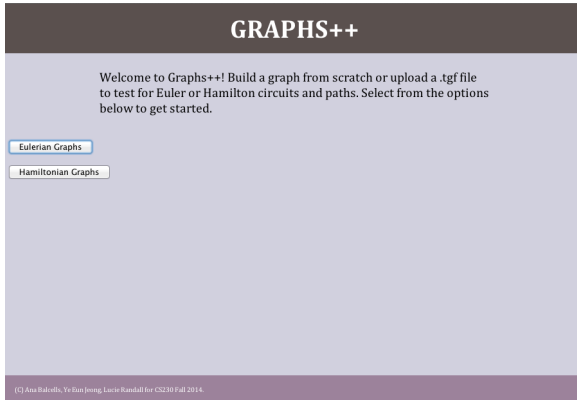


# Graphs++ User Manual

- A graph theory program for finding Eulerian and Hamiltonian circuits and paths -

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## A. Specify Graph Type



From the home page, begin by choosing the type of graph with which you want to work.

## B. Input A Graph

You can then create a graph from scratch (B1) or by uploading an existing graph from a TGF file (B2).

When your graph is complete, click either the 'Find Circuit' or 'Find Path' button to specify a calculation type.

→ You must specify an input method. Your selection (highlighted) will determine which graph is used for calculations.

## B1. Create Graph from Scratch

The interface for creating a graph from scratch. It features a 'Nodes' input field with an 'Add' button. Below it, a text box shows 'Nodes you have created: A B C'. The 'Edges' section has two dropdown menus, one with 'C' and one with 'A', followed by an 'Add' button. A list box on the right shows the edges created: 'A - B', 'B - C', and 'C - A'. At the bottom, it says 'Edges you have created:'.

- 1) Add one or more nodes by typing their names in the space provided and clicking the 'Add' button.
  - 2) Create edges between node by choosing two from the drop down menus and clicking the second 'Add' button.
- Nodes names must be unique and an edge cannot be created connecting a node to itself.

## B2. Create Graph from TGF File

The interface for creating a graph from a TGF file. It features a 'File path of .tgf file' input field with the text 'eulerPathTest.tgf' and an 'Upload' button.

- 1) Upload an existing graph by typing its file name and path in the space provided.
- 2) Make sure the file name ends with ".tgf". Other file types will not be accepted.
- 3) Click the 'Upload' button.

