Antalya Algebra Days XIX

17-21 May, 2017

Şirince - İzmir - Turkey

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Thursday, 18 May

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16:10-16:30: E. Medetoğulları
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17:00-17:20: B. A. Saylam
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15:30-15:50: G. K. Demirci
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Invited Speakers

Some connections between modular invariant theory and modular Lie algebras

Amiram Braun

Let F be an algebraically closed field and $p = \text{char}\, F > 0$. The structure of the center of the enveloping algebra of $sl(n, F)$, when p divides n, is a subject of investigation in the last 40 years. Unfortunately this is marred by false results. We shall describe here what is true, as well as the role of modular invariant theory in proving it.

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Polyhedral computations in social choice

Winfried Bruns

Polyhedral methods have been used for many years in social choice where they can be applied to compute the probabilities (and even exact numbers) of election results that yield unexpected phenomena, for example the famous Condorcet paradox. So far such computations have almost exclusively been restricted to elections with three candidates. Now our software Normaliz can compute many such probabilities also for four candidates. We will explain the method, discuss some examples and sketch the algorithmic approach.

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Koszul algebras of special types

Aldo Conca

We will discuss three types Koszul algebras with extra features: (1) absolutely Koszul algebras, (2) Koszul algebras with the Backelin-Roos property, (3) Koszul algebras over which every product of ideals of linear forms has a linear resolution. Relations among these properties will be described and large families of examples will be presented. This is a joint work with S. Iyengar, D.N.Hop and T.Roemer and with D.N.Hop and Thanh Vu.

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On a conjecture of Auslander and Reiten

Olgur Çelikbaş

There are many conjectures from the representation theory of finite-dimensional algebras that have been transplanted to commutative algebra, and this process has enriched both fields significantly. An example is the celebrated Auslander-Reiten conjecture on the vanishing of cohomology, which has been initially proposed over Artin algebras [2]. This long-standing conjecture, in local algebra, is stated as follows:

Conjecture. (*Auslander and Reiten* [2]) *A finitely generated module M over a commutative Noetherian local ring R satisfying $Ext^i_R(M,M) = Ext^i_R(M,R) = 0$ for all $i > 0$ must be free.*

The Auslander-Reiten conjecture stems from a conjecture of Nakayama [7], and it is closely related to other conjectures such as the Tachikawa conjecture [8]. Although there are various partial affirmative answers to the Auslander-Reiten conjecture, it is wide open in general; see, for example, [5, 6].

In this talk I will briefly survey the literature on the Auslander-Reiten conjecture and discuss some of my joint work [1, 3, 4] with Tokuji Araya, Kei-ichiro Iima, Arash Sadeghi and Ryo Takahashi.

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Endotrivial modules via homotopy theory

Jesper Grodal

For G a finite group and k a field of characteristic p, an endotrivial module is a $k\,G$-module M such that $\mathrm{End}(M)$ is isomorphic to a trivial module plus a projective module. Equivalence classes of such modules form a group under tensor product which identifies with the Picard group of the stable module category. Endo-trivial modules occur in many parts of representation theory as "almost 1-dimensional modules", and there has been a quest to classify them spanning the last 40 years, starting from the work of Dade in the 70s.

In my talk I'll survey the history of this problem and then present a way to calculate this group of endotrivial modules using homotopy theory, based on my recent preprint arXiv:1608.00499.

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Bordism group homology

Bernard Hanke

The investigation of free group actions on manifolds leads to bordism calculations of classifying spaces, a classical topic in equivariant topology. Continuing work of Conner-Floyd, Landweber, Johnson-Wilson and others we present new results for abelian groups. This has implications for the existence of positive scalar curvature metrics on non-simply connected manifolds, as predicted by the Gromov-Lawson-Rosenberg conjecture.

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On the trace of the canonical module and nearly Gorenstein rings (joint work with D. Stamate)

Jürgen Herzog

Gorenstein rings admit beautiful symmetry properties: self dual resolutions, symmetric h-vectors, and, by a theorem of Kunz, among the numerical semigroup rings they are those with symmetric semigroup. There have been several nice ideas to define properties of rings which are sightly weaker than that of being Gorenstein. Barucci and Fröberg, for example, defined almost symmetric numerical semigroups and Goto, Takahashi and Taniguchi generalized this concept and introduced almost Gorenstein rings. Since then, almost Gorenstein rings have been studied in numerous papers.

In a recent paper, together with Stamate, we considered the trace of the canonical module ω_R of a local Cohen-Macaulay ring $(R, \mathfrak{m})$. The significance of this trace is that it describes the non-Gorenstein locus of R. Thus R is Gorenstein if and only if $\mathrm{tr}(\omega_R) = R$. If the trace of ω_R comes very close to R, namely if $\mathfrak{m} \subseteq \mathrm{tr}(\omega_R)$, we call R nearly Gorenstein.

In this lecture we discuss nearly Gorenstein rings for Segre products and Veronese rings. The theory will be applied to give a full classification of all Hibi rings which are nearly Gorenstein in terms of the underlying poset. Furthermore, we discuss the relationship of almost Gorenstein to nearly Gorenstein.

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The maximum likelihood degree of toric varieties

Serkan Hoşten

We study the maximum likelihood degree (ML degree) of toric varieties, known as discrete exponential models in statistics. By introducing scaling coefficients to the monomial parameterization of the toric variety, one can change the ML degree. We show that the ML degree is equal to the degree of the toric variety for generic scalings, while it drops if and only if the scaling vector is in the locus of the principal A-determinant. Throughout, we include examples motivated by algebraic geometry and statistics. We compute the ML degree of rational normal scrolls and a large class of Veronese-type varieties. In addition, we investigate the ML degree of scaled Segre varieties, hierarchical loglinear models, and graphical models.

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Computational Arithmetic Invariant Theory

Gregor Kemper

Usually invariant theory works over a field. But for some purposes it would be useful to be able to compute invariants over a ring. This talk presents a new algorithm for doing that. The main tool is the Derksen ideal, named after Derksen's celebrated algorithm for computing invariants of reductive groups. The talk will recall Derksen's algorithm and then explain the computation of a localization of the invariant ring for groups that need not be reductive. Having computed such a localization, the last step is the extraction of the invariant ring from it, which this can be done in the arithmetic situation by using Gröbner bases over a ring. An application of the algorithm obtained in this way is the computation of invariant rings of finite groups acting on finitely generated domains over a Euclidean ring.

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Control of fixed points and unique existence of centric linking systems

Justin Lynd

A saturated fusion system over a finite p-group S is a category that aims to encode a pattern of conjugacy of the subgroups of S. The model example is the conjugacy induced by a finite group within one of its Sylow p-subgroups. The Martino-Priddy conjecture, first proved by Oliver and later generalized by Chermak, is the statement that the p-fusion system of a finite group determines (and is determined by) the homotopy type of the p-completed classifying space of the group. This was shown by proving that a fusion system always has a unique centric linking system, which provides the link to recovery of the p-completed classifying space. I will discuss a new proof of this theorem which removes previous dependencies on the classification of the finite simple groups. Most of the new insights are finite-group theoretic, and concern the general question: given a finite group G acting on an abelian p-group V, when is there a p-local subgroup H that has the same fixed points on V as does G?

This is joint work with George Glauberman.

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Automorphisms of fusion systems of nite simple groups

Bob Oliver

Fix a prime p. The fusion system of a finite group G with respect to a Sylow subgroup $\mathcal{S} \in \mathrm{Syl}_p(G)$ is the category $\mathcal{F}_\mathcal{S}(G)$ whose objects are the subgroups of $\mathcal{S}$, and whose morphisms are the homomorphisms induced by conjugation in G. We describe results which compare, when G is simple, the automorphism groups $\mathrm{Out}(G), \mathrm{Out}(\mathcal{F}_\mathcal{S}(G))$, and that of the closely related linking system $\mathcal{L}^c_\mathcal{S}(G)$. For example, when G is simple and $\mathcal{S}$ is nonabelian, and G is A_n for $n \equiv 0, 1 \pmod{p}$, a group of Lie type in de ning characteristic p, or a sporadic group, then $\mathrm{Out}(G) \cong \mathrm{Out}(\mathcal{L}^c_\mathcal{S}(G))$ with just four exceptions. We discuss this result, and also the remaining (more complicated) case when G is simple of Lie type in characteristic different from p.

This comparison of Out $(\mathcal{L}^c_\mathcal{S}(G))$ with Out (G) has consequences for the question of whether an extension of the fusion system of G can be realized by some extension of G.

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Finite Subgroups of Fields

Jim Shank

Suppose that F is field of prime characteristic p and E is a finite subgroup of the additive group $(F, +)$. Then E is an elementary abelian p-group. We view two such subgroups, say E and E', to be equivalent if there is a unit c in F^* such that $E = cE'$. This equivalence relation is motivated by a problem in invariant theory. The equivalence classes can be separated using rational functions. I will discuss the problem of finding explicit separating sets. This is joint work with Eddy Campbell, Jianjun Chuai and David Wehlau; details can be found in arXiv:1610.03709.

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Stable categories of modules for infinite groups

Peter Symonds

Joint work with Nadia Mazza. We construct a stable module category for a large class of infinite groups using complete resolutions. This is similar to the construction of Tate cohomology. We then restrict to the group of endotrivial (or invertible) modules, in other words the Picard group. This has been intensely studied for finite groups. We develop enough machinery to allow us to make calculations for certain infinite groups.

