Minimum Spanning Tree Algorithms Comparison and Analysis

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Abstract
Graph Theory is a common study of graphs in computer sciences and mathematics fields.
One of its well-known problems is finding the Minimum Spanning Tree(MST). A minimum spanning tree is a spanning tree of a connected, undirected graph which connects all the vertices together with a minimal total weight for its edges. In 1926, Czech mathematician Otakar Borůvka found the first algorithm of finding MST. As a matter of fact, there has been many algorithms invented since then. In this project, we will evaluate three existing algorithms by the following steps: first, modify the original code of three algorithms to make their input data types the same; second, run all of them on the same computer architecture -O3 -march=native; lastly, compare their performance based on access pattern, cache misses and execution time etc. The three algorithms we will use are Prim's Algorithm, Kruskal's Algorithm and Borůvka's algorithm.

Keywords MST, Kruskal, Prim, Boruvka, Architecture, Performance

I. Introduction

Minimum Spanning Tree (MST) is a subset of E of a undirected graph G = (V, E) that has minimum weight. MST is commonly used algorithm in many fields. In this project, we are going to use three algorithms: Kruskal‘s algorithm, Boruvka’s algorithm and Prim’s algorithm to compare their performances, in detail, cache misses and execution time etc in the same computer architecture. We will input the data in the same format for these three algorithms. Then, evaluate these algorithms in the same graph so that we can see the differences between these three.

II. Related Work

We haven’t found out any similar work yet.

III. The Algorithm

A. Boruvka’s Algorithm

Boruvka’s algorithm is used to find a minimum spanning tree in a graph that all edge weights are distinct. It was first introduced in 1926 by Otakar Boruvka. Similar to Kruskal’s algorithm, Boruvka first examines each vertex, then adds the cheapest edge from that vertex to another, continues grouping all edges into MST until all vertices are completed.

B. Prim’s Algorithm

Prim’s algorithm aims to find a minimum spanning tree for a weighted undirected graph. It was developed in 1930 by Czech mathematician and republished by Robert C.Prim in 1957. It runs in O((V+E)logV) time. This algorithm builds the tree by adding data at the subset of edges including every vertex,where the total weight is minimized. It operates from one starting vertex, continually adds the cheapest possible connection from the tree to another vertex.

C. Kruskal’s Algorithm

Kruskal’s algorithm is similar to Prim's algorithm. They both add an edge to the MST. However, Kruskal is different. It builds the MST in forest. Each vertex is in its own tree, then each edge is ordered by increasing weight. If an edge is connected between two different trees, (u,v) is added to the set of edges, and these two trees will be merged into a single tree. If (u,v)connects in the same tree, (u,v)will be discarded.

IV. Experimental Results

Undecided

V. Alternative Parallelization Approach

Reference