Yoyo Implementation

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Introduction

The yoyo algorithm which is used to elect a leader in a connected graph was implemented.

The 5 major steps involved were the following:

1. Creating a directed graph and marking the sources, sinks and internal nodes.
2. Yo-up
3. Yo-down
4. Edge Pruning
5. Edge Flipping

The steps were iterative which concluded its execution when only the leader remained.

The color code adopted was green for source, blue for internal node and red for sink.

Implementation Details

The Networkx and Matplotlib Library were used to visualize the algorithms.

The input of the graph was an adjacency list. An example is shown below

```
graph = {2: [14], 3:[13,9, 10], 4:[13,11], 5:[11,10,9], 7:[11, 14], 9:[3, 5, 10], 10:[3,5,9,11], 11:[4,5,7,10,12], 12:[11], 14:[2, 7], 13:[3, 4]}
```

Issues Involved

The major issue involved while formulating the logic were

1. An internal node received at least one no should send a no to all ancestor edges.

This issue was circumvented by identifying all the ancestors of the internal node and setting their labels to no.

Source Code

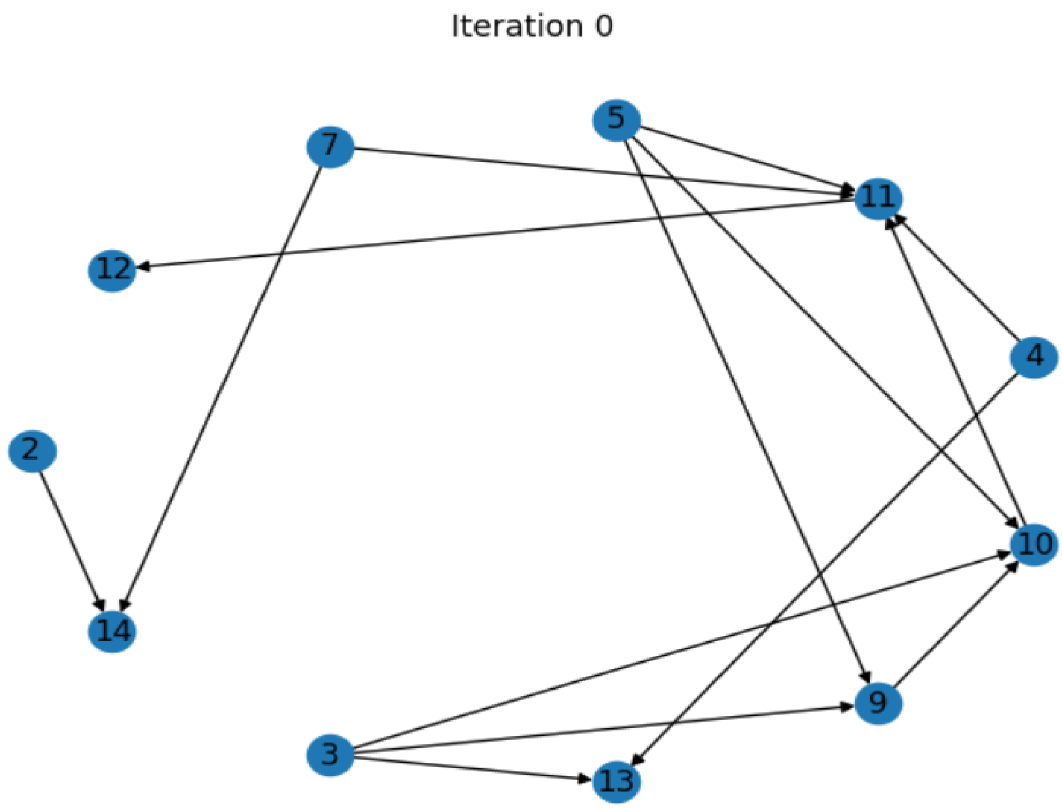
```
import matplotlib as mpl
import matplotlib.pyplot as plt
import networkx as nx

graph = {2: [14], 3:[13,9, 10], 4:[13,11], 5:[11,10,9], 7:[11, 14], 9:[3, 5, 
10], 10:[3,5,9,11], 11:[4,5,7,10,12], 12:[11], 14:[2, 7], 13:[3, 4]}

#Creating the directed graph
G = nx.DiGraph()
for key, values in graph.items():
    for value in values:
        if value > key:
            G.add_edge(key, value)

i = 0
while nx.number_of_nodes(G) != 1:
    header = "Iteration " + str(i)
    nx.draw(G, with_labels = True, pos=nx.shell_layout(G))
    plt.title(header)
    plt.show()
    i = i + 1
    sources = set([x for x in G.nodes() if G.out_degree(x)>=1 and 
G.in_degree(x)==0])
    targets = set([x for x in G.nodes() if G.out_degree(x)==0 and 
G.in_degree(x)>=1])
    internal = set(G.nodes) - sources - targets
    node_colors = []

    for node in G.nodes:
        if node in sources:
            node_colors.append('green')
        elif node in internal:
            node_colors.append('blue')
        else:
            node_colors.append('red')

    nx.draw(G, pos=nx.shell_layout(G), with_labels=True, node_color=
node_colors, node_size=1000, font_size=20)

    edge_labels = {}
    node_labels = {} #minimum value received at each node

    for edge in G.edges:
        if edge[0] in sources:
```

