2021年02月25日

九州大学　マス・フォア・インダストリ研究所長　殿

所属・職名　九州大学 汎オミクス計測・計算科学センター・准教授
櫻井大督

下記の通り共同研究の報告をいたします。

記

	整理番号	20200011
1. 研究計画題目	Fiber Topology Meets Applications	
2. 新規・継続	新規	
3. 種別	一般研究	
4. 種目	研究集会(II)	

5. 研究代表者	氏名	櫻井大督		
	所属部局名	九州大学 汎オミクス計測・計算科学センター	職名	准教授

6. 研究実施期間	2021年01月06日（水曜日）～2021年01月08日（金曜日）
7. キーワード	特異点論，ファイバーのトポロジー，可視化，地球温暖化問題，半導体，オペレーションズリサーチ
8. 参加者人数	35人

9.本研究で得られた成果の概要

In this forum, we gathered researchers from academia and the industry to discuss the future directions of fiber topology. This is a proudly unique communication where pure mathematicians, computer scientists and data analysis practitioners exchange ideas from the different ends of the broad scientific arena. As it followed, the speakers brought themes from broad spectra, including those in mathematics, topological analysis in visualization, the game industry, environmental sciences and chemistry. The goal of this forum is to develop fiber topology to solve problems in applications. This occasion was the first step for it.

The forum has viewed it important to investigate the application problems before constructing theories and algorithms for fiber topology. In fact, the entire planning of collaboration is driven by the applications, rather than by the theories. This approach has been favored as a means to keep this forum mission-oriented. It is also a favored approach of the Pan-Omics Data-Driven Research Innovation Center, who continues to sponsor this forum.

As has been visible in the program document, the applications of fiber topology in this forum include computational chemistry, eco-friendly aviation regulation and operational research. The key application in computational chemistry is to understand the conformation of molecules. We formulate this problem as the analysis of high-dimensional fields. The primary source of data is the simulations run by Yoshihiro Kangawa (Kyushu University).

The aviation regulation project led by Bastian Kern and Hiroshi Yamashita (both German Aerospace Center) investigates the tradeoff between costs for finance and various factors of air pollution such as CO_2 and NOx. Atmospheric simulations are conducted to estimate the varying costs for variations of aviation path. The tradeoffs conflicting costs in the considered paths are investigated through the Pareto analysis. The task for fiber topology in the coming years is to analyze such tradeoffs in the form of a high-dimensional field. Naoki Hamada joined the discussion to provide his expertise on Pareto analysis.

The Pareto analysis is itself an application of fiber topology as presented by Reiya Hagiwara (Kyushu University) and Hamad et al. The plan to treat benchmark problems using fiber topology was discussed. It is also an interesting inverse problem for the fiber topology computation. We are going to proceed to apply the upcoming results for the purpose of game developments, an industrial application important as a mission especially for this forum and the Institute of Mathematics for Industry.

Given these requirements by the applications, computational studies are going to focus on firstly the development of a Reeb space algorithm that works for arbitrary dimensional domains and is robust (Sakurai and Carr). Another focus is the scalability of related computation (Carr, Akito Fujii at Kyushu University) and simplification (Petár Hristov at University of Leeds), as introduced in their talks.

For this to work, a few key theoretical understanding of the topology of fibers were lacking in the computer scientists. The talks from pure mathematics therefore had an exceptional importance for all of us. Takahiro Yamamoto introduced the elimination of singularity at the boundary of the domain. Osamu Saeki explained his joint-work on simplifying the indefinite fibrations on 4-manifolds. These indications from the theorists are now being adapted by the computer scientists. These mathematical developments will also be continued in further support of this new community. Early results are already published [1].

Last but not least, we are grateful to all the participants including the audience, KLab, the Pan-Omics Center and IMI.

References:
1.   D Sakurai & T Yamamoto. "Visually Evaluating the Topological Equivalence of Bounded Bivariate Fields," Topological Methods in Visualization - Applications and Software. Springer, in print.

