DOWNLOAD PDF ALGEBRAIC AND TOPOLOGICAL DYNAMICS

Chapter 1 : AMS eBooks: Contemporary Mathematics

Algebraic and Topological Dynamics About this Title. Sergiy Kolyada, Yuri Manin and Thomas Ward, Editors. Publication: Contemporary Mathematics Publication Year.

For example, here is a question from Chris Leininger and Benson Farb: How many curvesâ€”that pairwise intersect each other at most onceâ€”is it possible to draw on a given surface? For the mathematically inclined, we want the curves to be pairwise non-isotopic simple closed curves. In general, however, the answer is still unknown. We can also ask related questions such as: How about if we let the curves intersect at most or exactly some other number of times? Groups are a fundamental object of study in the very large field of algebra, and for the past few centuries mathematicians have been thinking about groups and coming up with theorems about them. Many groups can be related to geometric objectsâ€”for instance, one kind of group might be the collection of ways you can rotate or flip a square called the symmetries of a square. I study geometric group theory, so I look at shapes and try to learn things about groups from them, and I look at groups and try to learn things about their associated geometric objects. The change happens as time goes on, and we study the time evolution of these systems. For example, a physical system that can be studied in the real world is water moving in a current, and we would want to know what happens to the molecules of water and to the overall system as time goes on. In particular, I study what happens to 0 under repeated iteration of specific quadratic polynomials, in a non-traditional number field setting: Does 0 ever come back to itself is it periodic? Does 0 ever enter a cycle not including itself is it eventually periodic? Does it escape to infinity? I hope to be able to state a connection between the behavior of 0 in these non-traditional settings and certain arithmetic properties of the original polynomial. As many high school students learn, this particular equation makes a picture called a parabola when plotted on a two-dimensional graph. This is an example of a polynomial with two variables x and y of degree 2 the highest power of any of the variables that shows up is 2. Algebraic geometers study zero sets of polynomials in any number of equations and any degree. They are curious about how different polynomials produce different shapes, and study when these shapes are similar, when they change the polynomials slightly, and when changing a polynomial slightly produces a fundamentally different shape. Photos by Joshua Clark.

Chapter 2 : Explaining the Work

This volume contains a collection of articles from the special program on algebraic and topological dynamics and a workshop on dynamical systems held at the Max-Planck Institute (Bonn, Germany).

In fact, most examples of interest are on metric spaces, but there are reasons to develop the theory for Hausdorff spaces. A weaker notion than minimality is topological transitivity , every non-empty invariant open set is dense. An intrinsic condition for minimality of an orbit closure is in terms of almost periodicity. The morphisms in topological dynamics are homomorphisms or continuous equivariant maps. This is in contrast to the situation in ergodic theory, where one need consider only ergodic systems. For one thing, it is not always the case that a flow decomposes into the union of minimal sets, and even when it does the minimal sets need not "fit together" nicely. Nevertheless, the classification of minimal flows is an important issue for the subject, and this article will be largely devoted to this. Equicontinuity The equicontinuous minimal flows are completely classified. Equicontinuous minimal flows are homogeneous spaces of compact topological groups. The proof of this fact depends on a construction of more general interest. Dynamical properties of flows can be correlated with algebraic and topological properties of the enveloping semigroup. Proximality, distality, and the Furstenberg theorem An important generalization of equicontinuity is distality. We first define the proximal relation. An elementary but useful observation is that proximality and almost periodicity in the product flow are incompatible. This in turn implies that a factor of a distal flow is distal. This result has combinatorial applications. The structure of distal minimal flows is given by a deep theorem due to Hillel Furstenberg. However, it is not the case that an equicontinuous extension of an equicontinuous flow is equicontinuous an example will be given below. In fact, this observation is the key to the structure theorem. Start with the one point flow and extend it equicontinuously, to obtain an equicontinuous flow. Extend this flow equicontinuously, to obtain a distal flow. Continue to extend equicontinuously possibly transfinitely often, as defined below always remaining in the class of distal flows. This is reasonably straightforward. What is remarkable and deep is that every distal minimal flow is obtained in this manner, starting with the one point flow, and successively extending equicontinuously. The precise statement of the Furstenberg structure theorem follows. At the opposite extreme from distal and equicontinuous are the weakly mixing flows. It follows that weakly mixing flows have no non-trivial equicontinuous factor so in light of the previous paragraph no distal factor. The Galois theory of minimal flows A partial classification is provided by the Galois theory of minimal flows, initiated by Robert Ellis. To this end, we need to introduce the universal minimal flow. A number of dynamical properties are "Ellis group invariants". That is, they depend only on the Ellis group of the minimal flow. One such is the property of proximal being an equivalence relation, and proximal closed is another such. A general structure theorem for minimal flows combines equicontinuous, proximal, and weakly mixing extensions. We omit the precise statement. If the extensions are equicontinuous and proximal this leads to the class of PI proximal isometric flows. A subclass of the latter are the point distal flows those minimal flows which have a distal pointâ€”one which has no other point proximal to it. These theorems were inspired by, and generalize the Furstenberg structure theorem. Their proofs make essential use of the Galois theory. Moreover, it is an equicontinuous extension of the equicontinuous irrational rotation of the circle, illustrating the Furstenberg structure theorem. The subject of symbolic dynamics , which originated from the study of geodesics on surfaces of negative curvature, provides a rich supply of examples of cascades. A historically important example is the Morse sequence, which has a number of definitions. One such, which has inspired more general constructions, is by "substitution". Its orbit closure, the Morse minimal set, is an example of a PI flow-its analysis requires both equicontinuous and proximal extensions. Important examples of distal but not equicontinuous real actions are the flows on nilmanifolds, which are homogeneous spaces of nilpotent Lie groups. At the other extreme are the horocycle flows which are minimal weakly mixing real actions on the unit tangent bundle of a surface. As was mentioned above, abelian groups do not admit minimal proximal actions. The existence of such examples has been applied to study the exponential growth of groups. A brief bibliography follows. References [Gottschalk and Hedlund,], [Ellis,], and [Auslander. Ellis, Lectures in topological dynamics, W. Benjamin, New York, H. Hedlund, Topological dynamics, A. Kuznetsov Conjugate maps. Scholarpedia , 2 James Meiss Dynamical systems.

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C-algebraic concepts themselves can range from the more measure-theoretic (like entropy and nuclearity, which involve weak-type approximation of multiplicative structure or norm approximation of linear structure) to the more topological (like periodicity and approxi-.

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