MS9

Topological Methods in Visualization

Vector fields are a very common data format in science and engineering. Topology analysis is often used to study vector fields because it clearly depicts the structure of the vector field. Mostly, only singularities are considered as topological features, neglecting the existence of other features. However, topological features can be defined based on asymptotic behavior of the flow, including important topological features, such as closed streamlines, which can be used to study even more complex properties of a flow. The talk will give an overview of topological methods followed by a detailed description of closed streamline detection.

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MS10

Weighted Delaunay Refinement

Simplicial meshes of polyhedral volumes are useful in finite element analysis and numerical simulations. The mesh quality is often measured by the element shape and the common goal is to obtain tetrahedra with bounded aspect ratio. Recent results have shown that Delaunay refinement is an effective paradigm for meshing polyhedral volumes, but slivers may persist in the output mesh. In this talk, I will outline how to use weighted Delaunay triangulation together with Delaunay refinement to offer provable bounds on the output angles.

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MS10

Meshing Surfaces with Delaunay Refinement

A Delaunay mesh of a surface is useful in many applications of science and engineering. We present an algorithm that can mesh an implicit surface with topological, geometric and quality guarantees. This algorithm is extended for polygonal surfaces that approximate smooth ones both point-wise and normal-wise. Both algorithms operate on the principle of Delaunay refinement that combine the classical furthest point insertion strategy with the epsilon-sampling theory in surface reconstruction. Polygonal surface (re)-meshing has been implemented and we show some of the results.

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MS10

Star Splaying: An Algorithm for Repairing Delaunay Triangulations During Mesh Movement

Consider the "Delaunay repair problem": suppose the vertices of a three-dimensional Delaunay mesh have moved in response to physical forces, and the mesh is no longer Delaunay. Can we recover the Delaunay triangulation of the new vertex configuration faster than reconstructing the triangulation from scratch? Star splaying is an algorithm that transforms any triangulation of any dimensionality into a Delaunay triangulation, and does so quickly if few changes are needed. Thus, it can serve as part of a system for maintaining high-quality moving meshes.

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MS10

Fast Delaunay Refinement Algorithms

Delaunay triangulations find great use in many fields, including engineering simulations, graphics, visualizations, robotics, geographic information systems, and biological modeling. Triangulations (meshes) are often required to have bounded aspect-ratio (quality guarantee) and small number of elements. Delaunay refinement is a popular method to compute such meshes. The original Delaunay refinement algorithm had quadratic time complexity in terms of the size of output. Recently, Har-Peled and Ungor designed a time-optimal Delaunay refinement algorithm to generate size-optimal quality-guaranteed triangulations in the plane. The algorithm takes $O(n \log n + m)$ time, where n is the input size and m is the minimum size of a good quality mesh. We will discuss challenges and ideas for extending this algorithm to three dimensions.

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MS11

Shape Operators for Manifolds

Geometric Algebra provides several alternative methods for coordinate-free differential geometry on manifolds of any dimension. This talk will explain how both extrinsic and intrinsic geometry of a manifold can be characterized a single bivector-valued one-form called the SHAPE OPERATOR, which is essentially the derivative of the unit pseudoscalar as it slides along the manifold. [Reference: D. Hestenes and G. Sobczyk, From Clifford Algebra to Geometric Calculus (Reidel: Dordrecht, 1984)]

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MS11

Introduction to Geometric Algebra

In this talk, I will give an introduction to the basics of Geometric Algebra, discussing the operators and the elements of the algebra. As an example of using geometric algebra, I will show how *bivectors* can be used to describe continuity between triangular Bezier patches.

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