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Horn's Conjecture, Faces of the Littlewood-Richardson Cone and Permutations

David Wehlau

Horn conjecture's deals with the following problem: If A and B are Hermitian matrices, how are the eigenvalues of $A+B$ constrained by the eigenvalues of A and B. In 1962, Alfred Horn conjectured a beautiful answer to this question. In the late 1990's, A. Klyachko and Knutson-Tao independently proved Horn's conjecture. Horn's conjecture has surprising and very important connections with several areas of mathematics, including the Schubert calculus, representations of Lie Groups, and quiver theory. The space of eigenvalues of A, B and $A+B$ forms a real polyhedral cone, known as the Littlewood-Richardson Cone. Understanding the geometry of the Littlewood-Richardson Cone, yields important information. We can describe the generating rays and many other faces of this cone in terms of inversion sets for elements of the symmetric group. I will describe this combinatorial problem, our solution and a few of the consequences.

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On the realizability of group actions

Antonio Viruel

If M is a $\mathbb{Z}G$-module for a group G, we say that a simply-connected space X realize this action if, for some k, $\pi_k(X)$ as a $\mathbb{Z}\mathcal{E}(X)$-module for the group $\mathcal{E}(X)$ of self-homotopy equivalences of X, is isomorphic to M as a $\mathbb{Z}G$-module. Which modules can be so realized? We obtain a positive answer for any faithful finitely generated $\mathbb{Q}G$-module, where G is finite. Our proof relies on providing a positive answer to Kahn's problem for a large class of orthogonal groups of which, by using invariant theory, our case is shown to be a particular one.

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Toric ideals and varieties via bouquets

Marius Vladoiu

We survey a combinatorial classification of toric ideals via bouquets. One important consequence of it is a kind of polarization-type operation, which allows passing from an arbitrary (positively graded) toric ideal to the toric ideal of a hypergraph preserving essential (all) combinatorial information of the original toric ideal. As an application of this combinatorial classification we classify the strongly robust toric ideals and discuss a related conjecture of A. Boocher on robust toric ideals. In addition, we complete the combinatorics of self-dual projective toric varieties equivariantly embedded classified by M. Bourel, A. Dickenstein and A. Rittatore. This talk is based on joint works with S. Petrovic and A. Thoma, and on ongoing project with A. Thoma.

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Castelnuovo-Mumford regularity of edge ideal of graphs

Siamak Yassemi

Let G be a graph with n vertices, $S = \mathbb{K}[x_1, \ldots, x_n]$ be the polynomial ring in n variables over a field $\mathbb{K}$ and $I(G)$ denote the edge ideal of G.

We survey a number of recent studies of the Castelnuovo-Mumford regularity of the edge ideal of G. Our focus is on bounds and exact values for the regularity in terms of combinatorial data from associated graphs.

In addition, for every collection $\mathcal{H}$ of connected graphs with $K_2 \in \mathcal{H}$, we introduce the notions of *ind-match*$_{\mathcal{H}}(G)$ and *min-match*$_{\mathcal{H}}(G)$. We will improve the inequalities for regularity of $S/I(G)$. Moreover, we will discus about Cohen–Macaulayness of a graph with girth at least five.

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Homogeneous numerical semigroups, their shiftings, and monomial curves of homogeneous type

Santiago Zarzuela

Given a numerical semigroup $S = \langle n_1, \ldots, n_d \rangle$ we introduce the concept of being homogeneous. This is done in terms of the Apéry set $\mathrm{AP}(S, n_1)$. We show that any homogeneous numerical semigroup S with Cohen-Macaulay tangent cone $G(S)$ is of homogeneous type, that is, the Betti numbers of S and $G(S)$ coincide. We study with some more detail the cases of small emebdding dimensions and the behavior of the homogeneous property under gluing. Finally, we prove that the property of being homogeneous and having Cohen-Macaulay tangent cone fulfills asymptotically under shifting, providing as a consequence a new proof of a result by J. Herzog and S. Stamate (2014), inspired on a work by T. Vu (2014), stating that for a monomial curve, the property of being of homogeneous type fulfills asymptotically under shifting.

This is a joint work with Raheleh Jafari.

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Contributed Talks

MacWilliams identity for complete m-spotty Rosenbloom-Tsfasman weight enumerators of linear codes

Tarık Arabacı

Information transfer is usually done on bit sequences via electronic channels. Errors occur due to various reason during transmission of information. These errors may result in misunderstandings or noise in the communication. They are detected and corrected by using error correction codes which are attached to the communication system. Mathematics plays an important role for designing codes and comparing them by considering their perspective.

Error detection and correction capability of a code depends on the minimum distance of that code. Minimum distance is equal to the minimum weight in a linear code. For this and a number of other criteria for comparing codes weight distributions of the codes are remarkable. Polynomials called weight enumerators are used for expressing the weight distribution of a code briefly.

In order to create a weight enumerator of a code, weights of all codewords in that code need to be calculated and classified. This is a laborious activity for codes containing a large number of codewords. However, the number of codewords in a code is inversely proportional to the number of codewords in its dual code. So the very large codes have very small dual codes. It is much easier and quicker to calculate the weight enumerator of the small dual code than to calculate the weight enumerator of a large code.

An identity between the weight enumerators of the codes and their duals was first established by Jessie Mac Williams using the classical vectorial inner product of Euclidean space and Hamming metric. Similar identities have been established for different metrics and inner products in subsequent years. These identities are called as Mac Williams identities in memory of Jessie Mac Williams.

There are several weight enumerators used in coding theory for different uses. While the Hamming metric and derived weight enumerators focus on the number of the errors/nonzero symbols in the vectors, the Rosenbloom-Tsfasman metric and derived weight enumerators deal with the position of that errors/nonzero symbols. Whereas both of them take codewords as a single unit and define the distance between them, m-spotty types of weight enumerators divide the codewords into pieces. These m-spotty types weight enumerators also have different types according to respecting the order of the pieces. Weight enumerators that maintain the information about the order of pieces are called "complete" and can only be expressed by multivariable polynomials. In this study, Mac Williams identity will be established for complete m-spotty Rosenbloom-Tsfasman weight enumerators.

This is a joint work Emre Kolotoğlu.

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Vanishing Ideals of Parameterised Toric Codes

Esma Baran

Let X be a complete simplicial toric variety over a finite field. In this talk, firstly I will focus on subvarieties of X which is parameterized by Laurent monomials and evaluation codes on them. We give two methods for computing generators of vanishing ideals of these parameterized sets by generalizing some results from [1]. Using these, one can compute basic invariants of evaluation codes on parameterized sets [2]. This is a joint work with Mesut Şahin of Hacettepe University.

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Generating sets of finite transformation semigroups $PK(n, r)$ and $K(n, r)$

Leyla Bugay

Let P_n and T_n be the partial transformation and the full transformation semigroups on the set $\{1, \ldots, n\}$, respectively. In this study we find necessary and sufficient conditions for any subset of partial transformations of height r in the subsemigroup

$$PK(n, r) = \{\alpha \in P_n : |im(\alpha)| \leq r\}$$

of P_n to be a (minimal) generating set of $PK(n, r)$; and similarly, for any subset of full transformations of height r in the subsemigroup

$$K(n, r) = \{\alpha \in T_n : |im(\alpha)| \leq r\}$$

of T_n to be a (minimal) generating set of $K(n, r)$ for $2 \leq r \leq n - 1$.

Keywords: Partial (full) transformation semigroup, idempotent, (minimal) generating set, rank.

This is a joint work with Hayrullah Ayık.

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$|\mathcal{S}_R|$-Semiprime and $|\mathcal{S}_R|$-Prime Rings

Didem K. Camcı

In this study, $|\mathcal{S}_R|$-prime ring and $|\mathcal{S}_R|$-semiprime ring have been defined where $\mathcal{S}_R$ is called the source of semiprimeness of a ring R and defined as

$$\mathcal{S}_R = \{a \in R \mid aRa = (0)\}.$$

In addition, the properties between $\mathcal{S}_R$ and prime radical of R have been studied. Furthermore, it is found that if R is isomorphic to a subdirect sum of H_i where H_i are $|\mathcal{S}_{H_i}|$-prime ring and $i \in \Lambda$ then $\beta(R) = \mathcal{S}_R$. Conversely, this theorem is true if R is a commutative ring with unity, $(\mathcal{S}_R)^2 = (0)$ and every prime ideal pair of R is a pairwise comaximal.

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Endopermutation Mackey functors for p-groups

Olcay Coşkun

Endopermutation modules for p-groups are introduced by Dade in 1970s and their classification is completed by works of Bouc in 2004 build upon results of Alperin, Carlson, Mazza and Thévenaz. In this talk, we introduce *endopermutation Mackey functors* and discuss basic properties of them.

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Connected Sums of Gorenstein Artin Rings

Ela Çelikbaş

Gorenstein rings, due to their various kinds of symmetries and duality properties, form an important and ubiquitous class of rings. In 2012 Ananthnarayan, Avramov and Moore introduced a new construction of Gorenstein rings (cf. [2]). They defined a *connected sum* of two Gorenstein local rings as an appropriate quotient of their fiber product. Although the fiber product is rarely Gorenstein, they proved that a connected sum of two Gorenstein local rings is always a Gorenstein ring.

In this talk, we discuss connected sums $R\#_k S$ of Gorenstein Artin local rings R and S over their common residue field k. We give a characterization for Gorenstein Artin local rings to be decomposable as connected sums. We show that the indecomposable components appearing in the connected sum decomposition are unique up to isomorphism. We also investigate conditions which force Gorenstein Artin local rings to be indecomposable as connected sums.

