■ Division of Science (Mathematics)

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(Current as of March 31, 2009)

Division of Science (Mathematics)

＊Professor **Hisashi Ishida**

■ Research Fields: Complex Analysis
■ Research Theme(s):
1. Moduli Problem of Riemann Surfaces
2. Complex Dynamical Systems
■ Academic Degrees: Doctor of Science, Kyoto University
■ Keywords for Research Field:
Riemann Surfaces, Conformal Mappings, Extremal Length, Complex Dynamical Systems
■ Office Phone Number: 81-75-705-1620
■ E-mail: isida@cc.kyoto-su.ac.jp

[Research Overview]

(1) Two plane regions are conformally equivalent if there exists a univalent holomorphic function (conformal mapping) that maps one region to the other one.
It is one of the fundamental problems of complex analysis to classify all plane regions (or Riemann surfaces) into conformally equivalent classes.
Among simply connected regions, consider all rectangles. We say that two rectangles are equivalent if there exists a conformal mapping which maps one to the other so that the vertices of one rectangle to the vertices of the other. In this case, two rectangles belong to the same class if one rectangle is similar to the other.
Now consider classification of triply connected plane regions. To decide whether two regions are conformally equivalent, we use the extremal length which corresponds to the ratio of sides of rectangles above. The extremal lengthes of three curve families allow us to completely classify triply connected plane regions.

(2) I have interest in complex dynamical systems, particularly the properties of Julia sets of polynomials and polynomial semigroups. Computers are very useful in this branch.

Division of Science (Mathematics)

＊Professor **Masami Ito**

■ Area and Subject Taught: Discrete Mathematics
■ Research Theme(s):
Theory of Formal Languages and Automata
■ Academic Degrees: Doctor of Engineering, Tohoku University
■ Keywords for Research Field:
Theoretical Computer Science, Formal Language Theory, Automata, Grammars
■ Office Phone Number: 81-75-705-1615
■ E-mail：ito@cc.kyoto-su.ac.jp

[Research Overview]

A language is the set of words generated by rewriting rules called a grammar. The purpose of formal language theory is to study the relationship between grammars and languages. On the other hand, the purpose of automata theory is to study the structure of machines that recognize languages. The theories of formal languages and automata are the fundamental theories of computer science, and research results are applicable in areas such as linguistics and automatic translation research. In this laboratory we conduct research from an algebraic perspective on topics such as composition/decomposition of automata, structure of formal languages, operations on languages, and related decision problems. It is not our intent to make this research directly useful in applications, but there is potential for applications in the development of new cryptography systems, among other things.

[Notable Publications and Works in the Last Three Years]

Editing Book：Lecture Notes in Computer Science 5257 (with M. Toyama) (2008) (Springer)

Papers：(1) Closure of language classes under bounded duplication (with P. Leupold and K. Shikishima-Tsuji), LNCS 4036 (2006), 238-247. (2) Some periodicity of words and Marcus contextual grammars (with P. Domosi, G. Horvath and K. Shikishima-Tsuji), Vietnam Journal of Mathematics 34 (2006), 381-387. (3) Generalized periodicity and primitivity for words (with G. Lischke), Math. Log. Quart. 53 (2007), 91-106. (4) Marcus contextual languages consisting of primitive words (with P. Domosi and S. Marcus), Discrete Mathematics 308 (2008), 4877-4881. (5) Shortest directing words of nondeterministic directable automata (with K. Shikishima-Tsuji), Discrete Mathematics 308 (2008), 4900-4905. (6) Duplication in DNA sequences (with L. Kari, Z. Kincad and S. Seki), LNCS 5257 (2008), 419-430　8 papers including the above mentioned papers.

Division of Science (Mathematics)

＊Professor　Fumihiro Ushitaki

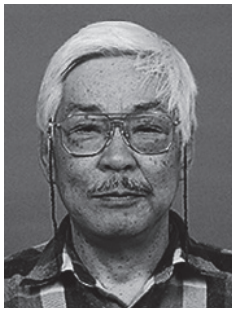
■ Area and Subject Taught: Theory of Transformation Groups
■ Research Theme(s):
Theory of Topological Transformation Groups, Development of Teachers' Training Programs in Arithmetic and Mathematics
■ Academic Degrees: Doctor of Science, Osaka University
■ Keywords for Research Field:
Transformation Groups, Borsuk-Ulam Theorem, Isovariant Maps, Development of Teachers' Training Programs in Arithmetic and Mathematics
■ E-mail: ushitaki@ksuvx0.kyoto-su.ac.jp

