GiMPy and GrUMPy: Visualization for Optimization in Python

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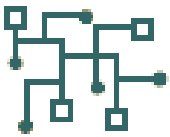

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GiMPy Overview

- A graph class written in Python 2.7.
- Depends on Pydot (and hence Graphviz) and Pygame.
- Builds, displays, and saves graphs.
- Focus is on *visualization* of well-known graph algorithms and use in the classroom.
  - Priority in implementation is on *clarity* of the algorithms.
  - Efficiency is *not* the goal (though we try to be as efficient as we can).

GiMPy Data Structure

- Derived from `Dot` class of `Pydot`.
  - `Pydot` is an API for building graphs and printing them in `Dot` language used by `Graphviz`.
  - `Graphviz` provides the methods for layout and visualization.
  - `Graphviz` produces images that can then either be displayed live or saved.
  -
- `GiMPy` extends the API and adds the data structures and methods needed to implement graph algorithms.
- The graph is stored in adjacency list format, but alternative data structures can be easily added.
- Includes a wide range of graph algorithms and more are being added.
- Derived classes implement tree and binary tree.
- Available open source through COIN-OR.

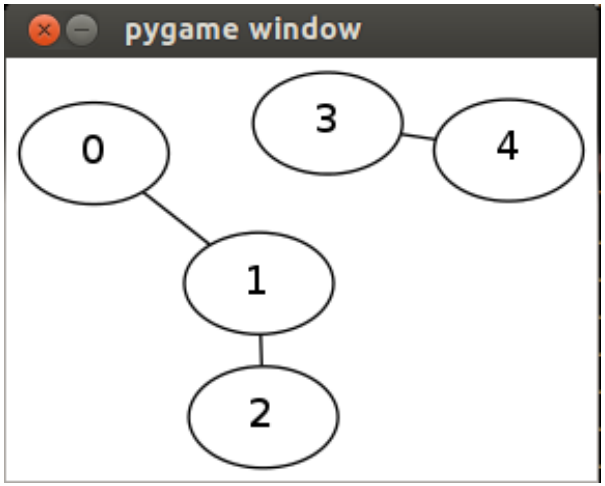
GiMPy Display Capabilities

- Has all the display capabilities of Graphviz.
- Can display graphs on a window or save to the disk in various formats.

