IOWA SECTION MAA
NEWSLETTER

Vol IV No. 2 Edited by A. M. Fink March 1988

The contents of this newsletter revolve around the spring meeting on the campus of Grinnell College. The college is centrally located in our state. The program has an interesting variety, from student talks to nationally recognized speakers; from research topics to pedagogical ideas; from esoteric mathematics to computer demonstration; who would want more?

The nominating committee report:

Nominees for chair-elect are Professor Anne Dow of MIU and Professor Calvin Van Niewall of Coe.

John S. Cross, Keith Stroyan.

Statements from the two candidates appear on page 4.

JOINT MEETINGS OF THE IOWA SECTIONS OF MAA, ASA

Grinnell College
April 15-16, 1988

GENERAL SCHEDULE OF EVENTS
(All events except the Mixer take place in the Hall of Science)

FRIDAY, APRIL 15

12:30 PM -	Registration	Lobby Outside Science 2001
1:00 - 4:00 PM	Student Papers	Science 2001
4:15 - 5:15 PM	Lecture: Ronald Thisted (University of Chicago) "Settling Questions of Shakespearean Authorship: Could Shakespeare have written a newly-discovered poem?" (Supported by a grant from the Alfred P. Sloan Foundation)	Science 2001
5:30 - 7:30 PM	Dinner on Own	
7:30 - 8:20 PM	Lecture: Herbert Wilf (University of Pennsylvania) "Gray Codes and Hamiltonian Graphs"	Science 2001
8:30 - 10:00 PM	Informal Mixer (Sponsored by the statistics departments at Iowa and Iowa State with support from Harper & Row, Publishers, Inc.)	Grinnell House

SATURDAY, APRIL 16

8:00 AM -	Registration	Lobby outside Science 2001
8:40 - 9:30 AM	Demonstrations of Computer Classroom and Laboratory Usage:	
	In Mathematics: Emily Moore (Grinnell College)	Science 3341
	In Computer Science: Henry Walker (Grinnell College)	Science 3325
9:50 - 10:40 AM	Lecture: Herbert Wilf "A General Setting for Unique Representation of Integers"	Science 2001
11:00 - 11:30 AM	Business Meeting and Student Awards	Science 2001
11:30 - 1:00 PM	Lunch on Own	
1:00 - 4:00 PM	Concurrent Paper Sessions	Science 3325, 3341, 3352

Schedule of Papers

STUDENT PAPERS

FRIDAY, APRIL 15	Science 2001
1:00 PM	Veronique Ziegler, Maharishi International University: "Characteristics of a Tangent Line"
1:25	Richard Patz, Grinnell: "Buffon's Needles in 3-Space"
1:50	Mary Wetjen, Clarke: "Relationships Between Music and Mathematics"
2:15	Paul M. Shimura, MIU: "Simplices, Euler Number, and Pascal's Triangle"
2:40	John Squires, Drake: "On Crossing Number for Select Graphs"
2:55	Paula Calkins, Drake: "Search for Unusual Vertices in Graphs"
3:10	John Kosmicke and John Seal, Drake: "Spectral Properties of Ulam's Subgraphs"
3:25	Chris Smith, Drake: "On Symmetry of Zero-Symmetric Graphs"
3:40	Pat Horan and Floyd Bates, Drake: "On Construction of Graphs"

CONCURRENT SESSIONS, CONTRIBUTED PAPERS

SATURDAY, APRIL 16

Session A	Science 3341
1:00 PM	Milan Randić, Drake: "Graph Supplements"
1:30	Bernadette Baker, Drake: "Isospectral Multigraphs"
2:00	Dennis Roseman, Iowa: "Searching for Spheres in Four Dimensional Space"
2:30	Catherine Gorini, MIU: "Adjoint Functors in Algebraic Topology"
3:00	Tan Cao Tran, Loras: "Classes of Weighted Symmetric Functions"
3:30	Maxwell Rainforth, MIU: "A Unified Field Chart for Abstract Algebra"

