HI 193.1 Activity: Recreation of *Generating Phenograms using Frequent Structure Mining Over Metabolic Pathways*

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***Abstract*—The purpose of this activity is to recreate Osorio's paper on phenogram generation to explore the topological similarities of different taxa using their glycolysis and citrate cycle networks. The group presents the phenograms generated using the Jaccard Similarity Indices and the Hamming Distance. These are then compared with NCBI generated phenograms using Phylip branch matchings and Maximum Consensus Tree.**

***Keywords***— **phenogram,**

1. Introduction

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1. Research Methods

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1. *Constructing FP-Table*

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1. Constructing FP-Table

Using Python, FP-Table is generated from the created sets of taxa.

1. *Creating the table*

An empty list of distinct edges is initialized to serve as a container for the combined edges (tuples) of all taxa in a specific set of taxa. To preserve its uniqueness, duplicate edges are removed. This characterizes the frequent subgraph of a particular graph dataset G.

Let G = {G1, G2, ... Gn}, n = 5, be the set of taxa converted into digraphs. DE is a list of tuples of ordered pairs (A,B) representing distinct edges from the combined edges of Gk.

1. *Assigning bit codes*

Bit codes, say m, are assigned for each distinct edge DEi. Using the bitCheck() method, a value of 1 is returned to indicate the presence of DEi in a particular graph Gj, otherwise a value of 0 is returned. The list of bit codes has a k-length bit. In this case, the bit code list has a length of 5, representing the 5 chosen taxa.

Additionally, upon completing the assignment of bits for each representation of taxa by a distinct edge DE, a temporary element named “parity” with a value corresponding to the frequency of 1’s in a list, is appended at the end of each bit code list for easier sorting.

1. *Sorting FP-Table*

For convenient classification, distinct edges DE are ordered based on the bit code weight determined by the number of 1’s (parity) and its decimal values. Initially, distinct edges DE are classified based on the temporarily appended element parity. It is arranged in descending order of parities. This denotes the clustering of the edges. Secondly, distinct edges DE are sorted based on the decimal-value location of 1’s which are also decreasingly arranged. This represents the classification of the nodes.

Using Python, decimal values for each bit code list are temporarily appended at the end of the list for easy sorting. Both the temporary elements are removed immediately afterwards. Processes involved occur in the method sortTable().

1. *Generating the FP-Table*

The method generateFPTable() is called to return and display the table. It accepts a parameter of type list which contains the list of digraphs (class Taxa) possessing lists of vertices and edges. It is followed by passing the table to sortTable() for the classification and clustering of nodes and clusters. To sum up, the steps followed are specified below:

1.Get the set of taxa converted into digraphs.

2. Obtain distinct edges from all taxa in the set.

3. Derive the bit codes for each distinct edge.

4. Sort the edges according to the weight of the bit codes.

a. Sort by parity to classify Clusters.

b. Sort by decimal values of 1’s to classify Nodes.

1. Deriving the similarity index matrix

Using Python, FP-Table is generated from the created sets of taxa.

1. *Using Jaccard Similarity Index (JSI)g the table*

An empty list of distinct edges is initialized to serve as a container for the combined edges (tuples) of all taxa in a s

1. *Using Hamming Distance (HD)*

An empty list of distinct edges is initialized to serve as a container for the combined edges (tuples) of all taxa in a s

1. Results

After obtaining the phenograms from SIM using JSI and HD having inputted of two sets of taxa containing five species each as indicated in the following table.

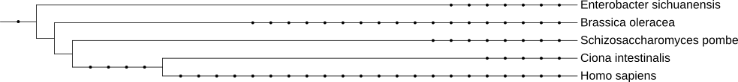
TABLE I  
selected species according to set

|  |  |
| --- | --- |
| **SET 1** | |
| **Code** | **Scientific name** |
| hsa | Homo sapiens |
| spo | Schizosaccharomyces pombe |
| cin | Ciona intesinalis |
| boe | Brassica oleracea |
| esh | Enterobacter sichuanensis |
| **SET 2** | |
| **Code** | **Scientific name** |
| thg | Vulcanisaeta distributa |
| hic | Haemophilus influenzae |
| ini | Ipomoea nil |
| ovi | Opisthorchis viverrini |
| psoj | Phytophthora sojae |

The following diagram is an NCBI-generated phenogram. This will be used as basis in comparing phenograms generated from SIM using JSI and HD in terms of matchings. Phylip branch matching and maximum consensus tree are the tools used to evaluate and further infer similarities of the compared phenograms.

