Project Title: AI Search Visualiser

User Manual

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Abstract

This project, A.I search visualiser, is a web application developed to visualise popular search algorithms used within Artificial Intelligence.

Nodes and edges are drawn onto a canvas and stored together as elements. The next step is to select a start and end goal for the algorithm. The user can then select one of four currently available algorithms to visualise. There are playback controls which allow the user to step through the visualisation in whichever way they please. The visualisation consists of nodes changing colours to distinguish between what state they currently are in throughout the algorithm. Users may also wish to enable comparison between algorithms to understand how they differ from each other by visualising both simultaneously. There is also an option to save the current arrangement of elements in the graph, to then upload that save at a later time and reuse the tree. To increase customisation, users have the ability to edit the heuristic values and names of nodes and edges.

One goal was to make the web application as simple as possible to use. To achieve this the user interface is, with every option layed out in front of the user rather than being hidden in menus and other pages. If at any point the user is confused there is a helpful tutorial which will assist them in using the tool. This contributes to achieving the main goal of the project, assisting those studying A.I search algorithms by using custom visualisation and interaction which are tools often used to understand and learn complicated ideas.

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1. Introduction

1.1 Compatibility

A.I Search Visualiser is compatible with the following browsers:

- Google Chrome
- Microsoft Edge
- Firefox
- Safari

1.2 Glossary

Term	Definition
A.I	Abbreviation for Artificial Intelligence. Machines replicate the behaviour of the human brain.
A.I Search Algorithm	The process of getting from a start state to a goal state.
Canvas	The section of the web application interface that holds the nodes and edges for visualisation.
Current node	The node that is currently being checked by the algorithm to see if it matches the goal node.
Edge	Connects two nodes in a tree.
Heuristic	A score used to rank options in a search, using information that is currently available.
JSON file	A popular file type consisting of data in a simple structure which is readable by humans.
Node	Part of a tree. A node represents a value or condition.
To-do node	A node that is on a list, waiting to be checked against the goal at a later stage in the search, if the goal is not found before it is reached.
Search tree	A collection of nodes and edges. One node is the root of the tree. Nodes have at most one parent and can have any amount of children. A tree in which nodes have at most 2 children is called a binary search tree.
Visited node	A node that has already been checked to see if it matches the goal node at a previous stage in the search.
Web application	Software that is run on a server, unlike software that you would run locally, on your own machine. It is accessed through an active network connection using a web browser.

2. User guide

2.1. Access web application

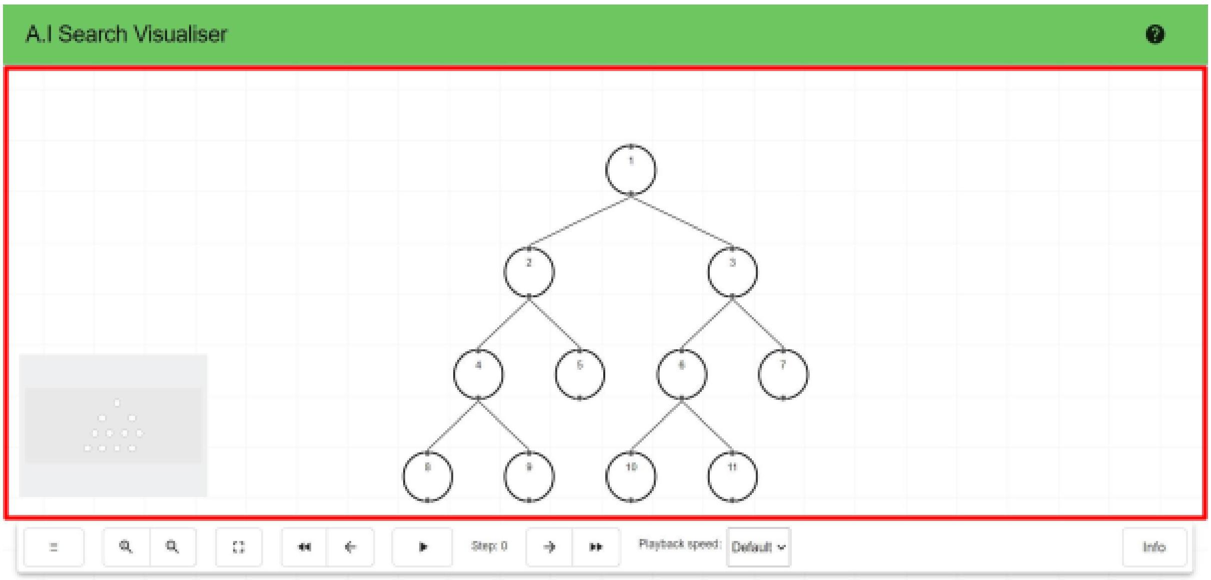
Enter the following URL into the address bar of your chosen web browser, or simply click on the link:

https://student.computing.dcu.ie/~whytee6/

Note: connection to the internet is required to access this web application.

2.2. Canvas

The canvas is highlighted in red in the following figure.



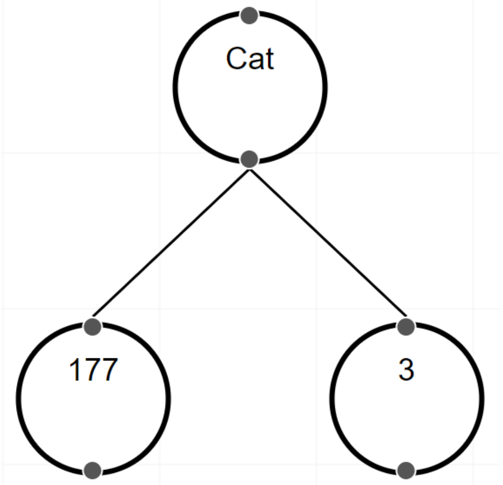
2.2.1. Tree

The collection of nodes and edges in the canvas when you first access the web application is the search tree. There is one root node and each node has at most 1 parent node.

