IOWA SECTION MAA NEWSLETTER

VOLUME VI No.2 Edited by Luz M. DeAlba March 1990

The nominating committee: Ron Smith, Graceland, and Kathryn Gorini MIU have nominated, for the position of Chairman-Elect: Alexander F. Kleiner of Drake University, and George N. Trytten of Luther College; for the position of Secretary/Treasurer: David O. Oakland of Drake University. Biographical sketches follow:

George N. Trytten

Position: Professor and Head, Department of Mathematics, Luther College, Decorah, Iowa

Education: B.A. - Mathematics, Luther College - 1951
M.S. - Mathematics University of Wisconsin Madison - 1953
Ph.D. - Applied Mathematics, University Maryland (College Park) - 1962

Professional Experience: Mathematician, U.S. Naval Ordnance Laboratory
Faculty Member and Associate Dean University of Maryland
Free-lance audio-visual production of Mathematics
Faculty, Hood College
Faculty, Luther College

Professional Interests: Numerical Methods, Partial Differential Equations, Continuum Mechanics, Mathematics Education, Computer Involvement in teaching Mathematics, Problem Solving.

Professional Organizations: American Mathematical Society, Mathematical Association of America (Chair, Maryland - D.C. - Virginia Section 1967 - 68; Chair, Iowa Section 1985 - 86), Iowa Council of Teachers of Mathematics, American Association of University Professors.

Alexander F. Kleiner, Drake University

He has been at Drake since 1969 and was appointed chair of the department in 1984. Before coming to Drake, he was at Texas A&M where he received a MS and a PH D (in analysis) and served as an instructor for three years. His BA is from ST Thomas in Houston. His current professional interests are in the application of mathematics to political processes, graph theory and the teaching of calculus. He has published seven papers in mathematics, given talks at national and regional meetings and has served as faculty advisor of the Drake team in the Mathematical Modeling Competition for each of the last four years.

David Oakland, Drake University

He received his Ph.D. from Iowa State University in 1970 with major work in set theory and boolean algebra. From 1971-79 he taught mathematics at Dakota Wesleyan University. In 1979 he returned to Ames to teach part-time and take courses in computer science. Since 1981 he has taught mathematics and computer science at Drake University. His main interests are the foundations of mathematics and computer science and programming languages. He has been a member of the MAA since 1965 and active in the Iowa Section since 1981.

Balance on hand - December 31, 1988				$747.58
Receipts:			868.29	
Interest:	44.67;	Registrations:	395.00;	
Nat'l Allotment:	160.00;	Book sale	244.20;	
Book commission:	24.42			
Disbursements:			753.21	
Postage:	129.45;	Printing:	334.96;	
Books sold:	244.20;	Ia-ASA (reg.)	44.60	
Balance on hand - December 31, 1989				$862.66

Joint Meetings of the Iowa Sections of MAA, ASA, AMATYC
Iowa State University, April 6-7, 1990

FRIDAY, APRIL 6

1:00pm -	Registration	Carver Hall, 2nd Floor
1:30-5:30pm	Student Papers (Concurrent Sessions)	Carver Hall, 2nd Floor
3:15-5:00pm	Student Data-Analysis Competition	256 Carver
5:30-7:30pm	Dinner on own	Ames
7:30-8:00pm	Alan Tucker, SUNY at Stony Brook "CUPM Recommendations for the Math Major Revisited"	101 Carver Hall
8:10-10:00pm	Informal Reception and Social Hour, sponsored by Iowa and Iowa State Statistics Departments, Wadsworth Publishing, and Macmillan Publishing	Campanile Room, MU

SATURDAY, APRIL 7

8:00am -	Registration	Carver Hall Lobby
8:35-9:35am	Alan Tucker SUNY at Stony Brook "Mathematics of Fair Representation"	101 Carver Hall
9:50-10:50am	Krishna Athreya Iowa State University "The Mathematics of Bootstrap"	101 Carver Hall
11:00-11:30am	Business Meetings and Student Awards	101 Carver Hall
11:30-1:00pm	Lunch on own	Ames
12:00-2:00pm	AMATYC luncheon	
1:00-4:30pm	Concurrent Sessions	Carver Hall, 2nd Floor
4:30pm	Mathematica (Informal Discussion)	449 Carver Hall

