Spring 2016

- **January 29**

  Speaker: FirstName LastName (Some University)
  Title: Organizational Meeting

  Abstract: We will discuss schedule and speakers for this semester

- **February 8**

  Speaker: Adrian Vasiu (Binghamton University)
  Title: Classification of Lie algebras with perfect Killing form

  Abstract: We will review basic properties of Lie algebras over arbitrary commutative rings. Then we will present the classification of Lie algebra over such rings whose killing forms are perfect. This re-obtains and generalizes prior works of Curtis, Seligman, Mills, Block–Zassenhaus, and Brown in late sixties and in seventies who worked over fields. This work will appear in Algebra and Number Theory journal.

- **February 15**

  Speaker: Adrian Vasiu (Binghamton University)
  Title: Classification of Lie algebras with perfect Killing form, Part II

  Abstract: We will go through few details of the proof of the classification stated last time that involve universal enveloping algebras, Casimir elements, and cohomology. Then we will talk about the main motivation behind this classification coming from extensions of group schemes.

- **February 22**

  Speaker: Jaiung Jun (Binghamton University)
  Title: Berkovich Analytification, Tropicalization, and hyperfields.

  Abstract: I will review the basic notions of Berkovich analytification in connection to tropicalization. Then I will explain how some basic definitions of Berkovich analytification can be restated by using hyperfields. In particular, this view can be linked to my previous work on hyperstructures of affine algebraic group schemes.

- **February 29**

  Speaker: Farbod Shokrieh (Cornell University)
  Title: Classes of compactified Jacobians in the Grothendieck ring

  Abstract: Let C be a **nodal curve** over an algebraically closed field k. Denote with $\textrm{Pic}^0(C)$ the **generalized** Jacobian of C, which is the classifying space for line bundles on C having degree zero on each irreducible component. If the dual graph of C is not a tree, then $\textrm{Pic}^0(C)$ is not compact. But (many) nice compactifications of $\textrm{Pic}^0(C)$ are known. I will describe how one can use the

combinatorics of the dual graph to compute the class of these compactifications in the ``Grothendieck ring of k-varieties''. This is ongoing joint work with Alberto Bellardini. The talk should be accessible to graduate students.

- **March 14**

Speaker: Jaiung Jun (Binghamton University)
Title: Matroid theory for Algebraic Geometers

Abstract: This is an expository talk based on a survey paper “Matroid Theory for Algebraic Geometers” (by Eric Katz). We will introduce the basic definitions of matroid theory in connection to tropical linear spaces and explain the idea that tropical linear spaces and valuated matroids are the same things. We also review the recent paper “Matroids over hyperfields” (by Matt Baker) to see how various classes of matroids can be unified under one framework.

- **March 21**

Speaker: Changwei Zhou (Binghamton University)
Title: Cohomology of Lie algebras

Abstract: In this talk we review the basic definition of cohomology of Lie algebras from an analytical point of view by tracing back the analytical theory of Lie groups using de Rham's theorem. If we have extra time we shall discuss related topics like the Loday-Quillen-Taygen theorem in cyclic homology, the unitary trick and some sample computations of groups.
Loday&Quillen's paper directly motivated the computation of Hochschild homology groups of differential operators, and much of later work on Hochschild homology on pseudo-differential operators is built up on it. Hopefully we can connect some of the dots in the talk to see a united picture.
The sources are Samuel&Ellenberg's paper “Cohomology groups of Lie groups and Lie algebras”, Loday&Quillen's paper “Cyclic homology and the Lie algebra homology of matrices”, and Melrose&Nister's paper “Homology of pseudodifferential operators I. Manifolds with boundary”.

- **April 11**

Speaker: Patrick Milano (Binghamton University)
Title: Growth in Groups

Abstract: Let G be a group and let A be a finite subset of G. Write $A^k=\{x_1x_2\dots x_k:x_i\in A\}$. We can ask how $|A^k|$ grows as k grows. We will survey some results and techniques related to this question, focusing on the case when G is a linear algebraic group. The material in this talk is taken from a course taught by Harald Helfgott at the 2016 Arizona Winter School.

- **April 18**

Speaker: Thomas Price (Toronto)

Title: Numerical Cohomology

Abstract: This talk will be an overview of a preprint of the same title. A lattice (i.e. a discrete subgroup of a finite-dimensional inner product space) can be thought of as a vector bundle over the “completion” of Spec(Z). We can associate numbers to a lattice that act like dimensions of cohomology vector spaces. Unfortunately, these numbers can be arbitrary nonnegative real numbers, and therefore can't literally be interpreted as dimensions of vector spaces. To get around this, we can develop a numerical approach to cohomology, where vector spaces and linear maps are replaced by real numbers.

