Abstracts

Adamaszek, Michal
Homology and complexity
We look for the boundary between easy (polynomial) and difficult (NP-hard) instances of computational problems for simplicial complexes. We take a combinatorial approach and exhibit a class of clique complexes of a natural class of graphs such that deciding their contractibility is polynomial but deciding triviality of any specified homology group is NP-hard. As a consequence we also prove that computing homology of arbitrary simplicial complexes given as a list of facets is NP-hard. (Joint work with Juraj Stacho).

Akinboade, Felix
Locality and checkability in wait-free computing
This paper studies notions of locality that are inherent to the specification of a distributed task and independent of the computing environment, in a shared memory wait-free system. A task T =(I,O,D) is checkable if there exists a wait-free distributed algorithm that, given s in I and t in O, determines whether t in D(s), i.e., if t is a valid output for s according to the specification D of T. Determining whether a projection-closed task is wait-free solvable remains undecidable, demonstrating the richness of this class. A locality property called projection-closed is identified, that completely characterizes tasks that are wait-free checkable.

A stronger notion of locality considers tasks where the outputs look identically to the inputs at every vertex (input value of a process). A task T =(I,O,D) is said to be locality-preserving if O is a covering complex of I. This topological property yields obstacles for wait-free solvability different in nature from the classical agreement impossibility results. On the other hand, locality-preserving tasks are projection-closed and therefore always wait-free checkable. A classification of locality-preserving tasks in term of their relative computational power is provided. A correspondence between locality-preserving tasks and subgroups of the edgepath group of an input complex shows the existence of hierarchies of locality-preserving tasks, each one containing at the top the universal task (induced by the universal covering complex), and at the bottom the trivial identity task.

Arnold, Matthew
Statistical aspects of persistent homology
We are studying statistical aspects of persistent homology, within the framework of "Topological Data Analysis". For points sampled uniformly at random from a topological object in Euclidean space, the persistence barcodes contain some intervals that represent topological "features" and some intervals that represent "noise" which occurs as a result of our uniform sampling strategy. We investigate the null distribution of noisy intervals for uniform samples, by investigating the distribution of the full barcode for a uniform sample from the unit square. This directs us towards algorithmically identifying noisy intervals in a given barcode, so that the remaining intervals are classified as actual features of the underlying space. Related to this is the study of how the noisy intervals change when the sampled points are not uniformly sampled from the object. By using a kernel density estimate of the sample we can correct for the non-uniformity to return barcodes that behave similarly to those we would expect if we could have sampled uniformly. This allows us to identify the noisy intervals using the null distribution described earlier. Some results in both of these areas will be presented.

Atiyah, Michael
Analysis, combinatorics and computation
Many topological invariants of manifolds arise from analysis. Sometimes these can be computed combinatorially. The classical case is that of a compact Riemann surface where the genus g (the dimension of the space of holomorphic forms), or rather 2g-2, can be computed by Euler's formula or by the Gauss integral. In higher dimensions things are much more complicated and there are subtleties on how good a combinatorial approximation has to be in order to compute a given invariant. I will pose some challenges in this direction.

Balduzzi, David

An information-theoretic presheaf for distributed learning

Statistical learning theory bounds the expected error of a learning algorithm (on unseen data) based on the number of errors on a finite training set and the complexity of the algorithm, quantified by measures such as VC (Vapnik-Chervonenkis) entropy. Recently, attention has shifted from individual learning algorithms to distributed systems of learners such as deep belief networks, where theoretical guarantees are notably lacking.

In my talk, I will formalize learning as performing an abstract measurement. VC entropy turns out to quantify the information generated by the measurement. The focus of the talk is then on the information-theoretic structure of distributed measurements, which is captured by the quale: a family of sections of a suitably defined presheaf. Using the quale I geometrically represent (i) the information content of a measurement; (ii) the extent to which a measurement is context-dependent; and (iii) whether a measurement decomposes into independent sub-measurements.

Finally, I show that only indecomposable measurements are more informative than the sum of their sub-measurements - which has implications for the VC-entropy of distributed systems and, therefore, bounds on their expected error.