STUDENT PAPERS

250 Carver

1:30	Dave Benz, Drake	ON THE SPECTRAL RANGE OF GRAPHS
2:05	Stephen Rathbun, ISU	A SPACE-TIME SURVIVAL POINT PROCESS FOR A LONGLEAF PINE FOREST
2:40	Robert Parker, ISU	ADJUSTING THE CENSUS
3:15	Jonathan Kessel, Drake	CONSTRUCTION OF HIGHLY SYMMETRICAL GRAPHS
3:50	Paul Shimura, MIU	TESSELLATION OF NON-ORIENTABLE SURFACES
4:25	Mark Lewis, ISU	STRATEGY DECISION MAKING IN PUZZLE PEG USING LINEAR PROGRAMMING
5:00	David Wilbur, Drake	HAMILTONIAN PATHS AND CYCLES IN TRIVALENT GRAPHS

260 Carver

1:30	David A. Overbeek, Drake	FACTORING LARGE TREES
2:05	Rachel Lamp, ISU	A PRINCIPAL IDEAL DOMAIN RING THAT IS NOT A EUCLIDEAN DOMAIN
2:40	Michael Deierling, Drake	CONSTRUCTION OF GRAPHS OF HIGH DIMENSION
3:15	Veronique Ziegler, MIU	INTEGRATING ALGEBRA AND TOPOLOGY: THE ZARISKI TOPOLOGY
3:50	Robin Taylor, Drake	BINARY CODES FOR ACYCLIC GRAPHS
4:25	Mark W. Coffey, ISU	PAINLEVÉ ANALYSIS OF A KDV-LIKE EQUATION WITH FIFTH DEGREE NONLINEARITY

SATURDAY AFTERNOON SESSIONS

250 Carver

1:00	Irving H. Anellis, Modern Logic Pub.	THE ROOTS OF MATHEMATICS AND MATHEMATICS EDUCATION IN RUSSIA IN THE AGE OF PETER THE GREAT
1:30	Irvin Hentzel, ISU	THE BEALE CIPHERS: ANY GOOD IDEAS?
2:00	Kenneth A. Heimes, ISU	POLYNOMIAL SOLUTIONS TO LINEAR PDE'S
2:30	Anita E. Solow, Grinnell	CALCULUS REFORM IN LIBERAL ARTS COLLEGES: PROGRESS REPORT
3:00	Jack H. Lutz, ISU	BOOLEAN CIRCUITS AND BANACH-MAZUR GAMES
3:30	Milan Randic and Alexander Kleiner, Drake	GRAPH POLYNOMIALS
4:00	Michael, Millar, UNI	CURVES FROM ANCIENT TIMES

256 Carver

1:00	Bernadette Baker, Drake	ISOSPECTRAL GRAPHS AND ASSOCIATED ISOSPECTRAL MULTIGRAPHS
1:30	Catherine Gorini, MIU	A MATHEMATICS CORE COURSE
2:00	Kirk E. Jones, ISU	THE FABER TRANSFORMATION AND PRESERVATION OF LIPSCHITZ CLASSES
2:30	J. D. Phillips, ISU	TOPICS IN QUASI GROUP REPRESENTATION THEORY
3:00	Pranava K. Jha, ISU	CONVEX EXPANSIONS ALGORITHMS FOR RECOGNITION AND ISOMETRIC EMBEDDING OF MEDIAN GRAPHS
3:30	Ronald K. Smith, Graceland	HYPERCARD IN THE MATHEMATICS CLASSROOM
4:00	A. M. Fink, J. A. Gatica, G. E. Hernandez, and P. Waltman	RADIALLY SYMMETRIC SOLUTIONS OF SOME ELLIPTIC BOUNDARY VALUE PROBLEMS