[Research Overview]

The symmetry of figures is an important concept in geometry. When a figure has symmetry, a symmetric transformation is obtained by moving the points on the figure to their corresponding symmetric points. Furthermore, if two symmetric transformations are applied successively, the result becomes another symmetric transformation. The reverse of a symmetric transformation is also a symmetric transformation. This shows that we can go beyond looking at each symmetric transformation individually, and consider all possibilities of symmetric transformation by introducing the algebraic concept of a group (constituted by combining transformations). Investigating the subject in such a framework clarifies the properties of figures containing symmetry. The purpose of the theory of transformation groups, the field of my research, is to use this approach to study problems relating to the symmetry of figures from the viewpoint of topology ("soft geometry"). However, since the figures are considered in terms of soft geometry, the term "symmetry" takes on a meaning quite different from that we learn in high school. Yet just as we learn in high school that there is a fixed point for a rotation, and there is a fixed line for a reflection, so the theory of transformation groups addresses problems such as fixed points, and the movement of points by transformations. At present, I am studying symmetry-preserving correspondences between figures with symmetry, and their properties.

[Notable Publications and Works in the Last Three Years]

1）長崎生光，牛瀧文宏：C_n－多様体から表現球面への等変写像とBorsuk-Ulam型定理，数理解析研究所講究録1517，pp.92-106（2006）
2）Fumihiro Ushitaki：Isovariant maps and Borsuk-Ulam type Theorems, Proceedings of 34th Symposium on Transformation Groups, ed. by T. Kawakami, Wing Co., Ltd., pp.84-93（2007）
3）牛瀧文宏：「教員研修モデルカリキュラム開発プログラム」の実施について，数学教育の会　数学教育研究　9号　95-103.（2007）
4）牛瀧文宏：算数・数学におけるカリキュラム構造の理解とそれを促すための教員研修のあり方について，京都産業大学教職研究紀要3号1-11 (2008)
5）Ikumitsu Nagasaki, Fumihiro Ushitaki：Isovariant maps from C_n-manifolds to representation spheres, Topology and Its Applications, Vol 155/10 1066-1076 (2008).
6）牛瀧文宏：「パパとママが子どもに算数を教える本」（メイツ出版　2008）
7）Ikumitsu Nagasaki, Tomohiro Kawakami, Yasuhiro Hara, Fumihiro Ushitaki: The Borsuk-Ulam Theorem in a Real Closed Field, Far East Journal of Mathematical Sciences Vol.33-1 113-124 (2009)



Division of Science (Mathematics)

＊Professor **Masashi Katsura**

■ Area and Subject Taught: Discrete Mathematics, Algebra
■ Research Theme(s):
Algebraic and Combinatorial Research on Formal Languages and Other Discrete Objects
■ Academic Degrees: Doctor of Engineering, Tohoku University
■ Keywords for Research Field:
Semigroups, Rewriting Systems, Primitive Words
■ Office Phone Number: 81-75-705-1617
■ E-mail: katsura@cc.kyoto-su.ac.jp

[Research Overview]

A set with a single associative operator is called a semigroup, and the set of all mappings from a certain (finite) set onto itself forms a semigroup. This is called a (finite) transform semigroup. Finite permutation groups have been studied in detail in finite group theory; as for semigroups, on the other hand, there is a long history of research and a huge number of research results, but research on the specific structures of semigroups is still inadequate. In particular, it is no exaggeration to say that almost no research is being done on finite semigroups and finite transformation groups. Therefore, I am conducting research on what happens when various classes of finite transformation semigroups are expressed as transformation semigroups on a finite set.

Additionally, I am currently studying the completeness of rewriting systems for finite representations. In particular, I am working to determine the decidability of the question of whether one-rule rewriting systems are complete or not.

I am also working on problems in language theory and automata theory, such as whether all primitive words are a context-free language or not.

