



Knight Foundation  
School of Computing  
and Information Sciences

# Knight Foundation School of Computing and Information Sciences

Fall 2022 Senior Design Project

## Analyzing Biological Networks

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### PROBLEM

Cytoscape is a bioinformatics software that allows researchers to graph networks and interact with them by using built in & third-party plugins to add functionality to the program. The current design of the CyFinder project is a plugin that gives users the ability to perform many types of clustering, pathfinding, and other algorithms over these complex biological networks.

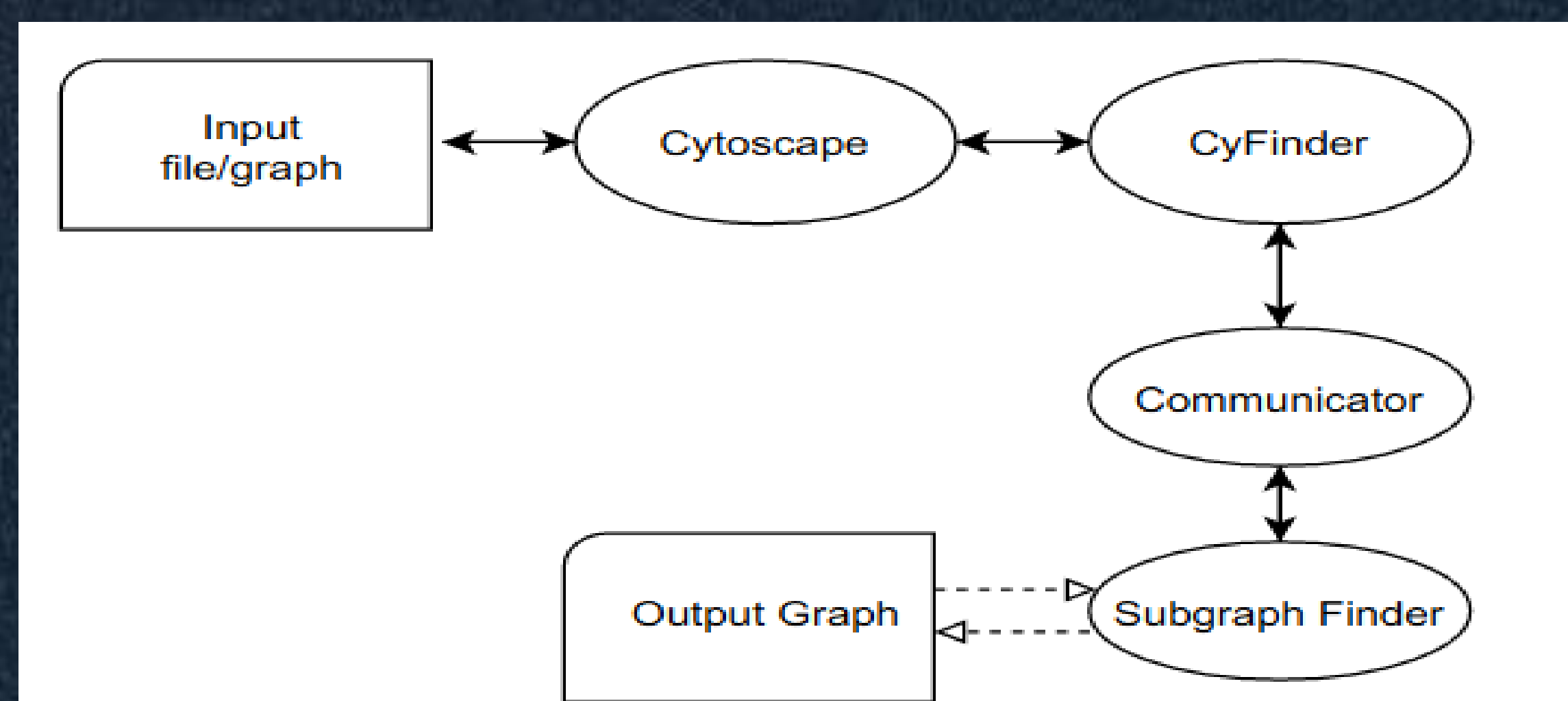
The focus of the project is to expand on the algorithms implemented in the CyFinder plugin, adding more community detection algorithms as well as fixing bugs, UI, and edge-case errors to improve the overall functionality of the plugin.

### CURRENT SYSTEM

The current system design of the CyFinder plug-in allows users or researchers to capture imported graphs directly or in no direction to be used within the Cytoscape interface or within the command-line interface implemented within the Subgraph Finder project.

From the current system, we ended up implementing map equation, Huffman coding techniques, and Infomap community detection algorithm into the backend of the Cyfinder plugin.