260 Carver

1:00	Tan Cao Tran, Loras	A NOTE ON THE RUSSELL PARADOX
1:30	A. M. Fink, ISU and J. A. Gatica, Iowa	FOR EVERY ANSWER THERE ARE TWO QUESTIONS
2:00	Eric W. Hart, MIU	THE ROLE OF DISCRETE MATHEMATICS IN IMPROVING COLLEGIATE MATHEMATICS EDUCATION - THE BUBBLE HAS NOT BURST
2:30	Stephen J. Willson, ISU	INDUCED MAPS ON THE SYMBOLIC DYNAMICS OF CHAOTIC SPACES: AN EXAMPLE
3:00	Steve Nimmo and Doug Swan, Morningside	COMPUTER LAB PROJECTS FOR DERIVE
3 :30	K. Shantha Jayawardena, ISU	AN $O(n^2)$ ALGORITHM FOR COMPUTING THE INVERSE OF A POSITIVE DEFINITE TOEPLITZ MATRIX
4:00	Luz M. DeAlba, Drake	APPLICATIONS OF INDEFINITE SCALAR PRODUCTS TO SEVERAL MATRIX THEORY IDEAS

STUDENT PAPERS

ON THE SPECTRAL RANGE OF GRAPHS

Dave Benz
Drake University

We investigate graphs with the maximal valency of d = 3 and focus attention on the extremal eigenvalues, i.e., the largest and the smallest eigenvalues. The difference between these extremal values gives the spectral range of a graph. In bipartite graphs the range is twice the maximal eigenvalue because of the pairing theorem. By examining associated eigenvectors, we investigated the connectivity conditions which give the same range in different graphs, or pairs which have one of the extremal eigenvalues the same. It will be seen that the spectral range depends on the neighbor sums of the vertices such that the same neighbor sums will necessarily have the same spectral range.

PAINLEVÉ ANALYSIS OF A KDV-LIKE EQUATION WITH FIFTH DEGREE NONLINEARITY

Mark W. Coffey
Department of Physics
Iowa State University

Using Painlevé analysis, we study a KDV-like equation with fifth degree nonlinearity that arises in quantum field theory and solid state physics. We show that although this equation has a noninteger (rational) resonance that it satisfies a weak form of the Painlevé test, in the sense that all resonances at positive integers are compatible. This result seems to indicate that this equation is in a sense partially integrable. The results of the Painlevé analysis are discussed in connection with the known kink solution found in the separate treatments of Coffey and Dey. We also comment on other aspects of the equation's integrability and on its applications.

CONSTRUCTION OF GRAPHS OF HIGH DIMENSION

Michael Deierling
Lincoln High School/Central Academy/Drake University

We will consider an extension of the well known procedure for the construction of an n-dimensional cube from an (n − 1) dimensional cube to other than cube graphs. In particular we will consider the use of canonical labels in the construction procedure and will illustrate higher dimensional graphs of some well known cases like Desargues-Levi graphs and others. The talk will include a discussion of selected properties of these graphs.

CONSTRUCTION OF HIGHLY SYMMETRICAL GRAPHS

Jonathan Kessel
Lincoln High School/Central Academy/Drake University

We will outline an approach to the construction of highly symmetrical (transitive) graphs based on 4 x 4 symmetric matrices as generators. In particular we will consider dense graphs (i.e., graphs with high valency) and will discuss some of their properties including the occurrence of integer eigenvalues in their spectrum.

A PRINCIPAL IDEAL DOMAIN RING THAT IS NOT A EUCLIDEAN DOMAIN

Rachel Lamp
Iowa State University

Most students of Abstract Algebra are aware that a Euclidean Domain must also be a Principal Ideal Domain. But finding a counterexample that shows the converse is not true is a rather formidable task. The ring $R = \{a + (b + b\sqrt{-19})/2 : a, b \text{ integers}\}$ is presented and the effort is concentrated on showing that it is not a Euclidean Domain. The value for the student will be in seeing that no norm can possibly exist that will make R a Euclidean Domain, not just that the usual norm for the complex numbers will not work in R.

STRATEGY DECISION MAKING IN PUZZLE PEG USING LINEAR PROGRAMMING

Mark L. Lewis
Iowa State University

In this paper we investigated, on the game Puzzle Peg (also called Solitaire or Hi-Q) the ability of a move to make it impossible for the player to solve the given starting position. We use linear programming to determine a characteristic function for given board positions. This function can indicate if it is not possible to solve a particular board situation. The function cannot determine that a board is solvable, its ability is only in recognizing impossible situations more quickly than even a skillful player. We can use this method to solve the game by checking ahead to see if the move causes a board that has no solution.