2.2.2. Nodes

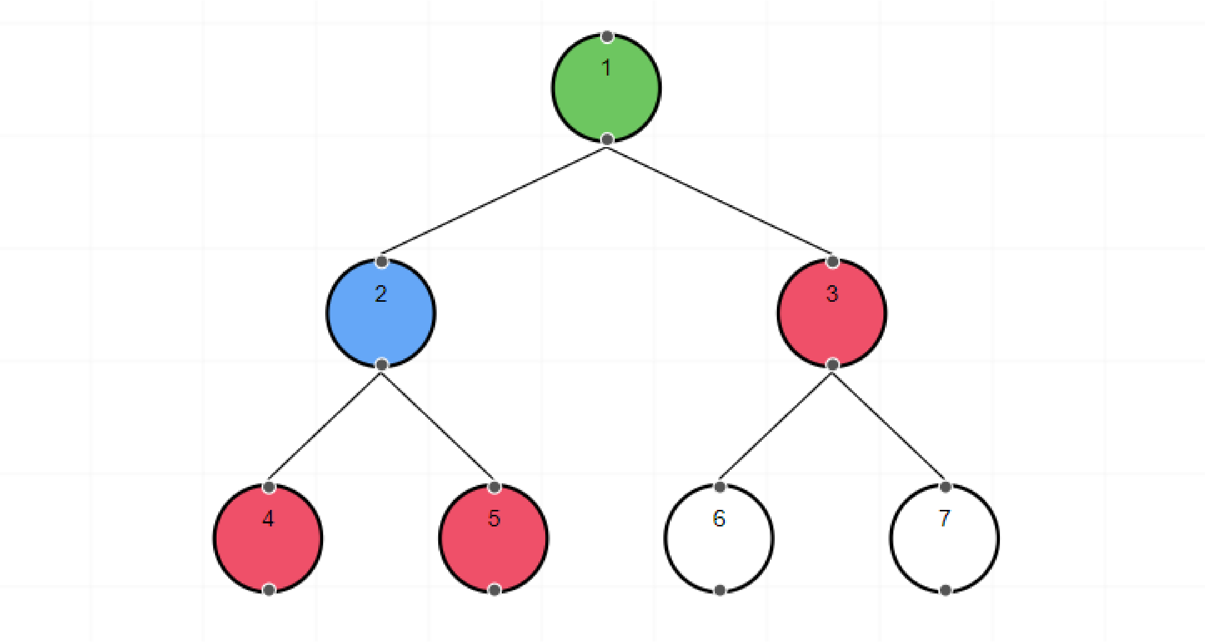
2.2.2.1. Node label

The label of a node is also known as the “name” of the node. It is used to represent each specific node. Labels can be numbers or strings, as shown in the following example figure:



2.2.2.2. Node colour

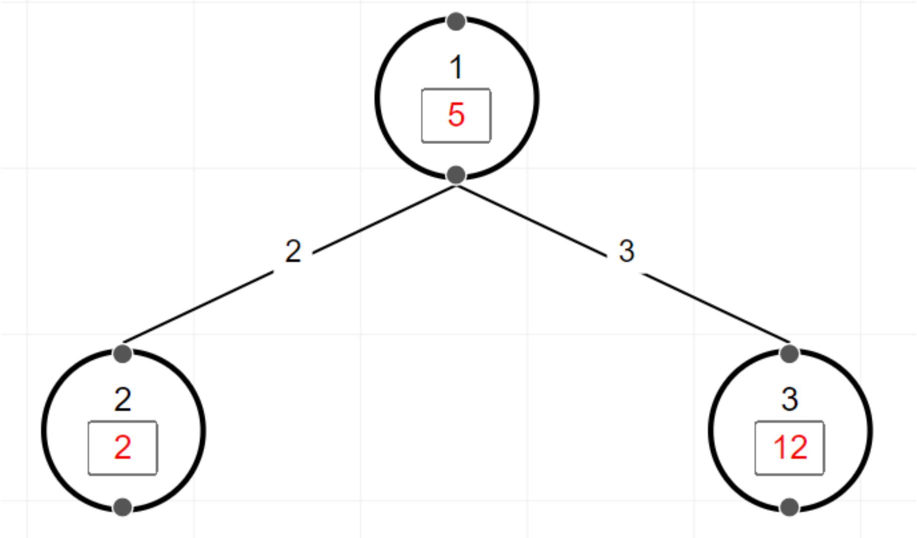
The default colour of all nodes is white. During visualisation, colours are used to represent the state of each node at different stages of the search. These states include current, visited and to-do. This is an example search tree mid-visualisation, to show the different node colours:



In this example, node 1 has been visited. Node 2 is the current node. Nodes 3, 4 and 5 are to-do and nodes 6 and 7 are yet to be considered in the search.

2.2.2.3. Node value

The red value of a node is displayed while A* Search is selected. This value is the heuristic value of the node, which is used to rank options during A* Search. This is a search tree while A* Search is selected:



In this example, node 1 has a heuristic value of 5, node 2 has a heuristic value of 2 and node 3 has a heuristic value of 12. Selecting the box within the node will allow you to edit the value.

2.2.2.4. Move node

To move a node around the canvas:

1. Hover your mouse over the node until you see a small hand replace your normal cursor.
2. Click and hold while moving your mouse around the canvas to move the node you have selected.
3. When you have decided where to place the node, simply let go and the node will remain at that position.

2.2.2.5. Delete node

To delete a node from the canvas:

1. Using your mouse, click on the node you wish to remove from the canvas.
2. Press the backspace key to delete the selected node.