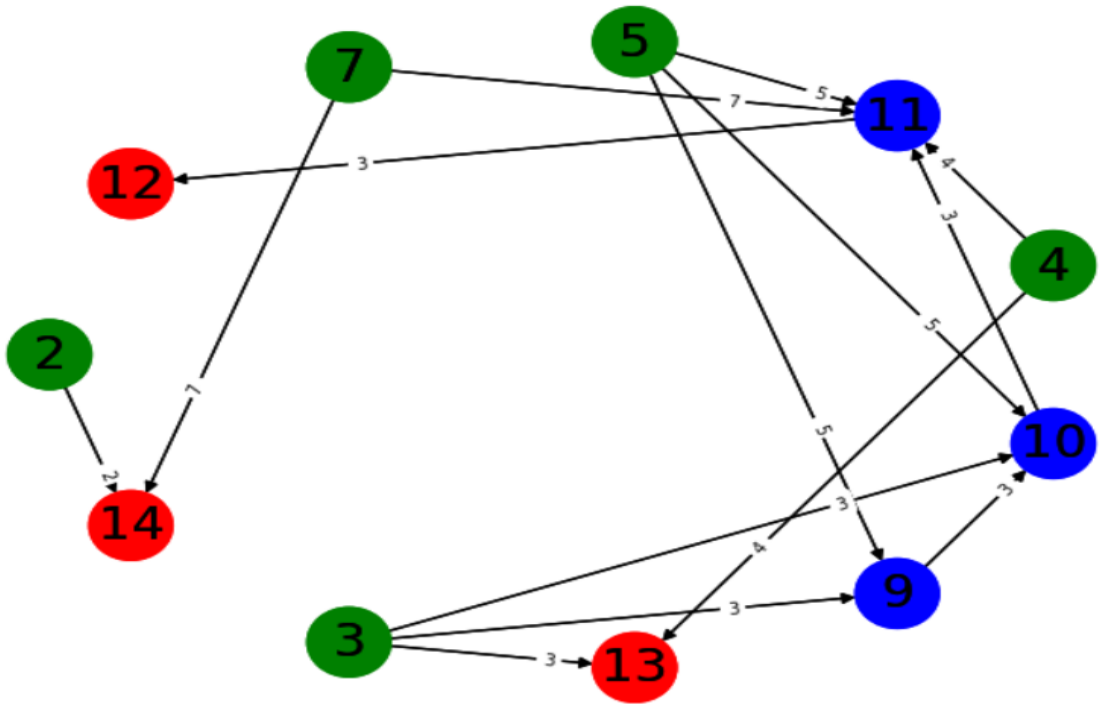
```
            edge_labels[edge] = edge[0]
        else:
            edge_labels[edge] = min(nx.ancestors(G, edge[0]))
    for edge in edge_labels:
        node_labels[edge[1]] = min(node_labels.get(edge[1], float('inf'))
,edge_labels[edge])

    nx.draw(G, pos=nx.shell_layout(G), with_labels=True, node_color=
node_colors, node_size=1000, font_size=20)
    nx.draw_networkx_edge_labels(G, pos=nx.shell_layout(G),
edge_labels=edge_labels, label_pos = 0.3, font_size=7)
    plt.show()

    single_yes = dict()
    internal_no = set()
    for edge in edge_labels:
        if edge_labels[edge] != node_labels[edge[1]]:
            edge_labels[edge] = 'NO'
            for nedge in G.in_edges(edge[0]):
                internal_no.add(nedge)
            for node in nx.ancestors(G, edge[0]):
                for nedge in G.in_edges(node):
                    internal_no.add(nedge)
        else:
            edge_labels[edge] = 'YES'
    for edge in internal_no:
        edge_labels[edge] = 'NO'
    for edge in edge_labels:
        if edge[1] in targets:
            if edge_labels[edge] == 'YES':
                single_yes[edge[1]] = single_yes.get(edge[1], 0) + 1
            else:
                single_yes.pop(edge[1], None)
    single_yes = {x for x in single_yes if single_yes[x] == 1}
    nx.draw(G, pos=nx.shell_layout(G), with_labels=True, node_color=
node_colors, node_size=1000, font_size=20)
    nx.draw_networkx_edge_labels(G, pos=nx.shell_layout(G),
edge_labels=edge_labels, label_pos = 0.7, font_size=7)
    plt.show()

    prune = set()
    edges_to_flip = []
    delete_edges = []
    for edge in edge_labels:
        if edge_labels[edge] == 'YES':
```

