Visualizations in Graph Theory and the Wolfram Language

Michael Sobolev Ph.D.
Chief Scientist at Orbi Labs


```
Graph[{1,2},
  {DirectedEdge[1, 2],
   DirectedEdge[2, 1]},
   VertexLabels = {1 → "Alice",
   2 → "Bob"},
   VertexStyle = {1 → Blue, 2 → Red},
   EdgeLabelStyle = {DirectedEdge[1, 2] → Black, DirectedEdge[2, 1] → Black},
   EdgeLabels = {DirectedEdge[1, 2] → "Hello", DirectedEdge[2, 1] → "Hi"},
   VertexLabelStyle = {1 → White, 2 → White},
   VertexSize = {1 → 0.15, 2 → 0.15},
   ImageSize → 300,
   Frame → True,
   FrameStyle → Gray,
   Background → RGBColor[0.95, 0.95, 0.95],
   PlotLabel → "Two Vertices Connected",
   LabelStyle → {Bold, 12},
   PlotRangePadding → 0.2]
```


Welcome to my talk

1. Coding and Graph Theory
2. Interactive Geographical Art

Q: What is the future of scientific communication?

A: Interactive Geographical Art

Example #1: New York Times

Visualizing current situations in central media

Example #2: OpenDNS

Visualizing network activity

Example #3: Healthcare

Visualizing movement of patient metadata

Example #4: Cosmic Web

Network Science for Cosmic Web

My Favorite Piece of MMA Code

Flyby by Zdzislaw and me

Problem motivation: Laszlo Babai and his algorithm

Graph Isomorphism

- **Input Description**: Two graphs, G and H
- **Problem description**: Find a mapping f from the vertices of G to the vertices of H such that G and H are identical.
  i.e. (u, v) is an edge of G iff $(f(u), f(v))$ is an edge of H.

Quasipolynomial Time

- Function $f(n) = 2^{c \log^k n}$ for an *arbitrary/constant* but *subexponential* and called **quasi-polynomial**.

Best Known Methods

Algorithms:

- Trivial bound $O(n!)$
- Eugene Luks 1980 bound of $\exp(O(\sqrt{n \log n}))$
- $\exp(O(\log n)^2)$ from Babai in 2015

Implementations:

- Pascal (Brendan McKay)
- VF2Lib graph-matching library
- Nauty graph-matching library
- Bliker and Simon

Summary & Implications

- Babai's proposed algorithm doesn't bring graph isomorphism all the way into P, but it comes close.

Isomorphic Animations

Pappus Graph

Generate Frames

```
Table[
  Show[
   GraphPlot[Pappus[], VertexLabels → False, VertexSize → 0.08, EdgeStyle → {Gray}, ImageSize → 300],
   Graphics[{Text[ToString[i], {0.9, 0.9}]}]
  ],
  {i, 1, 20}
]
```

Export Animations

```
Export["/Users/sobolev/Desktop/Pappus.gif",
  %,
  "AnimationRepetitions" → Infinity,
  "DisplayDurations" → 0.5,
  ImageSize → 300]
```

Enhancing the Animations

Limitation 1: Many Graphs

Limitation 2: Large Graphs

Great Rhombicosidodecahedral Graph

Deployment options

Dynamics on the Wolfram Cloud – Issues with stability and Frame-rates

How to deploy interactivity, really!

Javascript, HTML5, Electron, etc.

Demo #1: Sigma.js

Demo #2: D3

Demo #3: Javascript Limitations

Demo #4: Visualizing NeuGraph

Summary

- Workshop examples of Graph Theory
- Check out Lukasz Bielak's paper on the arxiv
- Use Wolfram Cloud for deployment of Graph Theory
- BRAIN needs canonical integration and/or enhanced expressibility
- Feature request: Please make exporting cool easy :)

Thanks for listening

Connect with me:

email michaelsobolev@gmail.com
www www.orbilabs.com
AIM Page mikeandrobots.com
twitter @OrbiLabs
blog www.orbilabs.com

Demo

- Bliki (Ludwig Wittgenstein)

- Al better score