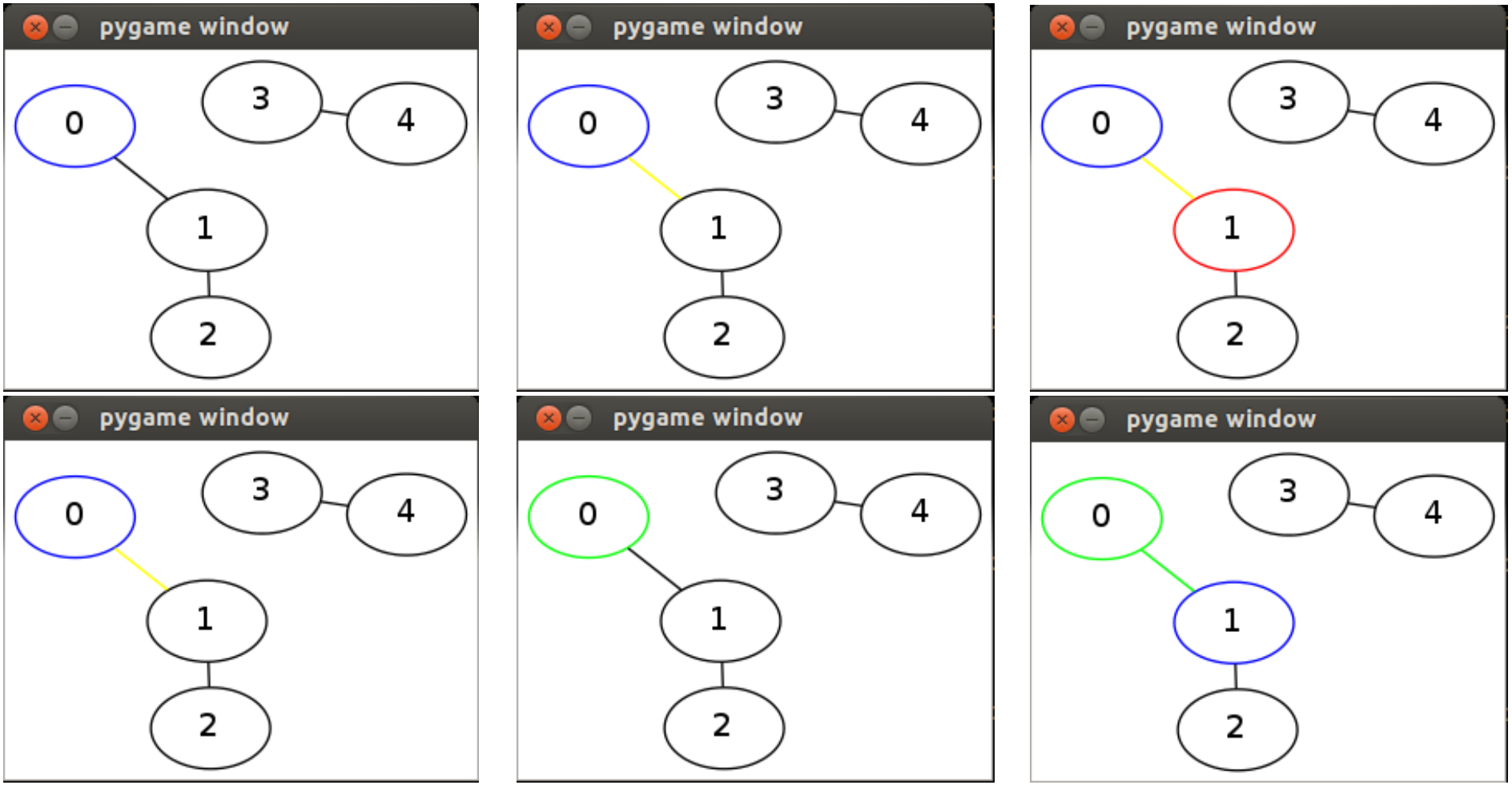
GiMPy Example

```
from gimpy import Graph
if __name__=='__main__':
  g = Graph(display='pygame')
  g.add_edge(0,1)
  g.add_edge(1,2)
  g.add_edge(3,4)
  g.display()
  g.search(0)
```

