Negative Cost Girth Problem Using Map-Reduce Framework

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Research

Keywords: Map-Reduce, Parallelism, Negative Cost Girth, Sequential, Message Passing Interface

Posted Date: June 8th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-508147/v1>

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Abstract

On a graph with a negative cost cycle, the shortest path is undefined, but the number of edges of the shortest negative cost cycle could be computed. It is called Negative Cost Girth (NCG). The NCG problem is applied in many optimization issues such as scheduling and model verification. The existing polynomial algorithms suffer from high computation and memory consumption. In this paper, a powerful Map-Reduce framework implemented to find the NCG of a graph. The proposed algorithm runs in $O(\log k)$ parallel time over $O(n^3)$ on each Hadoop nodes, where n, k are the size of the graph and the value of NCG, respectively. The Hadoop implementation of the algorithm shows that the total execution time is reduced by 50% compared with polynomial algorithms, especially in large networks concerning increasing the numbers of Hadoop nodes. The result proves the efficiency of the approach for solving the NCG problem to process big data in a parallel and distributed way.

Full Text

This preprint is available for [download as a PDF](#).

Figures

Figure 1

Map and Reduce phases in the proposed algorithm based on Map-Reduce

Figure 2

Details of equation 3

Figure 3

A sample graph with negative cost girth

Figure 4

Number of operations when a) $k = 0:25:n$, b) $k = 0:5:n$, c) $k = 0:75:n$

(a)

(b)

(c)

(d)

Figure 5

Execution time when a) $k = 0:25:n$ b) $k = 0:5:n$ c) $k = 0:75:n$ d) $k = 1:n$

Figure 6

Speedup according to Amdahl's Law