This presentation is based on a recent joint work with H. Ananthnarayan, Jai Laxmi, and Z. Yang in [1].

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Smooth models of singular $K3$-surfaces

Alex Degtyarev

According to a recent paper by Shimada and Shioda, the famous *Fermat quartic*

$$X_{48}\colon \quad z_0^4 + z_1^4 + z_2^4 + z_3^4 = 0$$

has another smooth projective model $X_{56} \subset \mathbb{P}^3$, which is Cremona, but not projectively equivalent to X_{48}. (This quartic was originally discovered, as one of the eight quartics containing more that 52 lines, by I. Itenberg, A.S. Sertöz, and the author.) We will start with showing that X_{48} and X_{56} are *all* smooth spatial models of X_{48}, a fact especially surprising considering that there are thousands of *singular* models. Generalizing, we will discover that there are relatively few smooth quartics of the form $X(T) \subset \mathbb{P}^3$, where $X(T)$ is a singular $K3$-surface and $\det T \le 80$. This classification sheds new light on the problem of counting lines in smooth quartics: all models found have many lines, and the champion, Schur's quartic

$$X_{64}\colon \quad z_0(z_0^3 - z_1^3) = z_2(z_2^3 - z_3^3)$$

containing 64 lines, can alternatively be characterized as the singular $K3$-surface of the smallest discriminant (which equals 48) admitting a smooth embedding to $\mathbb{P}^3$.

In spite of the previous result, the number of smooth spatial models of a given singular $K3$-surface $X(T)$ may grow very fast as $\det T \to \infty$; a few examples will be considered. In particular, if $\det T = 163$ (a case important for counting lines defined over $\mathbb{Q}$), there are over 3200 distinct models.

One can also obtain a similar classification for a few other commonly studied polarizations ($h^2 = 2$, 6, or 8), arriving at the following conjectures concerning the number of lines:

- a smooth sextic curve in $\mathbb{P}^2$ has at most 72 tritangents;
- a smooth sextic surface in $\mathbb{P}^4$ has at most 42 lines;
- a smooth octic surface in $\mathbb{P}^5$ has at most 36 lines.

These numbers are those realized by the singular $K3$-surfaces of the smallest discriminant (108, 39, and 32, respectively) admitting corresponding models.

The last two statements have been proved: at present, the maximal number of lines in a smooth polarized $K3$-surface is known for all polarizations $h^2 \geq 4$. The asymptotic bound, appearing infinitely often, is 24 lines, all lying in the fibers of an elliptic pencil.

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Classification of $5-$dimensional complex nilpotent Leibniz algebras

İsmail Demir

Leibniz algebras are certain generalization of Lie algebras. Classification of all nilpotent Lie algebras is still unsolved and it is very difficult problem. Due to lack of antisymmetry property in Leibniz algebras, the problem of classifying all nilpotent Leibniz algebras is more complicated. We give the classification of $5-$dimensional complex nilpotent Leibniz algebras. We use the canonical forms for the congruence classes of matrices of bilinear forms as in [1, 2] to classify some special subcases. Furthermore, using some algebraic invariants we classify the remaining cases.

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Rings whose simple modules are poor

Gizem Kafkas Demirci

Given right modules M and N, M is said to be injective relative to N (or M is N-injective) if, for any submodule K of N, any R-homomorphism $f : K \to M$ extends to an R-homomorphism $g : N \to M$. The class of modules N such that M is N-injective is called the injectivity domain of M and denoted by $In^{-1}(M)$. Clearly $In^{-1}(M)$ contains the class of semisimple right modules. As an opposite notion of injectivity, the authors of [1], defined a right module M to be poor if its injectivity domain is exactly the class of semisimple right modules.

A ring R is said to be right simple-destitute if every simple right module is poor. Simple-destitute rings are studied in [1] and [3]. Local rings are simple-destitute and a right Artinian ring is simple-destitute if and only if R is semisimple or it has a unique simple right module up to isomorphism (see [3]). The structure of simple-destitute general rings is not known. In this talk, we characterize the commutative simple-destitute rings. Also, some results in [3] are generalized.

This is a joint work with Engin Büyükaşık.

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Homological Algebra Techniques in Computation of R-Torsion

Esma Dirican

Let $\Sigma_{g,n}$ be an orientable surface with genus $g \geq 2$ bordered by $n \geq 1$ curves homeomorphic to circle. As is well known that one-holed torus $\Sigma_{1,1}$ is the building block of such surfaces. In this study, by using the notion of symplectic chain complex along with purely algebraic techniques, we prove a novel formula for computing Reidemeister torsion of one-holed torus. Moreover, applying this result and considering $\Sigma_{g,n}$ as the connected sum $\Sigma_{1,n}\#(g-1)\Sigma_{1,0}$, we establish a novel formula to compute Reidemeister torsion of $\Sigma_{g,n}$. This work is joint with Prof. Dr. Yaşar Sözen. This research was supported by TÜBİTAK under the project number 114F516 and I would also like to thank TÜBİTAK for the financial support.

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Approximating monoid actions by group actions

Mehmet Akif Erdal

Actions of monoids are very useful in modeling progressive processes. Due to the lack of inverses, and the resulting lack of technology, studying monoid actions is more difficult than studying group actions. We develop a method to study monoid actions by approximating with group actions. More precisely, to a space A with an action of a monoid M, we assign a collection spaces with actions of the group completions of each submonoid of M, in a universal manner. We use the structures of these spaces with group actions to approximate the structure of the M-space A. This method applies to both representation theory and homotopy theory. In this talk, we will discuss some applications of our approach to equivariant homotopy theories of spaces with monoid actions.

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Elliptic Curves and Recurrence Sequences

Betül Gezer

Let E be an elliptic curve over $\mathbb{Q}$ given by a Weierstrass equation

$$E : y^2 + a_1xy + a_3y = x^3 + a_2x^2 + a_4x + a_6$$

and let $P \in E(\mathbb{Q})$ be a non-torsion point. We can write the multiples of P as

$$nP = \left(\frac{A_{nP}}{B_{nP}^2}, \frac{C_{nP}}{B_{nP}^3}\right)$$

where $A_{nP},\ B_{nP}, C_{nP} \in \mathbb{Z}$ and $\gcd(A_{nP}C_{nP}, B_{nP}) = 1$. Then the sequence (B_{nP}) is an elliptic divisibility sequence. Indeed, if (h_n) is an elliptic divisibility sequence with $h_0 = 0$, $h_1 = 1$ then $h_n = \psi_n(P)$, where ψ_n is the n-th division polynomial of E and $h_n = \pm B_{nP}$ if $\gcd(a_3, a_4) = 1$. In this work we study properties of elliptic divisibility sequences and Somos 4 sequences associated to elliptic curves. In particular we will be interested in integrality properties of the sequences which can be expressed in terms of the x-coordinates of the points $(x_n,\ y_n) = Q + nP$ where $P = (0, 0)$ and $Q = (x, y)$ is a suitable point on an elliptic curve.

This is joint work with Osman Bizim.

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Factorizations in numerical semigroup algebras

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By a *numerical semigroup*, we mean a monoid generated by finitely many positive rational numbers. Let κ be a field and S be a numerical semigroup. The numerical semigroup ring $\kappa[\![t^S]\!]$, in the variable t, consists of power series $\sum_{s\in S} a_s t^s$ with coefficients $a_s \in \kappa$. Having two numerical semigroups $S \subset S'$, the inclusion $\kappa[\![t^S]\!] \subseteq \kappa[\![t^{S'}]\!]$ provides a numerical semigroup algebra. If S' is generated by S and rational numbers $s_1, \dots, s_n$, the numerical semigroup ring $R' := \kappa[\![t^{S'}]\!]$ is also denoted by $R[\![t^{s_1}, \dots, t^{s_n}]\!]$ to indicate its algebra structure over the coefficient ring $R := \kappa[\![t^S]\!]$. The absolute case refers to the situation where the coefficients of the algebra form a power series ring in one variable.

A flat numerical semigroup algebra $R[\![t^{s_1}, \dots, t^{s_n}]\!]$ is called *complete intersection*, if the kernel of some (and hence for all) local surjective R-algebra homomorphism $\hat{\pi}\colon R[\![Y_1, \dots, Y_n]\!] \to R'$ is generated by n elements.

We consider the case that $\hat{\pi}(Y_i) = t^{s_i}$. The flat numerical semigroup algebra $R[\![t^S]\!]$ is complete intersection if and only if the induced R-algebra homomorphism $\pi\colon R[Y_1, \dots, Y_n] \to R'$ is generated by n elements. The kernel of π is generated by binomials $t^{a_0}Y_1^{a_1}\cdots Y_n^{a_n} - t^{b_0}Y_1^{b_1}\cdots Y_n^{b_n}$ satisfying $t^{a_0}, t^{b_0} \in R$ and $a_0 + a_1 s_1 + \cdots + a_n s_n = b_0 + b_1 s_1 + \cdots + b_n s_n$. The expressions $t^{a_0}(t^{s_1})^{a_1}\cdots(t^{s_n})^{a_n}$

and $t^{b_0}(t^{s_1})^{b_1}\cdots(t^{s_n})^{b_n}$ are *factorizations* of $t^{a_0+a_1s_1+\cdots+a_ns_n}$ into minimal monomials. For the algebra $R[\![t^{s_1},\ldots,t^{s_n}]\!]$, to be complete intersection, we need to find n pairs of factorizations of a monomial, which determine other pairs of factorizations of monomials.