FACTORING LARGE TREES

David A. Overbeek
Drake University

We consider the problem of factoring the characteristic polynomials of large trees. In particular, our interest is in finding trees without polynomial factors. Since, if the trees have $n = 10$ or more vertices, their polynomials may have roots which cannot be expressed in terms of radicals. A list of trees without factors will be presented and some constructive schemes which produce larger trees of similar structure will be outlined.

ADJUSTING THE CENSUS

Robert L. Parker
Department of Statistics
Iowa State University

The U. S. Census Bureau's decennial census of the United States results in an undercount that is seen to be related to demographic factors (e.g. race, income.) Areas with higher proportions of "hard to count" groups would benefit, in terms of allocation of funding, allocation of congressional seating, etc., from an adjustment of the census counts. A model with demographic factors as predictors of undercount will be presented. A criterion for deciding if the adjustment is an improvement over census counts is developed and applied to 1980 census data.

A SPACE-TIME SURVIVAL POINT PROCESS FOR A LONGLEAF PINE FOREST

Stephen Rathbun
Department of Statistics
Iowa State University

The marked spatial point pattern of trees and their diameters is the result of a dynamic process that takes place over time as well as space. Such marked point patterns could be modeled as realizations of marked space-time survival point processes, where events are born at some random location and time, and then live and grow for a random length of time. A marked space-time survival point process is fit to data from a longleaf pine (*Pinus palustris*) forest in southern Georgia. The process is divided into three components: a birth process, a growth process, and a death process, and each component is modeled individually. By using this reductionist approach, ecological questions concerning individual processes can be addressed.

TESSELLATION OF NON-ORIENTABLE SURFACES

Paul Shimura
Maharishi International University

It is well known that there are seven band ornament groups and seventeen wallpaper pattern groups. This presentation will show which of these give tessellations for the well known non-orientable spaces, namely the Möbius band, the Klein bottle, and the real projective plane.

BINARY CODES FOR ACYCLIC GRAPHS

Robin M. Taylor
Drake University

We will consider for acyclic graphs the "Walk Around" binary codes (of Professor Read) and in particular we will investigate equivalence among derived binary codes. It will be shown that topologically allowed deformation of contours on a sphere depicts equivalence among codes. The correspondence between contours and binary codes allows us to generate tree graphs by deriving their binary codes first. We will also consider a non-topological "rupture" operation on associated contours and illustrate the metric associated with such operations. We hope in this way to contribute to the resolution of an old dilemma: How similar are trees?

HAMILTONIAN PATHS AND CYCLES IN TRIVALENT GRAPHS

David Wilbur
Drake University

Trivalent planar graphs were at one time believed to have a necessarily Hamiltonian cycle. Tutte presented the first counterexample to this hypothesis (with 46 vertices). We will examine a number of trivalent graphs and consider their 1-factors and 2-factors and the relationship of these factors to the presence of Hamiltonian circuits. The examples studied will include the so-called snarks (trivalent graphs, the edge coloring of which requires four colors).

INTEGRATING ALGEBRA AND TOPOLOGY: THE ZARISKI TOPOLOGY

Veronique Ziegler
Maharishi International University

The set of all prime ideals of a ring A, called Spec(A), is a topological space under the Zariski topology. In this talk, we shall investigate the properties of the Zariski topology and comment on how it connects algebra and topology.

ABSTRACTS

CUPM RECOMMENDATIONS FOR THE MATH MAJOR REVISITED

Alan Tucker
SUNY at Stony Brook

This talk summarizes the speakers thoughts about what makes for a successful Math Major Program. He will highlight one normal looking public college in upstate New York at which 20 % of the graduates are math majors. Hint: as you might guess, its success has nothing to do with curriculum.

MATHEMATICS OF FAIR REPRESENTATION

Alan Tucker
SUNY at Stony Brook

This talk will present two problems about allocating a contested resource. The first is 3000 years old and deals with three wives fighting over the estate of their dead husband. The second is 200 years old and concerns difficulties in allocating seats in the house of Representatives. A recently proved impossibility theorem shows that a fair allocation of the seats is not always possible.