Session B		Science 3352
	1:00 PM	Reginald Laursen, Luther: "Pedagogical Biases in the Calculus Classroom"
	1:30	Michael Millar, UNI: "Leonardo Pisano (Fibonacci) and The Book of Squares: More Than a Single Sequence"
	2:00	Tuong Ton-That, Iowa: "Geometry and Invariant Theory"
	2:30	Noel Cressie, ISU: "Estimating Census Undercount at National and Subnational Levels"
	3:00	Jon H. Lemke, Iowa: "Last Year's Applied Statistics Lectures Aren't Good Enough for this Year"
Session C		Science 3325
	1:30 PM	Stephen Haslett, ISU: "Degrees of Freedom in Sparse Complete Contingency Tables"
	2:00	Tim Wright, Iowa: "Superadditive Functions and a Statistical Application"
	2:30	Anita E. Solow, Grinnell: "Counting Words and the Clique Polynomial of a Graph"
	3:00	Theron Oxley, Drake: "On the Symmetry of Highly Symmetrical Graphs"
	3:30	Luz M. DeAlba, Drake: "'Shuffled' Toeplitz Matrices"

Business Meeting

1. Shall the Iowa Section participate in the MAA new Membership Incentive Program? Sections can earn money by recruiting new members. A section would name an official MIP Liason Person and appoint others to also validate section nomination forms.
2. Governor's report (brief).
3. Others.

Nominating Committee Report

M. Anne Dow was born in England and brought up near Detroit. She completed her BA at the University of British Columbia, Canada, and her MA at the University of Western Ontario, Canada. In 1973 she received her Ph.D. from the University of Queensland in Brisbane, Australia, for work on maximum principles for partial differential equations under R. Vyborny. From 1973 she worked as a professor in the Mathematics Department and the Division of External Studies of the University of Queensland. In the latter she served as Coordinator of the mathematics section and wrote complete course materials for correspondence study for nearly all subjects in the university's undergraduate mathematics curriculum including mathematical statistics.

In 1984 she joined the Mathematics Department of Maharishi International University in Fairfield, thus bringing together her lifelong interest in mathematics and a long time interest in Transcendental Meditation. She has found MIU to be dedicated to the highest standards of academic excellence, and also to be a most stimulating and rewarding place to do mathematics.

While in Australia she was an active member of the Australian Mathematical Society and of the Statistical Society of Australia. Her primary research interests lie in partial differential equations, although she also spent several years studying stochastic processes. Members may recall that she gave a paper at the 1985 Iowa MAA/ASA/SIAM meeting on estimating error in malaria diagnosis based on data from a WHO study. She is currently collaborating with members of the Physics Department of MIU on a problem in soliton theory and taking part in seminars at the University of Iowa. Last November she organized a one-day conference at MIU on geometric measure theory and physics, with speakers from MIU and the University of Iowa.

She has been a member of the MAA for eight years. She would very much like to serve the MAA in Iowa, and also to give the Iowa mathematical community an opportunity to get to know MIU.

Calvin (Cal) Van Niewaal is an Assistant Professor of Mathematics and Computer Science at Coe College. A graduate of Cornell College, Cal joined the Coe faculty in 1981 after graduate studies at the University of Kentucky where he earned a masters degree in mathematics and did additional work in infinite dimensional topology. More recently the "glamour" of computer science and the necessity to become better prepared to teach courses in that field have led Cal to to spend two summers as an IFRICS participant at Kent State. Currently on sabbatical leave from Coe, he is enrolled in the masters degree program in computer science at the University of Iowa.

Settling Questions of Shakespearean Authorship: Could Shakespeare Have Written A Newly-Discovered Poem?

Ronald Thisted
University of Chicago

In November of 1985, a nine-stanza poem attributed to Shakespeare was rediscovered in the Bodleian Library at Oxford. Apparently for the first time in some centuries the attribution was taken seriously by scholars, seriously enough to engender a long and energetic debate as to whether the poem whose first line reads, "Shall I Die?" should be added to the canon of Shakepearean work. In this talk I shall propose some statistical tests based on the use of Shakespearean vocabulary that Bradley Efron and I have developed to measure the consistency of a disputed passage with the whole body of acknowledged Shakespearean work. Then we shall look at "Shall I Die?" in the light of those tests. The talk will also examine the power of our methods to detect non-Shakespearean authors, the extent to which certain assumptions on which the theory is based hold in practice, and some aspects of robustness of the methods employed.