FIGURE X  
ncbi-generated phenograms

Set 1



A picture containing diagram

Description automatically generatedSet 2

The % match using Phylip was computed using the following formula:

Text

Description automatically generated

Maximum consensus tree was also used in computing for the same attribute:

Text

Description automatically generated

TABLE 2  
summary of similarity comparisons

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **% match** | | | |
|  | **Set 1** | | **Set 2** | |
|  | **JSI** | **HD** | **JSI** | **HD** |
| **Phylip** |  |  |  |  |
| **MCT** | 0.78 | 0.78 | 1 | 1 |

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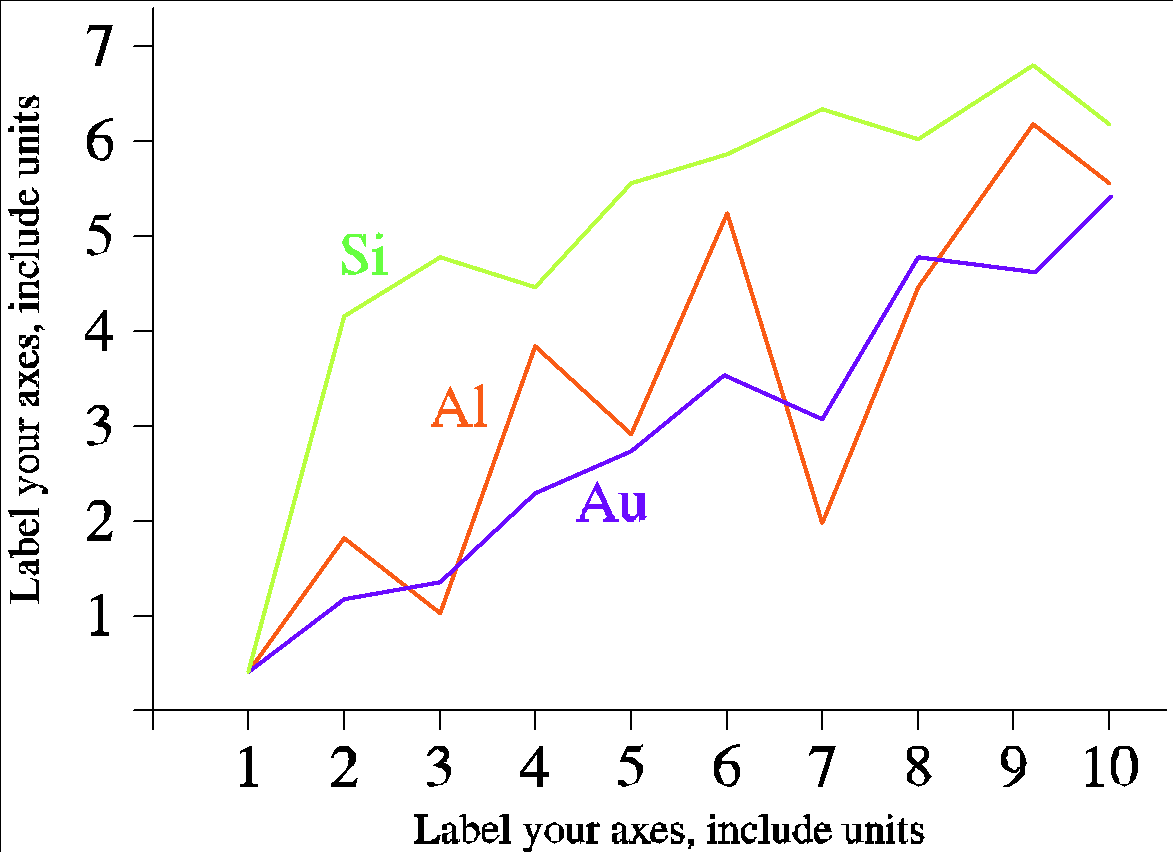


Fig. 1 A sample line graph using colors which contrast well both on screen and on a black-and-white hardcopy

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Fig. 2 Example of an unacceptable low-resolution image



Fig. 3 Example of an image with acceptable resolution

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1. Conclusions

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Causal Productions wishes to acknowledge Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template. To see the list of contributors, please refer to the top of file IEEETran.cls in the IEEE LaTeX distribution.

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