[Notable Publications and Works in the Last Three Years]

1）M.Katsura, Y.Kobayashi; Undecidable properties of monoids with word problem solvable in linear time, Theoretical Computer Science 290（2003）, 1301-1316

2）M.Katsura, Y.Kobayashi, F.Otto; Undecidable properties of monoids with word problem solvable in linear time. Part Ⅱ --- cross sections and homological and homotopical finiteness conditions, Theoretical Computer Science 301（2003）, 79-101

Division of Science (Mathematics)

Instructor **Yukiko Kawai**

■ Area and Subject Taught: Data Mining
■ Research Theme(s):
Next-Generation Web Applications, Data Analysis, Vector Space Models, Clustering, APIs, Language Analysis
■ Academic Degrees:
Doctor of Engineering, Nara Institute of Science and Technology
■ Keywords for Research Field: Data Engineering
■ Office Phone Number: 81-75-705-2958
■ E-mail: kawai@cc.kyoto-su.ac.jp

[Research Overview]

My research is personalization, information search, addressing the query of how to find needed information for users from the vast volume on the web, how to ensure understanding of discovered information and supply it as knowledge. Furthermore, I have been developing next generation Web applications that aim to achieve effective search and integration of Web content which is continually increasing. I'm also developing information-fusion technology, which integrates the user modeling and 3D content on the Web, in order to achieve fusion between people and the environment.

[Notable Publications and Works in the Last Three Years]

1）Adam Jatowt, Yukiko Kawai and Katsumi Tanaka: Browsing Assistant for Changing Pages, In: Nguyen N.T., Jain L.C. (Eds.): Intelligent Agents in the Evolution of Web and Applications, Springer-Verlag, pp. 137-160 (2009).

2）Adam Jatowt, Yukiko Kawai and Katsumi Tanaka: What Can History Tell Us? Towards Different Models of Interaction with Document Histories, The 19th ACM Conference on Hypertext and Hypermedia (HT2008), ACM Press, Pittsburgh, USA, pp. 5-14 (2008).

3）Adam Jatowt, Yukiko Kawai, Satoshi Nakamura, Yutaka Kidawara Katsumi Tanaka: Journey to the Past: Proposal for a Framework for Past Web Browser, The 17th ACM Conference on Hypertext and Hypermedia (HT2006), ACM Press, 2006, pp. 134-144 (2006).

4）Shumian He, Yukiko Kawai, Yutaka Kidawara, Koji Zettsu, Katsumi Tanaka：u-Cam: A User-driven Control Mechanism for Ubiquitous Cameras and Its Content Management, Proceedings of the 7th International Conference on Mobile Data Management (MDM'06).

Division of Science (Mathematics)

＊Professor Satoshi Kobayashi

- Area and Subject Taught: Mathematical Logic
- Research Theme(s):
  Non-Classical Logics and Their Application to Computer Science
- Academic Degrees: Doctor of Science, University of Tokyo
- Keywords for Research Field:
  Theoretical Computer Science, Foundations of Software, Non-Classical Logics, Constructive Logic

[Research Overview]

The logic ordinarily used in mathematics is called classical logic. This logic posits a world where the truth value (truth or falsity) of propositions is, in principle, completely determined. In computer science (CS), however, it is not enough for a truth value to be determined in principle; the problem is whether there is an algorithm to determine that truth value. Furthermore, "existence" in traditional logic simply means that "there is a solution," but in CS, the issue becomes algorithms for finding that solution. A logic called constructive logic, where the specific method for constructing a solution is always the issue, becomes useful here. In classical logic, a truth value never changes once it has been determined, but in the world of computers, we consider cases where truth values do change, due to the changing states of machines, and cases where unknown truth values become known due to the transmission of information. Such situations can be nicely expressed using a logic called modal logic. My research concerns these unusual logics (called non-classical logics), and their applications to CS. My specific interests include the logic of types in programs, theorem-proving using computers, program semantics, verification of program correctness, program derivation, and applications in intelligent information processing.

[Notable Publications and Works in the Last Three Years]

1) "Iwanami Encyclopaedic Dictionary of Mathematics, 4th edition" (in Japanese), Japan Math. Soc. (ed), Iwanami Shoten (2007)
2) Satoshi Kobayashi, "A New Translation for Semi-classical Theories — Backtracking without CPS", FLOPS 2008, 2008年4月.

Division of Science (Mathematics)

* Professor Yoshiki Tsujii

- Area and Subject Taught: Probability Theory, Mathematics of Computation
- Research Theme(s):
  Research on Multi-Term Portfolios, Research on Fractals
- Academic Degrees: Doctor of Science (Mathematics), Hiroshima University
- Keywords for Research Field: Fractals, Portfolios, Growth Models
- Office Phone Number: 81-75-705-1771
- E-mail: tsujiiy@cc.kyoto-su.ac.jp

[Research Overview]

The Brattka function is an example of a function that is Fine-continuous, but not locally uniformly Fine-continuous, and is characterized as the invariant set of infinite contractions. The graph of this function is also characterized as graph-directed sets. I am researching the new field of fractal characterization by generalizing these properties. I am also extending random iteration algorithms to graph-directed sets.