THE MATHEMATICS OF BOOTSTRAP

K. B. Athreya
Iowa State University

A major problem in statistics is to determine the probability distribution of various functions of the data set, especially when the number of observations is very large. The subject of limit theorems in probability theory was inspired by these problems. In 1976 B. Efron proposed a method of resampling the data itself to estimate these distributions. This method is known as the Bootstrap, and the recent progress in high speed computing makes it especially feasible and useful. In this talk we shall discuss some mathematical questions arising from this, and also successes and pitfalls of this method.

THE ROOTS OF MATHEMATICS AND MATHEMATICS EDUCATION IN RUSSIA IN THE AGE OF PETER THE GREAT

Irving H. Anellis
Modern Logic Publishers

A descriptive sketch is presented of mathematical knowledge in Russia during the 15th to 18th centuries as it developed in its cultural situation. Special consideration is given to the professional development of mathematics during the reign of Peter the Great (reigned 1682-1725), and to the origins and developments of mathematical education in that period. It will be shown that mathematical knowledge in pre-Petrine Russia and in the years of Peter's reign was considerably more developed than is commonly believed. Particular emphasis will be placed on descriptions of the mathematical contents of the *Synodal 42. Geometry*, a manuscript of the second half of the 17th century, and of the manuscript of Feofan Prokopovich's mathematical lectures of 1707-1708 at the Kiev-Mogila Academy. The latter will be compared with L. F. Magnitskii's better known book *Arifmetika* of 1703, which served as a textbook for much of the 18th century. An overview of elementary and collegiate education in mathematics, including a discussion of the roles of Peter the Great, J. D. Bruce, Henry Farquharson, Feofan Prokopovich, and Stefan Iavorskii in formulating policies of mathematical education in Russia, and the teaching of Magnitskii, Henry Farquharson, Prokopovich, and A. D. Adodurov, will be described, as will be the history of the founding of the School of Mathematics and Navigation in Moscow (1701) and the origins and activities of the mathematics faculty of the Academy of Sciences and its students.

ISOSPECTRAL GRAPHS AND ASSOCIATED ISOSPECTRAL MULTIGRAPHS

Bernadette Baker
Drake University

Isospectral graphs are those having the same characteristic polynomial and a number of these have been investigated over the past 30 years. Recently we focused attention on isospectral multigraphs which have not received prior attention. In this presentation we will report on the relationship between isospectral graphs and isospectral multigraphs. Also addressed will be interesting questions relating to isospectrality in general, such as: Can multigraphs always differentiate among isospectral graphs, trees in particular? Are there endospectral multitrees, i.e. multitrees which lead to isospectral multigraphs by substitutions at special vertices?

APPLICATIONS OF INDEFINITE SCALAR PRODUCTS TO SEVERAL MATRIX THEORY IDEAS

Luz M. DeAlba
Drake University

In this talk we will present the notion of indefinite scalar products, and how it may apply to matrix theory ideas, such as the adjoint of a matrix, unitary matrices, normal matrices, the field values of a matrix. Some new results will be presented, as well as some open questions.

FOR EVERY ANSWER THERE ARE TWO QUESTIONS

A. M. Fink* and J. A. Gatica**
*Iowa State University and **University of Iowa

Duality is a concept that appears frequently in modern optimization theory. The concept of duality that we are thinking of should consist of two problems with the property that: 1) they share the same data; 2) one of the problems has a solution if and only if the other does; and 3) the solution of one should give information about the solution of the other. The most familiar one is that associated with linear programming. Here we propose an elementary version of a duality theorem that can be introduced in Calculus.

RADIALLY SYMMETRIC SOLUTIONS OF SOME ELLIPTIC BOUNDARY VALUE PROBLEMS

A. M. Fink, J. A. Gatica, G. E. Hernandez, and P. Waltman

The presentation deals with the questions of existence, uniqueness and approximation of positive radially symmetric solutions of a class of semilinear elliptic boundary value problems which may have some singularities present. The approach is to transform the problem into an equivalent integral equation using the appropriate Green's function and then find a family of regularized problems approaching the original one; the regularized problems are shown to have unique positive solutions and it is proved that they do approach quite nicely the solution of the starting problem. An added advantage to this approach is that in many situations the solutions of the regularized problem can be approximated by iteration. (This paper is to be presented by J. A. Gatica.)