Bauer, Ulrich

Topological simplification problems

We show that function simplification on surfaces is easy: given a function f on a surface and a tolerance d>0, we construct a function g subject to |g-f|<=d such that g has a minimum number of critical points. Our construction relies on a connection between discrete Morse theory and persistent homology. The simplified function g achieves the lower bound dictated by the stability theorem of persistent homology. The solution can be computed in linear time after persistence pairs have been computed. (Joint work with Carsten Lange and Max Wardetzky)

On the other hand, we show that isosurface simplification is hard: given a function f on a subset of R^3 and a tolerance d > 0, it is NP-hard to find a function g subject to |g-f|<=d such that the t-level set {x: g(x)=t} minimizes the total Betti number. The proof uses a reduction from the homological factorization problem: given a pair of spaces L c K, is there a space L c X c K such that the induced homomorphisms of L c X and X c K are surjective and injective, respectively? This problem is shown to be NP-complete even for simplicial pairs embeddable in R^3. (Joint work with Nina Amenta, Dominique Attali, Olivier Devillers, Marc Glisse, and André Lieutier)

Boissonnat, Jean-Daniel

Delaunay-type structures for manifolds

The Delaunay triangulation is one of the most popular geometric data structure. In the last decade, the restricted Delaunay triangulation emerged as a central concept in surface meshing and reconstruction. It however suffers from several limitations when considering more general manifolds. We will discuss some recent variations on this concept and present new Delaunay-type simplicial complexes and practical algorithms to triangulate smooth submanifolds.

Chazal, Frederic

Detection and approximation of linear structures in metric spaces

In many real-world applications data come as discrete metric spaces sampled around 1-dimensional linear structures (metric trees or graphs). Building on elementary tools of the theory of delta-hyperbolic spaces introduced by M Gromov in 1987, we provide a framework in which one can measure how much a given data set can be approximated by 1-dimensional metric structures and we provide algorithms to reconstruct such approximating structures. We will also illustrate the performances of our algorithm on various data sets. This is a joint work with Jian Sun (Mathematical Sciences Center, Tsinghua University).

Cohen, Daniel

Topological complexity of hyperplane complements

The topological complexity of a space is a homotopy type invariant motivated by the motion planning problem from robotics. We determine this invariant for the complement of an arbitrary arrangement of complex hyperplanes.

Curry, Justin

Cosheaves and dualities in generalized sensor networks

In this talk, I will introduce the computational framework of cellular sheaves and cosheaves, and advocate for a different perspective on Morse Theory, persistent homology, network coding and pursuit–evasion problems in sensor networks. This framework provides local-to-global results as well as generalizations of Poincaré duality. To provide concrete examples, I will introduce a new model for sensing with different modalities (colours, sounds, etc.) and show how a long exact sequence of sheaf cohomology provides forcing results that allow you to infer what you don't know from what you do.

de Silva, Vin

Persistent cohomology and circle-valued functions

I will discuss the use of persistent cohomology to discover meaningful circle-valued coordinates on a data set, in the spirit of nonlinear dimensionality reduction (NLDR) algorithms such as Isomap, LLE, and Laplacian eigenmaps. The construction is closely related to the Abel–Jacobi map in algebraic geometry. There are possible applications to the study and simulation of dynamical systems. My collaborators in this work (some of it completed, some of it in progress) include Morozov, Vejdemo-Johansson, Skraba, Mischaikow.

Dlotko, Pawel

Computational (co)homology - applications and recent progress in computations

Computational homology and cohomology have recently become important tools in solving many problems in science and engineering. Consequently, new, efficient algorithms are needed to handle the amounts of data coming from real world problems. In this talk some recent developments and algorithms will be presented. I will concentrate on new methods to partially parallelize, distribute and speed up (co)homology and persistent (co)homology computations. Moreover a quick survey of recent applications of presented theory and algorithms will be given.

Edelsbrunner, Herbert

Adaptive triangulation of a digital image

To enjoy a digital version of the Jordan Curve Theorem, it is common to use the closed topology for the foreground and the open topology for the background of a 2-dimensional binary image. We introduce a single topology that enjoys this theorem for all thresholds decomposing a real-valued image into fore- and background. The topology is easy to construct and it generalizes to n-dimensional images. (Joint work with Olga Symonova.)

Fajstrup, Lisbeth

Periodicity and the trace space algorithm

The execution of a parallel program is the space of directed paths or traces in a particular d-space. The topological invariants of the trace spaces are invariants of the program. For a non-looped, non-branching program, it is known how to generate a simplicial model of the trace space from a certain index category. For looped processes, the state space is a (directed) torus and the trace space is a disjoint union of trace spaces of deloopings. The index category for the trace space of the deloopings is developed from the once delooped case. When just one process is looped, the index category is generated as words in a regular language. The automaton is constructed.

