Submission

Contest: 22nd Annual Graph Drawing Contest
Topic: Tic Tac Toe

Authors

Remus Zelina, e-mail: rzelina@meurs.ro
Sebastian Bota, e-mail: seby@meurs.ro
Siebren Houtman, e-mail: s.houtman@meurshrm.nl
Radu Balaban, e-mail: radu_balaban@meurs.ro

Analysis and layout

In order to capture the information hidden in the graph structure, we performed an analysis and used its results to emphasise certain features when creating the graph layout.

Given the graph containing 765 vertices and 2096 edges, the following types of vertices can be identified:

- 91 winning positions for X
- 44 winning positions for O
- 3 draw positions
- 321 positions in which X can force a win (regardless of what O moves)
- 158 positions in which O can force a win
- 148 neutral positions

The edges have two possible categories:

- edge representing a move by X
- edge representing a move by O

A vertex corresponds to a force-win position, for instance of X, if from that position, regardless of what edge of O we follow, there is at least one edge of X leading to either a winning position or to another force-win position for X.

In addition to the classification above, the vertices have a depth corresponding to the number of moves in the game (their distance from the empty-board vertex).

Therefore, we decided to represent the graph with a multi-layer clustered approach. We implemented a custom algorithm to perform the graph path analysis above as well as drawing the graph layout.

Visualization legend

The *vertex* clusters are arranged in 5 columns, in the following order:

- A - positions won by X - dark red
- B - positions from which X can force a win (regardless of what O moves) - light red
- C - positions from which no player can lose if they both play “correctly” - blue
- D - positions from which O can force a win - light green
- E - positions won by O - dark green

The *edges* use the color red if they represent a move by X and green if they represent a move by O.

There are 10 layers, each corresponding to a number of filled positions on the board, and they are ordered by this number (0 - empty board, 9 - full board).

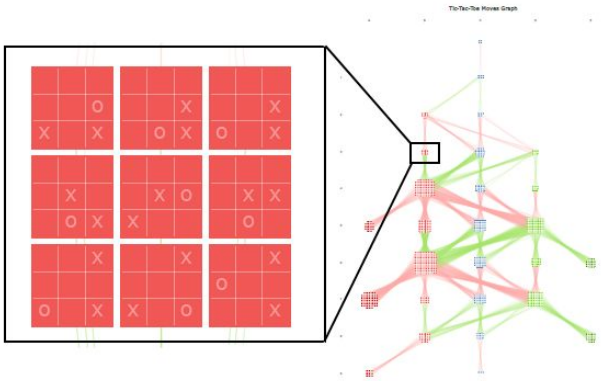
Notes and conclusions

The vertices belonging to the same cluster obviously have no edges between them.

In order to highlight the overall graph structure (especially the transitions between clusters of positions), edge bundling was used.

Red edges cannot go from right to left, green edges cannot go from left to right (except towards winning positions), which actually means that you cannot win unless the opponent makes a mistake.

The graph layout is vectorial, and zooming in closely (in a PDF viewer) will reveal the actual board position on each vertex in the graph.



Tic-Tac-Toe Moves Graph