New findings can be obtained by extending single-term portfolio theory to multiple terms. The key to optimum problems is what kind of utility function to use with a multi-term model. In my research, I investigate the relationships between natural utility functions.

[Notable Publications and Works in the Last Three Years]

2008 Y.Tsujii, T.Mori, M.Yasugi and H.Tsuiki, "Fine-continuous functions and fractals defined by infinite systems of contractions", Lecture notes in computer science, to appear.

2008 T..Mori, Y. Tsujii, and M.Yasugi, "Integral of Two-dimensional Fine-computable Functioms", Electronic Notes in Theoritical Computer Science, Vol. 221, 141-152.

2008 T..Mori, Y. Tsujii, and M.Yasugi, "Integral of Fine computable functions and Walsh Fourier series", Electronic Notes of Theoretical Computer Science, vol. 202, 279-293.

Division of Science (Mathematics)

＊Associate Professor **Shigeyuki Hirai**

■ Area and Subject Taught: Human Computer Interaction
■ Research Theme(s):
(1) Ubiquitous Computing Environments and User Interfaces
(2) Design and Authoring Tools for Interactive Arts and Entertainment Systems
■ Academic Degrees: Doctor of Engineering, Osaka University
■ Office Phone Number: 81-75-705-1613
■ E-mail: hirai@cse.kyoto-su.ac.jp

[Research Overview]

(1) Ubiquitous Computing Environments and their User Interfaces

The research of Ubiquitous Computing Environments handles embedded computers, networks, sensors for inputs, displays for outputs and applications. Our research interest of this is focusing on a smarthome and its user interface including fundamental studies of living activities and developing applications for everyday life. In order to realize the environments, we do research in an actual apartment for various experiments.

(2) Design and Authoring Tools for Interactive Arts and Entertainment Systems

Interactive Arts which includes sound, music, video and other media will be more important, and a demand for them will increase in the future. However, there is a trade off against flexibility and ease to create artistic works with computer programming. Therefore, we develop various softwares and platforms to enable production and creation of interactive works where ideas can be easily realized and various expressions are possible.

[Notable Publications and Works in the Last Three Years]

1）大西諒，平井重行：RFIDを用いた浴室内行動計測の基礎検討，情報処理学会論文誌 Vol.49，No.6，pp.1932-1941 (2008)
2）平井重行，藤井元，佐近田展康，井口征士：新たなアメニティ空間を目指した浴室:入浴状態を音で表現する風呂システム，ヒューマンインタフェース学会論文誌，Vol.6, No.3，pp.287-294 (2004)【論文賞受賞】
3）MaxBook第2版，カメオインタラクティブ (2004)

Division of Science (Mathematics)

＊Professor **Kazuhiko Fukui**

■ Area and Subject Taught: Topology
■ Research Theme(s):
Research on Diffeomorphism Groups with Geometric Structure
■ Academic Degrees: Doctor of Science, Kyoto University
■ Keywords for Research Field:
Homologies of Infinite Group, Diffeomorphism Group, Commutator length
■ Office Phone Number:075-705-1614
■ E-mail: fukui@cc.kyoto-su.ac.jp

[Research Overview]

A diffeomorphism group is a group consisting of diffeomorphisms (for example, a mapping in which in an image is expanded or contracted), in which the operation is defined by a composite mapping. I am doing research to clarify the geometrical significance of the first homologies of diffeomorphism groups and their subgroups. This is a fascinating topic that is deeply related to the topology of foliated structures. The first homology group of a group G is defined as the quotient group of G by its commutator subgroup. Therefore, when the first homology group of a group G is zero, G is a perfect group. Recently, I have been studying the structure of a diffeomorphism group that preserves a geometric structure (for example, group action, foliated structure, submanifold, etc). I am particularly interested in these first homologies. I am also interested in the problem of the product of how many commutators can represent each element of G when G is perfect. Rapid progress has been made recently regarding to this problem. Students who come to study with me will have the opportunity to learn about foliated structures and related topics, in addition to the topics mentioned above. I would also like to provide new topics for students interested in teaching as a profession.