Franek, Peter

Topological degree computation based on interval arithmetic

I present a new algorithm for computing the topological degree deg(f,B,0) of a continuous (not necessary differentiable) function $f:B\to R^n$ defined on an n-dimensional box B. The algorithm separates numerical from combinatorial computation: the numerical part computes the subdivision of partial B to a set of (n-1)-dimensional boxes such that on each box, F, there exists a component $f_{\{j(F)\}}$ with constant sign s(F) on F. This subdivision can be calculated by the use of interval arithmetic. The information {F,j(F), s(F)} determines the degree uniquely and the combinatorial part calculates it recursively, using a some degree identities.

I explain the main part of the algorithm, illustrate it on simple examples, give a proof of correctness, report on computational experiments and show applications in the verification of zeros of systems of equations. Comparison of the effectivity with older algorithm is discussed and an online demonstration of the program implementation will be shown. (Joint work with Stefan Ratschan).

Gonzalez, Jesus

Immersion dimension and topological complexity of projective product spaces

It is well known that Farber's topological complexity of real projective spaces agrees with the Euclidean immersion dimension of these manifolds. However this is an isolated phenomenon; even Davis' projective product spaces fail to have such a property. Indeed, for those manifolds, we characterize the immersion dimension and their topological complexity in terms of suitable generalizations of axial maps, from which the (large) differences between both invariants are apparent.

Goubault, Eric

Recent advances in directed algebraic topology, with applications to concurrent and distributed systems

I will give a survey of some of the recent results in directed algebraic topology, with a view to practical computations of topological invariants (trace spaces, component categories etc.) and their use for proving properties on concurrent and distributed programs.

Guibas, Leonidas

Understanding shapes through mappings

We discuss a number of ways of understanding shape collections jointly, through the mechanism of (1) finding novel representations and algorithms for maps between the shapes, and (2) investigating the resulting map networks so as to evaluate each map in the context of other maps.

Han, SangEon

A new type of locally finite topological space and its applications

In the fields of pure and applied topology we have the question: Is there a topological structure which can be used for studying both continuous and digital spaces? As an answer, this talk suggests a new type of locally finite topological space (or space set topology). Since the structure can play an important role in classical, computer, discrete and digital geometry as well as digital topology, the paper proposes a Jordan curve theorem of a simple closed SST-curve.

Finally, the paper shows that an SST can be used for studying both continuous and digital spaces so that it plays an important role in both classical and digital topology and further, discrete and computational geometry.

Heo, Giseon

Topological analysis of variance with applications in landmark data set

It is common to reduce the dimensionality of data before applying classical multivariate analysis techniques in statistics. Persistent homology, a recent development in computational topology, has shown to be useful for analyzing high dimensional (non-linear) data. In this talk, we connect computational topology with the traditional analysis of variance and demonstrate this synergy on a three-dimensional orthodontic landmark data set derived from the maxillary complex. Combining appropriate techniques of both persistent homology and analysis of variance results in a better understanding of the data's nonlinear features over and above what could have been achieved by classical means.

Hiraoka, Yasuaki

Applications of persistent diagrams to protein compressibility and phylogenetic trees

In this talk, we will present our recent research applying persistent diagrams to protein analysis. The first subject is the compressibility of proteins. We will show that we can derive a topological quantity from persistent diagrams of proteins which has a good linear correlation to the experimental data of compressibility.

Next subject is phylogenetic trees of proteins. Based on the distance function on persistent diagrams, we can define a tree for a given group of proteins. This tree possesses more information of three dimensional geometric/topological structures of proteins than a conventional phylogenetic trees derived by a 1-dimensional amino acid sequences. We show some examples which classify hereditary properties. We also discuss our trial to detect hereditarily important regions in a protein structure by persistent diagrams.

Kaczynski, Tomasz

Suspension of a measuring function

Given a measuring function f on M with values in R, we construct a measuring function g on the based topological suspension of M, also with values in R, and with the property that its rank invariants are those of f with the homology dimension q shifted by one. In particular, the 0-dimensional rank invariant, equivalently, the size function of g is trivial, and its 1-dimensional rank invariant provides the same information as the size function of f. We use this as a simple model for generating examples aimed at testing various topological invariants of shape for efficiency. In particular, our construction gives some insight into a discussion on what is a better tool in shape comparison: the rank invariant studied for several homology dimensions or the multidimensional size function.

Kahle, Matthew

The topological signature of randomness

We will survey the emerging field of probabilistic topology. This will include recent work which shows that almost all d-dimensional flag complexes have nontrivial homology (with real coefficients), only in degree [d/2].