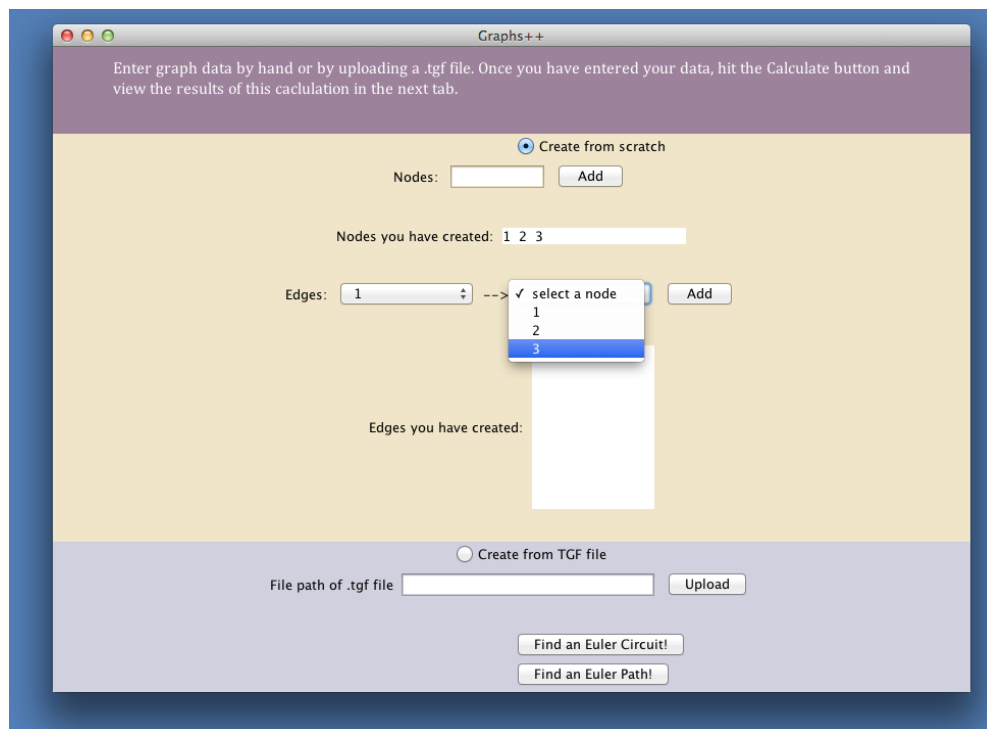
## C. Results

The 'RESULTS' page displays the outcome of the Euler path calculation. It asks 'Does your graph have an Eulerian path?' and answers 'No.' Under the 'Why?' section, it states 'The graph is connected.' and 'The graph does NOT have exactly two vertices of odd degree.' The 'Euler path node sequence' section indicates 'Euler circuit could not be found.' At the bottom, it says 'Click to return to the main page and begin again.' with a 'Go back to the main page' button.

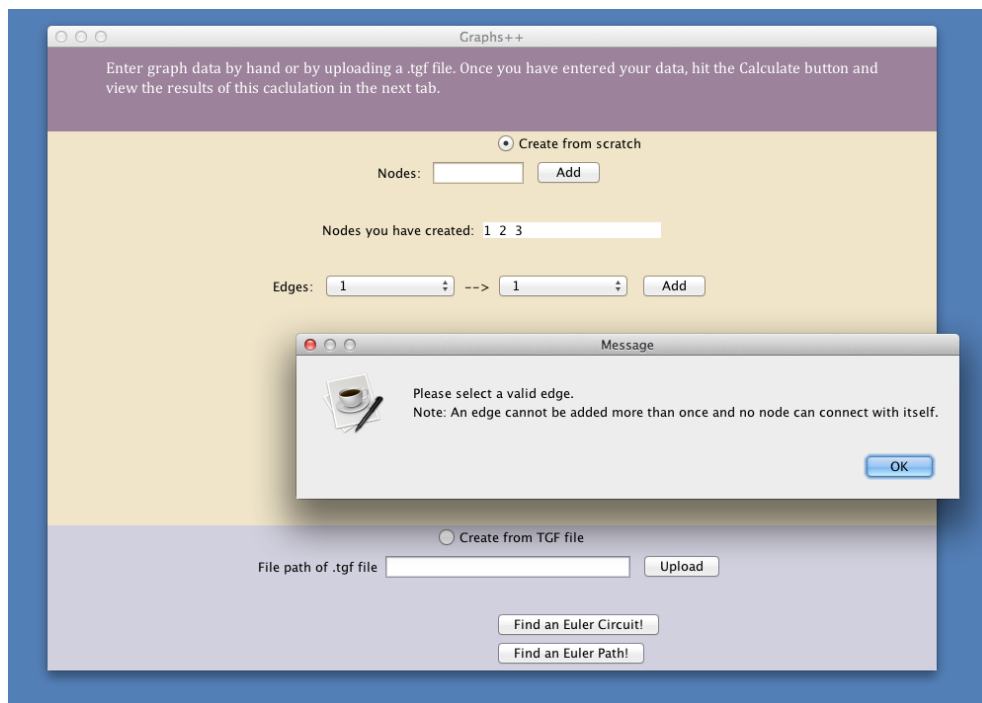
This page displays the result of your calculation, an explanation of the findings, and the node circuit sequence if there is one.