[Notable Publications and Works in the Last Three Years]

1）K.Abe and K.Fukui, Commutators of C^∞-diffeomorphisms preserving a submanifold, J. Math. Soc. Japan, 61-2, 427-436（2009）.
2）K.Fukui, On the first homology of the groups of foliation preserving diffeomorphisms for foliations with singularities of Morse type, Publ, RIMS Kyoto Univ., 44, 1057-1068（2008）.
3）K.Abe and K.Fukui, The first homology of the group of equivariant diffeomophisms and its applications, J. of Topology, 1, 461-476（2008）.
4）K. Abe, K. Fukui and T. Miura, On the first homology of the group of equivariant Lipschitz homeomorphisms, J. Math. Soc. Japan, 58-1, 1-15（2006）.

Division of Science (Mathematics)

＊Professor　Yuzo Hosono

■ Area and Subject Taught: Applied Analysis
■ Research Theme(s):
Mathematical Research on Dissipative Structures
■ Academic Degrees: Doctor of Science, Kyoto University
■ Keywords for Research Field:
Mathematical Models, Pattern Formation, Dissipative Structures, Reaction-Diffusion Systems
■ Office Phone Number: 81-75-705-1909
■ E-mail: hosono@cc.kyoto-su.ac.jp

[Research Overview]

We observe many kinds of beautiful and attractive patterns in the natural world - vivid stripes on the skin of tropical fish, regular patterns of the clouds floating like sheep (altocumulus), crystals of snow and so on. These spatiotemporal patterns are known as dissipative structures which appear in the open systems (i.e., the systems where there is a exchange of energy with the surrounding world). There have been many stimulating researches on dissipative structures since the 1970s, which give the insight to the mathematical understanding of both physical and biological systems in nature, The reaction-diffusion systems occupy an important position in mathematical studies of pattern formations in dissipative structures.

Typical examples of the reaction-diffusion systems include the followings. The Gierer-Meinhardt equations which is a model of the mechanism of morphogenesis; the Lotka-Volterra equations which appear in the population dynamics; and the Gray-Scott model which describes an autocatalytic chemical reaction. These equations exhibit the various kinds of stationary and spatiotemporal patterns as concentric patterns, rotating spiral patterns, spike patterns, traveling waves and so on.

The purpose of our research is to investigate the structure of solutions of reaction-diffusion systems through mathematical analysis and the numerical simulations, and to elucidate the mechanisms of pattern formations in the open systems.

[Notable Publications and Works in the Last Three Years]

1）細野雄三，感染症の空間的な伝播を記述する数理モデル，稲葉寿編著「感染症の数理モデル」，培風館，2008年，161-189.
2）細野雄三，感染症の伝播を視る，数理科学，No.535（2008年1月），34-38.
3）Y. Hosono, Phase plane analysis of traveling waves for higher order autocatalytic reaction-diffusion systems, Discrete Contin. Dyn. Syst. Ser. B, Vol.8, No.1, July (2007), 115-125
4）Y. Hosono,The propagation speeds of the spatial spread of infectious diseases (in Japanese), Acta Humanistica et Scientifica Uiversitatis Sangio Kyotiensis,Natural Science Series, No.36, March (2007), 1-19.
5）Y. Hosono, The propagation speeds of traveling fronts for higher order autocatalytic reaction-diffusion systems, Japan J. Indust. Appl. Math., Vol.24, No.1, (2007), 79-104.

Division of Science (Mathematics)

* Professor Hiroaki Masaoka

- Area and Subject Taught: Harmonic Analysis
- Research Theme(s):
  Ideal Boundary of Riemann Surface
- Academic Degrees: Doctor of Science (Mathematics), Kyoto University
- Keywords for Research Field:
  Harmonic Function, n-sheeted Unlimited Covering Surface, Fine Topology, Complex Structure
- E-mail: masaoka@cc.kyoto-su.ac.jp

[Research Overview]

Let D be the open unit disk excluding the origin and HP(D) a family of functions that are positive harmonic on D, and zero on the unit circle. It is known in this case (Bocher's Theorem) that the smallest linear space composed of the harmonic functions on D containing HP(D) is a one-dimensional linear space. If D is taken to be an n-sheeted unlimited covering surface of the open unit disk excluding the origin, then I consider, in the same way for such a D, the smallest linear space H composed of harmonic functions on D and containing HP(D). Letting k be a natural number satisfying $0<k<n+1$, I can show the existence of D such that the dimension of H becomes k. It is also shown that the dimension of H is characterized by the fine topology on D (the weakest topology that makes superharmonic functions on D continuous). At present I am examining how the dimension of H changes when the complex structure of D is changed.

