Graduate Talk

Early-split connectivity encoding for geometric models in graphics

Over the last few years there have been great advances in compression for geometric models that are represented by the meshes of their boundaries. We have seen a number of connectivity coding schemes that perform similar region growing operations but differ in details such as the set of symbols used, the mesh elements they are associated with, the frequency of "split" operations, and whether they require explicit "split offsets". In this talk we present the idea of "early splits", which leads to six new encoding schemes: four that are variants of existing coders, and two that are different and complete the lineup. Our work clarifies the relation between some of the main encoding schemes (e.g., the Touma Gottsman-coder, Edgebreaker, and the Cut-Border machine) . This is recent work by my PhD student, Martin Isenburg.

Colloquium I

Hilbert curves for spatial ordering in higher dimensions

There are a number of orderings of the entries of a matrix or cells of a regular grid that try to improve locality of reference by keeping spatiallly nearby cells close in the linear order: examples include Morton or Z order, Gray code order, U order, and Hilbert curve order. Of these, only Hilbert curves preserves adjacency. Unfortunately, although they are pretty, Hilbert curves suffer from being less regular and slower to generate, because they are created by a top-down recursive procedure that maintains state.

In this talk I'll describe a notation for generating Hilbert curves that allow one to generate lookup tables for fast computation of Hilbert curve orders. We use this to permute points in 3d and 4d for faster incremental computation of Delaunay diagrams, but believe that it has other applications in databases and geographic information systems. This is joint work with Leo (Yuanxin) Liu.

Colloquium II

Fast Delaunay tessellation in 3d and 4d for protein and volume data

One of the ways to sumultaneously achieve robustness and speed in geometric computation is to limit your input to the precision that floating point hardware can handle without error. Usually this is too limiting, for computations such as the Delaunay tessellation in 3d and 4d, which involve 5- and 6-fold precision computations. In this talk, we consider the Delaunay of points from protein data bank files and time-varying volume meshes, for which the input can be represented as integers of limited precision. We show that careful selection of insertion orders can reduce the precision demands on the arithmetic and avoid point location structures, which are two of the barriers to a simple but robust incremental Delaunay construction. Specifically, we partition the points into levels to reduce the needed precision, and order by Hilbert curves within each level to support point location by walking. Using these with a sphere-based representation of simplices, and a simple method to handle degeneracies while guaranteeing full-dimensional simplices, we obtain a fast implementation of a Watson-style incremental algorithm using native floating point or long integer arithmetic. This is joint work with Leo (Yuanxin) Liu.