Return to the home page to work with another graph type by clicking the button at the bottom of the window.

## D. GUI demo



Click on the top radio button, “Create from scratch,” and start adding nodes one by one. When a node is created, they are added to the combo boxes from which you can make selections of nodes to create edges between them. The edges created will be shown in the box below.



When creating edges, the user must select two different, valid nodes. Otherwise, there will be an error message.

Enter graph data by hand or by uploading a .tgf file. Once you have entered your data, hit the Calculate button and view the results of this calculation in the next tab.

☒ Create from scratch

Nodes:  Add

Nodes you have created: 1 2 3

Edges:  -->  Add

Edges you have created:

- 1 - 2
- 1 - 3
- 2 - 3

☐ Create from TGF file

File path of .tgf file  Upload

Find an Euler Circuit!

Find an Euler Path!

The edges created between two valid vertices will be displayed in the box below the combo boxes as the user clicks “Add.” The order of vertices does not matter, since the graphs will be undirected.

Enter graph data by hand or by uploading a .tgf file. Once you have entered your data, hit the Calculate button and view the results of this calculation in the next tab.

☐ Create from scratch

Nodes:  Add

Nodes you have created:

Edges:  -->  Add

Edges you have created:

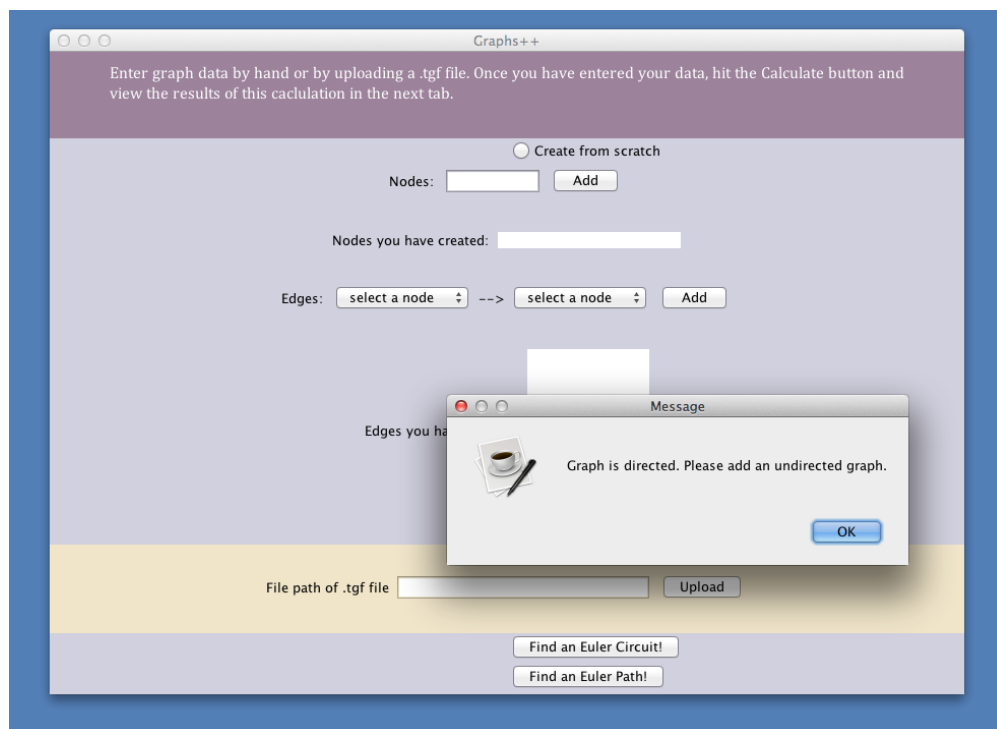
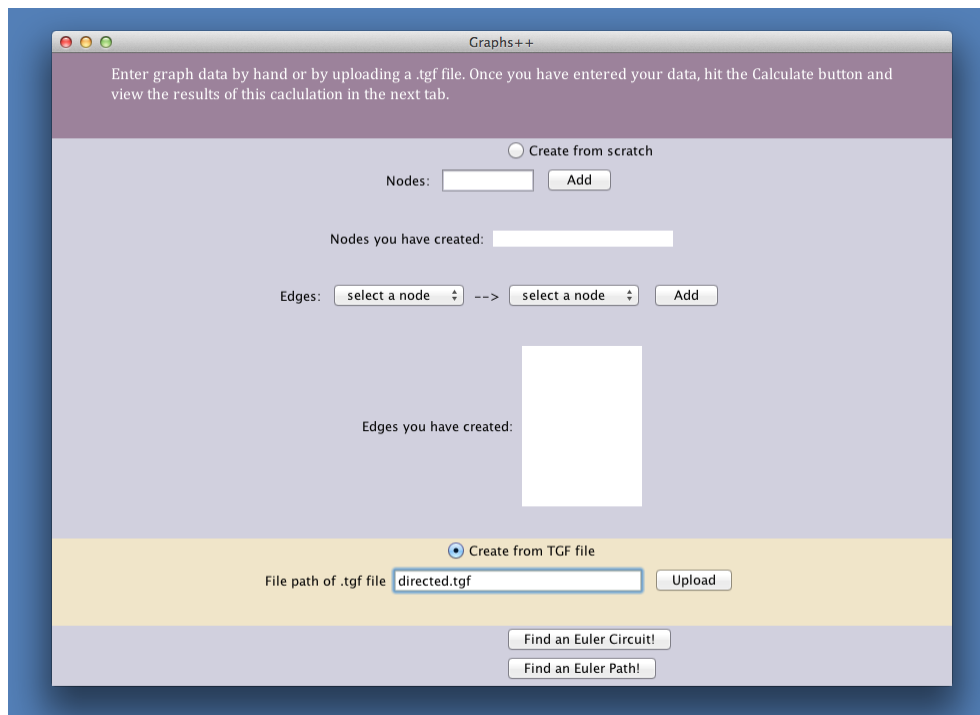
☒ Create from TGF file