### SYSTEM DESIGN



### VERIFICATION

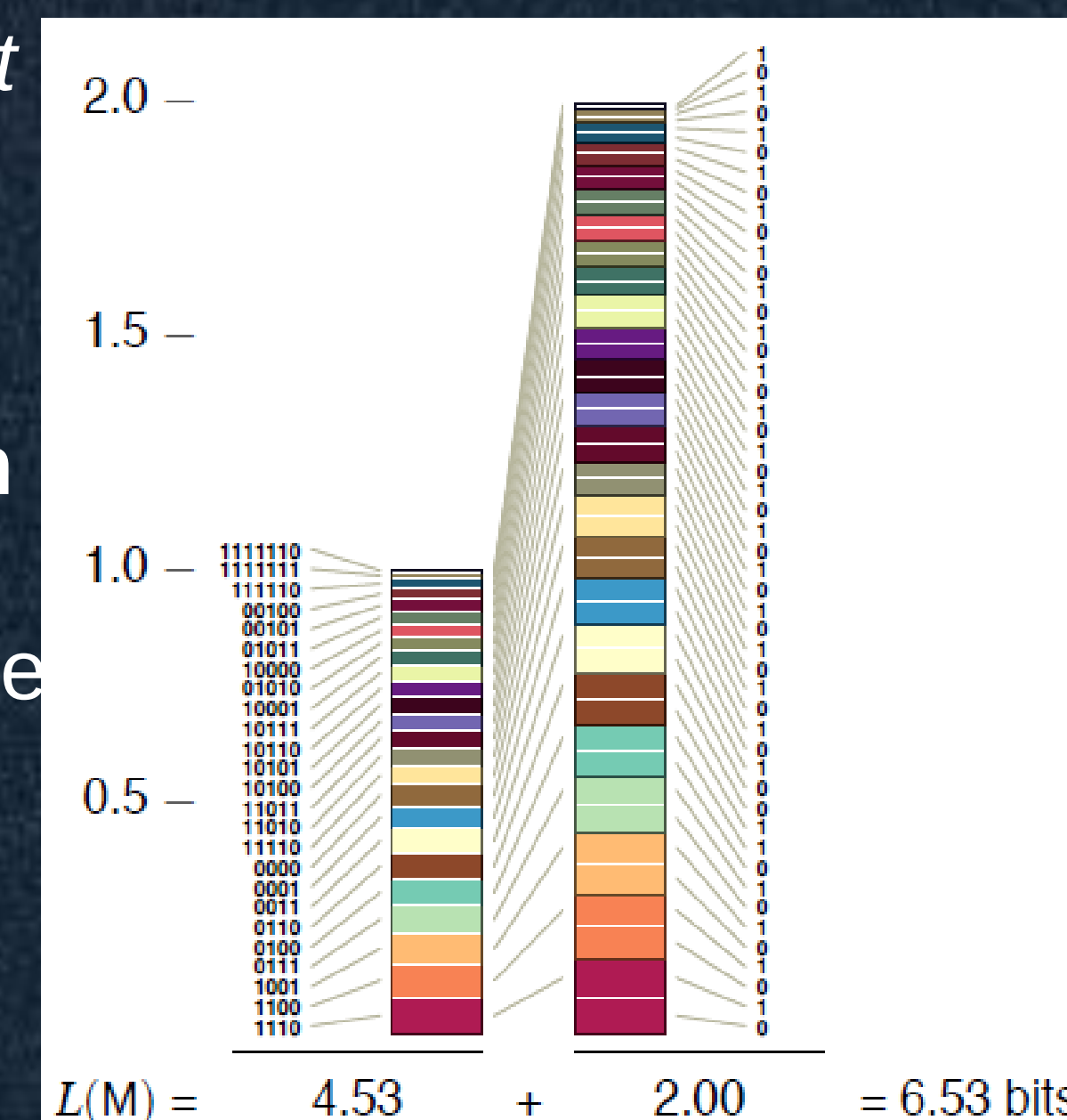
$$L(M) = q \sim H(Q) + \sum_{i=1}^m p_i \sim H(P^i).$$

Map Equation Verification:

- From the red term of the map equation indicates average number of bits necessary to describe movement **between** modules, which multiply of per step probability and entropy of movement between modules.
- From the blue term of the map equation indicates average number of bits necessary to describe movement **within** modules, which multiply of fraction of within-module movement and entropy of movement within modules.

Example of expected output visualization of the Map equation:

- Left-hand side: average bits movement **between** modules(4.53).
- Right-hand side: average bit movement **within** modules(2.00).
- Total average bit length  $L(M) = 6.53$  bits



### SUMMARY

- Researched & contributed on Map equation by interpreting original and expanded Map Equation.
- Provided resources and assisted in implementing Map Equation, for undirected graphs.
- Support other Subgroups with other User Stories.

### REQUIREMENTS

**Hardware:**

- There is no hardware requirement for this project.

**Software:**

- Java 11.0 & Maven
- Eclipse IDE (the latest version)
- Apache Ant
- Cytoscape API
- Cytoscape 3.8.0

**Version Control:**

- GitHub (<https://www.github.com>).

### IMPLEMENTATION



**Java 11.0**

Main language used to implement overall project.



**Maven**

Combined the logic with the GUI to generate JAR.



**Apache Ant**

Responsible for building the project that contains the logic of CyFinder.



**Cytoscape 3.8.0**

Software for visualizing networks & community detection algorithms.

### REFERENCES

- Rosvall, M., Axelsson, D., & Bergstrom, C. T. (2009). *The map equation*. The European Physical Journal Special Topics, 178(1), 13–23. <https://doi.org/10.1140/epjst/e2010-01179-1>
- Rosvall, M., & Bergstrom, C. T. (2007). *Maps of Random Walks on Complex Networks Reveal Community Structure*, 1118–1123. <https://doi.org/www.pnas.org/cgi/doi/10.1073/pnas.0706851105>

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### ACKNOWLEDGEMENT

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