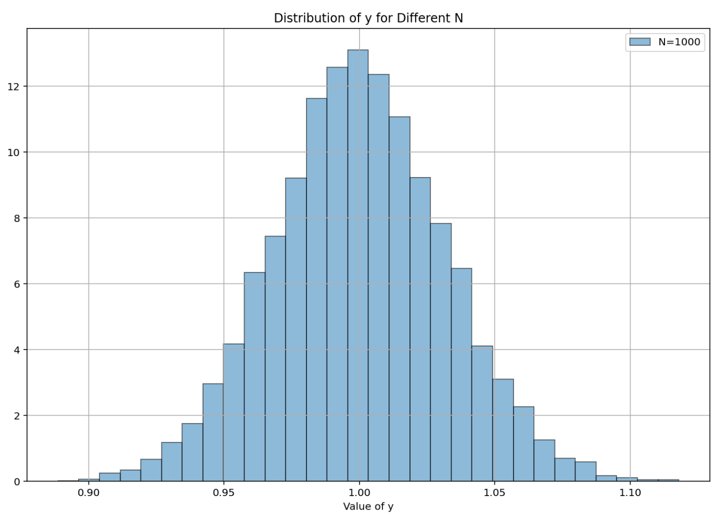
$$x = -(1/mu)ln(1-z)$$

to represent decays, I created the following model of the decay of Tl 208.



5 Problem 4

The purpose of this problem was to demonstrate the central limit theorem.


Distribution of y for Different N
N=1000
0
2
4
6
8
10
12
0.90
0.95
1.00
1.05
1.10
Value of y