File path of .tgf file  Upload

Find an Euler Circuit!

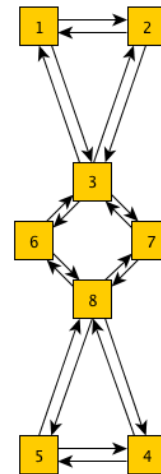
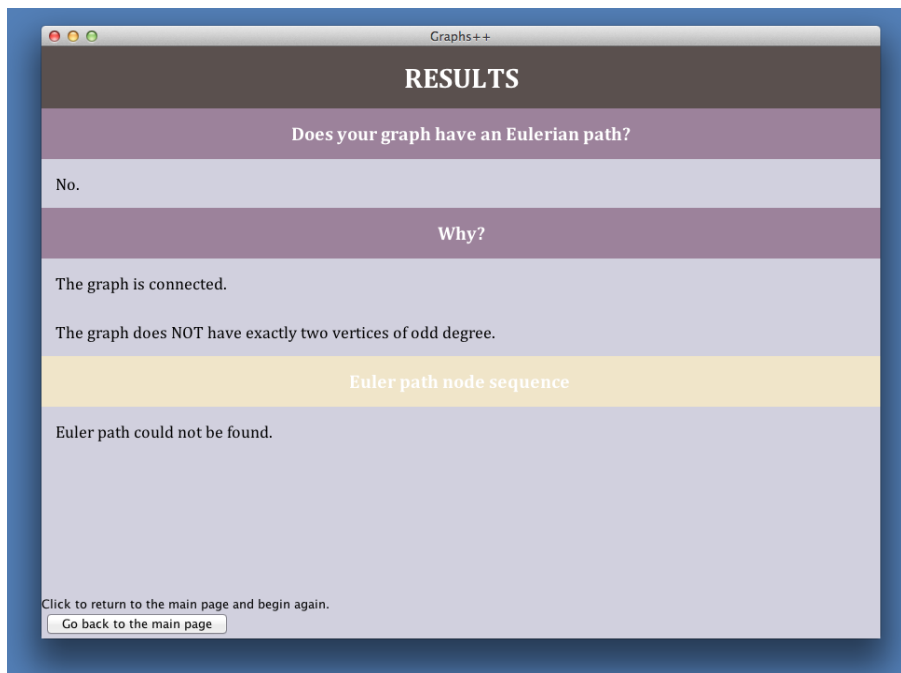
Find an Euler Path!