In this talk, we present an approach by bounded factorizations of monomials, to find n candidates for generators of $\ker\pi$. Our goal is to specify the class of complete intersection numerical semigroup algebras, in which every monomial has a unique bounded factorization.

This is based on a joint work in progress with I-Chiau Huang.

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Prescribing coefficients of invariant irreducible polynomials

Giorgos Kapetanakis

Let $\mathbf{F}_q$ be the finite field of q elements. We define an action of $\mathrm{PGL}(2,q)$ on $\mathbf{F}_q[X]$ and study the distribution of the irreducible polynomials that remain invariant under this action for lower-triangular matrices. As a result, we describe the possible values of the coefficients of such polynomials and prove that, with a small finite number of possible exceptions, there exist polynomials of given degree with prescribed high-degree coefficients.

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Extending modules with respect to projection invariant submodules

Yeliz Kara

A module M is called an *extending module* if every submodule of M is essential in a direct summand of M. There have been many generalizations of the extending property with respect to various sets of submodules. In this study, we deal with the classes of extending modules with respect to projection invariant submodules. Our focus is behaviour of the aforementioned classes of modules with module theoric properties including direct sums and direct summands.

This is a joint work with Adnan Tercan.

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$\mathcal{SS}$-Suplemented Modules

Engin Kaynar

In this work, $\mathcal{SS}$-supplemented modules are defined, and the basic properties of these modules are obtained. Moreover, characterizations of some rings are given via $\mathcal{SS}$-supplemented modules. In addition, the structure of $\mathcal{SS}$-supplemented modules over dedekind domains is studied.

Keywords: $\mathcal{SS}$-supplement, $\mathcal{SS}$-supplemented module.

This is a joint work with Ergül Türkmen, Hamza Çalışıcı.

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Irreducible Representations of Leavitt Path Algebras of Polynomial Growth

Ayten Koç

LPAs (Leavitt Path Algebras) of directed graphs were defined in 2004 (in [4] and [1]) after a detour through functional analysis (graph C*-algebras). Their roots are in the works of Bill Leavitt in the 60s on the IBN (Invariant Basis Number) property. LPAs are Cohn localizations of path (or quiver) algebras. Their representations form a subcategory of quiver representations, their finite dimensional representations are classified [5].

The interesting class of LPAs of polynomial growth (i.e. finite Gelfand Kirillov dimension) were characterized graphically and studied in [2] and [3]. They include the algebraic Toeplitz/Jacobson algebra and algebraic quantum spheres of every dimension. The purpose of this talk is to present a complete classification of all irreducible representations (including infinite dimensional representations) of LPAs of polynomial growth.

This is a joint work with Murad Özaydın.

Keywords: Leavitt path algebras, quiver representations, Gelfand Kirillov dimension, simple modules.

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On the Birman-Hilden property

Elif Medetoğulları

Let X denote a surface and $p : \tilde{X} \to X$ be a branched cover. $LMod(X)$ denotes the subgroup of mapping class group of X (i.e. $Mod(X)$) consisting of isotopy classes of liftable homeomorphisms of X and $SMod(\tilde{X})$ denotes the subgroup of $Mod(\tilde{X})$ consisting of isotopy classes of symmetric homeomorphisms of $\tilde{X}$. Birman-Hilden property is satisfied by a branched cover p, if $LMod(X)$ is isomorphic to $SMod(\tilde{X})/Deck(p)$, where $Deck(p)$ is the deck transformation group of the covering. In this talk a brief history about

Birman-Hilden property will be given and the property will be investigated for branched covers of non-orientable surfaces.

This is a joint work with Ferihe Atalan.

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On Modules with The SA Property

Figen Takıl Mutlu

In this work, matrix rings with the SIP and the ads (briefly, SA) are studied. A ring R has the right summand intersection property (SIP) if the intersection of two direct summands of R is also a direct summand. A right R-module M has the absolute direct summand property (ads) if for every decomposition $M = A \oplus B$ of M and every complement C of A in M, we have $M = A \oplus C$. Let R be any ring with identity, e an idempotent in R such that $R = ReR$ and S the subring eRe and $R = Mat_n(S)$. It is shown that R_R has the SA if and only if S^n_S has the SA. It is also shown the direct sum of two copies of a semisimple right Ore domain has both SIP and ads properties (briefly, SA property) as a right module over itself.

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Canonical Induction for Green functors

Hatice Mutlu

Brauer induction theorem says that each complex character of a finite group can be expressed as an integral combination of characters which are induced from linear characters of elementary subgroups. Boltje's theory of canonical induction gives a sufficent condition for canonical induction formulas of Mackey functors to be integral. Green functors are a kind of group functor, rather like Mackey functors, but with a further multiplicative structure. In general case, we want to develop the theory of canonical induction by making use of bisets to incorporate the options of inflation, deflation and exploring the rich features afforded by the Green functor structure including a comultiplication operation. In this talk I will present a joint work with Laurence Barker. We focus on a special Green functor called the monomial Burnside ring. We show that the canonical induction morphism factorizes through the multiplication and the comultiplication.

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On the category of cofinite modules which is Abelian

Reza Naghipour

Let R denote a commutative Noetherian (not necessarily local) ring, and I an ideal of R of dimension one. In this talk we provide a short proof of, K. I. Kawasaki's Theorem [1] that the category $\mathscr{M}(R, I)_{cof}$ of I-cofinite modules over a commutative Noetherian local ring R forms an Abelian subcategory of the category of all R-modules. Consequently, this assertion answers affirmatively the question raised by R. Hartshorne in [*Affine duality and cofiniteness*, Invent. Math. **9**(1970), 145-164], for an ideal of dimension one in a commutative Noetherian ring R.

Keywords: Abelian category, arithmetic rank, cofinite module, Noetherian rings.
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Squarefree Zero-Divisor Graphs of Stanley-Reisner Rings

Ashkan Nikseresht

Let $S = K[x_1, \ldots, x_n]$ be the polynomial ring in n indeterminates over a field K and I be a squarefree monomial ideal of S. The goal of this talk is to introduce a new zero-divisor based graph, from which we can derive all of the algebraic properties of the K-algebra $R = S/I$. Note that $R = K[\Delta] = S/I_\Delta$ is the Stanley-Reisner ring of a simplicial complex Δ on $[n]$, where I_Δ is the Stanley-Reisner ideal of Δ. One can consult [2] for a review of monomial ideals and Stanely-Reisner rings and their importance.

Recall that the *zero-divisor graph* $\Gamma(R)$ of R has as vertex set the set of all nonzero zero-divisors of R and two vertices are adjacent when their product in R is zero (see for example [1]). This (infinite) graph gives us little information about R. Indeed, for two simplicial complexes Δ and Δ' and two fields K and K', we prove that $\Gamma(K[\Delta]) \cong \Gamma(K'[\Delta'])$ if and only if $|\mathrm{Ass}(I_\Delta)| = |\mathrm{Ass}(I_{\Delta'})|$ and either $|K|, |K'| \leq \aleph_0$ or $|K| = |K'|$ ($\aleph_0$ denotes the smallest infinite cardinal). Thus if we fix K, we can only find the number of associated prime ideals of R from $\Gamma(R)$.

To remedy this weakness, we consider the subgraph of $\Gamma(R)$ induced by the set of all squarefree monomials in $R \setminus I$. We call this graph the *squarefree zero-divisor graph* of R and denote it by $\Gamma_{sf}(R)$. Clearly this (finite) graph does not contain any information about the base field K, but the main theorem in this talk states that $\Gamma_{sf}(K[\Delta]) \cong \Gamma_{sf}(K[\Delta'])$ if and only if $K[\Delta] \cong K[\Delta']$. Thus we can derive all of the algebraic properties of R from $\Gamma_{sf}(R)$ and K. In particular, we show that $|\mathrm{Ass}(I)| = \omega(\Gamma_{sf}(R)) =$ size of the largest clique of $\Gamma_{sf}(R)$ and the Krull dimension of R is $\log_2(\alpha + 1)$, where α is the size of the largest independent set of $\Gamma_{sf}(R)$ meeting a maximum clique. We also show that the diameter of $\Gamma_{sf}(R)$ is at most 3 and characterize Stanley-Reisner rings R with $\mathrm{diam}(\Gamma_{sf}(R)) \leq 2$ or 1.

This research is financially supported in part, by the National Elites Foundation of Iran.

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The localization theorem for finite dimensional compact group actions

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The localization theorem of Borel, Atiyah-Segal, Quillen, Hsiang is known for compact G-spaces, where G is a compact Lie group. In this study, we show that the localization theorem remains true for finite dimensional compact group actions, and Borel's fixed point theorem holds not only for torus actions but for arbitrary finite dimensional compact connected abelian group actions.

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$(\alpha, \beta)-$**Reverse Derivations On Prime and Semiprime Rings**

Merve Özdemir

In this paper we investigate some properties of $(\alpha, \beta)-$reverse derivations on prime and semiprime rings. The first of the main results is that if R is a prime ring of characteristic not 2, $(\alpha, \beta)-$reverse derivation and generalized $(\alpha, \beta)-$reverse derivation are $(\alpha, \beta)-$derivations and generalized $(\alpha, \beta)-$derivations of R, respectively. The next main result is that if R is a 2$-$torsion free semiprime ring, following properties are obtained. Let α, β be two homomorphisms of R, $a, b, c \in R$, D, F and G be three $(\alpha, \beta)-$reverse derivations of R. (i) Let α be automorphisms of R and β be epimorphisms of R. D is a $(\alpha, \beta)-$reverse derivations of R if and only if D is a $(\beta, \alpha)-$derivations of R. (ii) If $D(x) = c\alpha(x) + \beta(x)c$ then $D = 0$ and $c = 0$. (iii) If $D(x) = a\alpha(x) + \beta(x)b$ then D is inner $(\alpha, \beta)-$derivation of R which is determined by a. (iv) If $F(x)\alpha(y) + \beta(y)G(x) = 0$ for all $x, y \in R$ and α, β are automorphisms of R then $F(y)\,\alpha([z, x]) = \beta([z, x])\,G(y) = 0$ for all $x, y, z \in R$; in particular, F and G map R into $Z(R)$.