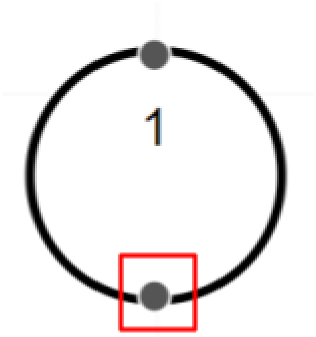
Note: deleting a node will also remove any edges that were connected to the node. You are not able to delete nodes from the canvas while comparison mode is turned on (see section 2.5.4).

2.2.3. Edges

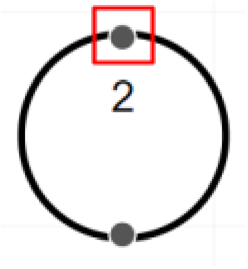
2.2.3.1. Create edge

To create an edge between two nodes:

1. Hover your mouse over the source circle (indicated in the figure below) on the bottom of the first node until your cursor changes to resemble a crosshair or plus symbol.



2. When the cursor appears, click and hold to begin creating the edge. As you move your mouse, you will see a preview of what the edge will look like.
3. Bring your cursor to the target circle (indicated in the figure below) on the top of the node you want to connect to.

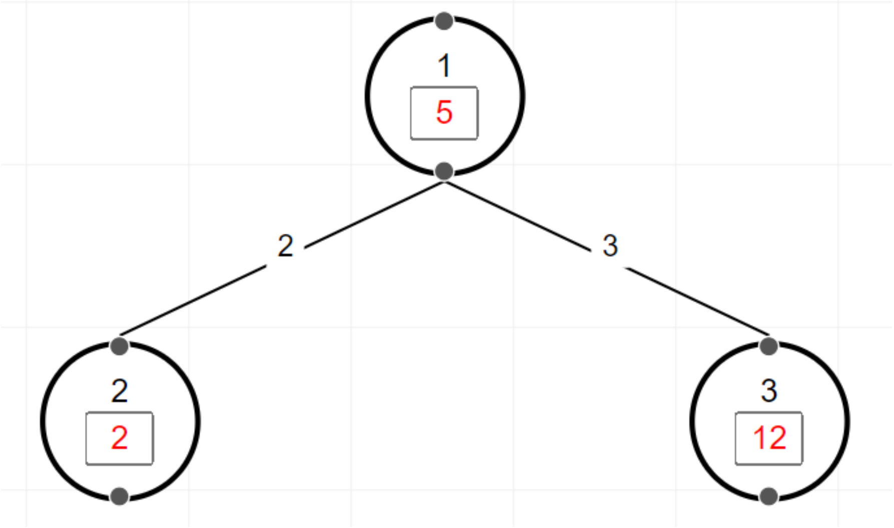


4. Over the target circle, release your mouse to successfully create a new edge.

Note: Using this method to create an edge will cause node 1 to be a parent of node 2. It is possible to create an edge backwards by connecting a target circle to a source circle, but you must remember the parent-child relationship will be reversed. You are not able to add nodes to the canvas while comparison mode is turned on (see section 2.5.4).

2.2.3.2. Edge value

The value on an edge is displayed while A* Search is selected. This value is the cost value of the edge, which can also be considered as the distance taken to travel along the edge. This is a search tree while A* Search is selected:



In this example, the cost of travelling from node 1 to node 2 is 2 and the cost of travelling from node 1 to node 3 is 3. Selecting the value on the edge will allow you to change it.

2.2.3.3. Delete edge

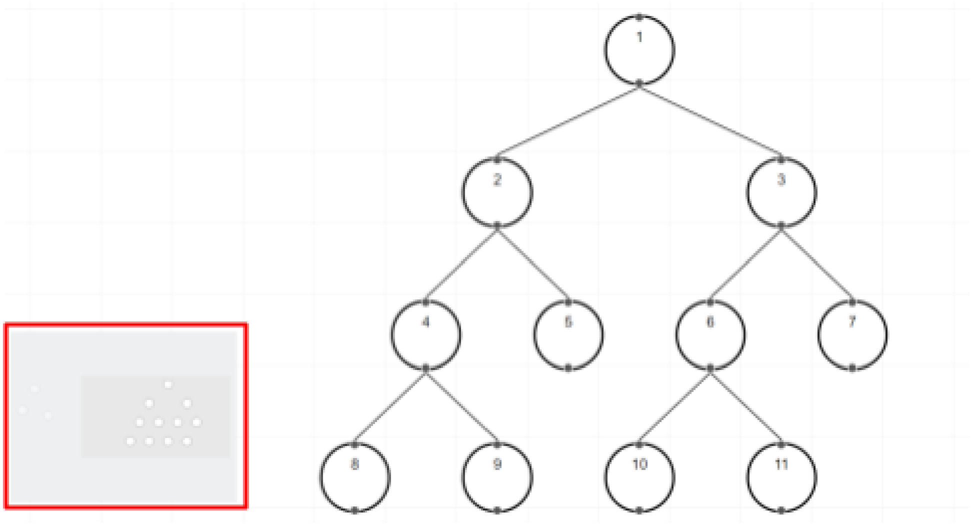
To delete an edge:

1. Using your mouse, click on the edge you wish to remove from the canvas.
2. Press the backspace key to delete the selected edge.

Note: You are not able to add nodes to the canvas while comparison mode is turned on (see section 2.5.4).