Alternatively, click on the bottom radio button, “Create from TGF file,” to upload a ready-made graph to the program.

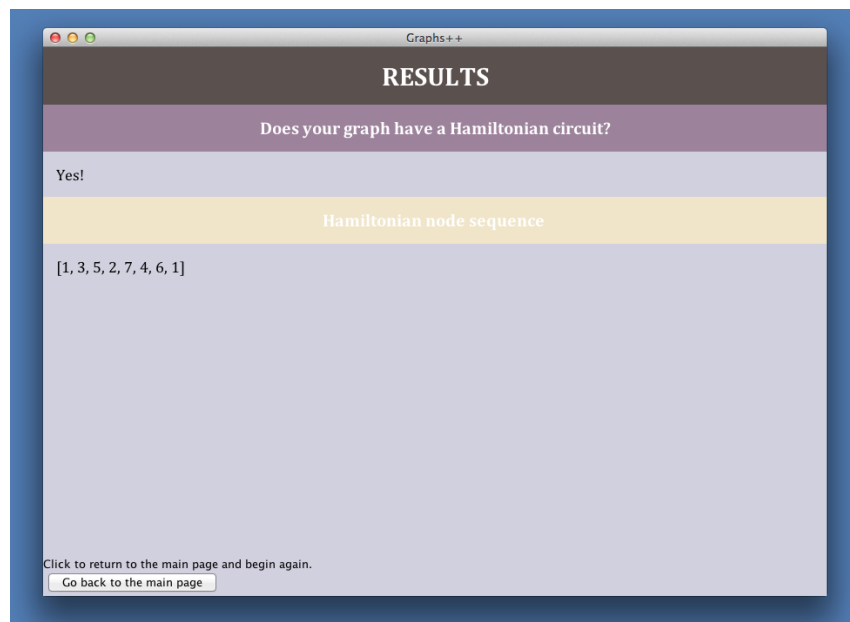
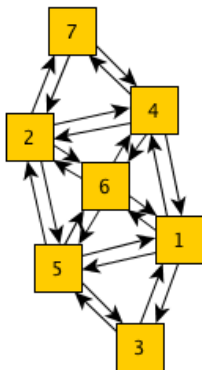


If you create a directed graph on yEd and try to upload it, it will refresh the file upload display and prompt you to add an undirected graph.

