Abstracts

Title : Morse functions, fold maps, and geometric and constructive studies of higher dimensional closed differentiable manifolds

Speaker : Naoki Kitazawa (Institute of Mathematics for Industry, Kyushu University)

Abstract : This talk introduces essential mathematical theory in this project. We introduce Morse functions and fold maps, higher dimensional variants of Morse functions. About applications of these tools to geometry of manifolds, we introduce backgrounds, history, and studies of the speaker, mainly, construction of explicit fold maps and various information of higher dimensional manifolds admitting these maps. We will also present dreams for applications to higher dimensional data analysis, visualizations etc..

Title : Quick Survey of Reeb Spaces in Topology and Visualization

Speaker : Osamu Saeki (Institute of Mathematics for Industry, Kyushu University)

Abstract : Given a map between topological spaces, we have the associated Reeb space, which is the space of all the connected components of the fibers. In this talk, the speaker will survey the studies of Reeb spaces themselves together with those researches which use Reeb spaces as important tools, both in topology and in visualization, as far as the speaker knows.

Title : Applying Reeb Graphs and Reeb Spaces

Speaker : Daisuke Sakurai(Research Institute for Information Technology,Kyushu University)

Abstract : The Reeb graph of a function represents the connectivity of the inverse images.

The computational geometry community generalized this to the Reeb space of a mapping.

This talk gives a concise review around the speaker, who studies visual data analysis, on how they can be used for understanding data.

In fact, the Reeb graph and Reeb space play a role in visual data analysis in the researchers' pursuit for efficiently exploring features in data of interest.

The study of adapting these concepts partly emerged in the context of understanding contours in volumetric data such as computational tomography where the Reeb graph and space give an overview of objects in the volume.

The speaker discusses a few examplary applications and how mathematics on homology may be adapted for data analysis.

Title : Visual analysis of geospatial multivariate data for investigating radioactive deposition processes

Speaker : Shigeo Takahashi (University of Aizu)

Abstract : This talk presents our application study for investigating radioactive deposition processes through visual analysis of geospatial multivariate data. The Fukushima Daiichi Nuclear Power Plant (FDNPP) accident in 2011 raised awareness of the importance of radioactive deposition processes, especially for proposing aerosol measures against possible air pollution. However, identifying the types of deposition processes often results in difficult tasks due to complicated terrains around the FDNPP. Therefore, we developed an approach for interactively investigating the correspondence of the geospatial positions to the air dose rate along with relevant attributes. Our idea is to compose a set of scatterplots for pairwise attributes, onto which we project terrain surfaces to find specific patterns of such ttributes. We applied our approach to the visual analysis of air dose distribution data around FDNPP after the accident and clearly distinguished contamination areas derived from different deposition processes. This is joint work with Japan Atomic Energy Agency and Kyushu University.

Title : Modeling Pareto sets of multiobjective optimization problems

Speaker : Naoki Hamada (K Lab Inc.)

Abstract : In industry, multi-objective optimization is often used to simultaneously optimize multiple conflicting objective functions, such as performance and cost. The solution set that achieves the optimal trade-off between objective functions is called the Pareto set, and finding it leads to the development of new products. The Pareto set is known to generically be a stratified set of dimension m-1, where m is the number of objective functions. In practical problems, the number of variables to be optimized ranges from tens to hundreds, and the number of objectives is 2 to 7, so the Pareto set is a stratified set of dimension 1 to 6, embedded in a Euclidean space of dimension tens to hundreds. If the intrinsic dimension is less than 4, then some dimensionality reduction method can be used to model the Pareto set without losing the essential features of the data. However, when the intrinsic dimension is 4 or more, there is no established method to model the Pareto set without losing the intrinsic features. This talk will introduce a modeling method using the Bézier simplex, which was recently developed by the speakers, and describe the challenges of modeling solution sets for multi-objective optimization.

Title : An Efficient Triangulation for Extruded Spatiotemporal Prism Meshes

Speaker : Akito Fujii (Graduate School and Faculty of Information Science and Electrical Engineering, Kyushu University)

Abstract : It is common to run simulations on a spatial mesh with an associated (spatial) triangulation. We consider the problem of re-triangulating space-time mesh that conforms to the pre-defined spatial triangulation. Today the general dimensionality, and especially 4D, has become relevant for online (aka in-situ) analysis. As the analysis is especially important for visualizing big data from scientific computation, providing a spatiotemporal triangulation equipped with the very fine temporal resolution thanks to in-situ opens the door to a reconsideration of spatiotemporal analysis and computational geometry algorithms. This presentation introduces a fast and easy combinatorial triangulation for an arbitrary sub-complex of the space-time. We assume a static spatial triangulation, which is still common in today's simulations, including atmospheric simulations. We extrude the spatiotemporal triangulation along the time axis, which gives us a prism mesh, and apply re-triangulation to get the spatiotemporal triangulation. The algorithm is memory efficient, works for arbitrary dimension, is parameter free, inserts no additional vertex and is easy to parallelize even for distributed memory machines.