成果報告書

Report on The Forum Fiber Topology Meets Applications

Representative (研究代表者):
Daisuke Sakurai (櫻井 大督) @ Kyushu University Pan-Omics Data-Driven Research Innovation Center in Research Institute for Information Technology（九州大学 情報基盤研究開発センター 附属汎オミクス計測・計算科学センター）

Organizing Board（組織委員会）:
- Daisuke Sakurai （櫻井 大督）: Associate Professor @ Kyushu University Pan-Omics Data-Driven Research Innovation Center in Research Institute for Information, Japan Technology（九州大学 情報基盤研究開発センター 附属汎オミクス計測・計算科学センター）
- Osamu Saeki （佐伯修）: Professor @ Kyushu University Institute of Mathematics for Industry, Japan （九州大学 マス・フォア・インダストリ研究所）
- Shigeo Takahashi （高橋成雄）: Professor @ University of Aizu, Japan （会津大学）
- Hamish Carr: Professor @ University of Leeds, UK
- Takahiro Yamamoto (山本卓宏): Associate Professor @ （東京学芸大学）
- Naoki Hamada（濱田直希）: PhD @ KLab（KLab 株式会社）

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1.   D Sakurai & T Yamamoto. "Visually Evaluating the Topological Equivalence of Bounded Bivariate Fields," Topological Methods in Visualization - Applications and Software. Springer, in print.

Daisuke Sakurai
2021-02-19, In Fukuoka.

Fiber Topology Meets Applications

日時： 2021年1月6日（水）14:30 ～ 2021年1月8日（金）16:45
場所： 九州大学 伊都キャンパス ウエスト1号館 D棟4階
　　　　IMIオーディトリアム(W1-D-413)
　※Zoomミーティングを使用したハイブリッド型で開催されます
https://www.imi.kyushu-u.ac.jp/kyodo-riyo/research_meetings/view/13

　▶下記URLより参加登録をお願いいたします
https://forms.gle/EBEQP7VjivtienPEA

1月6日（水）

14:30-15:15
Title : Fiber Topology Meets Applications: Where We are Heading
Speaker : Daisuke Sakurai (Kyushu University)

15:15-16:00
Title : Why Topology is Necessary at Exascale - And Why it's Not Easy
Speaker : Hamish Carr (University of Leeds)

16:00-16:45
Title : Modeling semiconductor epitaxy for next generation power device application
Speaker : Yoshihiro Kangawa (Kyushu University)

1月7日（木）

14:30-15:15
Title : Data Parallel Hypersweeps for in Situ Topological Analysis
Speakers : Petar Hristov (University of Leeds), Gunther Weber (Lawrence Berkeley National Laboratory and University of California, Davis), Hamish Carr (University of Leeds), Oliver Rübel (Lawrence Berkeley National Laboratory) and James Ahrens (Los Alamos National Laboratory)

15:15-16:00
Title : Design of Multimodal Test Problems in Multiobjective Optimization Using Fiber Topology
Speakers : Reiya Hagiwara (Kyushu University), Takahiro Yamamoto (Tokyo Gakugei University), Naoki Hamada (KLab Inc.), Daisuke Sakurai (Kyushu

University)

16:00-16:45
Title : Eco-efficient Flight Trajectory Exploration by Using the
Chemistry-climate Model EMAC
Speakers : Hiroshi Yamashita and Bastian Kern (German Aerospace Center)

1月8日（金）

14:30-15:15
Title : Elimination of B2 singularities
Speaker : Takahiro Yamamoto (Tokyo Gakugei University)

15:15-16:00
Simplifying Indefinite Fibrations on 4-manifolds
Speaker : Osamu Saeki (Kyushu University)

16:00-16:30
Title : An Efficient Triangulation for Extruded Spatiotemporal Prism Meshes
Speakers : Akito Fujii, Kenji Ono and Daisuke Sakurai (Kyushu University)

16:30-16:45
Concluding Remarks
Daisuke Sakurai (Kyushu University)