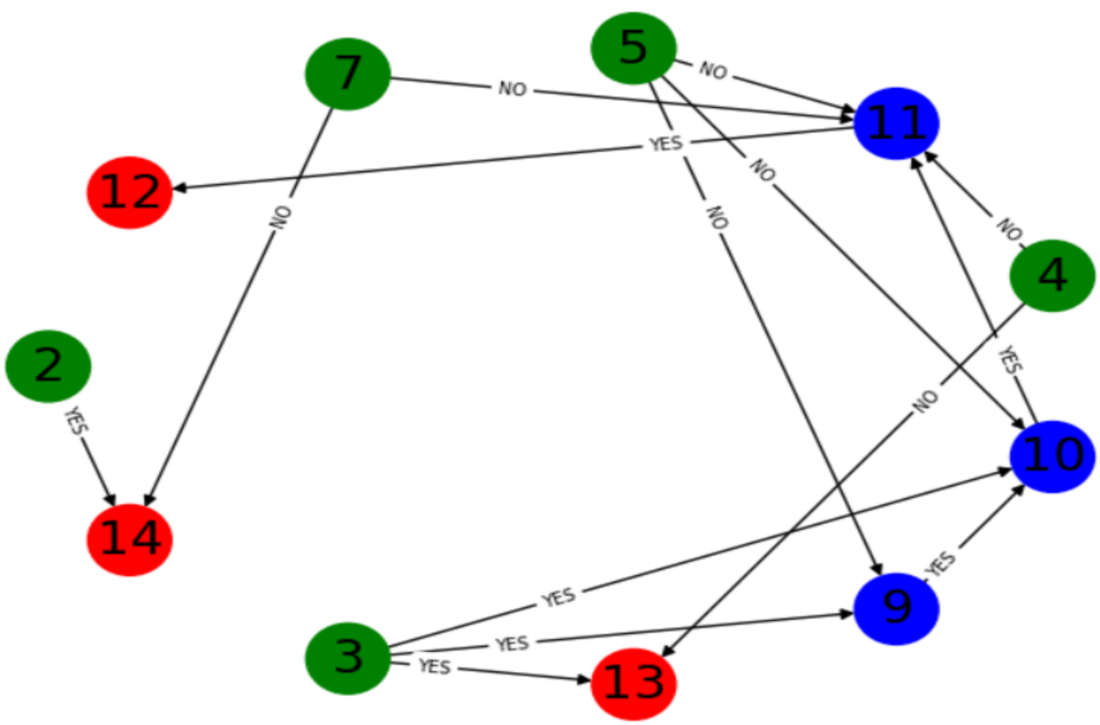
```
            if edge[1] in prune:
                G.remove_edge(edge[0], edge[1])
                delete_edges.append(edge)
            elif edge[1] in single_yes:
                G.remove_edge(edge[0], edge[1])
                G.remove_node(edge[1])
                delete_edges.append(edge)
            else:
                prune.add(edge[1])
        elif edge_labels[edge] == 'NO':
            edges_to_flip.append(edge)

    for edge in delete_edges:
        del edge_labels[edge]

    node_colors = []
    for node in G.nodes:
        if node in sources:
            node_colors.append('green')
        elif node in internal:
            node_colors.append('blue')
        else:
            node_colors.append('red')
    nx.draw(G, pos=nx.shell_layout(G), with_labels=True, node_color=
node_colors, node_size=1000, font_size=20)
    nx.draw_networkx_edge_labels(G, pos=nx.shell_layout(G),
edge_labels=edge_labels, label_pos = 0.7, font_size=7)
    plt.show()

    for edge in edges_to_flip:
        G.remove_edge(edge[0], edge[1])
        G.add_edge(edge[1], edge[0])
    nx.draw(G, pos=nx.shell_layout(G), with_labels=True, node_color=
node_colors, node_size=1000, font_size=20)
    plt.show()
```