[Notable Publications and Works in the Last Three Years]

1) H. Masaoka, When do the harmonic Hardy spaces with distinct indices coincide on a hyperbolic Riemann surface?, Acta Human. Sci. Univ. Sangio Kyotiensys Vol.37(2008),1-9.

2) H. Masaoka and S. Segawa, On several classes of harmonic functions on a hyperbolic Riemann surface, Proceedings of the 15th ICFIDCAA Osaka 2007 OCAMI Studies Vol.2(2008), 289-294.

3) H. Masaoka, Quasiconformal mappings and minimal Martin boundary of p-sheeted unlimited covering surfaces of the once punctered Riemann sphere $\hat{C}\setminus\{0\}$ of Heins type, Advanced Studies Pure Math., 44(2006), 211-266.

4) H. Masaoka and S. Segawa, Hyperbolic Riemann surfaces without unbounded positive harmonic functions, Advanced Studies Pure Math., 44(2006), 227-232.

Division of Science (Mathematics)

＊Professor **Hiroyuki Miyoshi**

■ Area and Subject Taught: Theoretical Computer Science
■ Research Theme(s):
Mathematical Theory of Programs, Functional Programming, Category Theory, Philosophy of Computation
■ Academic Degrees: Doctor of Science, University of Tokyo
■ Keywords for Research Field:
Mathematical Theory of Programs, Category Theory, Philosophy of Computation
■ E-mail: hxm@cc.kyoto-su.ac.jp

[Research Overview]

The mathematical theory of programs is a theory for precisely discussing computer systems, especially software. Mathematical techniques such as logic and category theory are used to develop tools for this task. However, the subject matter is quite different from physics or mathematics, and thus there is frequently a need to create even the techniques themselves. But that is what makes this field so interesting. Research results in this area are being used to the greatest effect in strongly-typed functional programming languages such as Haskell and ML. Languages of this type are not very well known, but they are being increasingly studied as languages for use in real-world development, due to recent improvement in the performance of computers, increasing complexity of software, and the need for security. I am conducting research together with my graduate students on the theory and practice of various programming techniques and distributed systems employing functional languages. As an individual member of the academic staff, I am also conducting mathematical research on category theory, which is one of the techniques mentioned above, and researching the philosophical foundations of computation. I can also provide guidance to interested students in these areas.

[Notable Publications and Works in the Last Three Years]

1）A. Higuchi and H. Miyoshi, T. Tsujishita, Strict n-Hypercategories, Hokkaido Mathematical Journal, Vol. 31（2002）, 469-511.
2）H. Miyoshi, Form Reflection to Interaction: An Indirect Apporoach to the Philosophy of Computation, in: J. Weckert and Y. Al-Saggaf（eds.）, Computers and Philosophy 2003, Conferences in Research and Practice in Information Technology, Vol. 37（Australian Computer Society, 2004）, pp. 33-38.

Division of Science (Mathematics)

＊Professor Atsushi Murase

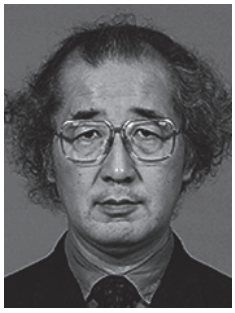
■ Area and Subject Taught: Number Theory
■ Research Theme(s):
Number Theory of Automorphic Forms of Several Variables
■ Academic Degrees: Doctor of Science, University of Tokyo
■ Keywords for Research Field:
Number Theory, Automorphic Forms, L-Functions
■ Office Phone Number: 81-75-705-1611
■ E-mail: murase@cc.kyoto-su.ac.jp

[Research Overview]

Number theory began by consideration of the properties of the integers 1, 2, 3..., particularly the prime numbers. My field of research expands the focus from the world of ordinary integers to things called "automorphic forms of several variables," and considers objects corresponding to prime numbers in that domain. Automorphic forms are functions of complex variables with strong symmetry. They appear not only in number theory, but in a variety of other fields including group theory, analysis, geometry, and physics, and have extremely beautiful properties. The one variable case has been extensively investigated since the era of Abel and Gauss, and played a major role recently in the proof in Fermat's Last Theorem. Research on automorphic forms of several variables, on the other hand, has a relatively recent and short history, and current knowledge is far less developed than for the one variable case. There are many interesting, unsolved problems in this area. Research is carried out using a variety of tools, such as algebra, analysis and geometry; in my case, I frequently rely on analytical techniques such as the theory of group representation and harmonic analysis. At present, I am focusing on the automorphic forms of unitary groups of degree three, an area with lots of mysteries. This is a fertile subject, which is also related to differential equations and algebraic geometry, and I find it interesting because the more I research it, the more the puzzles deepen.