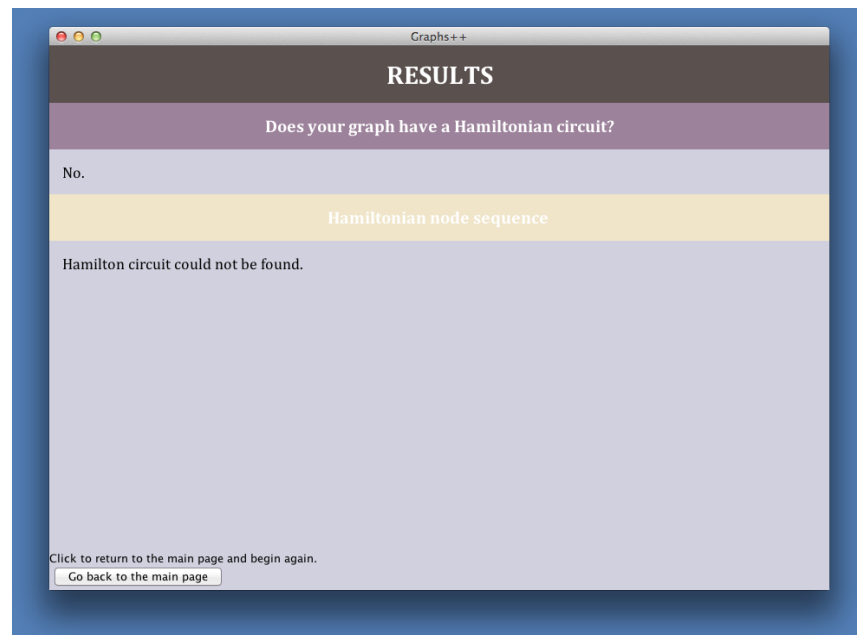
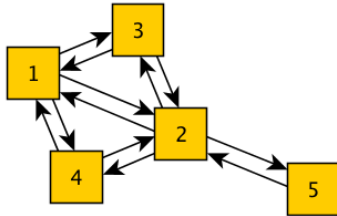




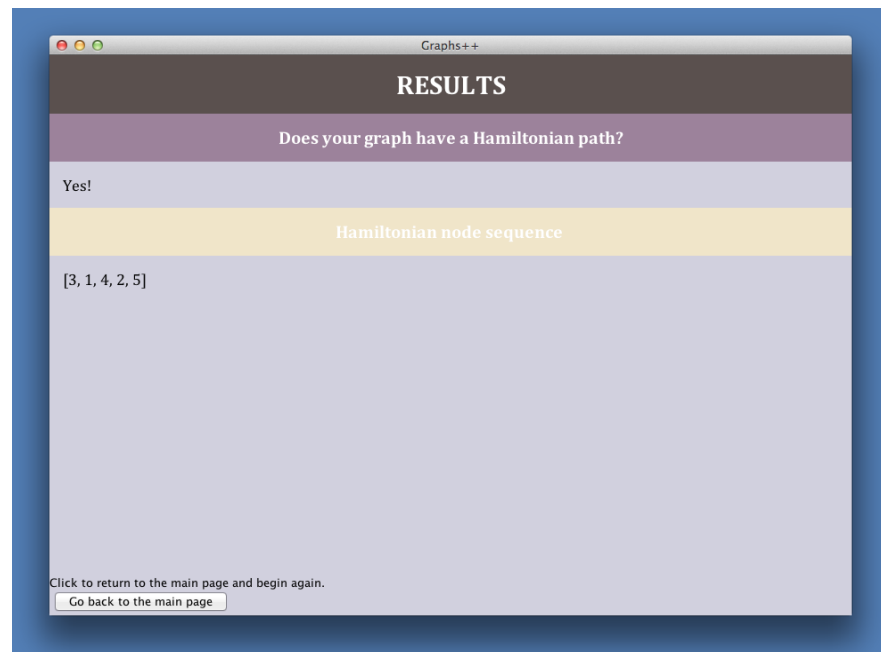
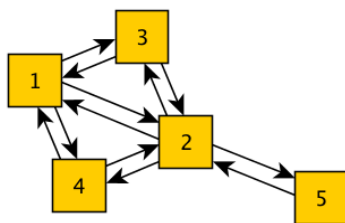
The same graph tested for an Euler path tests negative, because the graph has a circuit, not a path. The graph does not have exactly two vertices of odd degree.



This graph tested for a Hamiltonian circuit tests positive, and the resulting node sequence for a circuit is displayed.



This graph, which obviously cannot have a Hamiltonian circuit because of a “bridge” at node 5, tests negative for a Hamiltonian circuit.



However, the same graph tests positive for a Hamiltonian path, and the corresponding node sequence for such a path is displayed.