Herbert S. Wilf
University of Pennsylvania and Stanford University
Editor, American Mathematical Monthly

GRAY CODES AND HAMILTONIAN GRAPHS

A Gray code is a list of objects, arranged so that each one differs only "slightly" from its predecessor. I'll show a zoo of several such animals, and then discuss some of the general principles and open problems.

A GENERAL SETTING FOR UNIQUE REPRESENTATION OF INTEGERS

We all know that every positive integer is uniquely a sum of Fibonacci numbers, suitably restricted, and of binomial coefficients, suitably restricted. What is the general principle here, and what other results can be obtained from it?

Characteristics of a Tangent Line

Veronique Ziegler
Maharishi International University
Fairfield, Iowa 52556

According to Greek geometry a tangent is a line that intersects a curve at just one point with the characteristic that no other straight line can be interposed in the space between the curve and the tangent. Calculus approaches the notion of tangent lines through limits. Combining Greek concepts with calculus leads us to a deeper understanding of what a tangent line is.

Buffon's Needles in 3-space

Richard Patz
Grinnell College

Buffon's famous needle problem is presented and extended into three-dimensional space. The solutions, which involve calculus and probability, have interesting implications for the statistical estimation of pi.

Relationships Between Music and Mathematics

Mary Wetjen
Clarke College

Music and mathematics are two fields which people have nurtured to become highly developed activities of discovery. A mathematical investigation of several musical elements will emphasize the close relationships binding these two activities together. The presentation will include components on the mathematical regularity of vibrations, the relation of tones to one another in harmony and melody, rhythm, and musical form.

On Crossing Number for Select Graphs

John Squires
Drake University

The crossing number is defined as the smallest number of line (edge) crossings that occur when a graph is depicted in a plane. For a general graph it is unusually hard to determine the crossing number. The results are known only for very special graphs which include complete graphs K(n) and complete bipartite graphs K(m,n). We will consider a class of graphs we call pseudo bipartite KK(m,n;n) which consists of a complete bipartite graph K(m,n) whose vertices of one class form a complete subgraph (clique K(n)). In particular we are interested to see how known results for K(n) and K(m,n) relate to crossing numbers of KK(m,n;n).

Simplices, Euler Number, and Pascal's Triangle

Paul M. Shimura
Maharashi International University
Fairfield, Iowa 52556

The numbers in the (n + 1)th row of Pascal's triangle give us the numbers of vertices (0-faces), edges (1-faces), faces (2-faces), ..., n-faces of an n-simplex. We give arithmetic and combinatorial proofs that the alternating sum of each row (except for the first row) of Pascal's triangle equals 0 and thus the Euler number of an n-simplex equals 1.

On Symmetry of Zero-Symmetric Graphs

Chris Smith
Drake University

Zero-symmetric graphs have an equivalent set of vertices but the edges incident on each vertex are not equivalent. A number of such graphs having 120 and less vertices have been compiled in the literature. The authors: Coxeter, Frucht and Powers conclude that "In spite of our intentions, we very likely have overlooked some 0-symmetric graphs or erroneously included some that are not 0-symmetric because of hidden symmetry." While it is difficult to find omissions, we undertook to determine symmetry for those reported as zero-symmetric in an effort to verify the list. Outline of the approach and preliminary results will be reported.

On Construction of Graphs

Pat Horan and Floyd Bates
Drake University

We confined our attention to transitive graphs (i.e., graphs in which all vertices are equivalent). Such graphs can be obtained using the "graph generator" approach in which one selects k $n \times n$ symmetric permutation matrices and considers their pairwise product as vertices. When no new element of the group emerges the derived graph (as will be outlined) can be depicted. A number of graphs and their supplements using 4×4 matrices using four or more generators will be presented.