Kramar, Miroslav

The dynamics of granular materials

We present a novel approach based on topological measurements to study force chain structures of particulate systems. We concentrate on systems undergoing compression. Our method distinguishes different types of friction as well as different amounts of polydispersity. These topological measures can be also used to understand the dynamic features of the system and can be correlated to phenomena such as jamming.

Krcal, Marek

Computing all maps into a sphere

We present an algorithm for computing [X,Y], i.e., all homotopy classes of continuous maps X -> Y, where X,Y are topological spaces given as finite simplicial complexes, Y is (d-1)-connected for some d>1 (for example, Y can be the d-dimensional sphere S^d), and dim X < 2d-1. These conditions on X,Y guarantee that [X,Y] has a natural structure of a finitely generated Abelian group, and the algorithm finds generators and relations for it. We combine several tools and ideas from homotopy theory (such as Postnikov systems, simplicial sets, and obstruction theory) with algorithmic tools from effective algebraic topology (spaces with effective homology).

We hope that a further extension of the methods developed here will yield an algorithm for computing, in some cases of interest, the Z_2-index, which is a quantity playing a prominent role in Borsuk–Ulam style applications of topology in combinatorics and geometry, e.g., in topological lower bounds for the chromatic number of a graph. In a certain range of dimensions, deciding the embeddability of a simplicial complex into R^d also amounts to a {Z_2-index} computation. This is the main motivation of our work.

Krishnan, Sanjeevi

Poincaré duality and linear optimization

In this talk, I will recast and generalize certain dualities in linear optimization, such as max-flow min-cut, as a form of twisted Poincaré Duality for space-times and more singular "directed spaces". Flows correspond to the top-dimensional homology, taking local coefficients and values in a sheaves of semigroups, on directed spaces. Cuts correspond to certain distinguished sections of a dualizing sheaf. Thus max-flow min-cut dualities extend to higher dimensional analogues of flows, higher dimensional analogues of directed graphs, and constraints more complicated than upper bounds. I will describe the formal result and some real-world applications.

Landi, Claudia

Uniqueness of models in persistent homology

We consider the question whether the rank of persistent homology groups of a function f defined on a manifold M uniquely characterizes f, at least up to self-homeorphisms of the manifold. For a function f taking values in IR this is easily seen to be false. However, we can give partially positive answers to this question for vector-valued functions. Our uniqueness problem is clearly strictly related to the decision problem in shape matching, that is, given two patterns, deciding whether there exists a transformation taking one pattern to the other pattern. Rephrased differently, we wish to study to which extent persistent homology can give rise to complete shape invariants.

Linial, Nati

Random simplicial complexes

For the last several years we have been investigating a model of random simplicial complexes that is the higher-dimensional counterpart of the classical Erdos–Renyi model from graph theory. Several new phenomena have already been discovered, but many more questions remain open. I will try to give an overview of this emerging theory. My talk covers work done jointly with R. Meshulam T Luczak and L Aronshtam.

McTague, Carl

A new approach to Euler calculus for continuous integrands

I will describe a new approach to Euler calculus for continuous real-valued integrands inspired by the work of Baryshnikov–Ghrist. The resulting calculus is additive and satisfies a Fubini theorem under fairly general conditions.

Memoli, Facundo

Metric geometry and persistent topology

We study questions regarding the stability of persistence diagrams arising from pseudo-metric data. One first example is the stability of persistence diagrams of Vietoris–Rips filtrations. These can be proved to be stable in the Gromov–Hausdorff sense. Similar stability results hold for more general filtrations that arise from finite metric measure spaces, in which case the stability is w.r.t. the Gromov–Wasserstein metric. These stability results provide lower bounds for the GH distance, whose computation in general leads to NP-hard problems. These results have applications in data analysis and shape classification.

Mrozek, Marian

Homological persistence of maps

When a topological space is known only from sampling, persistence provides a useful tool to study its homological properties. In many applications one can sample not only the space, but also a map acting on the space. The understanding of the topological features of the map is often of interest, in particular in time series analysis. We recall the concept of persistence in finite dimensional vector spaces and use it to study the persistence of eigenspaces of maps induced in homology. Our technique is based on the graph approach to computing homology of maps. (This is joint work with Herbert Edelsbrunner and Grzegorz Jablonski)

Mukherjee Sayan

Probability measures on the space of persistence diagrams

This paper shows that the space of persistence diagrams has properties that allow for the definition of probability measures which support expectations, variances, percentiles and conditional probabilities. This provides a theoretical basis for a statistical treatment of persistence diagrams, for example computing sample averages and sample variances of persistence diagrams. We first prove that the space of persistence diagrams with the Wasserstein metric is complete and separable. We then prove a simple criterion for compactness in this space.