2.2.4. Minimap

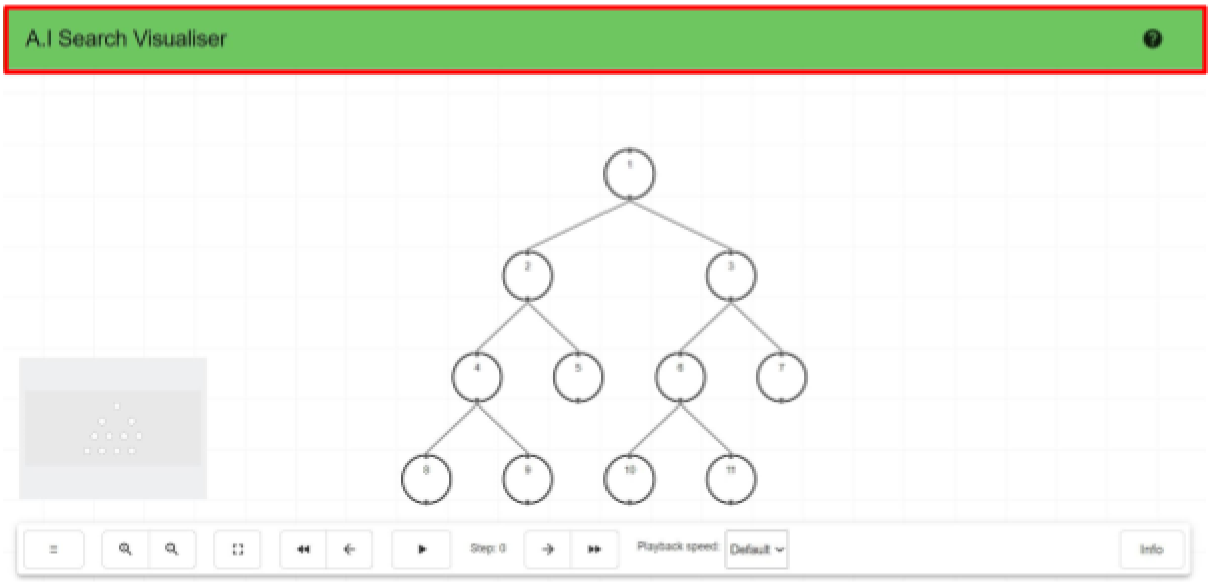
The minimap is located on the bottom left of the canvas (highlighted in the figure below).



The minimap shows a miniature, simple version of the whole canvas, highlighting the area that is currently within your view.

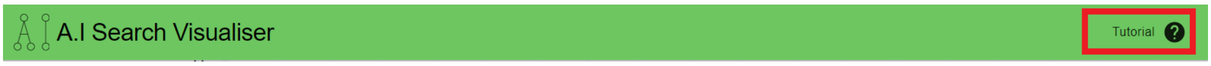
2.3. Navigation bar

The navigation bar is highlighted in red in the following figure.

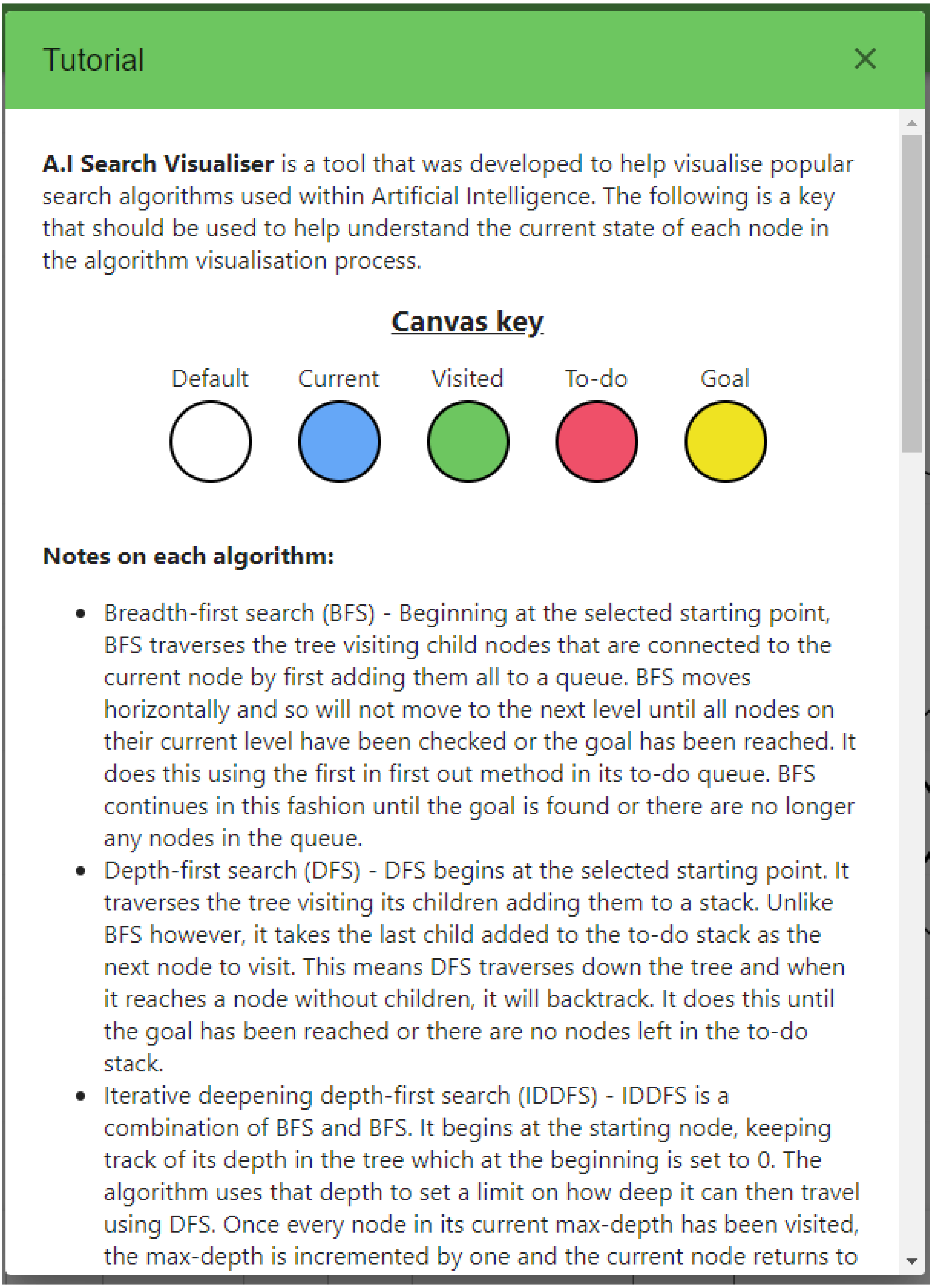


2.3.1. Tutorial

To open the tutorial, click on the (?) button on the right side of the navigation bar, highlighted below.