Search for Unusual Vertices in Graphs

Paula Calkins
Drake University

Unusual vertices are defined as vertices in different graphs which show the same count for self-returning walks of any length. Such vertices with coincidental counts of self-returning walks are rare. Once graphs with this property are found the task is to search for the simplest graphs in which unusual vertices still occur. The reduction can be undertaken so that the number of vertices is constant and number of edges is reduced, or alternatively, one may try to reduce not only the number of vertices but also the number of edges. We will illustrate both situations on several graphs not previously analyzed in the literature.

Spectral Properties of Ulam's Subgraphs

John Kosmicke & John Seal
Drake University

Ulam subgraphs are defined as subgraphs obtained by deleting a single vertex at a time from a given graph. Clarke reported a somewhat unexpected result: The characteristic polynomials of all Ulam subgraphs add up to the derivative of the characteristic polynomial of the initial graph. We will examine numerous isospectral trees to see if the spectral properties of Ulam subgraphs allow some discrimination between isospectral trees derived form a single parent and those (sporadic cases) which have no parent predecessor. Also we will consider the analogous properties associated with distance matrices of these graphs.

Counting Words and the Clique Polynomial of a Graph

Anita E. Solow
Grinnell College

We start by considering some famous elementary counting problems about the number of different words of length n that can be formed from an alphabet of m letters. We then impose some commutativity relations among the letters, making the counting problem much more difficult. For example, consider the problem of determining the number of words of length n that can be formed from the letters a,b,c, and d if ab=ba, bc=cb, cd=dc, and bd=db.

In order to solve this harder problem, graphs will be used. A polynomial, called the clique polynomial, is defined on the graph. The solution to the word problem using the clique polynomial will be given and examples computed for several types of commutativity relations.

The remainder of the talk will focus on the clique polyonomial itself: its behavior under graphical operations, its coefficients, and its roots.

On The Symmetry of Highly Symmetrical Graphs

Theron Oxley
Drake University

We use canonical labeling of vertices such that the associated adjacency matrix represents the smallest possible (binary) number code if its rows are read from left to right and from top to bottom. By counting the number of alternative labelings producing the same matrix we determine the order (size) of the automorphism (symmetry). We have limited our considerations to highly symmetrical graphs, particularly graphs depicting simple polyhedra in n-dimensions. We start the discussion with n-cubes which apparently yield an order of n!! (even factorials).

'Shuffled' Toeplitz Matrices

Luz M. DeAlba
Drake University

A class of Toeplitz-like matrices is presented along with a discussion of how these matrices arise from functions in H^{∞}. Using the properties of functions in H^{∞}, some algebraic properties of such matrices are shown.

Isospectral Multigraphs

Bernadette Baker
Drake University

Graphs having the same set of eigenvalues (spectrum) are called isospectral (or cospectral) graphs. They have been studied extensively. Very little is known about graphs having multiple edges (multigraphs) and coincidental spectra. We reported a number of trees with this property. We have continued to search for isospectral multigraphs (not necessarily trees) and will report on a number of new cases.

Leonardo Pisano (Fibonacci) and The Book of Squares: More Than a Single Sequence

Michael Millar
University of Northern Iowa

A discussion of some of the diophantine equations considered by one who has been called "the greatest Western mathematician of the Middle Ages."

Estimating Census Undercount at National and Subnational Levels

Noel Cressie
Department of Statistics
Iowa State University
Ames, IA 50011

Before estimation of census undercount can be carried out, several questions need to be answered. Which estimators will be compared, at what level should these estimators be applied, and how should aggregation and disaggregation proceed?

In order to answer these questions sensibly, a model of undercount errors is needed which is "level-free" in the sense that it is preserved for areas at the national, state, county, etc. level. Such a model will be proposed in this paper; it groups like subareas into strata, assuming that the grouped subareas' adjustment factors have a common stratum mean and have variances inversely proportional to their census counts. By taking into account sampling of the ares (e.g., by dual-system estimation), empirical Bayes estimators that compromise between the stratum average and the sample value, can be constructed. Implications of empirical Bayes estimation at various levels will be the focus of this paper.

