Salem numbers and Pisot numbers from stars

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Abstract

We use trees to construct families of algebraic integers. These include certain families of Salem numbers and of Pisot numbers, constructed from stars. The family of Pisot numbers we construct forms a proper closed subset of the set of all Pisot numbers. We show that this subset contains Pisot numbers of arbitrary trace. In particular, we exhibit a Pisot number of trace -5 and degree $141,731,565,070,951$.

1991 Mathematics Subject Classification: 11R06.

To Professor Andrzej Schinzel on the occasion of his sixtieth birthday

1 Introduction.

A *Pisot number* is an algebraic integer $\theta > 1$, all of whose other conjugates have modulus < 1. A *Salem number* is an algebraic integer $\tau > 1$, all of whose other conjugates have modulus ≤ 1, with at least one conjugate of modulus 1. The set of all Pisot numbers, traditionally if somewhat confusingly denoted by S, was shown by Salem [Sa] to be closed in $\mathbb{R}$. The structure of the set of Salem numbers is not known; its derived set includes S, however, and it may be that its derived set is precisely S. There is an algorithm (due essentially to Dufresnoy and Pisot [DP] but developed by Boyd [Bo1], [Bo2], [Bo3]) for determining the structure of S in a finite interval. The algorithm applies to any such interval containing only a finite number of elements of S. It also treats intervals containing certain limit points of S. In particular, for any $\delta > 0$, $S \cap [1, 2 - \delta]$ can be determined.

We give here a method for constructing Salem numbers (Corollary 9) and Pisot numbers (Theorem 1). While the method is believed to be new in this form,

Pisot And Salem Numbers

Karin Nielsen-Saines

Pisot And Salem Numbers:

Pisot and Salem Numbers Marie J. Bertin,Annette Decomps-Guilloux,Marthe Grandet-Hugot,Martine Pathiaux-Delefosse,Jean Schreiber,2012-12-06 the attention of The publication of Charles Pisot s thesis in 1938 brought to the mathematical community those marvelous numbers now known as the Pisot numbers or the Pisot Vijayaraghavan numbers Although these numbers had been discovered earlier by A Thue and then by G H Hardy it was Pisot s result in that paper of 1938 that provided the link to harmonic analysis as discovered by Raphael Salem and described in a series of papers in the 1940s In one of these papers Salem introduced the related class of numbers now universally known as the Salem numbers These two sets of algebraic numbers are distinguished by some striking arith metic properties that account for their appearance in many diverse areas of mathematics harmonic analysis ergodic theory dynamical systems and alge braic groups Until now the best known and most accessible introduction to these num bers has been the beautiful little monograph of Salem Algebraic Numbers and Fourier Analysis first published in 1963 Since the publication of Salem s book however there has been much progress in the study of these numbers Pisot had long expressed the desire to publish an up to date account of this work but his death in 1984 left this task unfulfilled Pisot and Salem Numbers Marie José Bertin,A. Decomps-Guilloux,1992 Pisot and Salem Numbers from Polynomials of Height One Keshav Mukunda,2007 We will be primarily concerned with two special kinds of real algebraic integers called Pisot and Salem numbers both of which are characterized by the location of their conjugates in relation to the unit circle in the complex plane While both types of numbers have been studied extensively for many years certain important questions about Pisot numbers are generally better understood than corresponding questions about Salem numbers In 1978 David Boyd extending earlier work done by Jacques Dufresnoy and Charles Pisot in the 1950 s constructed an algorithm to generate all Pisot numbers in any given finite interval of the real line Using this algorithm we describe all Pisot numbers whose minimal polynomial is a Littlewood polynomial one with 1 1 coefficients These are examples of polynomials that are said to have height 1 the height of a polynomial being simply the largest coefficient in absolute value We show that every such Pisot number is a limit point from both sides of sequences of Salem numbers that are roots of Littlewood polynomials We also consider analogous questions for another subset of Height 1 polynomials those with 0 1 coefficients Such polynomials under a suitable normalization have been called Newman polynomials We describe all Pisot numbers whose minimal polynomial is derived from a Newman polynomial and show that each Pisot number of this kind is also a limit from both sides of sequences of Salem numbers derived from Newman polynomials Finally we investigate some similarities and differences between the sets of Littlewood and Newman polynomials especially in connection with their roots One indicator of the location of these roots is the Mahler measure which for a monic polynomial is defined as the product of the absolute values of those roots that lie outside the unit circle Another indicator of the location of roots is the number that lie on the unit circle and we investigate both types of polynomials with palindromic

coefficient sequences in this regard **Number Theory** Canadian Number Theory Association. Conference,1999-01-01 This book contains papers presented at the fifth Canadian Number Theory Association CNTA conference held at Carleton University Ottawa ON The invited speakers focused on arithmetic algebraic geometry and elliptic curves diophantine problems analytic number theory and algebraic and computational number theory The contributed talks represented a wide variety of areas in number theory David Boyd gave an hour long talk on Mahler s Measure and Elliptic Curves This lecture was open to the public and attracted a large audience from outside the conference **Algebraic Numbers and Harmonic Analysis** ,2000-04-01 Algebraic Numbers and Harmonic Analysis **Computational Excursions in Analysis and Number Theory** Peter Borwein,2012-12-06 This book is designed for a topics course in computational number theory It is based around a number of difficult old problems that live at the interface of analysis and number theory Some of these problems are the following The Integer Chebyshev Problem Find a nonzero polynomial of degree n with integer eoeffieients that has smallest possible supremum norm on the unit interval Littlewood s Problem Find a polynomial of degree n with eoeffieients in the set 1 I that has smallest possible supremum norm on the unit disko The Prouhet Tarry Escott Problem Find a polynomial with integer co effieients that is divisible by z l n and has smallest possible 1 norm That 1 is the sum of the absolute values of the eoeffieients is minimal Lehmer s Problem Show that any monie polynomial p p O i 0 with in teger coefficients that is irreducible and that is not a cyclotomic polynomial has Mahler measure at least 1 1762 All of the above problems are at least forty years old all are presumably very hard certainly none are completely solved and alllend themselves to extensive computational explorations The techniques for tackling these problems are various and include proba bilistic methods combinatorial methods the circle method and Diophantine and analytic techniques Computationally the main tool is the LLL algorithm for finding small vectors in a lattice The book is intended as an introduction to a diverse collection of techniques

