Workshop
Topology and Computer 2014

A workshop "Topology and Computer 2014" will be held as follows. This workshop is supported financially by the Grants-in-Aid for Scientific Research (A) (Director: Sadayoshi Kojima #22244004).

Date: November 14 – 16, 2014
Location: Room 002, Graduate School of Mathematical Sciences, The University of Tokyo
Address: Komaba 3-8-1, Meguro, Tokyo, Japan
Web: http://auemath.aichi-edu.ac.jp/~ainoue/workshop/TopologyComputer2014.html

Program

November 14

13:30 – 13:40 Opening

13:40 – 14:10 Kazushi Ahara (Meiji University)
On a system allowing us to simulate Reidemeister moves

14:25 – 14:55 Hyuntae Kim (KAIST)
Classification of prime knots by arc index

15:10 – 16:10 Tetsuya Ito (RIMS)
Quantum versus Geometric topology, new prospect

16:30 – 17:30 Kenneth L. Baker (University of Miami)
Visualizations of Surfaces and Shapes I: Sketching Mathematics

November 15

9:30 – 10:00 Kentaro Ito (Nagoya University)
An attempt to obtain hyperbolic Penrose tilings

10:15 – 10:45 Ken'ichi Kuga (Chiba University)
Formalization of some basic theorems in geometric topology using Coq

11:00 – 12:00 Shin Satoh (Kobe University)
Description of a surface-knot

12:00 – 13:30 Lunch

13:30 – 14:30 Mikami Hirasawa (Nagoya Institute of Technology)
Recognition and visualization of the 120-cell

15:00 – 16:00 Kenneth L. Baker (University of Miami)
Visualizations of Surfaces and Shapes II: Methods and Maneuvers

16:30 – 17:30 Kaoru Arakawa (Meiji University)
Nonlinear Image Processing System for Beautifying Facial Images

November 16

9:30 – 10:00 Seonmi Choi (Kyungpook National University)
On some descriptions of surfaces in 4-dimensional space
(joint work with Y. Bae, J. S. Carter and S. Kim)

10:15 – 11:15 Masaaki Wada (Osaka University)
Stable cuts

11:30 – 12:30 Wayne Rossman (Kobe University)
Topology and computer graphics as aids in mathematical surface theory,
and applications to architecture

12:30 – 14:00 Lunch

14:00 – 14:30 Yuki Miura (Meiji University), Kento Nakamura (Meiji University)
Software displaying the limit set of Kleinian group over the quaternion
(joint work with Kazushi Ahara)

14:45 – 15:45 Gyo Taek Jin (KAIST)
Polygonal approximation of knots by quadrisecants

15:45 – 15:55 Closing

Organizers: Ayumu Inoue (Aichi Univ. of Edu.), Takuya Sakasai (The Univ. of Tokyo),
Kazuhiro Ichihara (Nihon Univ.), Masaaki Suzuki (Meiji Univ.)

Abstracts

Kazushi Ahara (Meiji University)
On a system allowing us to simulate Reidemeister moves

In this talk we show 'living' figures of knot projections. We consider a space of knot projection as planer graphs and we try some physical models on it. We want a stable configuration again perturbation. We introduce one of 'looks better' schemes. We add some edges (called 'bones') and vertices (called 'edge vertices') on a knot projection and simulate a spring model on the 2-sphere geometry.

Hyuntae Kim (KAIST)
Classification of prime knots by arc index

Every tame knot admits a special rectangular knot diagram, called a grid diagram, in which all edges are at distinct levels and vertical edges always cross over horizontal edges. Grid diagrams are readily inputted for computer programs and provide various computational advantages. The minimal number of levels in grid diagrams for a given knot is called the arc index of the knot. We discuss about how to detect whether a grid diagram of a knot realizes its arc index or not, and using this we provide our classification result of prime knots with arc index 12 up to 16 crossings.

Tetsuya Ito (RIMS)
Quantum versus Geometric topology, new prospect

It is well-known that the spectral radius of the Burau representation gives a lower bound of the entropy of braids. We show that the spectral radius of quantum $\mathfrak{sl}_2$ representation also provides a lower bound of entropy. This seems to suggest new connection between quantum invariants and geometric topology. We will explain several conjectures arising from this observation, and give some sample calculations.

Kenneth L. Baker (University of Miami)
Visualizations of Surfaces and Shapes I: Sketching Mathematics

Through several case studies, we will explore approaches to understanding and communicating ideas in Low Dimensional Topology through computer visualizations. We will highlight advantages of virtual models and discuss issues of design and presentation.

Kentaro Ito (Nagoya University)
An attempt to obtain hyperbolic Penrose tilings

Penrose tilings in the Euclidean 2-plane are obtained by immersing the plane into the 5-dimensional torus $\mathbb{R}^5/\mathbb{Z}^5$. In this talk, we want to consider the hyperbolic geometric analogue of Penrose tilings. More precisely, we will consider patterns obtained by immersing the totally geodesic hyperbolic 2-plane into compact (or finite volume) hyperbolic 3-manifolds. We will show you some computer graphics.