Last Year's Applied Statistics Lectures Aren't Good Enough for this Year

Jon H. Lemke
University of Iowa

Every week our lives are influenced by the news media by reports of trends in government statistics, business projections, and results of medical research. A statistics instructor's ability to react to current media issues can enhance students' enthusiasm for statistics, as well as improve the overall quality of their education. This will be demonstrated by discussion of the current controversial issue of AIDS testing, and the evidence supporting regular use of aspirin to prevent heart attacks.

Degrees of Freedom in Sparse Complete Contingency Tables

Stephen Haslett
Iowa State University and
Victoria University of Wellington
New Zealand

For multiway tables containing cells with zero counts due to sampling, the calculation of degrees of freedom for fitted hierarchical loglinear models requires checking of marginal totals for sampling zeros. Although the required calculation has been established in principle for some time, the routines available in GENSTAT, GLIM, $SPSS^X$ and SAS Version 5 all give the wrong degrees of freedom for models fitted to such tables. Some results which facilitate computer implementation, and an appropriate computer program will be mentioned.

Searching for Spheres in Four Dimensional Space

Dennis Roseman
Department of Mathematics
University of Iowa, Iowa City

We address the question of how to explore four dimensional space. We use projection to reduce our considerations to a three dimensional problem. Topology further reduces the problem to a graph problem. We then use computer calculations to handle the graph problem.

The mathematical study of knotted circles has been fundamental in the study of three dimensional space; they capture in a very real sense, the three-dimensionality of space. Similarly, a good tool to study four-dimensional spaces are the knotted surfaces. The simplest surface is a sphere.

Historically, knotted circles were first studied by constructing tables of the simplest knots. We describe a method for obtaining a similar table for knotted spheres and show some examples of entries in this table.

Adjoint Functors in Algebraic Topology

Catherine Gorini
Maharishi International University
Fairfield, Iowa 52556

Two mathematical structures are usually regarded as identical if there is an isomorphism between them. In category theory, however, the notion of an isomorphism between categories is not as fruitful as the concept of adjoint functors, which locate similarity only between the hom sets of two categories. The usefulness of adjoint functors will be illustrated in this paper by examples from algebraic topology.

A Unified Field Chart for Abstract Algebra

Maxwell Rainforth
Maharishi International University
Fairfield, Iowa 52556

A unified field chart is a diagram which indicates the main conceptual relationships in a discipline or field of study and shows how all knowledge in the field sequentially unfolds from the most fundamental level of knowledge, the unified field of all the laws of nature. This talk will present a unified field chart for abstract algebra and will demonstrate its usefulness in illustrating the interconnectedness between diverse concepts in abstract algebra. The talk will also illustrate the usefulness of unified field charts in general, as teaching and learning tools.

Pedagogical Biases in the Calculus Classroom

Reginald Laursen
Luther College

Personal biases will be presented on how best to promote the understanding of function operations and the concept of the limit of a function at the theoretical level in a beginning calculus course. The talk will conclude with a local example to illustrate problem solving using the Calculus.

GEOMETRY AND INVARIANT THEORY

T. TON–THAT

U. OF IOWA

It is well–known that the theory of invariants plays a fundamental role in Geometry and vice–versa (See, for example, "Geometrische Methoden in der Invariantentheorie" by H. Kraft). We propose to investigate a generalization of the following classical result (Cf. H. Weyl's "Classical Groups"): Let $G = GL(n,\mathcal{K})$ denote the general linear group of order n over an algebraically closed field $\mathcal{K}$. Let $M_n = gl(n,\mathcal{K})$ denote its Lie algebra which can be taken to be the set of all matrices of order n over the field $\mathcal{K}$. Then G acts on M_n via the adjoint representation

$(g,X) \longrightarrow g\cdot X = gXg^{-1}$ $(g\in G, X\in M_n)$. Let $S \equiv S(M_n)$ denote the symmetric algebra of all $\mathcal{K}$–valued polynomial functions on M_n. Then the action of G on M_n induces an action of G on S:

$(g,f) \longrightarrow g\cdot f, (g\in G, f\in S)$, where $g\cdot f$ is defined by

$(g\cdot f)(X) = f(g\cdot X) = f(gXg^{-1})$ for all $X\in M_n$.

