Optimization

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February 21, 2019

How to run

There is a python script along with a jupyter notebook included with this report. Python, version 3.7, was used.

Packages and Environemnt

The following packages are required to run both the script and the notebook: **numpy, scipy, pymprog, networkx, matplotlib, sympy**. The first three packages are used for generating and solving the linear programs. **networkx and matplotlib** are used to draw the graphs. **sympy** is used to convert to rational format. All these packages can be installed to a python environemnt in the linux machines using pip install. For the notebook, it will require an anaconda environemnt along with all the packages mentioned.

Run Instructions

Jupyter notebook

If you have an anaconda distribution, activate the environment that includes all the packages mentioned previously and use python3. Run the command 'jupyter-notebook'; this will print a url that navigates to the notebook UI. Once you navigate to the notebook included for this assignment from the UI, run all the cells (Kernel $->$ Restart and Run All) There are some examples included at the end of the notebook and comments that specify all the included functions. There are two main functions: **lp_clique(G)** and **lp_entropy(G)**. Both functions take a paramater which is a graph that is in the dictionary of sets format e.g.

$$\text{G} = \{1{:}\{2,4,5\},\ \ 2{:}\{1,3,4\},\ \ 3{:}\{2,5\},\ \ 4{:}\ \ \{1,2,5\},\ \ 5{:}\{1,3,4\}\}$$

The graph is undirected so an edge uv means that v should be a neighbour of u and vice-versa. Running **lp_clique(G)** in one of the cells will return the optimal value for the fractional clique cover number $\pi^*(G)$ and the vector $\overline{x}$ in rational format. Similarly, running **lp_entropy(G)** will return the optimal value for shannon entropy $\eta(G)$ and the vector $\overline{x}$ in rational format. A mapping between $\overline{x}$ vector and the subsets is included as well for clarity; the columns of the vector represent different subsets depending on the graph G itself.

Python Script

Make sure you are using an environemnt that includes all the packages and uses python3. Only the following command is required for this script:

```
python3 linear_programs.py
{1:{2,4,5}, 2:{1,3,4}, 3:{2,5}, 4: {1,2,5}, 5:{1,3,4}} > output.txt
```

The script takes the graph in the same format mentioned for jupyter notebook version. This script will print out the output for both linear programs. For a more verbose output, this will require setting the verbose flag at the top of the script file:

```
SET_VERBOSE = True
```

Linear Programs

Different solver packages were tested

Fractiona Clique Cover Number $\pi^*(G)$

Shannon Entropy $\eta(G)$