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On S-closed submodules

Salahattin Özdemir

A submodule N of a module M is called S-closed (in M) if M/N is nonsingular. In this talk, we describe the smallest proper class (in the sense of Buchsbaum) containing the class of short exact sequences determined by S-closed submodules, and consider coprojective modules of this class which we call *ec-flat* modules. We present some results that give a connection between ec-flat modules and other classes of modules.

This is a joint work with Yılmaz Durğun.

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Algebraic structures arising from isotonian maps between posets

Ayesha Asloob Qureshi

Our main goal is to study the ideal $L(P,Q)$ and toric ring $K[P,Q]$ whose generators are in bijection to the isotone maps from P to Q. We examine the several algebraic properties of $L(P,Q)$ including Alexander duality behaviour. The class of algebras $K[P,Q]$, called isotonian, are natural generalizations of the so-called Hibi rings. We determine the Krull dimension of these algebras and for particular classes of posets P and Q we discuss their normality behaviour. Also, we determine special classes of P and Q for which defining ideal of $K[P,Q]$ admits a quadratic Gröbner basis.

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On the isoperimetric number and bisection width of Fibonacci cubes

Elif Saygı

The hypercube graph Q_n is the graph formed from the vertices and edges of an n-dimensional hypercube. The vertices of Q_n are represented by all binary strings of length n and two vertices are adjacent if and only if they differ in exactly one position. The Fibonacci cube Γ_n of dimension n is a subgraph of Q_n, where the vertices correspond to those without two consecutive 1s in their string representation.

Let $G = (V(G), E(G))$ be an undirected finite graph with vertex set $V(G)$ and edge set $E(G)$. For any nonempty subset X of $V(G)$ let δX denote the edge boundary of X, that is, the set of edges which connects vertices in X to the vertices in $V(G) \setminus G$. Then the isoperimetric number of G (also called Cheeger constant of G) is defined as

$$i(G) = \min \left\{ \frac{|\delta X|}{|X|} : X \subseteq V(G), 0 < |X| \leq \frac{1}{2}|V(G)| \right\}.$$

A subset X of $V(G)$ which has the minimum $i(G)$ is called an isoperimetric set. The isoperimetric number is closely related to the notion of bisection width $bw(G)$ of G, which is the minimum number of edges that must be removed from G in order to split $V(G)$ into two equal sized (within one if $|V(G)|$ is odd) subsets. That is,

$$bw(G) = \min \left\{ |\delta X| : X \subseteq V(G), |X| = \left\lfloor \frac{|V(G)|}{2} \right\rfloor \right\}.$$

In theoretical computer science, one wishes to devise network configurations having high $i(G)$ (at least, bounded away from zero) even when the number of computers in the network ($|V(G)|$) is large. It is known that $i(Q_n) = 1$. In this work we obtain upper and lower bounds on the isoperimetric number and bisection width of Γ_n. We have used the recursive structure of Γ_n and an embedding technique to obtain the bounds.

This is a joint work with Ömer Eğecioğlu.

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On the Number of k-normal Elements over Finite Fields

Zülfükar Saygı

In this study we enumerate k-normal elements over finite fields for some special cases. k-normal elements are generalization of normal elements [**?**]. Let $\mathbb{F}_q$ be the finite field of order q and let $\alpha \in \mathbb{F}_q$. If the degree of gcd $\left(x^n - 1, \alpha x^{n-1} + \alpha^q x^{n-2} + \cdots + \alpha^{q^{n-1}}\right)$ is $n-k$, we say that α is a k-normal element. Properties of k-normal elements were studied in [1] and their numbers were given implicitly by

$$\sum_{h|x^n-1,\ \deg(h)=n-k} \Phi(h), \tag{1}$$

where Φ is the Euler Phi function for polynomials. A problem of finding an explicit formula for this sum was presented in [1]. Since the sum in (1) involves a factorization of the polynomial $x^n - 1$, this problem is closely related with the factorization of $x^n - 1$ and therefore the factorization of cyclotomic polynomials. We used various results and techniques given in [3], [4], [5], [2] to answer this problem. We obtain some results for finite fields having even and odd characteristics.

This is a joint work with Ernist Tilenbaev and Çetin Ürtiş.

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Locally isomorphic torsionless modules over domains of finite character

Başak Ay Saylam

Let R be an integral domain. We call R an h-local domain if it is of finite character, that is any non-zero ideal of R is contained in but a finite number of maximal idelas, and every non-zero prime ideal of R is contained in only one maximal ideal of R. In [1], P. Goeters and B. Olberding compare local, near, and stable isomorphisms of torsionless modules over h-local domains. In this talk, we will provide some fundamental results towards comparing these weaker forms of isomorphisms of torsionless modules over domains of finite character.

This talk is based on a joint work with Lee Klingler. The work has been supported by TÜBİTAK with project number 113F235.

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Lattice ideals and toric codes

Mesut Şahin

I will briefly recall basics of toric varieties over finite fields and evaluation codes on them. Then, we will see that some vanishing ideals of subvarieties are lattice ideals. Using this and [1], we can characterize whether they are complete intersections or not. In the former case; dimension, length and regularity of the code will be understood easily by [2].

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Unit Additive Map

Serap Şahinkaya

Let R be a ring. A map $f : R \to R$ is additive if $f(a+b) = f(a) + f(b)$ for all elements a and b of R. Here a map $f : R \to R$ is called unit-additive if $f(u+v) = f(u) + f(v)$ for all units u and v of R. Motivated by a recent result of Xu, Pei and Yi in [2] that, for any field F, every unit-additive map of $M_n(F)$ is additive for all $n \geq 2$, this paper is about the question when every unit-additive map of a ring is additive. It is proved that every unit-additive map of a semilocal ring R is additive if and only if either R has no homomorphic image isomorphic to $\mathbb{Z}_2$ or $R/J(R) \cong \mathbb{Z}_2$ with $2 = 0$ in R. Consequently, for any semilocal ring R, every unit-additive map of $M_n(R)$ is additive for all $n \geq 2$. These results are further extended to rings R such that $R/J(R)$ is a direct product of exchange rings with primitive factors Artinian. A unit-additive map f of a ring R is called unit homomorphic if $f(uv) = f(u)f(v)$ for all units u, v of R. As an application, the question of when every unit-homomorphic map of a ring is an endomorphism is addressed.

This is a joint work with M. Kosan and Y. Zhou (see [1]).

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Free Actions on Product of Spheres

Berrin Şentürk

In transformation group theory, there is a well known conjecture which states that if p is a prime and $G = (\mathbb{Z}/p\mathbb{Z})^r$ acts freely on a product of l spheres $S^{n_1} \times \cdots \times S^{n_l}$, then $r \leq l$. The equidimensional case is verified with some additional conditions. For instance, it is proved by Carlsson [1] when the induced action on the integral homology of the product of spheres is trivial. Carlsson [3] also proved this conjecture for $p = 2$ and $r = 3$ without any further restrictions on the dimensions of the spheres and the induced action on the homology. In fact, for $p = 2$ and $r = 3$ Carlsson proved a stronger version of this conjecture which he stated in [2] as follows; assume R is a polynomial ring in r variables over an algebraically closed field k of characteristic p then given a free, finitely generated differential graded R-module M whose homology is nonzero, finite dimensional as a k-vector space, then $rk_R(M) \leq 2^r$. In this talk, I will discuss another conjecture which implies this stronger conjecture by using the fact that the differential of M can be represented by a square-zero strictly upper triangular matrix. I will give evidence to support this conjecture by utilizing Rothbach's work [4] on the variety of square-zero upper triangular matrices.

This is joint work with Özgün Ünlü.

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Research Statement

Bilge Sipal

My research interest includes computer algebra, symbolic computation, computational commutative algebra and machine learning. My first encounter with these subjects were during my master degree studies. My MSc thesis in Koc University was "Groebner Bases and Its Applications" in which I also had a section on border bases. That thesis led me to my Phd advisor Prof Martin Kreuzer and by his suggestion I start working on border basis schemes.

The border basis scheme theory has been established relatively recently. The pioneering article in this subject is [12] which introduces the name border basis scheme, as well. Before explaining border basis schemes, let me give a brief look into border basis theory. Let $\mathcal{P}$ be a polynomial ring and let I be a zero-dimensional ideal. The basic idea of border basis theory is to describe a zero-dimensional ring $\mathcal{P}/I$ by an order ideal of terms $\mathcal{O}$ whose residue classes form a K-vector space basis of $\mathcal{P}/I$ (for further information I refer to [15]). Let $\mathcal{O}$ be an order ideal with μ terms. An $\mathcal{O}$-border basis scheme is a scheme that parametrizes all zero-dimensional ideals that have $\mathcal{O}$-border basis. Therefore, it is an open sub-scheme of Hilbert scheme of μ points $H_n^\mu = Hilb^\mu(\mathbb{A}^n)$. The affine varieties mentioned in [5] Proposition 2.1 are exactly the border basis schemes of points on the plane.