These facts allow us to show the existence of the standard statistical objects needed to extend the theory of topological persistence to a much larger set of applications. We also develop algorithms to compute Frechet means and provide law of large numbers results for these means.

Müllner, Daniel

Consistent scale selection for exploratory visualization and analysis of data sets

Choosing an appropriate scale is a frequently encountered problem in data analysis, and paradigms in the field support both the choice of strategies to make smart, definite choices and the hierarchical or persistence approach of looking at all scales at once. In the core of the "Mapper algorithm" for visualization and analysis of point cloud data, a scale choice must be made multiple times for overlapping fragments of the data set. We present the concept of a *scale graph*, where scale choices in neighbouring regions are brought into conjunction to make consistent decisions at local scale, while retaining global flexibility. By selecting an optimal path through the scale graph, we can make more plausible choices, overcome existing weaknesses, validate results more easily and simplify the data analysis process for the user. (Joint work with Gunnar Carlsson, Facundo Memoli and Gurjeet Singh.)

Nanda, Vidit

Discrete Morse theory for persistence

Computing persistent homology efficiently has become an integral part of modern topological data analysis. An extension of discrete Morse theory to filtrations produces a much smaller Morse filtration with isomorphic persistent homology groups.

Nicolau, Monica

Unraveling the biology of disease through data transformations and topological data analysis

The past decade has witnessed developments in the field of biology that have brought about profound changes in understanding the dynamic of disease and of biological systems in general. New technology has given biologists an unprecedented wealth of information, but it has generated data that is hard to analyze mathematically, thereby making its biological interpretation difficult. These challenges have given rise to a myriad of novel exciting mathematical problems and have provided an impetus to modify and adapt traditional mathematics tools, as well as develop novel techniques to tackle the data analysis problems raised in biology. I will discuss a general approach to address some of these computational challenges by way of a combination of data transformations and topological methods, to highlight specific biologically driven questions. These methods have been applied in a wide range of settings, in particular for the study of the biology of disease.

I will discuss some concrete applications to these methods, including their use to discover a new type of breast cancer and the associated biology that drives the disease, identify disease progression trends, and highlighting the driving mechanisms in acute myeloid leukemia. Much of this is joint work with Gunnar Carlsson.

Obeng-Denteh, William

Topological dynamics in the contemporary era

Topological dynamics is the study of asymptotic or long term properties of families of maps of topological spaces. This paper will treat us to the concepts of flows, minimal sets, minimal flows, proximality and distality. This is the prerequisite for appreciating examples of continuous actions and groups of homeomorphisms.

Rudyak, Yuli
On higher topological complexity and configuration spaces
In 2010 I developed the concept of Farber topological complexity, by introducing the so-called higher topological complexity. The symmetrization of this invariant leads to interesting geometry and, in particular, to research some cofiguration spaces. This is a joint work with Basabe, Gonzalez and Tamaki.

Schuetz, Dirk
Homology of moduli spaces of linkages in high-dimensional euclidean space
We consider closed linkages in d-dimensional Euclidean space, up to translations and rotations, and obtain topological information on the resulting moduli spaces and how they depend on the lengths of the links. In particular, we calculate the Poincaré polynomial in the case d=5 in terms of the length vector determining the linkage.

Sheehy, Donald
Linear-size approximations to the VietorisRips filtration
The VietorisRips filtration is a versatile tool in topological data analysis. Unfortunately, it is often too large to construct in full. We show how to construct an O(n)-size filtered simplicial complex on an n-point metric space such that the persistence diagram is a good approximation to that of the Vietoris–Rips filtration. The filtration can be constructed in O(n log n) time. The constants depend only on the doubling dimension of the metric space and the desired tightness of the approximation. For the first time, this makes it computationally tractable to approximate the persistence diagram of the Vietoris–Rips filtration across all scales for large data sets.

Our approach uses a hierarchical net-tree to sparsify the filtration. We can either sparsify the data by throwing out points at larger scales to give a zigzag filtration, or sparsify the underlying graph by eliminating edges at larger scales to give a standard filtration. Both methods yield the same guarantees.