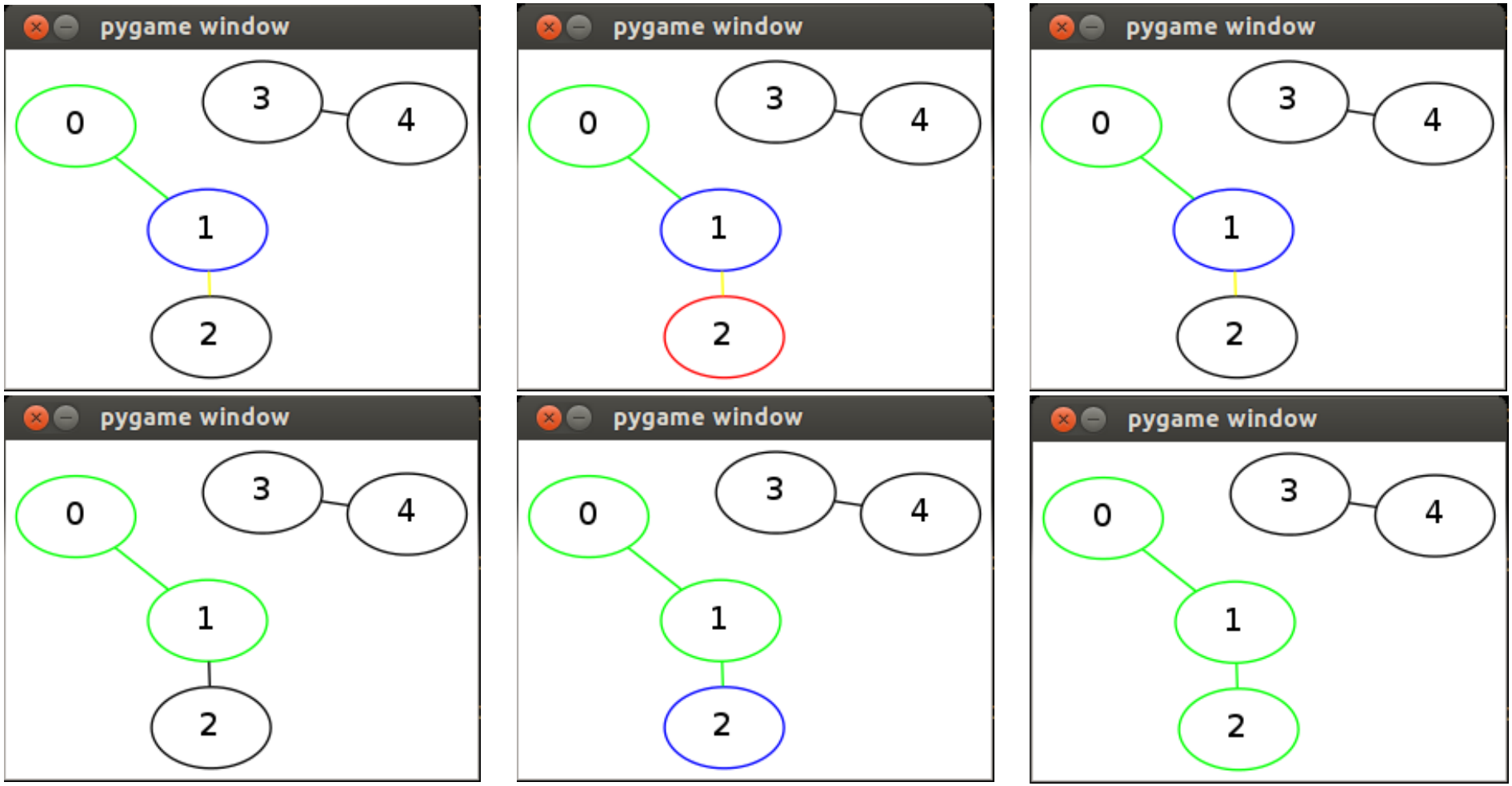
Figure : Resulting window



GIMPy Example



GiMPy Example



GiMPy Algorithm Visualization

```
from gimpy import Graph
if __name__=='__main__':
    g = Graph(display='pygame')
    g.add_edge(0,1)
    g.add_edge(1,2)
    g.add_edge(3,4)
    g.search()
```

GiMPy Algorithm Visualization

The following problem/algorithm pairs with similar visualization options exist.

- Graph Search: BFS, DFS, Prim's, Component Labeling, Dijkstra's, Topological Sort.
- Shortest path: Dijkstra's, Label Correcting
- Maximum flow: Augmenting Path, Preflow Push
- Minimum spanning tree: Prim's Algorithm, Kruskal Algorithm
- Minimum Cost Flow: Network Simplex, Cycle Canceling
- Data structures: Union-Find (quick union, quick find)

GiMPy Binary Tree

- `Tree` class dervide from `Graph` class.
- `BinaryTree` class dervide from `Tree` class.
- Has binary tree specific API and attributes.

GrUMPy Overview

- Visualizes branch and bound process.
- Adds dynamic visualization to the Branch and Bound Analysis Kit (BAK).
- Reads branch and bound data in a specific format.
- Derived from `BinaryTree` of GiMPy.
- Builds branch and bound binary tree.
- Has all the analysis (search/visualization) capabilities of GiMPy.
- Biggest advantage to all its predecessors is the capability to do visualizations on the fly.