Clicking the button will make a pop up window appear over the rest of the webpage. The tutorial contains information about the different features of the web application for you to read while using it. This is an example of what the window would look like:



A.I Search Visualiser is a tool that was developed to help visualise popular search algorithms used within Artificial Intelligence. The following is a key that should be used to help understand the current state of each node in the algorithm visualisation process.

Canvas key

Default	Current	Visited	To-do	Goal
○	🔵	🟢	🔴	🟡

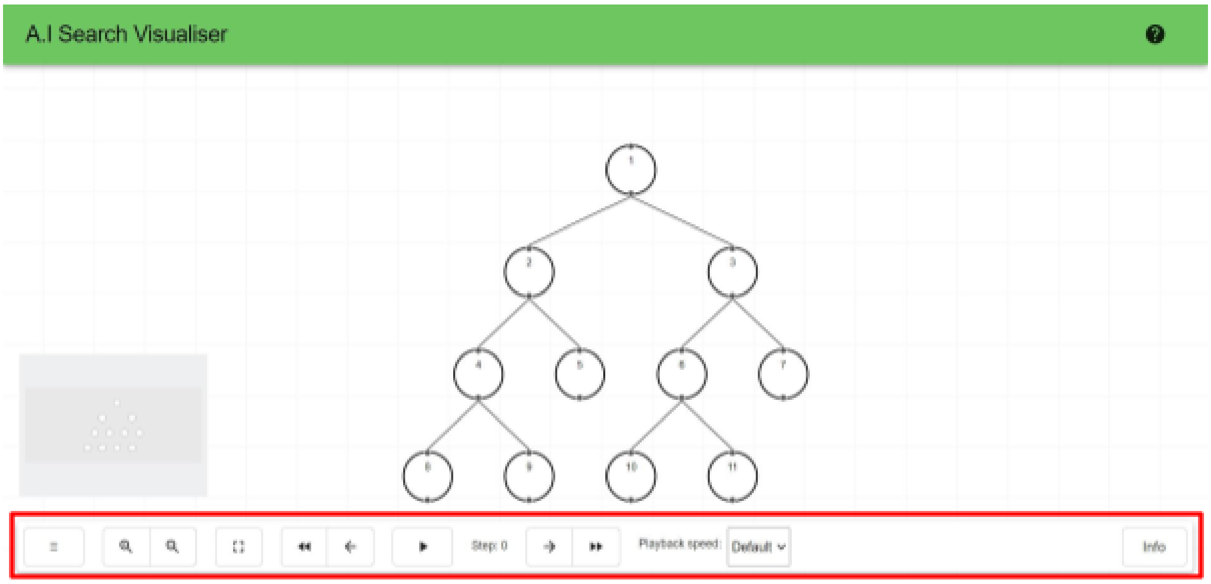
Notes on each algorithm:

- Breadth-first search (BFS) - Beginning at the selected starting point, BFS traverses the tree visiting child nodes that are connected to the current node by first adding them all to a queue. BFS moves horizontally and so will not move to the next level until all nodes on their current level have been checked or the goal has been reached. It does this using the first in first out method in its to-do queue. BFS continues in this fashion until the goal is found or there are no longer any nodes in the queue.
- Depth-first search (DFS) - DFS begins at the selected starting point. It traverses the tree visiting its children adding them to a stack. Unlike BFS however, it takes the last child added to the to-do stack as the next node to visit. This means DFS traverses down the tree and when it reaches a node without children, it will backtrack. It does this until the goal has been reached or there are no nodes left in the to-do stack.
- Iterative deepening depth-first search (IDDFS) - IDDFS is a combination of BFS and BFS. It begins at the starting node, keeping track of its depth in the tree which at the beginning is set to 0. The algorithm uses that depth to set a limit on how deep it can then travel using DFS. Once every node in its current max-depth has been visited, the max-depth is incremented by one and the current node returns to

To close the tutorial window, click on the X button in the top right corner.

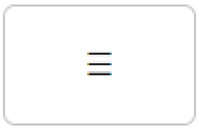
2.4. Toolbar

The toolbar is highlighted in red in the following figure.



2.4.1. Open sidebar

To open the sidebar, click on the first button (pictured below) on the left of the toolbar. The sidebar will appear on the left of the screen.



2.4.2. Canvas view controls

The canvas view controls are the next set of buttons to appear on the toolbar.

2.4.2.1. Zoom in

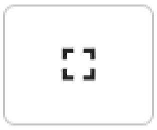
Use the zoom in button to zoom into the canvas.

2.4.2.2. Zoom out

Use the zoom out button to zoom out of the canvas.

2.4.2.3. Fit to view

Use the fit to view button to fit all items on the canvas within your window.

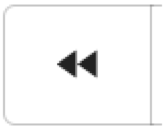


2.4.3. Playback controls

The playback controls are the next set of buttons to appear on the toolbar.

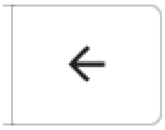
2.4.3.1. Skip backward

During a visualisation, use this button to return to step 0.



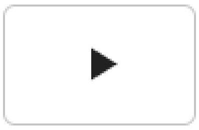
2.4.3.2. Step backward

During a visualisation, use this button to move back by one step.