A MATHEMATICS CORE COURSE

Catherine A. Gorini
Maharishi International University

All freshmen at MIU take a core course program covering a broad range of different disciplines. In the mathematics core course, students are given a taste of the goals and techniques of modern mathematics by studying modular arithmetic, logic, and set theory. This paper describes the current state of this course, its challenges, and its successes.

THE ROLE OF DISCRETE MATHEMATICS IN IMPROVING COLLEGIATE MATHEMATICS EDUCATION—THE BUBBLE HAS NOT BURST

Eric W. Hart
Maharishi International University

First, let us take a quick look at the big picture. Clearly we would have a solution to all problems in collegiate mathematics education if we had three things: receptive students, effective teaching, and a worthwhile curriculum. Discrete mathematics fits primarily into the worthwhile curriculum category, and is the main focus of this talk. But I would like to pass along two recommendations concerning effective teaching and receptive students. The problem of receptive students has long been an intractable problem in education. An effective solution to the problem is to have students practice Transcendental Meditation. TM is simply an effortless mental technique which relieves stress and develops one's full potential. There are many research studies that show students who practice TM are indeed more receptive, as measured by several different parameters.

Effective teaching is also a crucial ingredient for successful education. Here we might find some tips in a recent report from the National Council of Teachers of Mathematics entitled *Professional Standards for Teaching Mathematics*. The NCTM is not a college organization but many of the principles laid out for effective teaching, such as effective uses of technology and an emphasis on understanding and problem solving, certainly carry over to the college level.

So, now onto the category of worthwhile curriculum. Discrete mathematics is a worthy part of the mathematics curriculum and, contrary to some impressions I received at the Louisville MAA Meeting, the bubble has not burst. The recent MAA report, *Discrete Mathematics in the First Two Years*, outlines the results of six projects around the country that were begun in the mid-80's. It is particularly worth looking at because of the course outlines and tests provided. I would like to discuss and give examples of how discrete mathematics can be taught throughout the undergraduate curriculum.

Pre-Calculus/Remedial Courses:

- Emphasize topics that are already there, such as matrices, counting, induction, sequences (particularly recursive definitions).
- Teach some new topics, such as, bin packing, machine scheduling, voting theory, apportionment, graph theory. Topics are fun, require almost no mathematical prerequisites (at least for an introduction), and can show the power and beauty of mathematics to an otherwise unappreciative audience.

Freshman/Sophomore Courses:

- Integrate discrete mathematics and calculus. This is an appealing but difficult project. Certainly difference equations could be part of a calculus course.
- Teach discrete mathematics as a *mathematics* course, not a computer science service course. Such a course can serve the needs of computer science while at the same time be an invaluable course for many math majors who go into business, industry, or high school teaching.

Junior/Senior Courses

- Teach an upper division course in discrete mathematics, as is often done.
- Integrate some discrete mathematics topics into other courses. For example, codes used to send messages accurately in the presence of occasional noise provide a fascinating application of group theory.

In this talk I will outline the above and give examples of bin packing, voting theory, and group codes, as time permits.

POLYNOMIAL SOLUTIONS TO LINEAR PDE'S

Kenneth A. Heimes
Iowa State University

By use of an operator series similar to the cosine series, polynomial solutions can be constructed to the Laplace equation, the heat equation, and the wave equation in several different geometries.

THE BEALE CIPHERS: ANY GOOD IDEAS?

Irvin Roy Hentzel
Iowa State University

I have not solved the Beale ciphers. This talk is to mention things that I have tried, and to present the difficulties involved in solving them. I have tried the standard approaches, and they lead nowhere because the code is only about 30 % redundant. I have used hints given by people who claim that they have solved them, but even when their partial phrases are set into the code, the remaining parts have too few letters to fill out the message. There are five accepted solutions on file in the Beale Cipher Association. They are all different. At least this tells us that the codes can fit a message and are not just numbers. One of them supposedly ends with the words APRIL FOOL.