GrUMPy Branch and Bound Visualizations

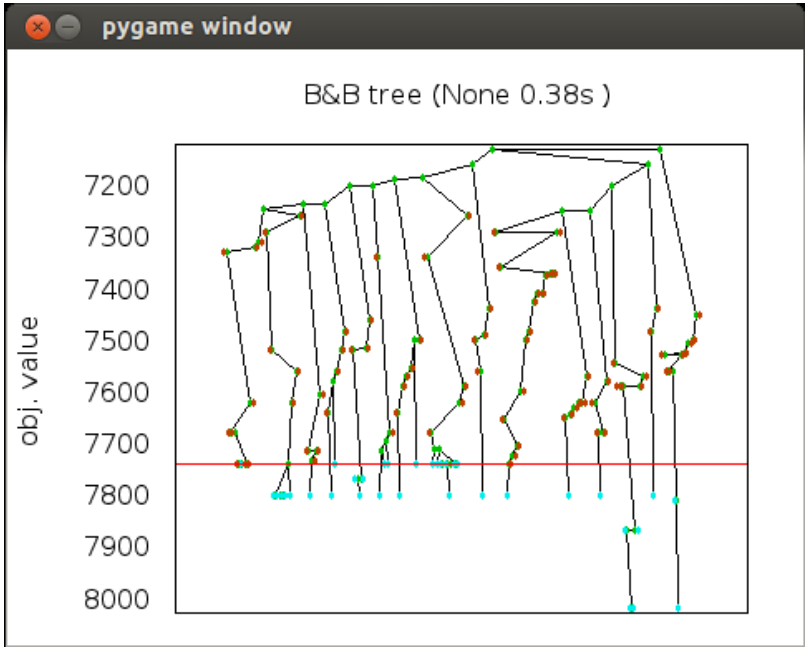
There are four visualizations of BB tree provided by GrUMPy.

- BB tree
- Histogram
- Scatter plot
- Incumbent path

```
from baktree import BAKTree
if __name__ == '__main__':
    bt = BAKTree()
    bt.set_display_mode('pygame')
    line_number = 0
    file_ = open('p0201_GLPK.in', 'r')
    for line in file_:
        bt.ProcessLine(line)
        line_number = line_number+1
        if line_number%100 != 0:
            continue
        if bt.root is not None:
            gnuplot_image = bt.GenerateTreeImage()
            if gnuplot_image is not None:
                bt.display_image(gnuplot_image)
```