Ken'ichi Kuga (Chiba University)
Formalization of some basic theorems in geometric topology using Coq

We discuss techniques and problems in formalizing geometric topology using the Coq/Ssreflect proof assistant. We plan to talk about theorems related to the Bing Shrinking Criterion.

Shin Satoh (Kobe University)
Description of a surface-knot

A surface-knot is a closed surface embedded in Euclidean 4-space. Such a surface-knot is often visualized by using a surface diagram or a motion picture. A surface diagram is the image by a projection from 4-space to 3-space, and a motion picture is a sequence of cross-sections by parallel hyperplanes. We explain a relationship between these two methods.

Mikami Hirasawa (Nagoya Institute of Technology)
Recognition and visualization of the 120-cell

The 120-cell is one of the six regular polyhedra in 4-space. Each cell is a regular dodecahedron, and there are 600 vertices, each of which is shared by four dodecahedra. The coordinates are well described by using the golden ratio. In this talk, we show a simple method to obtain the coordinates of the vertices of the 120-cell, together with the information on the dodecahedral cells. The path alternates between taking linear combinations of vectors and seeing the local combinatorial structure by computer visualization. Similar methods also work for other regular polyhedra in 3D and 4D.

Kenneth L. Baker (University of Miami)
Visualizations of Surfaces and Shapes II: Methods and Maneuvers

Centered upon cable spaces, we will demonstrate procedures for constructing surface bundles, Seifert fibrations, and branched covers. This will feature several common tricks and tools that also inform us about the nature of cable spaces and their fibrations.

Kaoru Arakawa (Meiji University)
Nonlinear Image Processing System for Beautifying Facial Images

A nonlinear image processing system for beautifying human facial images is presented. This system utilizes a nonlinear digital filter bank, named as an ε-filter bank, which can remove undesirable skin components, such as wrinkles and spots, from the skin, while keeping the edges of the image sharp and keeping the natural roughness of the skin unchanged. Also, edge enhancement and contrast enhancement are applied to make the face look clear-cut. This system is designed optimally on the basis of human subjective criteria and taste, using interactive evolutionary computing (IEC). The degree of skin smoothing and that of the enhancement of the edges and contrast are adjusted by IEC, so that the obtained face image is satisfactory to the user. This system is realized as a smartphone application and actually utilized. Some examples of processing facial images are presented to verify its high performance.

Seonmi Choi (Kyungpook National University)
On some descriptions of surfaces in 4-dimensional space
(joint work with Y. Bae, J. S. Carter and S. Kim)

This talk is based on my article, "Non-orientable surfaces in 4-dimensional space" (joint work with Y. Bae, J. S. Carter and S. Kim). I will introduce the descriptions and constructions given by means of movies, charts, diagrams, or decker sets. I will explain how to draw them for surfaces in 4-dimensional space.

Masaaki Wada (Osaka University)
Stable cuts

Let $G = (V, E)$ be a weighted simple graph. A cut $C = (A, B)$ of G is a splitting of V into a pair of disjoint subsets, and its weight $\omega(C)$ is the sum of weights of the edges crossing C. The cut is said to be stable if the weight increases whenever a vertex is moved from one side to the other side of C. We give a sufficient condition for the existence of a nontrivial stable cut using what we call the minimax traversing cut weight of a graph. For some cut $C = (A, B)$, if both of the induced subgraphs of G by A and by B have the minimax traversing cut weight greater than the weight of C, then there exists a nontrivial stable cut of G.

Wayne Rossman (Kobe University)
Topology and computer graphics as aids in mathematical surface theory,
and applications to architecture

In this talk, we will consider how computer graphics (a field with much real-world applicability) and topology (an abstract purely mathematical field) can be applied to greatly enhance mathematical surface theory. Then, in turn, we will consider how that abstract surface theory has real-world applicability, with particular attention paid to applications in architecture.

Yuki Miura (Meiji University), Kento Nakamura (Meiji University)
Software displaying the limit set of Kleinian group over the quaternion
(joint work with Kazushi Ahara)

We introduce original software (, developed by Kento Nakamura, B2, FMS/IMS) which draws the limit sets of some high dimensional Kleinian groups over the quaternion field. One family is 'Sakugawa slice', which is introduced by K. Sakugawa in 2007. The other is family of kissing Schottky groups with three generators. This software is supported by a parallel processing system for high speed computation.

Gyo Taek Jin (KAIST)
Polygonal approximation of knots by quadrisecants

We consider tame knots in space. Every knot can be deformed to a polygonal knot without changing its knot type. If a set of finitely many points is chosen on a knot, we may straighten each subarc between nearby points of the set to form a polygonal curve. Such a curve is called a polygonal approximation of the given knot. A polygonal approximation of a knot is said to be good if it has the same type as the given knot. A quadrisecant of a knot is a straight line which intersects the knot in four distinct points. Every nontrivial knot can be perturbed to have finitely many quadrisecants. If a knot has finitely many quadrisecants, we may use the secant points to form a polygonal approximation, called the quadrisecant approximation. Quadrisecant approximations are conjectured to be good polygonal approximations. We report on our test of this conjecture on a family of random polygonal unknots.