[Notable Publications and Works in the Last Three Years]

1）Murase, A, and Sugano, T., Inner product formula for Kudla lift, Automorphic forms and zeta functions, in memory of Tsuneo Arakawa, World Scientific, 280-313（2006）
2）Murase, A. and Sugano, T., On the Fourier-Jacobi expansion of the unitary Kudla lift, Compositio Math. 143, 1-46（2007）
3）Murase, A. and Narita, H., Commutation relations of Hecke operators for Arakawa lifting, Tohoku Math, J, 60, 227-251（2008）



Division of Science (Mathematics)

＊Professor Takakazu Mori

■ Area and Subject Taught:
Computable Analysis, Applied Probability Theory

■ Research Theme(s):
Computable Analysis, Analysis of Time Series Data by Simulated Annealing

■ Academic Degrees: Doctor (Mathematics), Kyoto Sangyo University

■ Keywords for Research Field:
Computable Functions, effective Convergence, Approximation of Time Series Data, Simulated Annealing

[Research Overview]

Computable Analysis: Intuitively, a computable function is defined to be a function whose value is calculated by a kind of an ideal computer such as Turing machine. Pour-El and Richards had formulated the notion of computable functions by the two properties: (1) Sequential Computability and (2) Effective Continuity. They also introduced the notion of Effective Convergence. In this formulation, Computable Analysis can be said to be an investigation of the definition of computable functions and of the possibility of replacement of classical convergence with effective convergence. The effective continuity is stronger than the classical continuity. So, computable functions must be continuous. My main concern is to obtain suitable notion of computable functions which include discontinuous functions.

Analysis of time series data by Simulated Annealing: Simulated annealing is a probabilistic algorithm to find a minimum value of a function on a finite set. We had applied this method to obtain a smooth approximating function to the linear chart of time series data by a finite linear combination of Meyer wavelets and defined a characteristic quantity, "similarity distance", which is defined for a pair of time series data and reflects similarity between them.

[Notable Publications and Works in the Last Three Years]

(1) Similarity Analysis of time series data by WISAM. Journal of the Japanese Society of Computational Statistics, Vol.19 No.1, 15-26. (2007)

(2) Integral of Fine computable functions and Walsh Fourier series. Proceedings of the Second International Conference on Computability and Complexity in Analysis (CCA2007), 265-282. Electronic Notes in Theoretical Computer Science, vol. 202, 279-293, 2008.

(3) Integral of Two-dimensional Fine-computable Functions. Electronic Notes in Theoretical Computer Science, Vol. 221, 141-152, 2008.

Division of Science (Mathematics)

＊Associate Professor **Hiroki Yagishita**

■ Area and Subject Taught: Nonlinear Analysis
■ Research Theme(s):
Qualitative Theory of Nonlinear Diffusion Equations
■ Academic Degrees: Doctor of Mathematical Sciences, University of Tokyo
■ Keywords for Research Field:
Applied Analysis, Dynamical Systems,
Parabolic Partial Differential Equations
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[Research Overview]

My primary research interest is nonlinear diffusion equations-partial differential equations describing various diffusion phenomena. This field is not just mathematically interesting; these equations are widely used as models in physics, biology and many other areas of natural science and engineering. Our research approach is distinctive in that we investigate global properties of the solutions of initial value problems for parabolic partial differential equations by combining dynamic systems perspectives and techniques (e.g., Lyapunov functions, invariant manifolds and the comparison principle) with conventional techniques based on classical analysis. The following are two basic topics I have actually worked on so far:

1. Bistable reaction-diffusion equations have two spatially uniform stable states, and describe phenomena where those states interact through diffusion. A spatially localized structure called a "boundary," which links the two uniform stable states, appears in these equations, and we are studying the motion of these boundaries.