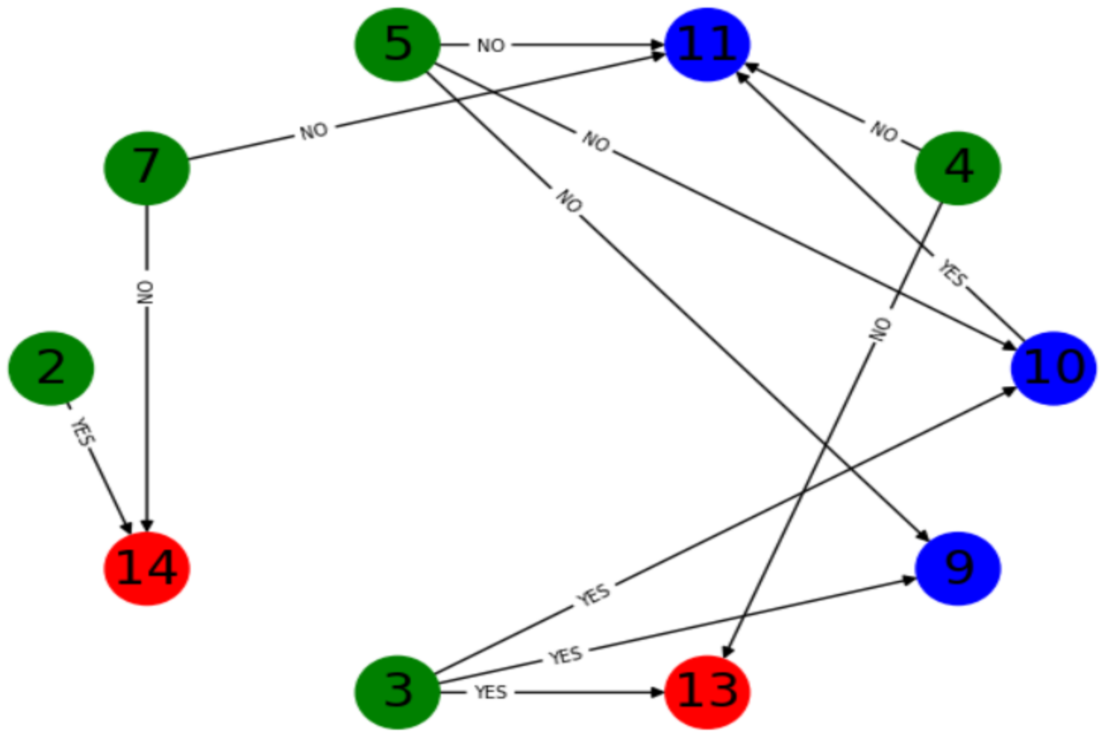
Sample Output

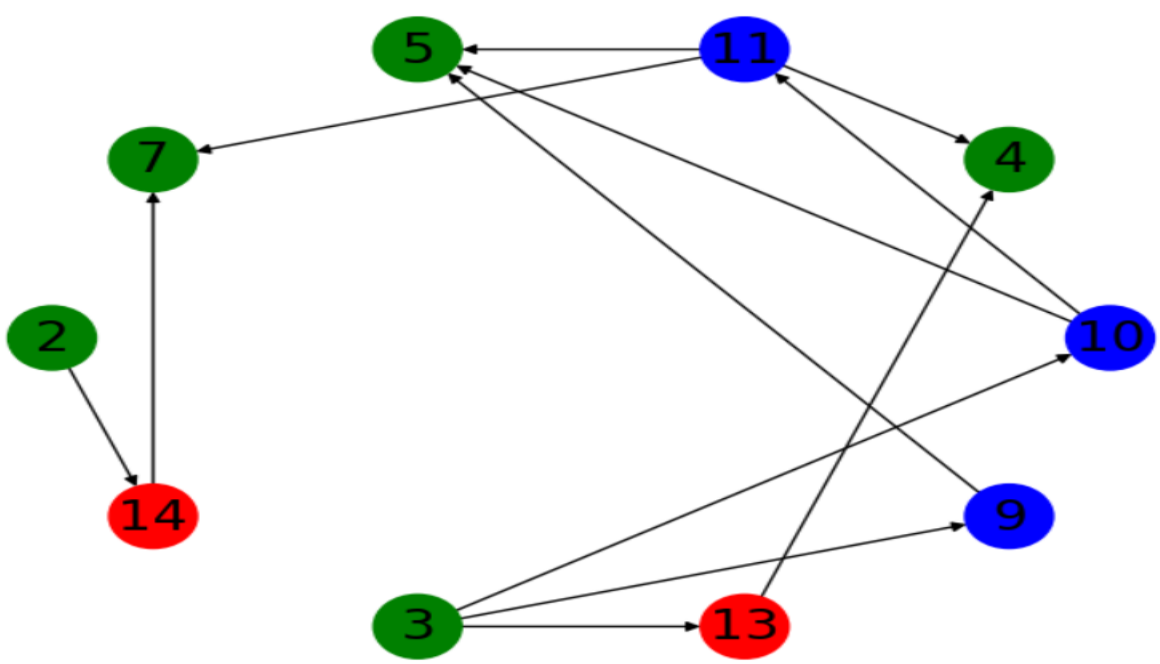
For the graph displayed above, the first iteration of each of the steps is given below.



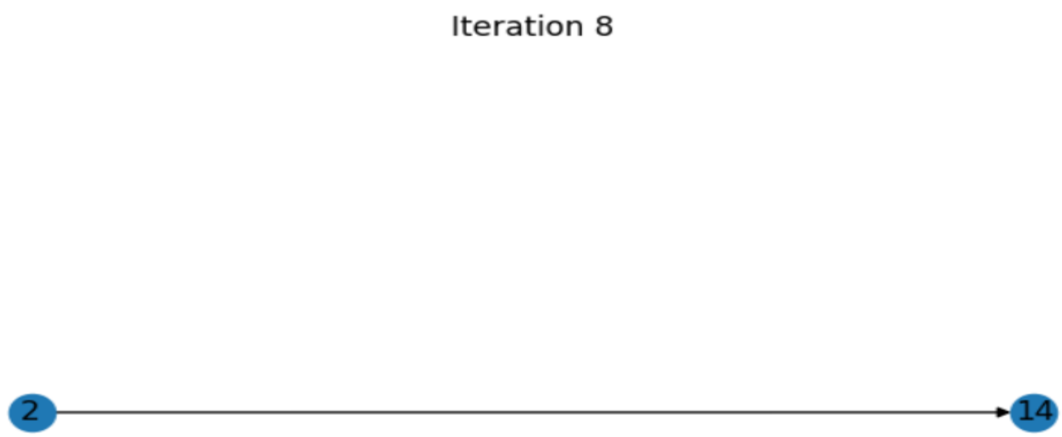

7
5
11
12
4
2
10
14
9
3
13
5
7
3
4
3
5
7
5
2
3
4
3
3
3


7
5
11
12
4
2
10
14
9
3
13
NO
NO
YES
NO
NO
NO
NO
YES
NO
YES
YES
YES
YES
YES


5
11
7
4
2
10
14
9
3
13
NO
YES


5
11
7
4
2
10
14
9
3
13

The following image represents the final iteration of the algorithm which ceases to run when only a single node, that is the leader is elected.




2
YES
14


2


2