Detecting Communities through Connected Components in Large Graphs using MapReduce

SE256 Course Project

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Outline

1. Community Detection
   - What is community?
   - Problem
2. Traditional Algorithms
   - Girvan-Newman Algorithm
   - BGLL Algorithm
3. Enumerating SCC
   - Strongly Connected Components
   - Bi-Directional Label Propagation Algorithm
   - Correctness
4. MapReduce Implementation
   - Edge Counter
   - Adjacency Lists
   - Adjacency Lists Reversed
   - Label Propagation
   - Merger
   - Combiner

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- Problem: How to identify such a part of the graph? It depends on how we quantify the notion of "dense". Visual check of the graph is not enough, and can sometimes be misleading. Also, such regions in the graph can be nested.

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- 4. Steps 2 and 3 are repeated until no edges remain.

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- The algorithm then goes back to the first phase to iterate until the modularity cannot be increased any further.

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Strongly Connected Components

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- Step: 1. Positive Label Propagation (PLP)
  (1) Initialize the positive labels of all vertexes with the vertexs identifier and set t=1;
  (2) The vertex sends its label to adjacent vertexes along the directed edge.
  (3) If the minimal positive label of the received labels is smaller than vertexs label, update the vertexs label with the minimal positive label
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- Step: 2. The original network is reversed. This means that all directed edges are turned the other way.

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- Step 3. Negative Label Propagation
  On this reversed graph negative label propagation (NLP) is performed. This is the same as the PLP however the labels assigned are given a negative value and the negative label only starts from minimal vertexes which marked in PLP.

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  Vertexes with the same positive and negative labels are collected and these constitute a strong connected component.

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- Because every vertex can reach each other via the root vertex, reduce step outputs strongly connected components.

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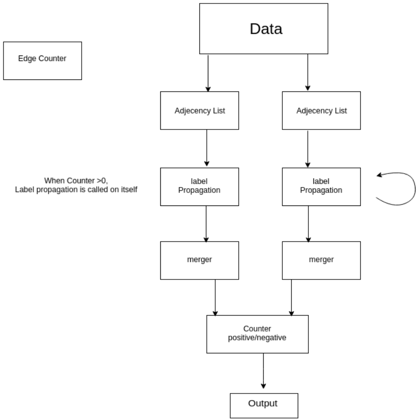

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  $< \text{key} = \text{user}, \text{value} = \text{follower} > \rightarrow < \text{key} = \text{"Count"}, \text{value} = 1 >$
- Reducer outputs the sum of the counts.

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- Reducer finally emits user as key and (a positive label + list of followers) as value.

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- Reducer outputs follower as key, (negative userid + list of users as key)

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- In the Reducer, everything is grouped together on the basis of ID. For each ID, the minimum absolute value of the label is chosen.
- The Reducer output is in the format of userid, positive or negative label, and the adjacency list.Since label propagation is iterative, input to mapper and output of reducer should be similar.

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- The Merger Reducer essentially groups users by their label and outputs this label as the key and a list of corresponding users with a , separator as the value.

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- For each user as key, the label is emitted as key together with the value as the user.

References

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Thank you.