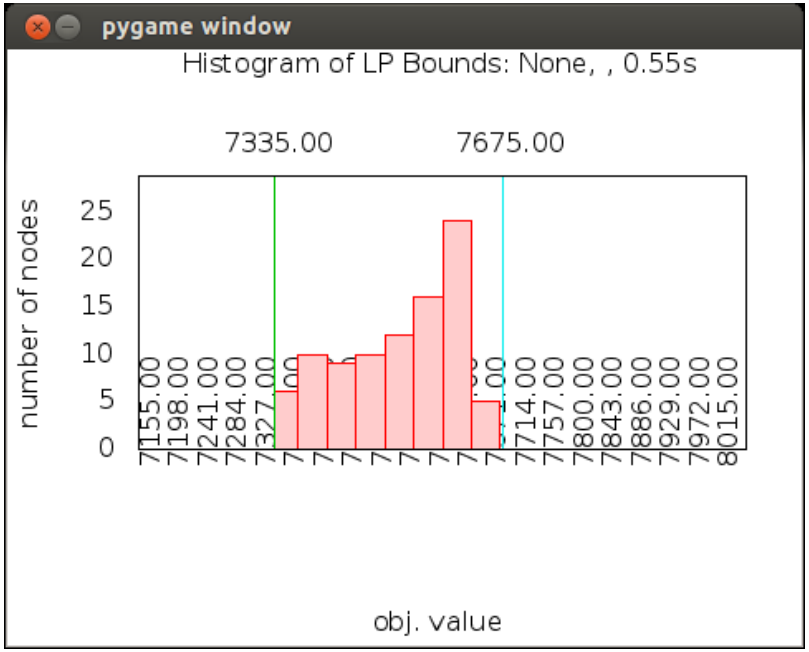
GrIMPy BB Tree

Figure : BB tree generated by GrUMPy



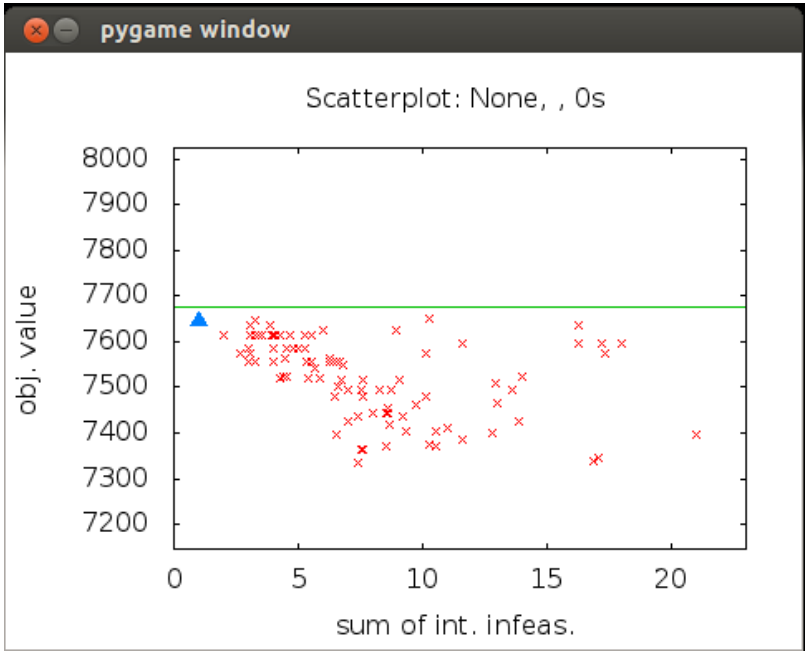
GrUMPy Histogram

Figure : BB histogram generated by GrUMPy



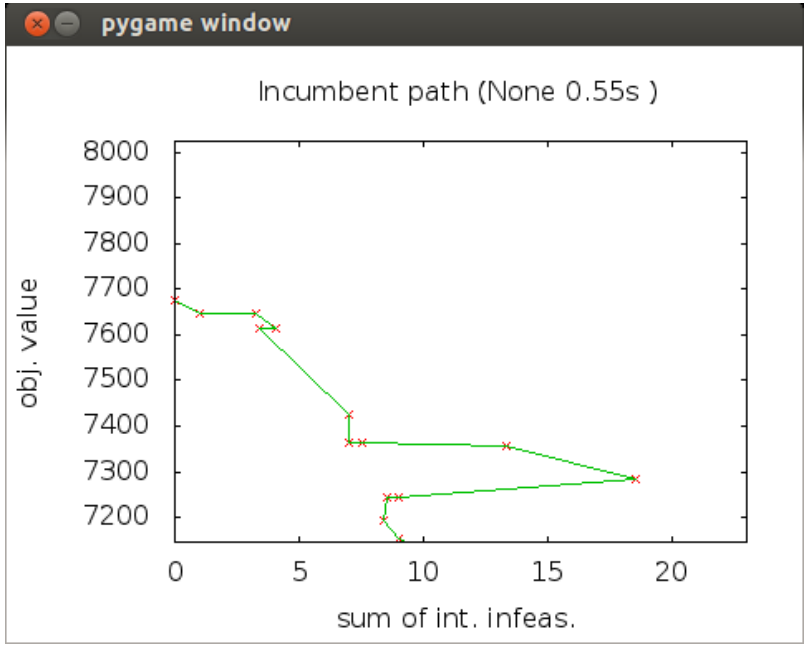
GrUMPy Scatter Plot

Figure : Scatter plot generated by GrUMPy



GrUMPy Incumbent Path

Figure : Incumbent path generated by GrUMPy



Depends on scatterplot

GrUMPy On the Fly

- GrUMPy can read input from stdin.
- By configuring the solver output you can make GrUMPy generate visualizations as your problem is being solved.
- GrUMPy reads stdin and updates binary tree and visualizations on the fly.
- GrUMPy can be used on the fly with the following command.

```
solver problem | python baktree.py
```

```
from baktree import BAKTree
import sys
if __name__ == '__main__':
    bt = BAKTree()
    bt.set_display_mode('pygame')
    line_number = 0
    file_ = open('p0201_GLPK.in', 'r')
    for line in sys.stdin:
        bt.ProcessLine(line)
        line_number = line_number+1
        if line_number%100 != 0:
            continue
        if bt.root is not None:
            bt.display_all()
```

Wrap-up

- The software is available and under active development.
- Please try it and help us improve!