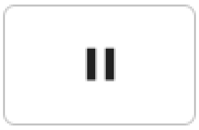


2.4.3.3. Play/Pause

During a visualisation, press play to automatically step through the visualisation from start to finish.



During playback, you can press pause to stop the visualisation.



Once playback is complete, pressing play will cause the playback to replay from the start.

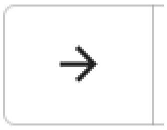
2.4.3.4. Step counter

The step counter indicates which step of the search the visualisation is currently on.

Step: 7

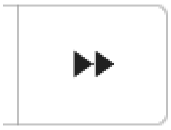
2.4.3.5. Step forward

During a visualisation, use this button to move ahead by one step.



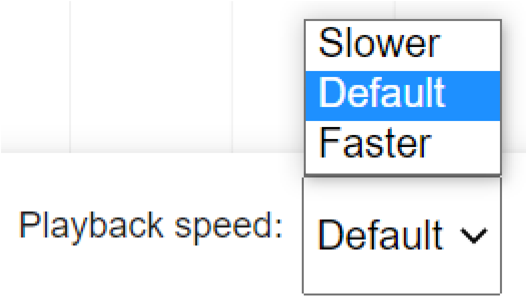
2.4.3.6. Skip forward

During a visualisation, use this button to skip to the final step.



2.4.3.7. Playback speed

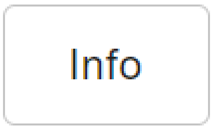
You can choose to play visualisations at a slower, default or faster speed using the popup menu on the toolbar.



2.4.4. Information box

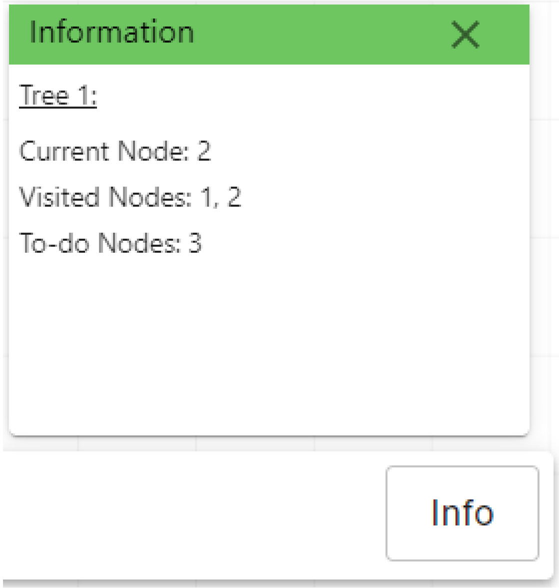
2.4.4.1. Open information box

Open the information box by clicking on the “info” button at the end of the toolbar.



2.4.4.2. Information

During visualisation, the information box will display information about the search at the current step. This includes the current, visited and to-do nodes in textual lists and sometimes additional information such as information about the second tree during comparison mode or heuristic information during A* Search.



Information

Tree 1:

Current Node: 2

Visited Nodes: 1, 2

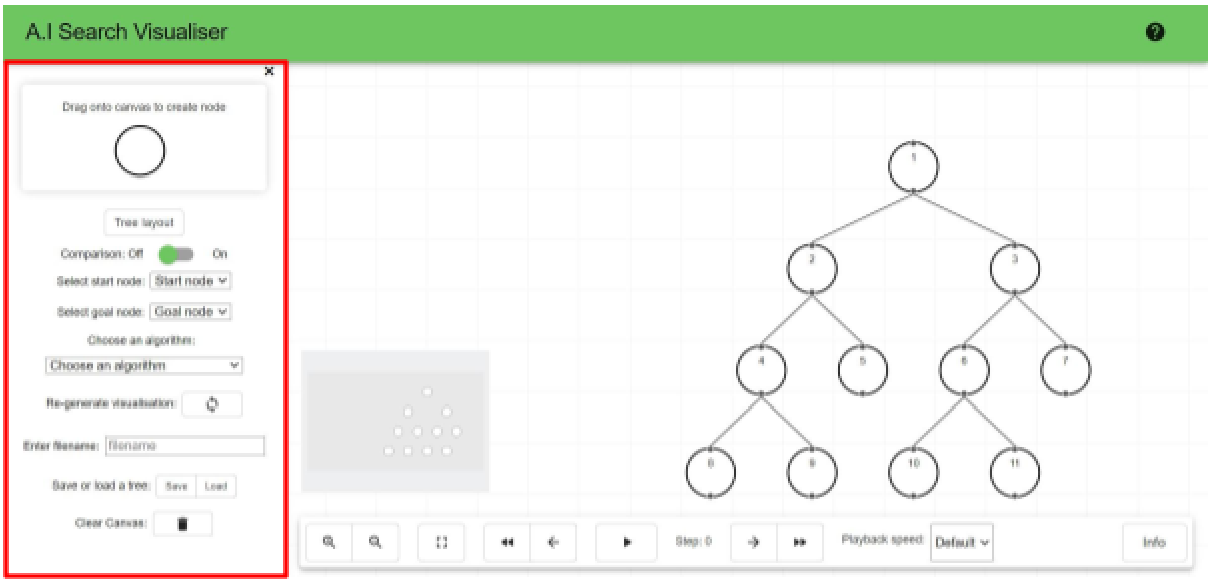
To-do Nodes: 3

2.4.4.2. Close information box

To close the information box, press the X on the top right corner.

2.5. Sidebar

The open sidebar is highlighted in red in the following figure.



2.5.1. Accessing sidebar

To access the sidebar, use the button in the toolbar, described in section 2.4.1.