AN $O(n^2)$ ALGORITHM FOR COMPUTING THE INVERSE OF A POSITIVE DEFINITE TOEPLITZ MATRIX

K. Shantha Jayawardena
Iowa State University

Here we will develop an $O(n^2)$ algorithm to find the inverse of a positive definite Toeplitz matrix, which requires the same order of floating point operations as the Trench algorithm.

CONVEX-EXPANSIONS ALGORITHMS FOR RECOGNITION AND ISOMETRIC EMBEDDING OF MEDIAN GRAPHS

Pranava K. Jha
Department of Computer Science
Iowa State University

Let G = (V, E) be a finite, simple graph. For a triple of vertices *u, v, w* of G, a vertex *x* of G is a median of *u, v, and w* if *x* lies simultaneously on suitably chosen shortest paths joining *u* and *v*, *v* and w, and *w* and *u* respectively. G is a median graph if and only if G is connected, and every triple of vertices of G admits a unique median. All trees, n-cubes, and grid graphs are examples of median graphs.
The following is a characterization of median graphs given by Mulder (*The Structure of Median Graphs*, Discr. Math., 24 (1978): 197-204): G is a median graph if and only if G can be obtained from a one-vertex graph by a sequence of convex expansions. I will present a $O(n^2 \log n)$ algorithm for recognizing median graphs, which is based on Mulder's convex expansion technique. This improves the previously best-known bound of $O(n^4)$ given by Chung, Graham and Saks (*Dynamic Search in Graphs* "Discrete Algorithms and Complexity", (H. Wilf, Ed.), Academic Press, New York, 1987.) Further, I will present an $O(n^2 \log n)$ algorithm for obtaining an isometric embedding of a median graph in a hypercube of least possible dimension. This algorithm employs the theory of isometric embedding as developed by Graham and Winkler (*On Isometric Embeddings of Graphs*, TAMS, 288 (1985): 527-536), and has a structure similar to that of the recognition algorithm.

THE FABER TRANSFORMATION AND PRESERVATION OF LIPSCHITZ CLASSES

Kirk E. Jones
Iowa State University

Let Ω be a nonempty open, simply connected subset of the complex plane **C** with bounded boundary rotation and let $\Delta = \{z : |z| < 1\}$. Let Ω, Δ denote the closures of these sets, respectively. Then there exists a bijective analytic mapping g: $\mathbf{C}\backslash\Omega \rightarrow \mathbf{C}\backslash\Delta$. We note that g has a continuous extension to the boundary Γ of Ω. Let A (Δ) be the Banach algebra of functions continuous on Δ and analytic on Δ. We consider the transformation **T** mapping f in A (Δ) to

$$\mathbf{T}f(w) = \frac{1}{2\pi i} \int_{\Gamma} \frac{f(g(t))}{t - w}\, dt,$$

in the Banach algebra of functions continuous on Ω and analytic on Ω. The mapping **T** is called the Faber transformation and is an injective continuous linear transformation ($\|\mathbf{T}\| \leq (1 + V/\pi)$ where V is the total boundary rotation of Γ).
It is of interest to determine the properties of f in A (Δ) which are preserved under the Faber transformation **T**. In particular, we assume that f has a modulus of continuity $\omega(t)$ on Δ and consider the modulus of continuity of **T**f on Ω. We show that the modulus of continuity of **T**f is affected by the modulus of continuity of f and the smoothness of Γ, and we obtain qualitative results when f and g satisfy a Lipschitz condition.

BOOLEAN CIRCUITS AND BANACH-MAZUR GAMES

Jack H. Lutz
Department of Computer Science
Iowa State University

The classical Banach-Mazur game is an infinite, 2-person game of perfect information, played on the real line. Recent computational generalizations of this game have shed new light on questions involving the number of logic gates required for Boolean circuits to solve certain classes of problems. This talk describes these <u>resource-bounded</u> Banach-Mazur games, along with new applications to Boolean circuit complexity.