My Contributions

The work I mention in this section is from my PhD thesis which is submitted in July 2016.

I introduce a grading on the polynomial ring, where the vanishing ideal of a border basis scheme is defined. I shall call this grading *the arrow grading.* Then I show that vanishing ideal of a border basis scheme is homogenous with respect to the arrow grading. Although this is a known fact (see for example Lemma 4.1 [9]), I give a slightly different proof by using the generic multiplication matrices. Moreover, I show that the torus action (see page 208 of [5] and page 363 of [18]) on $\mathbb{B}_{\mathcal{O}}$ results in the arrow grading. The arrow grading is not of positive type ([15], Definition 4.2.4). Thus it follows that there might exist more than one maximal homogenous ideal in $\mathrm{B}_{\mathcal{O}}$. This shows that the claim on the page 363 of [18] is wrong. Consequently, giving an algebraic proof of any claim on a border basis scheme is tricky because of the peculiarity of the grading, which is defined on the coordinate ring of a border basis scheme.

Then I investigate the cotangent space of a border basis scheme at the monomial point. In [5], M. Haiman proposed a new method of constructing the cotangent space of a border basis scheme of μ points in the plane. I call this method the *arrow method.* The main idea is to consider every indeterminate from the set $\{c_{11}, ..., c_{\mu\nu}\}$ parametrizing the border basis scheme as an arrow from an order ideal term to a border term, then to construct a basis of the cotangent space by using the relations of border terms and order ideal terms. Then in Chapter 4 and 5 of [8] is a pre-print that is only published in arXiv., M. Huibregste generalizes this "arrow method" to n dimensions and gives a way a for constructing a basis of the cotangent space of a border basis scheme. Note that none of those citations contains the name border basis scheme. However in [5], the set U_μ given in Equation 2.3 and in [8] the set U_β given in Equation (4) in Chapter 2.2 are both border basis schemes. My work is inspired by both of those sources, but mainly by [8]. In contrast to these articles I do not use the arrow method. The foundation of my work depends on the generating set of the vanishing ideal of a border basis scheme, which is on all the relations of border terms and order ideal terms. Thus, every relation that M. Haiman and M.Huibregste use to construct the basis set is coded in elements defining equations of border basis scheme. By using these equations one can compute all the equivalence classes modulo $\mathfrak{m}^2$. I denote this set of equivalence classes by $\mathfrak{E}$. I show that the arrow degree is well-defined on this set. Then I show that $\mathfrak{E}$ contains at least $n\mu$ elements. Consequently, by using the set $\mathfrak{E}$, I give a basis of the cotangent space. From this I deduce a smoothness criterion for the monomial point of a border basis scheme.

Theorem 1. *Let $\mathcal{O} \subset \mathbb{T}^n$ be an order ideal with μ elements. The monomial point $\mathfrak{o} \in \mathbb{B}_{\mathcal{O}}$ is smooth if and only if the number of elements of $\mathfrak{E}$ is $n\mu$.*

A similar result can be found in [8], Theorem 5.1.1. I reprove the statements in Chapter 4 and 5 of [8] for border basis schemes by using the tools I have in the border basis scheme theory such as border relations and the arrow grading.

The trace and the Jacobi identity syzygies were first introduced in [9]. In Section 10 of [9] trace syzygy method is used to show that any border basis scheme of points contained in a plane is an *ideal-theoretic complete intersection.* Moreover, in the same article for the specific case $\mathcal{O} = \{1, x_1\} \subset \mathrm{K}[x_1, x_2, x_3]$ both trace syzygy and Jacobi identity syzygy computation methods were used to prove that $\mathbb{B}_{\mathcal{O}}$ is an ideal-theoretic complete intersection. Let $\mathcal{B}(2,2,2)$ denote the order ideal

$$\{1, x_3, x_2, x_1, x_2x_3, x_1x_3, x_1x_2, x_1x_2x_3\} \in \mathrm{K}[x_1, x_2, x_3].$$

I show that these methods are not sufficient to decide whether $\mathbb{B}_{\mathcal{B}(2,2,2)}$ is a complete intersection or not. I reprove some of the properties of the trace and Jacobi identity syzygies. My aim is to characterize these syzygy computations by the arrow grading. I show that there are at most 60 redundant polynomials in the set of defining equations of the border basis scheme $\mathbb{B}_{\mathcal{B}(2,2,2)}$ that can be computed by Jacobi identity and Trace syzygy methods and I illustrate the reasons why these methods are not sufficient. Moreover, I implemented the Jacobi identity and the trace syzygy computation methods in the package *bbsmingen* of the computer algebra system [1].

Let $\mathcal{O} = \{1, x_1, x_1^2, \ldots, x_1^{\mu}\} \subset \mathbb{K}[x_1, ..., x_n]$ be an order ideal. I call such order ideals as segment order ideals and the $\mathcal{O}$-border basis scheme as segment border basis scheme. I compute Jacobi identity and trace syzygies of the defining equations of a segment border basis scheme. Besides, I show that they are not enough to give all the redundant generators of the vanishing ideal of this scheme. Then I give a new method to find all the redundant generators of the vanishing ideal of a segment border basis scheme. This method led me to the following result.

Theorem 2. *A segment border basis scheme is an ideal-thoretic complete intersection.*

In [6] it is proven that if the order ideal $\mathcal{O} \in \mathrm{K}[x_1, x_2]$ is of the shape "*saw tooth*" then the $\mathcal{O}$-border basis scheme is isomorphic to an affine space. I show that one can generalize this as follows. Let $\mathcal{O} \in \mathrm{K}[x_1, ..., x_n]$ be an order ideal. Let $\mathcal{T}$ denote the set of defining equations of $\mathcal{O}$-border basis scheme. Let $\{c_{11}, ..., c_{\mu\nu}\}$ be a set of further indeterminates and $\mathrm{K}[c_{11}, ..., c_{\mu\nu}]$ denote the polynomial ring where $\langle \mathcal{T} \rangle \subset \mathrm{K}[c_{11}, ..., c_{\mu\nu}]$. Let $\mathcal{S}$ denote the local system of parameters of $\mathbb{B}_{\mathcal{O}}$ chosen in special way. Let M be the set of indeterminates that does not include indeterminates c_{ij} where $\bar{c}_{ij} \in \mathcal{S}$. Let $\mathcal{T}'$ denote the set of defining equations without the redundant ones. Let $\mathcal{M}$ be a matrix whose entries are derivatives of elements from $\mathcal{T}'$ with respect to elements of M.

Theorem 3. *Let $\mathcal{O}$ denote an order ideal in $\mathrm{K}[x_1, ..., x_n]$, having μ elements. If there exists a set $\bar{\mathcal{S}} \subset \mathrm{B}_{\mathcal{O}}$ with $n\mu$ elements such that the entries of the corresponding matrix $\mathcal{M}_{\mathcal{S}}$ are in the polynomial ring $\mathrm{K}[\mathcal{S}]$ and the determinant of this matrix is ± 1, then $\mathbb{B}_{\mathcal{O}}$ is isomorphic to an affine space of dimension $n\mu$.*

In other words, for a given $\mathcal{O}$-border basis scheme, if there exists a maximal minor of $\mathrm{Jac}(\mathcal{T})$ that is ± 1 and the corresponding sub-matrix is in $\mathrm{Mat}_m(\mathrm{K}[\mathcal{S}])$, the $\mathcal{O}$-border basis scheme is isomorphic to an affine space. Moreover, it is an ideal theoretic complete intersection where the vanishing ideal is generated by $\mathcal{T}_{\mathcal{S}}$. We note that if $\mathbb{B}_{\mathcal{O}}$ is isomorphic to an affine space of dimension $n\mu$, then it is not trivial that it is an ideal theoretic complete intersection (see [17]).

We apply Theorem 3 to prove Proposition 7.3.1 of [6] which is as follows.

Theorem 4. *Let $\mathcal{O} = \{t_1, ..., t_\mu\}$ be an order ideal in $\mathbb{T}^2$. If the order ideal $\mathcal{O}$ has the sawtooth form then $\mathbb{B}_{\mathcal{O}}$ is isomorphic to an affine space.*

An order ideal has the *sawtooth* form if the diagram of $\mathcal{O}$ is of the form such that every step width, except possibly the topmost,

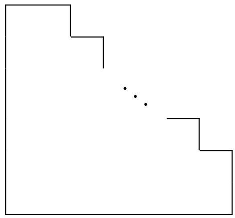

Table 1: Diagram of $\mathcal{O}$ has the *sawtooth* form

and every step height, except possibly the rightmost, is of size one. My aim is to compare the two methods and to emphasize the fact that Theorem 3 is more general than the methods applied in the proof of Theorem 7.3.1 of [6].

Then, by applying the methods I develop, I prove the following theorem.

Theorem 5. *A segment border basis scheme is isomorphic to an affine space.*

In [19], Corollary 3.13, it is also shown that a segment border basis scheme is isomorphic to an affine space. Our result depends on Theorems 3 and 2 which differs from [19].

For further research I strongly believe that Theorems 3 can be generalized to the following criterion.

Conjecture Let $\mathcal{O} \subset \mathrm{K}[x_1, ..., x_n]$ be an order ideal. Let K be a perfect field. The border basis scheme $\mathbb{B}_{\mathcal{O}}$ is isomorphic to an affine space, if there exists a spanning set $\bar{\mathcal{S}}$ of $\mathfrak{m}/\mathfrak{m}^2$ such that the determinant of $\mathcal{M}$ is ± 1.