2. If the boundary in bistable reaction-diffusion equations is viewed in coarse grain, it becomes a surface in space, and the rules governing its time evolution become an equation where the speed of movement in the direction normal to the surface is given by the curvature. We are analyzing the time evolution equations for this surface.

[Notable Publications and Works in the Last Three Years]

1） T. Ushijima and H. Yagisita, Convergence of a three-dimensional crystalline motion to Gauss curvature flow, Japan Journal of Industrial and Applied Mathematics, 22, 443-459, 2005.

2） H. Yagisita, Blow-up profile of a solution for a nonlinear heat equation with small diffusion, Journal of the Mathematical Society of Japan, 56, 993-1005, 2004.

Division of Science (Mathematics)

Associate Professor Atsushi Yamagami

■ Area and Subject Taught: Algebraic Number Theory
■ Research Theme(s):
P-Adic Modular Forms and Theory of Deformations of Galois Representations
■ Academic Degrees: Doctor of Science, Hokkaido University
■ Keywords for Research Field:
Number Theory, Modular Forms, Galois Representations
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[Research Overview]

The main areas of research in algebraic number theory include rational solutions of algebraic equations and the behavior of rational points on algebraic curves defined on an algebraic number field. In researching these topics, it is crucial to closely investigate the Galois representations that arise there. A noteworthy example is the affirmative proof in 1995 by the English mathematician Wiles of "Fermat's Last Theorem," a conjecture which had not been proved in 350 years and had been shrouded in mystery. An important key to that proof was the fact that it is possible to prove, using a powerful theory called the "theory of deformations of Galois representations," that the Galois representations corresponding to algebraic curves called "elliptic curves" correspond, under certain conditions, to complex functions called " modular forms." Through my research, I am attempting to shed light on the problem of whether Galois representations correspond to modular forms or not, based on deeper knowledge of the properties of the Hecke algebras of p-adic modular forms. Recently, I have been focusing in particular on Galois representations of "Hilbert modular forms."

[Notable Publications and Works in the Last Three Years]

1）A. Yamagami,
On p-adic families of Hilbert cusp forms of finite slope,
J. Number Theory 123 (2007), 363-387.
概要：ヒルベルト保型形式のｐ進解析的無限族を構成した。

2）A. Yamagami,
On the unobstructedness of the deformation problems of residual modular representations,
Tokyo J. of Math. 27, No.2 (2004), 443-455.
概要：保型形式に付随するガロア表現の変形問題は、ほぼすべての場合において非障害であることを証明した。

3）A. Yamagami,
On Gouvea's conjecture in the unobstructed case,
J. Number Theory 99 (2003), 120-138.
概要：グベアの変形理論に関する予想を、変形問題が非障害である場合に解決した。

4）A. Yamagami,
On Gouvea's conjecture on controlling the conductor,
J. Number Theory 94 (2002), 90-102.
概要：グベアの変形の導手にまつわる予想を、変形問題が非障害である場合に解決した。

Division of Science (Mathematics)

＊Professor **Shuji Yamada**

- Area and Subject Taught: Low-Dimensional Topology
- Research Theme(s):
  Knot Theory and Theory of Three-Dimensional Manifolds
- Academic Degrees: Doctor of Science, Osaka University
- Keywords for Research Field:
  Knots, Three-Dimensional Manifolds, Invariants
- Office Phone Number: 81-75-705-1760
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[Research Overview]

Topology in two, three and four dimensions is called low-dimensional topology. Phenomena specific to lower dimensions that occur there differ from general dimensions (higher dimensions).

The primary subjects of research in low-dimensional topology are topological classification of low-dimensional manifolds, and classification of the topological positions of submanifolds within lower-dimensional manifolds.

My main research interests are three-dimensional manifolds, one-dimensional submanifolds within three-dimensional manifolds (i.e., knots), and one-dimensional complexes within three-dimensional manifolds (i.e., spatial graphs, which are a generalization of knots).

"Invariants" are tools for researching these subjects, and in our research we are using a recently discovered type of invariant called a "quantum invariant." Our particular focus is Jones polynomials and Vassiliev invariants, and we are studying spatial graphs, which are an extension of knots, using Yamada polynomials defined based on Jones polynomials.

[Notable Publications and Works in the Last Three Years]

Yoshiyuki Ohyama, Kouki Taniyama, Shuji Yamada: Realization of Vassiliev invariants by unknotting number one knots. Tokyo Journal of Mathematics, Vol. 25, No. 1 (2001) pp. 17-31