CSC337/CSCM37 Data visualization

Credit points: 15
Teaching block: Teaching block 2 (TB2)
Contact Hours: 20 lectures + 9 optional labs
Lecture Times: Tuesdays, 14:00, Engineering central B003
Thursdays, 11:00, Engineering central B003
Optional Laboratory/Practical: Wednesdays, 12:00, Computational foundry 203 (windows lab)
Thursdays, 12:00, Computational foundry 203 (windows lab)
(there is no lab the first week of lecture)
Lecturer: Dr. Thomas Torsney-Weir
Office: Room 113 Computational Foundry
Email: t.d.torsney-weir@swansea.ac.uk
Office Hours: TBA and by appointment (afternoons are best)
Teaching Assistants: TBA — Please make an appointment with the TA if you cannot make it to the laboratory session.

Online Resources

Website: All the material used in the lecture will be posted on Blackboard: https://blackboard.swansea.ac.uk
Lectures will be recorded and posted on blackboard
Visguides.org: We will also be using an interactive web site, http://visguides.org/ for the assignments. VisGuides is a democratic discussion forum about visualization guidelines. It welcomes all students and teachers who are interested in data visualization and visual analyticsregardless of their background.

Assessment

- 50% coursework:
  - If you are in CSC337, there are 2 options for the coursework
    1. 50% assignment 1, 50% assignment 2
    2. $\frac{1}{3}$ assignment 1, $\frac{1}{3}$ assignment 2, $\frac{1}{3}$ assignment 3

  - If you are in CSCM37, then the weights will be: 15% assignment 1, 25% assignment 2, and 10% assignment 3
- 50% exam: The exam aims to assess the theoretical knowledge gained from

(1) lectures and (2) assessed coursework

Schedule

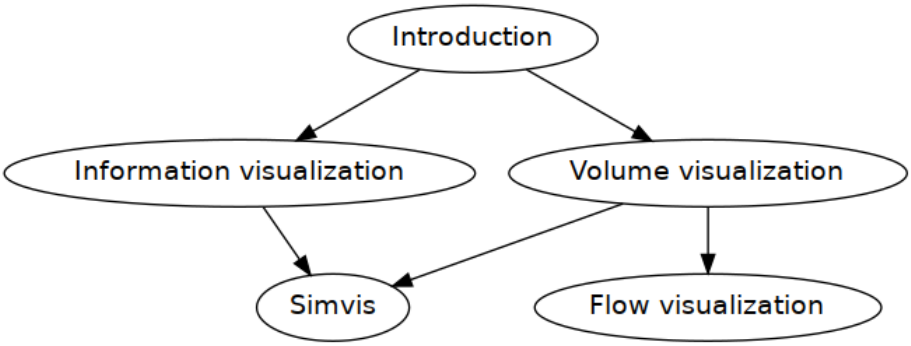

Figure 1: Topic dependency graph

Topics

Introductory Topics Include: purposes and goals of visualization, applications, challenges, sources of data: measurement, simulation, modeling, data dimensionality: 1D, 2D, 2.5D, 3D,time-dependent, data types: scalar, vector, nominal, multi-variate, color

Information Visualization Topics Include: abstract data, hierarchical data, conventional infor-mation visualization techniques, tree maps, focus and context techniques, glyphs graphs and graph layouts, multi-dimensional data, scatter plots, scatter plot matrices, icons, parallel coordinates, in-teraction techniques, linking and brushing

Volume Visualization Topics Include: slicing, surface vs. volume rendering, transfer functions:compositing, MPI (maximum intensity projection), first-hit, average (x-ray), scalar data, sources of volume data, challenges, voxels vs. cells, interpolation schemes, surface fitting methods: march-ing cubes, marching tetrahedra, image order vs. object order algorithms, gradients direct volumevisualization: ray casting, shear-warp factorization, ray tracing vs. ray casting, diffuse lighting(Phong shading), ray traversal, filtering, interpolation, gradients, shear-warp factorization–fast object/image-order rendering, hardware rendering of volume data, indirect volume visualization isosurfacing, “surface-fitting”methods, surface reconstruction methods, marching cubes, surface rendering vs. volume rendering

Flow Visualization Topics Include: simulation, measured, and analytical data, 2D, surface-based(2.5D), and 3D flow, steady and time-dependent (unsteady) flow, direct and indirect flow visual-ization, experimental flow visualization, applications, hedge hog plots, vector glyphs, numerical integration schemes, Euler integration, Runge Kutta Integration, streamlines, illumi-nated streamlines, streamline placement, pathlines, streaklines, stream ribbons, stream surfaces, stream arrows, flow volumes, stream tubes, line integral convolu-tion (LIC), texture advection, flow topology, critical points/singularities,

Recommended reference books

- Ward, Matthew O., Georges Grinstein, and Daniel Keim. *Interactive Data Visualization: Foundations, Techniques, and Applications, Second Edition - 360 Degree Business* 2015.
- Telea, Alexandru C. *Data Visualization: Principles and Practice, Second Edition* 2014.

Further reading

Books

- Schroeder, William, Ken Martin, and Bill Lorenson. *The visualization toolkit* 2004.
- Hansen, Charles D., and Chris R. Johnson. *The visualization handbook* 2004.
- Munzner, Tamara. *Visualization Analysis and Design* 2014.

Papers

- Rees, D., and R. S. Laramee. "A Survey of Information Visualization Books," Computer Graphics Forum. 2019.
- Jobard, Bruno, and Wilfrid Lefer. "Creating Evenly-Spaced Streamlines of Arbitrary Density," Visualization in Scientific Computing '97. 1997.
- Levoy, M. "Display of surfaces from volume data," IEEE Computer Graphics and Applications. 1988.
- Cabral, Brian, and Leith Casey Leedom. "Imaging vector fields using line integral convolution," Proceedings of the 20th annual conference on Computer graphics and interactive techniques. 1993.
- Amar, R., J. Eagan, and J. Stasko. "Low-level components of analytic activity in information visualization," IEEE Symposium on Information Visualization, 2005. INFOVIS 2005. 2005.
- Lorensen, William E., and Harvey E. Cline. "Marching cubes: A high resolution 3D surface construction algorithm," Proceedings of the 14th annual conference on Computer graphics and interactive techniques. 1987.

- Shneiderman, B. “The eyes have it: A task by data type taxonomy for information visualizations,” Proceedings 1996 IEEE Symposium on Visual Languages. 1996.
- Meyer, Miriah, Michael Sedlmair, and Tamara Munzner. “The four-level nested model revisited: Blocks and guidelines,” Proceedings of the 2012 BELIV Workshop: Beyond Time and Errors - Novel Evaluation Methods for Visualization. 2012.
- Laramee, Robert S., Helwig Hauser, Helmut Doleisch, Benjamin Vrolijk, Frits H. Post, and Daniel Weiskopf. “The State of the Art in Flow Visualization: Dense and Texture-Based Techniques,” Computer Graphics Forum. 2004.