Algorithms for graph visualization

Project - Orthogonal Grid Layout with Small Area

Winter semester 2013/2014
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Orthogonal Grid Layout with Small Area

Let $G = (V, E)$ be a graph with maximum degree 4. An orthogonal grid layout is a drawing of $G$ such that:

- Vertices are on distinct grid points
- Edges are orthogonal, (sequence of vertical and horizontal segments)
- Bends lie on grid. No limit on the number of bends.
- Crossings are allowed. They occupy grid points. No limit on the number of crossings.
- Overlaps are forbidden.

Area of orthogonal layout is the number of grid points in the smallest rectangle that encloses the layout.
Orthogonal Grid Layout with Small Area

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We are looking for orthogonal grid drawings with small area.
Orthogonal Grid Layout with Small Area

Given an orthogonal layout of $G$ one can do the following to reduce the area:

- Move vertices
- Move edges
- Redraw/re-route edges
Orthogonal Grid Layout with Small Area

Demo
Orthogonal Grid Layout with Small Area

- **Our target**: A program that takes as input a graph layout and outputs a layout with as small area as possible.
Orthogonal Grid Layout with Small Area

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- **Input and output** format:

```
5 ← Number of vertices
4 2 ← Vertex 0
2 4
4 4
6 4
4 6

1 0 [ 2 2 ] ← Edge (1, 0)
0 3 [ 6 2 ]
2 1 []
0 2 []
1 4 [ 2 6 ]
4 3 [ 6 6 ]
0 4 [ 4 0 0 0 0 8 4 8 ]
```
Orthogonal Grid Layout with Small Area

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- **Input and output** format:

- **What are you expected to do?**
  - Come up with your own algorithm, heuristics, interactive approach
  - Use existing algorithms, their combination, modifications

```
5  ➔ Number of vertices

4  2  ➔ Vertex 0
2  4
4  4
6  4
4  6

1  0  [ 2  2 ]  ➔ Edge (1, 0)
0  3  [ 6  2 ]
2  1  []
0  2  []
1  4  [ 2  6 ]
4  3  [ 6  6 ]
0  4  [ 4  0  0  0  0  8  4  8 ]
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- **What can you use?**
  - Any library freely available for academic use
  - Any graph drawing algorithm, whether included in the lecture material or not

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<table>
<thead>
<tr>
<th>5</th>
<th>Number of vertices</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 2</td>
<td>Vertex 0</td>
</tr>
<tr>
<td>2 4</td>
<td></td>
</tr>
<tr>
<td>4 4</td>
<td></td>
</tr>
<tr>
<td>6 4</td>
<td></td>
</tr>
<tr>
<td>4 6</td>
<td></td>
</tr>
</tbody>
</table>

```
1 0 [ 2 2 ]  # Edge (1, 0)
0 3 [ 6 2 ]
2 1 []
0 2 []     # Sequence of bend coordinates
1 4 [ 2 6 ]
4 3 [ 6 6 ]
0 4 [ 4 0 0 0 0 8 4 8 ]
```
Some Available Tools

- **OGDF** - Open Graph Drawing Framework
  - C++ library with implementations of graph drawing algorithms
  - open-source, free
  - Contains an implementation of orthogonal layout algorithm

- **yFiles**
  - Java library with implementations of graph drawing algorithms
  - Version 2.9 can be provided
  - Implementation of orthogonal layout algorithm
  - Compaction algorithm for orthogonal layout

- **JUNG** - Java Universal Network/Graph Framework
  - Java library with algorithms for analysis and visualization of graphs
  - open-source, free

- **Gephi** - Interactive Visualization and Exploration Platform
  - open-source, free
  - Plugin using Gephi API
  - Existing plugin?
You will be provided with several data files to test your algorithms
An application that displays this data format and allows manual modifications
How to Start?

- Play with the provided tool and the graphs to create ideas on how to proceed
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- Think which other algorithms can provide you an initial layout

Graph $G \rightarrow$ Initial Layout $\Gamma \rightarrow$ Orthogonalize $\Gamma$
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Graph $G$ $\rightarrow$ Initial Layout $\Gamma$ $\rightarrow$ Orthogonalize $\Gamma$

- Think but have your mind open in the upcoming lectures to get further ideas!
Before You Start

- Form Groups of 2 to 4 people
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- Schedule Meetings
  - **1st Meeting** - Discuss Ideas, Questions: **Before Christmas**
  - **2nd Meeting** - Finalize Ideas: **Mid January**
  - **3rd Meeting** - Intermediate Discussion: **Late January**
  - **4th Meeting** - 1st Version: **February**
  - **5th Meeting** - Final Version, Presentation, Competition: **Late March**
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Presentation
- 20 min presentation (including questions) of the ideas behind your approach
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Competition:
- Teams will receive a new collection of graphs
- After one hour, all teams will submit their final drawings
- The team with the highest cumulative score wins