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A New Variation of Injective Modules

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In this paper, we provide the various properties of GE and GEE-modules as a new variation of injective modules. In particular, we prove that semisimple modules are a GE-module. We show that a module M is a GEE-module if and only if every submodule is a GE-module. We study on the structure of GE and GEE-modules over dedekind domains. The class of GE-modules lies between $\overline{WS}$-coinjective modules and Zöschinger's modules with the property (E). We also prove that, if a ring R is a local dedekind domain, an R-module M is a GE-module if and only if $M \cong (R^*)^n \oplus K \oplus N$, where R^* is the completion of R, K is injective and N is a bounded module.

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$\mathcal{Z}^*$-Semilocal Modules and The Proper Class $\mathcal{RS}$

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Over an arbitrary ring a module M is said to be $\mathcal{Z}^*$-*semilocal* if every submodule U of M has a $\mathcal{Z}^*$-supplement V in M, that is, $M = U + V$ and $U \cap V \subseteq \mathcal{Z}^*(V)$, where the *Rad-small* submodule $\mathcal{Z}^*(V) = \{\, m \in V \mid Rm \; is\, a \; small \; module \,\}$. In this paper, we study on the basic properties of these modules as a proper generalization of semilocal modules. Also, we show that the class $\mathcal{RS}$ of all

short exact sequences $\mathbb{E} : 0 \longrightarrow M \xrightarrow{\psi} N \xrightarrow{\phi} K \longrightarrow 0$ such that $Im(\psi)$ has a $\mathcal{Z}^*$-supplement in N is a proper class over left hereditary rings. We study on some homological objects of the proper class $\mathcal{RS}$.

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On a Lie ring of generalized inner derivations

Selin Türkmen

Let R be a ring with the center $Z(R)$, $L(R)$ be the Lie ring of R with the product given by $[r,s]$ for all $r,s \in R$ and the set of all inner derivations of R be denoted by $I(R)$. In [1], N. Jacobson proved that there exists a Lie epimorphism between $L(R)$ and $I(R)$ with kernel $Z(R)$. In [3], an additive mapping $f : R \to R$ is called a *generalized derivation* if there exists a derivation d of R such that $f(xy) = f(x)y + xd(y)$ for all $x, y \in R$. For fixed $a, b \in R$, $f(x) = ax + xb$ is called a *generalized inner derivation*. In [4], the set of all generalized derivations of R is denoted by $Gder(R)$ which is a Lie ring with the product $[f_1, f_2] = f_1 f_2 - f_2 f_1$ for all f_1, $f_2 \in Gder(R)$.

In this study, for a fixed $a \in R$ $f_a : R \to R$ such that $f_a(x) = [x,a]_{\sigma,\tau}$ is a generalized derivation associated with inner derivation $i_{\sigma(-a)}$ where σ, τ are homomorphisms of R. The set

$$f_R = \left\{ f_a : R \to R \mid f_a(x) = [x,a]_{\sigma,\tau}, a \in R \right\}$$

is a Lie subring of $GderR$. $f_A = \{f_a \in f_R \mid a \in A\}$ is a Lie subring as well as a Lie ideal of f_R where A is a Lie ideal of R. Firstly, the epimorphism in [1] is generalized and some properties of f_R are investigated. Secondly, it is proved that if f_R is a prime Lie ring and A, B are Lie ideals of R then $[f_A, f_B] = (0)$ implies that either $f_A = (0)$ or $f_B = (0)$.

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Generating Sets of Certain Semigroups of Partial Isometries

Melek Yağcı

Let I_n be the symmetric inverse semigroup on $X_n = \{1, \ldots, n\}$, and let DP_n be its subsemigroup of partial isometries on X_n under its natural order. In this talk we find the rank and the structure of generating sets of the subsemigroup $DP_{n,r} = \{\alpha \in DP_n : |im(\alpha)| \leq r\}$ for $2 \leq r \leq n-1$.

This is a joint work with Hayrullah Ayık and Leyla Bugay.

Keywords Partial isometries, order-preserving map, order-reversing map, generating set, rank.

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A New Class of Quantum Codes

Eda Yıldız

If a complete successful quantum computer can be built, it needs an error correction procedure based on quantum mechanics. Thus, the theory of quantum error correcting codes is a recent and an interesting topic. Also, there is a relation between quantum codes and classical linear codes over finite fields [5]. One of the main problem in Coding Theory is the existence of a code with a given parameter set and optimizing some parameters for a given fixed parameter set. Hence, researchers are working on constructions of new codes over different mathematical structures [1]. Classical codes over Eisenstein-Jacobi integers are constructed and a new distance is defined in [3]. CSS code construction states that a quantum code can be constructed from two classical codes. In this study, we construct quantum error correcting codes over Eisenstein-Jacobi integers by using the CSS construction. Since there is an isomorphism between Eisenstein-Jacobi integers and finite fields, direct constructions of quantum codes over Eisenstein-Jacobi integers can be obtained. Error bases, error matrices and a new weight are defined and they are illustrated with examples. Also, we prove the commutative property of error operators with respect to this new distance. Obtaining these codes can lead an answer for the existence question for some new parameters.

Keywords: Quantum code; error correcting codes; Eisenstein-Jacobi integers; CSS code construction.

Joint work with Fatih Demirkale.

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Minimal Relative Generating Sets Of Some Partial Transformation Semigroups

Ebru Yiğit

Let $PT_{n,r} = S_n \cup PK_{n,r}$ where S_n is the symmetric group on X_n and $PK_{n,r}$ is the semigroup of partial maps $\alpha : X_n \to X_n$ such that $|im(\alpha)| \leq r$ for $1 \leq r \leq n-1$. In this talk I represent the necessary and sufficient conditions for any subset of $PK_{n,r}$ to be a (minimal) relative generating set of the subsemigroup $PT_{n,r}$ modulo S_n. Then, for each $1 \leq r \leq n-1$, we show that the smallest number of elements of $PK_{n,r}$ which, together with S_n, generate $PT_{n,r}$ is $\sum_{s=0}^{n-r} p_r(n-s)$ where $p_r(n-s)$ denotes the number of partitions of $n-s$ with r terms.

The results presented in my talk have been obtained in collaboration with Gonca Ayık and Hayrullah Ayık.

Keywords: (Partial) transformation semigroup; (Minimal) generating set.

2010 Mathematics Subject Classification: 20M20.

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Efficient Computation of Dual Space and Directional Multiplicity of an Isolated Point

Zafeirakis Zafeirakopoulos

Isolated singularities typically occur at self-intersection points of planar algebraic curves, curve offsets, intersections between spatial curves and surfaces, and so on. There are many different ways to approach the notion of multiplicity of an isolated singularity and even more tools.

In this talk we present how the information characterizing the singularity can be captured in a local dual basis, expressing combinations of vanishing derivatives at the singular point. This approach was first taken by Macaulay, who presented his classic algorithm for computing such a basis. The integration method of Mourrain [2] constructs much smaller matrices than Macaulay's approach, by performing integration on previously computed elements. In recent work [1] a new criterion for constructing smaller matrices based on the integration method was introduced. This criterion is easy to implement and allows to avoid redundant computations during the computation of the dual basis, by deleting certain columns from the matrices in the integration method.

A second aspect of dual bases that we explore is that of orthogonal projection. We introduce the notion of directional multiplicity, which expresses the multiplicity structure with respect to an axis, and is useful in understanding the geometry behind projection. We use the notion of directional multiplicity in order to shed light on the gap between the degree of the generator of the elimination ideal and the corresponding factor in the resultant.

Finally, we show an application of dual bases on root deflation. Given an ideal and an isolated (possibly multiple) point in its variety, root deflation is the process of finding a polynomial system having the same point as a simple isolated root. Root deflation is important both for its theoretical merits and for practical computation, e.g., in Newton's method.

The talk is based on joint work with Angelos Mantzaflaris and Hamid Rahkooy presented in [1].

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Posters

Hilbert function of non-standard bigraded algebras

Amir Bagheri

In this presentation we prove that behavior of non-standard bigraded polynomial rings comes from a quasi-polynomial. Let $B = k[T_1, \ldots, T_n]$ be a bigraded polynomial ring over field k with $\deg(T_i) = (d_i, 1)$. In fact we show that there exist a finite index sublattice L of $\mathbb{Z}^2$, collections of polynomials P_i and Q_{ij} for $1 \leq i \leq r-1$ and $1 \leq j \leq s$ such that for any $(\mu, \nu) \in R_i$,

$$HF(B, (\mu, \nu)) = P_i(\mu, \nu) + Q_{ij}(\mu, \nu)$$

where $(\mu, \nu) + L = g_j$ is an element of $\mathbb{Z}^2/L = \{g_1, \ldots, g_s\}$ and R_i is the convex polyhedral cone generated by linearly independent vectors $\{(d_i, 1), (d_{i+1}, 1)\}$. The main technique that we use is the fact of vector partition function.

Furthermore this result can be extended for every non-standard $\mathbb{Z}^n$-graded polynomial rings.

MSC 2000: 13D45, 13D02

Keywords: Hilbert functions, non-standard polynomial rings, vector partition functions, chamber complexes

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On The Representation Theory of The Symmetric Groups

Cihan Sahillioğulları, Sedef Taşkın

We present a new approach to the complex finite dimensional irreducible representations of the symmetric group which was developed by Anatoly Vershik and Andrei Okounkov. The main aim of any representation theory of the symmetric groups is to explain the appearence of Young Diagrams and Young Tableaux in the theory in a natural way. The traditional approach is indirect and rests upon nontrival auxiliary constructions. The presence of Young tableaux in the theory is justified only in the end, after the proof of the branching rule.

