Henry Segerman — *Publication List*

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Geometry and Topology

- *Triangulations of hyperbolic 3-manifolds admitting strict angle structures*, with Craig D. Hodgson and J. Hyam Rubinstein, 2011, arXiv: 1111.3168, 27 pages, 8 figures, submitted for review.
  A long standing problem is to give an ideal hyperbolic triangulation of a given cusped hyperbolic 3-manifold for which all tetrahedra have positive volume. In a step towards this, we show that a large class of hyperbolic 3-manifolds (including all link complements) have triangulations with strict angle structures, which are a weaker form of geometric structure associated to the triangulation.
- *Pseudo-developing maps for ideal triangulations I: Essential edges and generalised hyperbolic gluing equations*, with Stephan Tillmann, *Topology and Geometry in Dimension Three: Triangulations, Invariants, and Geometric Structures (Proceedings of the Jacofest conference)*, AMS Contemporary Mathematics **560** (2011), pp. 85–102, 18 pages, 8 figures.
  We show that if a triangulation of a 3-manifold admits a solution to the hyperbolic gluing equations (these conditions on the hyperbolic shapes of the tetrahedra in the triangulation ensure that they glue together properly), then all edges of the triangulation are *essential*, meaning that they cannot be deformed into the boundary of the manifold. The edges being essential is a necessary requirement for the definition of the map which sends solutions to the gluing equations into representations of the fundamental group of the manifold.
- *A generalisation of the deformation variety*, 2011, arXiv:0904.1893, 41 pages, 26 figures, submitted for review.
  This paper introduces a generalisation of the variety of solutions of the hyperbolic gluing equations. By allowing degenerate shapes of tetrahedra (when two or more of the vertices coincide), it contains solutions that can be missed with only the standard gluing equations, if one makes a "bad" choice of triangulation. We also give an application to the calculation of the A-polynomial (an invariant of the manifold).
- *Veering triangulations admit strict angle structures*, with Craig D. Hodgson, J. Hyam Rubinstein and Stephan Tillmann, *Geometry & Topology* **15** (2011), pp. 2073–2089, 15 pages, 9 figures.
  We show that "veering triangulations" (a recently defined class of triangulations of 3-manifolds) all have strict angle structures, which implies that the manifolds are hyperbolic. We also give some data on the prevalence of veering triangulations as found by computer search.
- *Incompressible surfaces in handlebodies and boundary compressible 3-manifolds*, *Topology and its Applications* **158** (2011), no. 4, 551-571, 31 pages, 14 figures.
  The main result is that for every compact surface with boundary, orientable or not, there is an incompressible embedding of the surface into the genus two handlebody. Incompressible embeddings of surfaces (often just "incompressible surfaces") are intrinsic to the topology of the manifold, with no extra handles that could be simplified away.
- *Detection of incompressible surfaces in hyperbolic punctured torus bundles*, *Geometriae Dedicata* **150** (2011), pp. 181–232, 52 pages, 25 figures.
  We show that all incompressible surfaces in hyperbolic punctured torus bundles (a well studied class of examples of 3-manifolds) can be produced by a well known construction involving "splittings" of the manifold at limiting geometric structures (where the lengths of paths through the manifold diverge to infinity).
- *On spun-normal and twisted squares surfaces*, 15 pages, 13 figures, in *Proc. Amer. Math. Soc.* **137** (2009), pp. 4259–4273.
  We explore the relationship between spun-normal and twisted squares surfaces, two different ways to describe surfaces embedded in a triangulation of a 3-manifold.

In progress

- *Triangulations of 3-manifolds with essential edge loops*, with Craig D. Hodgson, J. Hyam Rubinstein and Stephan Tillmann.
  We give three different constructions of essential and strongly essential triangulations of 3-manifolds. As above, an essential triangulation has no edge homotopic into a point, and a strongly essential triangulation has no two edges are homotopic, keeping their endpoints fixed.
- *Taut developing maps*, with Saul Schleimer.
  A taut angle structure on an ideal triangulation of a 3-manifold is a simple combinatorial structure, which can be thought of as a flattened angle structure. We investigate connections with layered triangulations of fibred manifolds, and with

flat geometric structures on the boundary of Dehn surgery space.

Neuroscience

· *Evaluation of fractional learning indices for associative conditioning*, with Sukant Khurana, Wen-ke Li and Nigel S. Atkinson, submitted for review.
We analyse a number of different "learning indices" that biologists have used to measure how well organisms (e.g. fly larvae) learn. These indices are simple functions of the response rates of organisms to a stimulus before and after training. We discuss the merits and limitations of the different indices, show that the choice of learning index can give qualitatively different results, and investigate the validity of assuming normality in the distribution of learning indices.

In progress

· *Larval olfactory responses are insensitive to population size*, with Sukant Khurana and Wen-ke Li.
A common experimental procedure to test the movements of small organisms (e.g. fly larvae) in the presence of some stimulus involves putting many of the organisms in a Petri dish together with the stimulus being tested. After a few minutes, one counts how many of the organisms are in a "stimulus zone" near the stimulus. In these experiments, it is tacitly assumed that there are no group effects: that single organisms in the same situation would act in the same way. Using an overhead video tracking system, we are able to show that this assumption is generally valid.

Mathematical Art and Recreational Mathematics

· *Recent 3D printed sculptures*, *Hyperseeing*, in press, 2011, 10 pages, 11 figures.
This is a portfolio piece, showing eleven recent 3D printed designs and describing the ideas behind them.

· *Fractal graphs by iterated substitution*, 20 pages, 20 figures, *Journal of Mathematics and the Arts*, ©Taylor and Francis, Volume 5, Issue 2, 2011, pp. 51–70.
We introduce a new class of graphs, inspired by physical structural problems inherent in 3d sculptures of steps in the constructions of space filling curves. The new class retains the self-similarity properties of previous constructions, but with more interconnections within the graphs they are more robust. We also introduce the use of the Cheeger constant to measure structural robustness.

· *The Sunflower Spiral and the Fibonacci Metric*, 2010, *Proceedings of the Bridges conference 2010*, 4 pages, 4 figures.
This paper explains an interesting pattern on the "sunflower spiral" when the nodes are coloured according to the number of Fibonacci numbers that must be summed to give the index of each node.

· *Autologlyphs*, with P.-O. Dehaye, *Math. Intell.* **26** (2004), no. 2, cover art and pp. 37–39.
This recreational piece showed some examples of self-referential mathematical typography.

· *100 prisoners and a lightbulb*, with P.-O. Dehaye and D. Ford, *Math. Intell.* **25** (2003), no. 4, pp. 53–61.
We investigate a difficult puzzle involving communication through a very inefficient and unreliable signalling system.

In progress

· *Sculptures in* S^3, with Saul Schleimer.
This documents a number of projects resulting in 3D printed sculptures of objects native to S^3 and realised in $\mathbb{R}^3$ via stereographic projection. We consider radial projections of 4-dimensional polytopes onto the unit 3-sphere, and particularly symmetric parameterisations of tori, Möbius strips and Klein bottles.