COMPUTER LAB PROJECTS FOR DERIVE

Steve Nimmo and Doug Swan
Morningside College

In this paper, we will discuss several labs that have been written for (and used by) our second semester calculus students this Spring at Morningside College. These labs have been designed for use with the CAS Derive. We shall also be discussing how writing can be used in the teaching of calculus.
We will be discussing labs over the following topics: numerical methods, natural logs, growth and decay, integration by parts, sequences, and series.
We are using Derive (which is a menu driven CAS) on a network with 10 stations. We shall discuss several of the good and bad aspects of Derive that we have encountered so far.
We have the students work in pairs on the labs. For each lab, the group must hand in a formal paper discussing each problem. We shall look at several student papers that have been handed in for these labs.

TOPICS IN QUASIGROUP REPRESENTATION THEORY

J. D. Phillips
Iowa State University

The aim of group representation theory is to represent an arbitrary abstract group via a concrete group, usually a group of matrices. For nonassociative quasigroups this representation theory via associative matrices fails. The situation is rendered tractable by identifying the representations of a quasigroup **Q** with the representations of the stabilizer of an arbitrary element of a particular universal group which acts on **Q**. We identify a particular class of these universal groups, and in the process isolate a new canonical subgroup construction in varieties of groups.

GRAPH POLYNOMIALS

Milan Randic and Alexander F. Kleiner
Drake University

We briefly review various graph polynomials, including characteristic, acyclic (matching), bipartite and distance polynomials and will, in particular, focus attention on selected properties of bipartite polynomials. Additionally we will discuss a list of open problems concerning graph polynomials, including problems on polynomial reconstructions.

HYPERCARD IN THE MATHEMATICS CLASSROOM

Ronald K. Smith
Graceland College

Microcomputers can be used with great effectiveness in the mathematics classroom, but they are only as powerful as the software available. HyperCard is a readily available software package, free with any Macintosh computer, that allows users to create, customize, and/or run applications. Innovative uses of HyperCard in mathematics classrooms will be demonstrated, including animated overhead projection, interactive curve generation, and on-screen testing and evaluation.

CALCULUS REFORM IN LIBERAL ARTS COLLEGES: PROGRESS REPORT

Anita E. Solow
Grinnell College

Twenty six liberal arts colleges, the ACM and GLCA consortia, have gotten together to work on Calculus reform. With funding from the National Science Foundation, we are working to produce five resource collections for use in Calculus. I will report on the project and the ways that any of you who are interested can get involved.

A NOTE ON THE RUSSELL PARADOX

Tan Cao Tran
Loras College

The naive theory of sets has many paradoxes, among which the Russell paradox is the most challenging for mathematicians. The author of this short paper generates the concepts of membership and set, then proves that the set of all sets that are not members of themselves of any order is a limit-member of itself. Thus the Russell paradox is not formed in the theory of Generalized Sets.

INDUCED MAPS ON THE SYMBOLIC DYNAMICS OF CHAOTIC SPACES: AN EXAMPLE

Stephen J. Willson
Iowa State University

Let $f: \mathbf{R} \to \mathbf{R}$ be given by $f(x) = rx(1 - x)$ for $r > 2 + \sqrt{5}$. Suppose that

$$\Lambda = \{x : f^n(x) \in [0,1] \text{ for all } n \geq 0\},$$

where f^n denotes f composed with itself n times. It is known that Λ is a Cantor set C which can be conveniently described as

$$\{x_0x_1x_2...x_j...: \text{each } x_j \text{ is either 0 or 1}\}.$$

Moreover, it is known that f on Λ is conjugate to the shift map $T : C \to C$ given by $T(x_0x_1x_2...) = x_1x_2x_3...$. If the proper map $g: \mathbf{R} \to \mathbf{R}$ commutes with the map f, then g induces a map $G: C \to C$ which commutes with T. We give restrictions on the nature of the induced map G.

CURVES FROM ANCIENT TIMES

Michael Millar
University of Northern Iowa

It is not widely known that the Greeks used many different curves, surfaces, and mechanical devices to obtain solutions of the so-called 'classical construction problems' of antiquity. We will look at three different curves - the *quadratrix* of Hippias and Dinostratus, the *conchoid* of Nicomedes, and the *cissoid* of Diocles - to see how they were used in finding respective solutions of the quadrature of the circle, the trisection of the angle, and the duplication of the cube.

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