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Number Theory and Polynomials James Fraser McKee,Chris Smyth,2008-05-08 Contributions by leading experts in the field provide a snapshot of current progress in polynomials and number theory **Number Theory** Kalman Gyoery,Attila Pethoe,Vera T. Sos,2011-06-24 No detailed description available for Number Theory *Canadian Journal of Mathematics* ,1981-12 **Distribution Modulo One and Diophantine Approximation** Yann Bugeaud,2012-07-05 A treatment of cutting edge research on the distribution modulo one of sequences and related topics much of it from the last decade There are numerous exercises to aid student understanding of the topic and researchers will appreciate the notes at the end of each chapter extensive references and open problems **Ergodic Theory of Numbers** Karma Dajani,Cor Kraaikamp,2002-12-31 Ergodic Theory of Numbers looks at the interaction between two fields of mathematics number theory and ergodic theory as part of dynamical systems It is an introduction to the ergodic theory behind common number expansions like decimal expansions continued fractions and many others However its aim does not stop there For undergraduate students with sufficient background knowledge in real analysis and graduate students interested in the area it is also an introduction to a dynamical way of thinking The questions studied here are dynamical as well as number theoretical in nature and the answers are obtained with the help of ergodic theory Attention is focused on concepts like measure preserving ergodicity natural extension induced transformations and entropy These concepts are then applied to familiar expansions to obtain old and new results in an elegant and straightforward manner What it means to be ergodic and the basic ideas behind ergodic theory will be explained along the way The subjects covered vary from classical to recent which makes this book appealing to researchers as well as students **Number Theory with an Emphasis on the Markoff Spectrum** Andrew Pollington,2017-10-05 Presenting the proceedings of a recently held conference in Provo Utah this reference provides original research articles in several different areas of number theory highlighting the Markoff spectrum Detailing the integration of geometric algebraic analytic and arithmetic ideas Number Theory with an Emphasis on the Markoff Spectrum contains refereed contributions on general problems of diophantine approximation quadratic forms and their connections with automorphic forms the modular group and its subgroups continued fractions hyperbolic geometry and the lower part of the Markoff spectrum Written by over 30 authorities in the field this book should be a useful resource for research mathematicians in harmonic analysis number theory algebra geometry and probability and graduate students in these disciplines Canadian Journal of Mathematics ,1985-09 *Computer Algebra 2006* Ilias Kotsireas,Eugene Zima,2007 Written by world renowned experts the book is a collection of tutorial presentations and research papers catering to the latest advances in symbolic summation factorization symbolic numeric linear algebra and linear functional equations The papers were presented at a workshop celebrating the 60th birthday of Sergei Abramov Russia whose highly influential contributions to symbolic methods are adopted in many leading computer algebra systems **Mathematical Constants** Steven R. Finch,2003-08-18 Steven Finch provides 136 essays each devoted to a mathematical constant or a class of

constants from the well known to the highly exotic This book is helpful both to readers seeking information about a specific constant and to readers who desire a panoramic view of all constants coming from a particular field for example combinatorial enumeration or geometric optimization Unsolved problems appear virtually everywhere as well This work represents an outstanding scholarly attempt to bring together all significant mathematical constants in one place

Number Theory in Progress Kálmán György,Henryk Iwaniec,Jerzy Urbanowicz,2012-02-13 Proceedings of the International Conference on Number Theory organized by the Stefan Banach International Mathematical Center in Honor of the 60th Birthday of Andrzej Schinzel Zakopane Poland June 30 July 9 1997 *Number Theory* Jean-Marie De Koninck,Claude Levesque,1989 Monumental proceedings very handsomely produced of a major international conference The book contains 74 refereed articles which apart from a few survey papers of peculiar interest are mostly research papers 63 in English 11 in French The topics covered reflect the full diversity of the current trends and activities in modern number theory elementary algebraic and analytic number theory constructive computational number theory elliptic curves and modular forms arithmetical geometry transcendence quadratic forms coding theory NW Annotation copyrighted by Book News Inc Portland OR **Mathematical Challenges from Theoretical/Computational Chemistry** Committee on Mathematical Challenges from Computational Chemistry,Commission on Physical Sciences, Mathematics, and Applications,Division on Engineering and Physical Sciences,National Research Council,1995-04-12 Computational methods are rapidly becoming major tools of theoretical pharmaceutical materials and biological chemists Accordingly the mathematical models and numerical analysis that underlie these methods have an increasingly important and direct role to play in the progress of many areas of chemistry This book explores the research interface between computational chemistry and the mathematical sciences In language that is aimed at non specialists it documents some prominent examples of past successful cross fertilizations between the fields and explores the mathematical research opportunities in a broad cross section of chemical research frontiers It also discusses cultural differences between the two fields and makes recommendations for overcoming those differences and generally promoting this interdisciplinary work *Number Theory* Richard Mollin,2016-12-19 No detailed description available for Number Theory

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