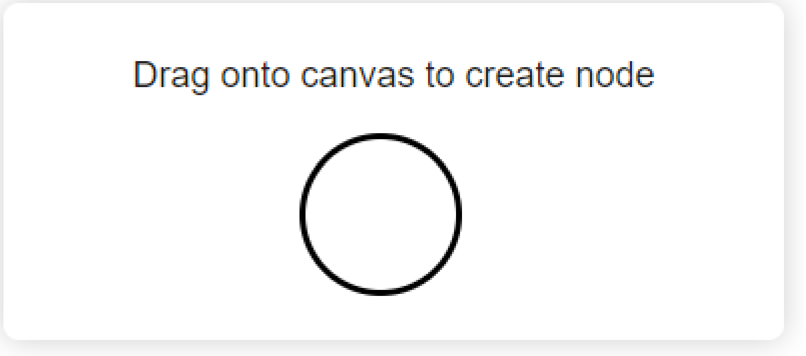
2.5.2. Create node

To create a node:

1. Hover over the node at the top of the sidebar until your cursor changes into a hand.
2. Click and drag the node from the sidebar over onto the canvas.

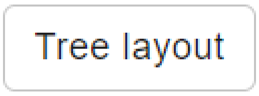
3. When you are holding the node where you want to place it, release your mouse and it will be added to the canvas with an automatically generated label.

Note: You are not able to add nodes to the canvas while comparison mode is turned on (see section 2.5.4).



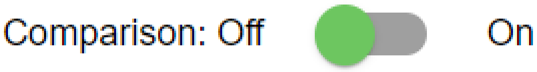
2.5.3. Tree layout

Click the tree layout button to automatically position nodes into a tidy tree structure.



2.5.4. Comparison switch

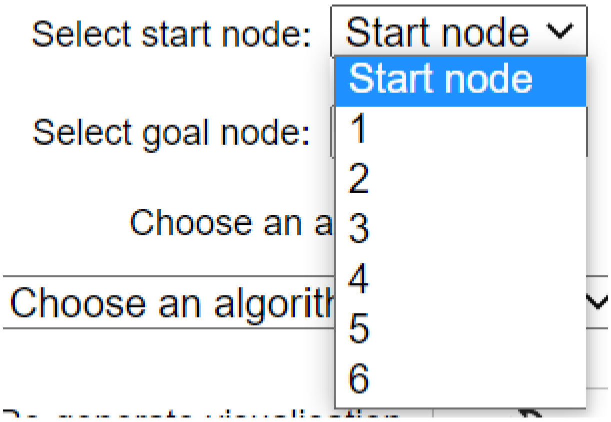
Clicking on the comparison switch will toggle it from off to on and vice versa. When switched on, the current tree on the canvas will be duplicated. This is to allow for two identical trees so two algorithms can be simultaneously visualised, side-by-side.



2.5.5. Visualisation setup

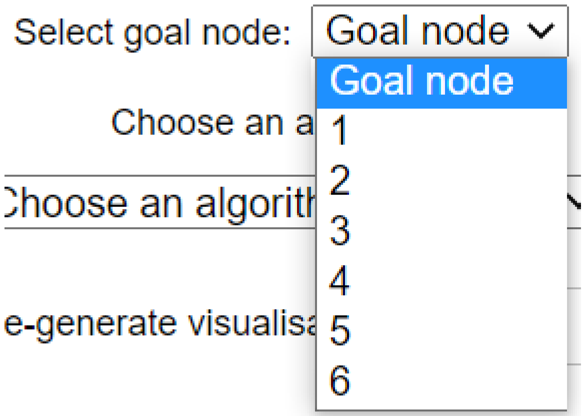
2.5.5.1. Select start node

Select the start node for the search using the dropdown menu. The start node is where the search will begin.



2.5.5.2. Select goal node

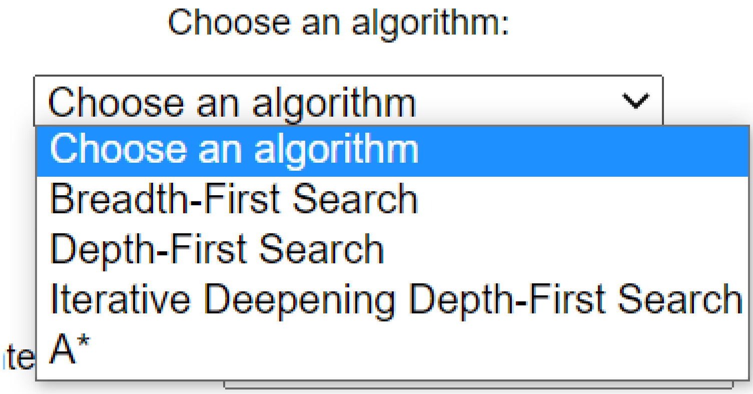
Select the goal node for the search using the dropdown menu. The goal node is the node the search is trying to find. If the search is successful, this node is where the search will end.



Note: if you wish to visualise Iterative Deepening Depth-First Search, the goal must be reachable from the start node

2.5.5.3. Choose algorithm

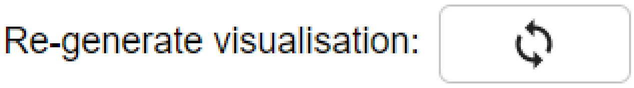
Select the algorithm you wish to visualise using the dropdown menu.



Once you have made the necessary selections, you can use the playback controls (see section 2.4.3) to view the visualisation you have generated.
Note: In comparison mode, A* search is not an available algorithm option. In this mode you will also need to make a second algorithm selection in a second dropdown menu.

2.5.5.4. Re-generate visualisation

If you make changes to the values of any nodes or edges, you need to re-generate the visualisation to account for the new values. To do this, click the refresh button.

