USER MANUAL - Mathematical Morphology Grid Graph Visualizer

INTO TO Mathematical Morphology: **(For users new to the concept) (aka MM)**
Mathematical Morphology (MM) is a theory and technique initially used in analyzing geometrical structures. It is based on set theory, lattice theory and topology. It is most commonly used in images, to perform different types of image transformations

The simple explanation is to use a <u>structuring element</u>, which is a predefined set that is used to transform the input image. It is used by matching itself with the image, and based on the 4 different operations that will be mentioned in time, it would have different behaviors on the image.

The same concept of mathematical morphology can be applied on graph type structures

Structuring Element
The structuring element is implemented differently when used on graphs. Each structuring element must have a point of origin (it can be a node or an edge) and can contain nodes/edges. It can be connected or disconnected. It can be broken down into 3 parts:

1.) What to do with nodes: This part has a node as its origin. In the case of nodes , the origin node does not have to be part of the result, but can still be the origin as the origin is a reference point.

2.) What to do with Horizontal edges: This part has a horizontal edge as its origin. In the case edges the nodes that are in between the edge must be present.

3.) What to do with Vertical edges: This part has a horizontal edge as its origin. In the case edges the nodes that are in between the edge must be present.

Fig 1 shown below is an example of what a 3 part structuring element looks like. The origin is highlighted in green for all three cases. Dashed edges mean that the edge is not included.

Fig 2 shows the scenario where the node can be selected as the origin but not included in the final result. The color is used to represent this and is similar to the tool.
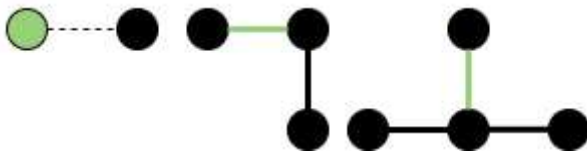
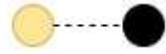Fig 1: 3 Part Structuring Element

Fig 2: Node Case Type 2

A structuring element is mandatory when performing these MM operations as without it , no meaningful transformation will occur.

MM Operations:

There are 4 Operations that will be discussed which are implemented in this program:

1) Dilation: The idea behind dilation in graphs is to add the structuring element to the sub-graph if the origin matches with the sub-graph. There can be cases where some parts of the structuring element cannot be added to the graph as when the match is made , a portion of the structuring element could extend beyond the graph. Another interesting behavior is when the sub graph is empty, the dilated sub graph is also empty.

2) Erosion: The idea behind erosion in graphs is to add the origin of the structuring element to the sub-graph if the origin matches with the sub-graph. There can be cases where some parts of the structuring element cannot be added to the graph as when the match is made , a portion of the structuring element could extend beyond the graph. Another interesting behavior is when the sub graph is empty, the eroded sub-graph contains all the elements of the original grid.

3)Opening: Erosion followed by Dilation

4)Closing: Dilation followed by Erosion

Note that the resulting subgraph may not always contain the nodes and edges that were originally present in the subgraph. The result will also always be a subgraph.

The App:

This tool is hosted on a web application. After providing graph dimensions you will see the following interface.
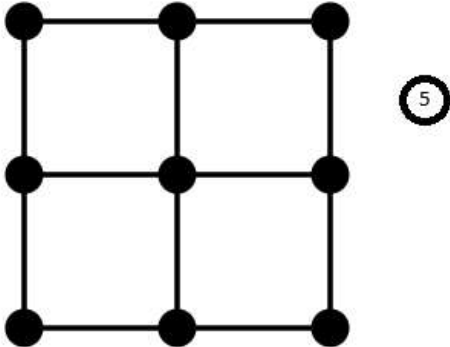

This Is The Grid

1.) Subgraph Popup: Clicking on this button will result in a popup. The popup provides instructions on how to to select a subgraph
2.) Predefined SE Selector: Clicking on this dropdown gives you a few predefined cases along with the option to choose a custom structuring element. Each predefined case has an image that shows how the structuring element looks like along with its origin. If the user selects the "Custom Structuring element option" , additional pop up buttons next to (1) will be visible, providing instructions on how to select.
3.) The MM operation Dropdown: Used to select the operation you want to perform on the subgraph.
4.) Perform Operation Button: When you have completed (1), (2) and (3), click on this button to perform the operation
5.) Grid Displays: This section of the screen displays the original grid, subgraph and resulting subgraph after the MM operation