

Lab 6 Documentation

Statement

Given a directed graph, find a Hamiltonian cycle, if one exists. Use multiple threads to parallelize the search. The search should start from a fixed vertex (no need to take each vertex as the starting point), however, the splitting of the work between threads should happen at several levels, for all possible choices among the neighbors of each current vertex.

Sequential algorithm:

Starting from a fixed vertex: 0 we go through the neighbours of this vertex and check if we visited all neighbours and we can go back to the starting vertex. We stop as soon as we get a solution.

Parallel algorithm:

The parallel algorithm is similar to the sequential one with the exception that for the starting index we divide the parsing of the neighbours through the 8 threads, which improves the times. We avoid doing this all the time, because as the depth grows the overhead of creating so many threads is not beneficial for the performance.

For the parallel one, we use an atomic boolean to check if we found a solution, and for the path we do not need synchronisation mechanism (which would make the algorithm linear), because we create copies of the paths such that we can backtrack in the case of unsuccessful search.

Performance Measurements (time measured in milliseconds):

- For 500 vertices:

```
Found a solution: [0, 3, 4, 1, 2, 6, 5, 10, 7, 8, 12, 9, 11, 13, 20, 18, 14, 15, 17, 16, 21, 25, 23, 19, 24]
Sequential Time: 495
Found a solution: [0, 85, 4, 1, 2, 6, 3, 11, 9, 7, 5, 10, 12, 13, 20, 18, 14, 15, 17, 8, 16, 21, 25, 23, 19, 24]
Parallel Time: 881
```

- For 1000 vertices:

```
Found a solution: [0, 3, 1, 2, 4, 5, 7, 6, 8, 9, 10, 11, 14, 15, 12, 16, 13, 19, 18, 23, 17, 20, 25, 27, 26]
Sequential Time: 323
Found a solution: [0, 110, 1, 2, 4, 5, 3, 9, 6, 7, 12, 16, 8, 10, 11, 14, 15, 13, 19, 18, 23, 17, 20, 25, 26]
Parallel Time: 340
```

- For 2000 vertices:

```
Found a solution: [0, 1, 4, 2, 3, 8, 6, 7, 13, 9, 14, 17, 11, 15, 22, 16, 10, 12, 5, 18, 28, 19, 20, 21, 24, 26]
Sequential Time: 2002
Found a solution: [0, 1828, 1, 4, 2, 3, 8, 6, 7, 13, 9, 14, 17, 11, 15, 22, 16, 10, 12, 5, 18, 28, 19, 20, 21, 24]
Parallel Time: 1359
```

- For 3000 vertices:

```
Found a solution: [0, 2, 1, 8, 11, 15, 5, 9, 10, 4, 6, 7, 16, 13, 17, 3, 14, 18, 19, 21, 12, 20,  
Sequential Time: 7166  
Found a solution: [0, 2760, 1, 8, 11, 15, 2, 3, 6, 7, 4, 18, 5, 9, 10, 14, 21, 12, 19, 22, 16, 13  
Parallel Time: 4784
```