Skraba, Primoz and Vejdemo-Johansson, Mikael (joint talk)
Persistence modules — algebra and algorithms (joint talk with Primoz Skraba)
Persistent homology was identified by Zomorodian–Carlsson (2005) as homology in the category of graded k[t]-modules, for an underlying field k. Recognizing this algebraic framework allows us to draw on lessons from computational algebra when working out algorithms in computational topology.

We demonstrate some fundamental facts about the category of graded k[t]-modules, and some constructions from computational commutative algebra relevant to the computation of persistent homology: giving constructions for kernels, cokernels, images, pushouts, pullbacks, tensor products, and symmetric and external powers in the category of graded k[t]-modules. These allow, inter alia, for the purely algebraic computation of image, kernel and cokernel persistence, and suggest an out-of-order algorithm for computing persistent homology.

Smale, Stephen
Topology and immunology
Topology of spaces of genes will be discussed.

Szymczak, Andrzej
Piecewise constant vector field topology
The talk will focus on recent work on algorithms for computing Morse decompositions and approximating recurrent dynamics of piecewise constant vector fields, motivated by scientific visualization applications.

Tamaki, Dai
A Salvetti-type model for configuration spaces
We propose a combinatorial/categorical model for configuration spaces of "good" cell complexes. The model is realized as the classifying space of a topological category by using the notion of cellular and stellar stratified spaces.

Vaccarino, Francesco
Minimal resolutions of graded modules and multi bar codes
A polynomial ring over a filed is a PID. This is the main reason why persistent homology can be encoded by a simple bar code. To understand multi persistence one needs to deal with rings of higher projective dimension. However a polynomial ring in several variables is not the right choice. Instead one should look at the representation of the product of the poset of natural numbers. Homological properties of the category of its representations are much easier than for polynomial rings. The aim of this talk is to discuss those properties, in particular illustrate how easy it is to construct minimal resolutions in this category. These resolutions are the multi bar codes. This is a joint work with W Chacholski and M Scolamiero.

van de Weijgaert Rien
The geometry and topology of the Cosmic Web
The Cosmic Web is the fundamental spatial organization of matter on scales of a few up to a hundred Megaparsec, scales at which the Universe still resides in a state of moderate dynamical evolution. Galaxies, intergalactic gas and dark matter exist in a wispy weblike spatial arrangement consisting of dense compact clusters, elongated filaments, and sheetlike walls, amidst large near-empty void regions. While the complex intricate structure of the cosmic web contains a wealth of cosmological information, its quantification has remained a major challenge. In this lecture, we describe recent work towards invoking concepts from computational topology and computational geometry to our understanding of the structure of the Cosmic Web and to new insights into the conditions in the primordial Universe out of which it emerged.

Voronoi and Delaunay tessellations form the basis of DTFE, the formalism to infer the density field of an anisotropic and multiscale mass distribution sampled by discrete points. I will describe the new Nexus multiscale morphology filter, based on DTFE, that helps to identify the filaments and walls in the maps of the galaxy distribution. Also, I will shortly describe the Watershed Void Finder, the Morse theory based technique to outline voids in the galaxy distribution.

An important aspect of our understanding of the Cosmic Web concerns the connectivity of the various components. This leads us to recent work on the topological analysis of the Megaparsec scale distribution. To this end, we resort to the homology of the weblike structure, and determine the scale-dependent Betti numbers. To infer this from the discrete spatial galaxy distribution (or of particles in computer models of cosmic structure formation) we extract the Betti numbers from alpha shapes. We have studied the alpha complex of the cosmic weblike point patterns, in order to assess the signature of filaments, walls and voids. Of considerable importance within the context of the multiscale nature of the cosmic mass distribution, is the information contained in persistence diagrams. Amongst others, I will describe recent work on persistence properties of Gaussian and non-Gaussian random density fields, which form the initial conditions out of which the cosmic web emerged through the force of gravity.

Wagner, Hubert
Computational topology in text mining
I would like to present an application of computational topology, especially persistence, to analysis of text documents. More precisely: analysis of the structure of similarities within a corpus of text documents. First, some basic tools from the field of text-mining will be presented. With these tools we map text data into a high dimensional space, which can be treated with topological methods. Then, we give an interpretation to the information captured by persistence. Finally, we overview the computational difficulties and describe the technique of iterated Morse decomposition we use to preprocess the data. (The project is done in collaboration with Google, within the Google Research Award program.)

Weinberger, Shmuel
Disordered solids and the dynamics of bounded geometry
I will explain a program of J Bellissard and S Ulgen-Yildirim associating a pre-foliated space to complete manifolds with bounded geometry with (anticipated) applications to quasicrystals and less ordered solids.