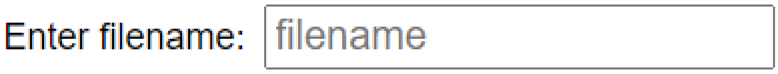


2.5.6. Saving and loading JSON files

The nodes and edges on the canvas can be recorded in JSON files.

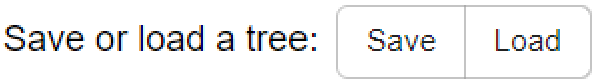
2.5.6.1. Enter filename

To save the JSON file with a particular filename, enter it into the input box above the save and load buttons.



If you leave the box blank, the file will be saved with the name “elements.json”.

2.5.6.2. Save or load a tree



2.5.6.2.1. Save

Click the save button to save the elements that are currently on the canvas. This will download a JSON file that you can reuse or edit onto your device.

2.5.6.2.2. Load

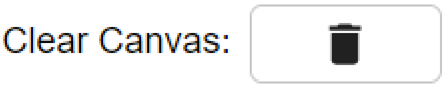
Click the load button to select a JSON file to upload to the canvas. You can use this feature to open trees you have previously saved or edited.

2.5.6.2.3. Edit information in JSON

You can change the label of nodes by changing the label value of the node inside a JSON file. If you upload this edited file, you will see the new label.

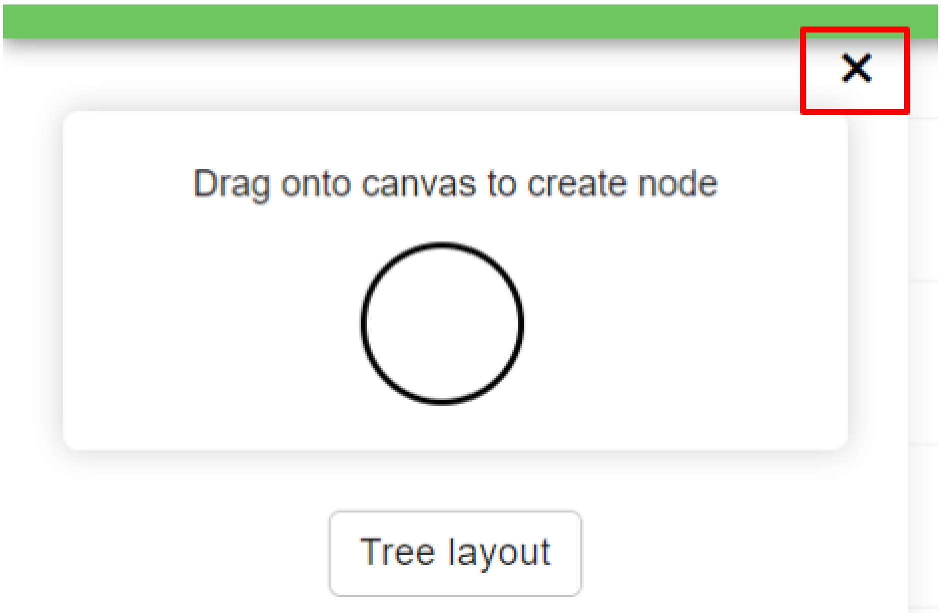
2.5.7. Clear canvas

Click the clear canvas button to remove all nodes and edges from the canvas, leaving it blank.



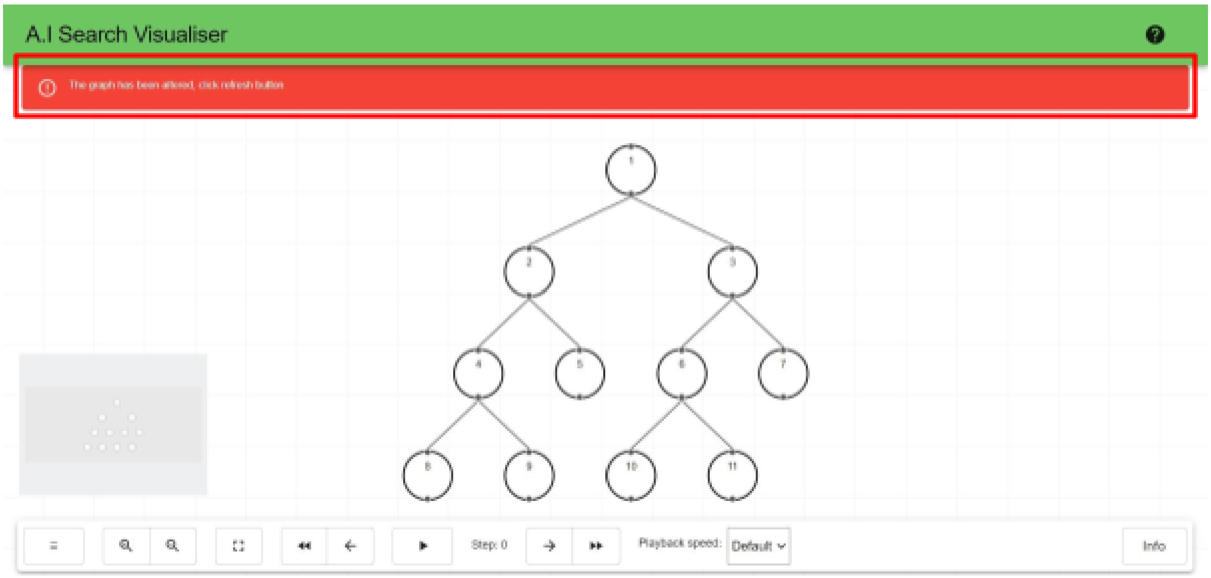
2.5.8. Close sidebar

To close the sidebar, click the X button on the top right of it.



2.6. Warnings

Warnings appear at the top of the canvas, as highlighted in the figure below.



The graph has been altered, click refresh button

Warnings let you know when something is preventing the visualisation, such as the start node not being selected or a node being removed during playback.