Bratelli Diagram Let

$$\{1\} = G_1 \subseteq G_2 \subseteq \therefore \subseteq G_n \subseteq \therefore$$

be an inductive chain of finite groups. Denote by $G_n^{\wedge}$ the set of equivalence classes of finite dimensional complex irreducible representations of G_n. Denote by V^{λ} the irreducible G_n module corresponding to $\lambda \in G_n^{\wedge}$. Define the following directed graph, called the branching multigraph or Bratelli Diagram of this chain: its vertices are the elements of the set

$$\bigcup_{n\geq 1} G_n^{\wedge}$$

and two vertices μ ,λ are joined by k directed edges from μ to λ whenever $\mu \in G_{n-1}^{\wedge}$ and $\lambda \in G_n^{\wedge}$ for some n, and the multiplicity of μ in the restriction of λ to G_{n-1} is k. We call $G_n^{\wedge}$ the nth level of the branching multigraph. We write $\mu \nearrow \lambda$ if there is an edge from μ to λ. When we consider G_n as the symmetric group s_n, multiplicities of all restrictions are 0 or 1. Since branching is simple, the decomposition

$$V^{\lambda} = \bigoplus_{\mu} V^{\mu}$$

where the sum is over all $\mu \in G_n^{\wedge}$ with $\mu \nearrow \lambda$, is canonical. By iterating this composition, we obtain

$$V^{\lambda} = \bigoplus_{T} V_T$$

where the sum is over all possible chains

$$T = \lambda_1 \nearrow \lambda_2 \nearrow \therefore \nearrow \lambda_n$$

with $\lambda_i \in G_i^\wedge$ and $\lambda_n = \lambda$. By choosing a nonzero vector v_T in each one-dimensional space V_T, we obtain a basis v_t of V^λ, called the Gelfand-Tsetlin basis. Let Z_n denote the center of the algebra $\mathbb{C}[S_n]$ and set $GZ(n) =< Z_1, Z_2, \therefore, Z_n >$. This set is called the Gelfand-Tsetlin algebra. **Young-Jucys-Murphy elements** For $i = 2, 3, .., n$, we define YJM elements as follows

$$X_i = (1n) + (2n) + ... + (n-1n)$$

These elements generate Gelfand-Tsetlin algebra,

$$GZ(n) =< X_1, X_2, ..., X_n >$$

The algebra $GZ(n)$ is a maximal commutative subalgebra of $\mathbb{C}[S_n]$. In each irreducible representation of S_n, the Gelfand-Tsetlin basis is determined up to scalar factors. This basis is called the Young basis. The Young basis is a common eigenbasis of the YJM-elements. Let w be a vector of Young basis in some irreducible representation, denote by

$$\alpha(w) = (b_1, b_2, ..., b_n) \in \mathbb{C}[S_n]$$

the eigenvalues of $X_1, X_2, ..., X_n$ on w.

$$Spec(n) = \{\alpha(w), \text{v belongs to the Young basis}\}$$

the spectrum of the YJM-elements and we have

$$|Spec(n)| = \sum_{\lambda \in S_n^\wedge} dim(\lambda)$$

We have an equivalence relation ˜on $Spec(n)$

$$\alpha \sim \beta, \quad \text{where} \quad \alpha, \beta \in Spec(n)$$

if v_α and v_β belong to the same irreducible S_n-module. Let

$$\alpha = (b_1, ..., b_i, b_{i+1}, ..., b_n) \in Spec(n)$$

We have the followings,

- $b_i \neq b_{i+1}$ for all i,

- if $b_i = b_i \pm 1$, then $s_i.v_\alpha = \pm v_\alpha$, where $s_i = (ii+1)$

- if $b_{i+1} \neq b_i \pm 1$,then

$$\alpha^{'} = s_i.\alpha = (b_1, ..., b_{i+1}, b_i, ..., b_n) \in Spec(n)$$

On above, s_i is called admissible transposition for α.

Young Graph We now introduce content vector and its relation with Young graph and $Spec(n)$. We say that $\alpha = (a_1, ..., a_n)$ is a content vector,
if α satisfies the following conditions:

- $a_1 = 0$

- $\{a_q - 1, a_q + 1\} \cap \{a_1, ..., a_{q-1}\} \neq \emptyset$ for all $q > 1$,

- if $a_p = a_q = a$ for some $p < q$, then

$$\{a - 1, a + 1\} \subset \{a_{p+1}, .., a_{q-1}\}$$

There is an equivalence relation $\approx$ on $Cont(n)$ $\alpha \approx \beta$ where $\alpha, \beta \in Cont(n)$ if α is an admissible permutation of the entries of β. Since the number of elements of $Cont(n)/\approx$ equals to the number of the elements of $Spec(n)/\sim$, we have

$$Spec(n) = Cont(n) \quad \text{and} \quad \sim = \approx$$

.

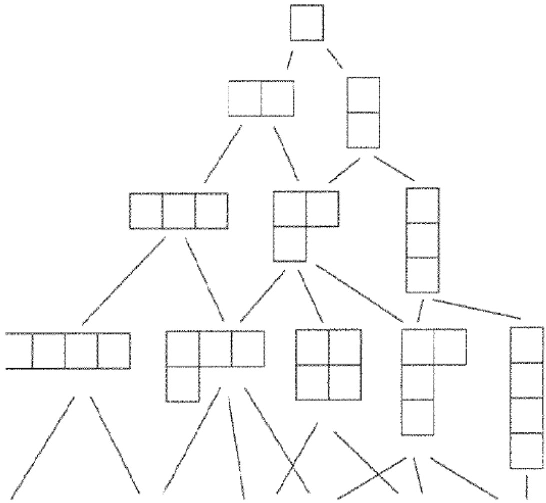

Figure 1: Young Graph

Denote by $\mathbb{Y}$ the Young graph. The vertices of $\mathbb{Y}$ are Young diagrams, and two vertices v and n are joined by a directed edge if and only if $v \subset n$ and n/v is a single box. In this case we write $v \nearrow n$. By $Tab(v)$ denote the set of paths in $\mathbb{Y}$ from $\emptyset$ to v, such paths are called standard tableaux. A convenient way to represent a path $T \in Tab(v)$,

$$\emptyset = v_0 \nearrow ... \nearrow v_n = v$$

is to write numbers $1, ..., n$ in the boxes $v_1/v_0, ..., v_n/v_{n-1}$ of v_n, respectively. We have

$$Tab(n) = \bigcup_{|v|=n} Tab(v)$$

The Young tableaux with the partition $\lambda = (4, 3, 1) \vdash 8$ is shown below.

(1,1)	(1,2)	(1,3)	(1,4)
(2,1)	(2,2)	(2,3)	
(3,1)			

Figure 2: Content of boxes

The content of the above young tableaux is

$$\alpha(T) = (0, 1, 2, 3, -1, 0, 1, -2) \in Cont(8)$$

For any $T \in Tab(n)$ we have $C(T) \in Cont(n)$ and the map

$$Tab(n) \longrightarrow Cont(n)$$

$$T \longmapsto C(T)$$

is one-to-one and onto. Moreover, if $\alpha, \beta \in Cont(n)$, say $\alpha = C(T)$ and $\beta = C(P)$ with $T, P \in Tab(n)$ then $\alpha \approx \beta$ if and only if T and P are tableaux of the same shape. **Conclusions**

- The Young graph $\mathbb{Y}_n$ is the branching graph of the symmetric groups; the spectrum of the Gelfand-Tsetlin algebra $GZ(n)$ is the space of paths in the finite graph $\mathbb{Y}_n$.
- $Spec(n)$ is the spectrum of $GZ(n)$ with respect to the YJM-generators $X_1, ..., X_n$ and $Cont(n)$ is the set of content vectors, the corresponding equivalence relations coincide: $\sim = \approx$.

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Cofinitely I-Rad-$\oplus$-Supplemented Modules

Burcu Taş

Let M be an R-module and let I be an ideal of R. We say that M is *cofinitely* I-Rad-$\oplus$-*supplemented modules*, provided for every cofinite submodule N of M, there exists a direct summand K of M such that $M = N+K$, $N \cap K \subseteq IK$ and $N \cap K \subseteq \mathrm{Rad}(K)$. We show that cofinitely I-Rad-$\oplus$-supplemented modules is closed under finite direct sums. In addition, we prove that an R-module M is cofinitely I-Rad-$\oplus$-supplemented if and only if K and $\frac{M}{K}$ are cofinitely I-Rad-$\oplus$-supplemented for an ideal I of R and cofinite fully invariant direct summand K of M. (Ergül Türkmen and Burcu Nişancı Türkmen provides developing of this paper.)

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Finding Maximum Likelihood Estimators using Generalized Newtones Method

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Newtones method involves iteratively maximizing a local quadratic approximation to an objective function. This paper uses an optimization routine that generalizes Newton's method and presents applications to some well-known probability distribution functions. Initial steps of this approach were studied in two Microsoft Research papers [1] and [2]. We apply non-quadratic local approximations using various class $C^{k\geq 2}$ functions and find the maxima of some well-known probability distribution functions. As in Newton's method, after approximating the objective function, we iteratively update the x-value and find maximum likelihood estimators. Finally, we compare the results of this new optimization routine to the Newton's method and other routines proposed in [1].

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