- **April 25**

Speaker: Jaiung Jun (Binghamton University)
Title: Analytic geometry over $\mathbb{F}_1$ as relative algebraic geometry

Abstract: Several years ago, Berkovich introduced a notion of analytic geometry over $\mathbb{F}_1$ by directly generalizing his construction of an analytic space over a non-Archimedean field. On the other hand, recently, Ben-Bassat and Kremnizer took a functorial approach of Toen and Vaquie on algebraic geometry over a closed symmetric monoidal category and proved that the category of analytic spaces (in the sense of Berkovich) embeds fully faithfully into the category of relative schemes which they constructed. I will present some of these ideas. The aim of this talk is to provide backgrounds on the material and explain my research projects in this direction.

- **April 26**
(CROSS LISTING WITH THE ALGEBRA SEMINAR; SPECIAL DAY TUESDAY and TIME 2:50pm)
Speaker: An Huang (Harvard University)
Title: Riemann-Hilbert problem for period integrals

Abstract: Period integrals of an algebraic variety are transcendental objects that describe, among other things, deformations of the variety. They were originally studied by Euler, Gauss and Riemann, who inspired modern Hodge theory through the theory of periods. Period integrals also play a central role in mirror symmetry in recent years. In this talk, we will discuss a number of problems on period integrals that are crucial to understanding mirror symmetry for Calabi-Yau manifolds. We will see how the theory of D-modules have led us to solutions and deep insights into some of these problems.

- **May 2**
(CROSS LISTING WITH THE COLLOQUIUM –Dean's Speaker Series in Geometry/Topology)
Speaker: Melvyn Nathanson (CUNY)
Title: Every Finite Set of Integes is an Asymptotic Approximate Group

Abstract: A set A is an *(r, l)-approximate group* in the additive abelian group G if A is a nonempty subset of G and there exists a subset X of G such that $|X| \leq l$ and $rA \subseteq X + A.$ The set A is an asymptotic (r, l)-approximate group if the sumset hA is an (r, l)-approximate group for all sufficiently large integers $h.$ It is proved that every finite set of integers is an asymptotic $(r, r + 1)$-approximate group for every integer $r \geq 2.$

- **May 3**

(CROSS LISTING WITH THE COLLOQUIUM –Dean's Speaker Series in Geometry/Topology; SPECIAL DAY TUESDAY and TIME 4:30pm):
Speaker: Melvyn Nathanson (CUNY)
Title: Every Finite Subset of an Abelian group is an Asymptotic Approximate Group

Abstract: If A is a nonempty subset of an additive abelian group G, then the *h-fold sumset* is \[hA = \{x_1 + \cdots + x_h : x_i \in A_i \text{ for } i=1,2,\ldots, h\}.\]
We do not assume that A contains the identity, nor that A is symmetric, nor that A is finite. The set A is an *(r,ℓ)-approximate group in G* if there exists a subset X of G such that $|X| \leq \ell$ and $rA \subseteq XA$. The set A is an *asymptotic (r,ℓ)-approximate group* if the sumset hA is an (r,ℓ)-approximate group for all sufficiently large $h.$ It is proved that every polytope in a real vector space is an asymptotic (r,ℓ)-approximate group, that every finite set of lattice points is an asymptotic (r,ℓ)-approximate group, and that every finite subset of every abelian group is an asymptotic (r,ℓ)-approximate group.

- **May 9**
(DEAN'S SPEAKER SERIES IN GEOMETRY/TOPOLOGY)
Speaker: Alexandru Buium (University of New Mexico)
Title: Arithmetic analogue of Painleve VI

Abstract: The Painleve VI equations are a family of differential equations appearing in a number of contexts in mathematics and theoretical physics.On the other hand the theory of differential equations possesses an arithmetic analoguein which derivatives are replaced by Fermat quotients. The aim of the talk isto explain how one can set up an arithmetic analogue of the Painleve' VI equations.We prove that this arithmetic analogue has a “Hamiltonian structure” analogous to the classical one.The talk is based on joint work with Yuri I. Manin.

- **May 10**
(CROSS LISTING WITH THE COLLOQUIUM –Dean's Speaker Series in Geometry/Topology; SPECIAL DAY TUESDAY and TIME 4:30pm):
Speaker: Alexandru Buium (University of New Mexico)
Title: The differential geometry of Spec Z

Abstract: The aim of this talk is to show how one can develop an arithmetic analogue of classical differential geometry. In this new geometry the ring of integers Z will play the role of a ring of functions on an infinite dimensional manifold. The role of coordinate functions on this manifold will be played by the prime numbers. The role of partial derivatives of functions with respect to the coordinates will be played by the Fermat quotients of integers with respect to the primes. The role of metrics (respectively 2-forms) will be played by symmetric (respectively antisymmetric) matrices with coefficients in Z. The role of connections (respectively curvature) attached to metrics or 2-forms will be played by certain adelic (respectively global) objects attached to matrices as above. One of the main conclusions of our theory will be that Spec Z is ``intrinsically curved;” the study of this curvature will then be one of the main tasks of the theory.