GT ASSIGNMENT 3

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# A Novel Approach for Detecting Relationships in Social Networks Using Cellular Automata Based Graph Colouring

# Introduction

All social networks can be represented by a graph G = [V, E] where V represents the vertices of the graph and E represents the set of edges connecting the vertices of the vertices of the graph. In this graph, in comparison to a social network, each person represents a vertex and the relationship between two people on a social network can be represented by an edge of the graph. The complement of graph G can be represented by graph G’ = [V’, E’] where V’ represents vertices not connected in the original graph G and E’ represents the complement of set of edges E of graph G.

Every social network represented as a graph can be assigned into groups where each member of the group has the same or similar features. The goal of this paper was to find a faster way to detect or visualise these groups and minimize their representation by colours. The authors of the paper utilize a novel cellular automat methodology for finding these groups and in the process, introduce a new graph colouring algorithm. Graph colouring is the task of labelling the components of the graph by a specific colour with given constraints such that the entire graph can be coloured with minimum colours. Vertex colouring is a type of graph colouring problem such that a vertex can be assigned a specific colour such that none of its neighbouring vertices have the same colour. Likewise, edge colouring is a type of graph colouring such that two adjacent edges fail to have the same colour. Graph colouring is used in many fields like biochemistry, electrical engineering and network engineering. An example of using graph colouring for resource allocation would be optimizing the exam time table problem.

# State of the art

Various studies have been conducted for analysing social networks using graph colouring. In 2011, a heuristic algorithm based on any graph G and its complement G’. The study analysed the number of friendships in a social network using complementary graph colouring. Graph colouring is also utilized in clustering properties and data. In 2018, a study attempted to develop a decentralized graph colouring approach. The main idea was the local conflict index which measures the local colour conflicts arising at each node. It can easily be computed using local node information.

In 2014, a study presented three methods for identifying the users on social networks based on their data entry process. The first method relied on the time at which the user was admitted into the network. The second method relies on what pages the user visits. The third method was an ensemble of the first two methods. Artificial neuro-fuzzy networks have been utilized in analysing emotions and behaviour on social networks. Emotions and behaviour on social networks act as key indicators of friendships on social networks. In 2017, a hybrid approach of graph colouring and ACO (Ant Colony Optimization) based summarization was used in social networks to get powerful brief comments without reading the entire list. The purpose of graph colouring in this study was to shrink the solution area such that the search process is more facilitated. The algorithm after utilizing the ACO LS STS algorithm returned the summary with the best colour.

# Proposed solution

The authors of this study implemented their algorithm using the concepts of complementary graphs, which was extracted from the original graph, and cellular automata. Cellular automat is used to colour the graph. The number of colours utilized denote the number of groups formed within the social network, represented as a graph. Key points about the algorithm are:

1. All vertices must be coloured.
2. Vertices sharing the same colour should not be juxtaposed.
3. The minimum number of colours must be used.
4. Initially all vertices are assigned colour 1
5. The value of vertex n is set colour 2

In case vertex n shared the same colour with vertices 1 or n-1, the colour is incremented at vertex n. Step 3 is repeated until all graph vertices had unique colours, in comparison to their neighbours.

# Results

The proposed algorithm is demonstrated on three graphs which simulate social networks. The graphs had 100, 500, and 2000 vertices respectively. The number of colours utilized in these graphs are 20, 100 and 400 respectively.

The algorithm was then compared to greedy based approach and random colouring algorithms on Facebook-like social network and Facebook-like forum network graph. The social network graph consisted of 1899 vertices with 20296 edges while the forum network graph consisted of 899 vertices and 142760 edges. On the Facebook-like social network, the greedy, random and proposed algorithm used 11, 18 and 10 colours respectively while running for 1.30s, 1.08s and 1.01s respectively. On the Facebook-like forum network the greedy, random and proposed algorithm utilized 126, 126 and 123 colours respectively and had a runtime of 1.30s, 1.30s and 1.21s respectively. From the results comparison it is clear that that proposed algorithm is not only faster than the greedy and random colouring based approach but it also utilized lesser number of colours.

# Conclusion

In this study, social networks were represented by graphs and their complements were calculated. The number of complement graph colours represent the number of subgroups in a social network was measured using the prosed algorithm. The objective of this study was to minimize the running time of graph colouring and the colours used utilized. The results on the simulated graphs and data from social networks prove that not only the proposed algorithm can run faster, it also provides an optimal solution to the problem. The proposed algorithm outperforms greedy colouring and random colouring in terms of colours and run time.