

SHPC4001 - Assignment 8

Due 13/05/21

Part 1

Clone the assignment files from:

<https://github.com/Edric-Matwiejew/Cython.git>

1. Using the cython examples as reference, cythonize the module 'PyQuantumWalk' to create a faster C-extension module 'CyQuantumWalk'. (2 Marks)

As a suggested order:

- * Identify scalar variables to statically type
- * Convert constant length arrays into static C arrays
- * Experiment with the dynamic allocation of C arrays

Report the speed up of your final Cythonized module.

Note: Marks will be awarded based on the reported speedup - or the variety in your usage of the Cython programming language.

2. Do you think the code in PyQuantumWalk is a good candidate for parallelism? Justify your position, present the problem or a parallel solution. (2 Marks)

Background Information

'PyQuantumWalk' is a module simulating the discrete-time quantum walk of a 1/2-spinor a line (or path) graph.

https://en.wikipedia.org/wiki/Quantum_walk

Loosely speaking,

- a. If the spinor is spin down, $[1,0]$, it moves to the left.
- b. If the spinor is spin up, $[0,1]$, it moves to the right.
- c. If the spinor is in a superposition, it will move both left and right.

At each step the spinor:

- i. Is put into an equal superposition at each of the line nodes (where it has probability density).
- ii. Moves from that node following rules (a) to (c).

Changes to the code using Cython should not interfere with the algorithm's logic, the output should remain the same.

Part 2

3. The n-dimensional unit-sphere is an object whose parameters satisfy: $x_1^2 + \dots + x_n^2 = 1$ With reference to,

https://en.wikipedia.org/wiki/Monte_Carlo_integration#Overview,

and

https://en.wikipedia.org/wiki/Algorithms_for_calculating_variance#Welford's_online_algorithm,

Develop a parallel algorithm capable of calculating the volume of an n-dimensional unit sphere (at least) up to $n=10$. Outline your algorithm using a program flow chart.

Implement this algorithm so it can solve up to (at least) $n=10$.

Plot the performance of your package as a function of thread count, and target variance, comment on the success of your algorithm in terms of its speed and accuracy. (6 marks)

(Assignment Total Marks: 10)