<u>DEFINITION</u>: A polynomial $f\in S$ is said to be <u>G–invariant</u> if $g\cdot f = f$ for all $g\in G$. Let $X\in M_n$ and consider its characteristic polynomial

$$\chi_X(t) = \det(1 - tX) = 1 - \varphi_1(X)t + \varphi_2(X)t^2 - \varphi_3(X)t^3 + \cdots + (-1)^n\varphi_n(X)t^n.$$

Then it can be shown that
$$\varphi_s(X) = \sum_{i_1<\cdots<i_s} \det \begin{bmatrix} X_{i_1 i_1} \cdots X_{i_1 i_s} \\ X_{i_s i_1} \cdots X_{i_s i_s} \end{bmatrix}, \quad 1 \le s \le n.$$

Let $O(X) = \{g\cdot X : g\in G\}$ denote the <u>orbit of X under G</u>, then if f is G–invariant the restriction of f to any orbit $O(X)$ is constant. It follows that the subalgebra of all G–invariant polynomials can be viewed as an algebra of functions on the set of orbits of G. Using this geometric method of orbits one can prove the following:

<u>THEOREM I</u>. <u>The algebra of all G–invariant polynomial functions is generated by the constants and the algebraically independent polynomial functions $\varphi_1, \cdots \varphi_n$.</u>

Now let $\sigma_s(X) = \text{trace}(X^s)$, $1 \le s \le n$, then H. Weyl proved the following theorem:

<u>THEOREM II</u>. <u>The algebra of all G–invariant polynomial functions is also generated by the constants and the algebraically independent polynomial functions $\sigma_1, \ldots, \sigma_n$. Moreover, the polynomials φ_i and σ_j, $1 \le i,j \le n$, are related by the following recursive formula $(-1)^k(k+1)\varphi_{k+1} = \sum_{i+j=k} (-1)^i\varphi_i\sigma_{j+1}$, $k = 0,1,2,\ldots$</u>

Classes of Weighted Symmetric Functions

Tan Cao Tran
Loras College

ABSTRACT. This paper is a generalization of the classes of symmetric and symmetrically continuous functions, and also a generalization of the concept of kth symmetric difference in the sense of Stein and Zygmund. Note that Marshall Ash has generalized these concepts in his own way, but he focused on the Riemann derivative.

We call a weight system of order n a set of real numbers

$$W_n = \{ w_{-n}, \ldots, w_{-1}, w_0, w_1, \ldots, w_n \}$$

such that

$$\sum_{k=-n}^{k=n} w_k = 0 \quad \text{and} \quad |w_{-n}| + |w_n| > 0 .$$

The symmetric difference with respect to a weight system W_n of order n for an extended real function f(x) is defined as the following expression :

$$\Delta f(x;W_n,h) = \sum_{k=-n}^{k=n} w_k f(x+kh/2) .$$

A function f(x) will be called symmetric with respect to W_n if

$$\lim_{h\to 0} \Delta f(x;W_n,h) = 0.$$

We study properties of functions symmetric with respect to a weight system, and particularly, those of functions symmetric with respect to an even or an odd weight system, which can be discontinuous only in a countable set and which are consequently in Baire class one. We also see that the functions symmetric with respect to W_n form a linear space $V(W_n)$. The uniform limit of a sequence in $V(W_n)$ belongs to $V(W_n)$. Moreover, if $B(W_n)$ is the subspace of $V(W_n)$ consisting of bounded functions, then $B(W_n)$ is a Banach space with norm

$$\|f\| = \sup |f(x)| .$$

Graph Supplements

Milan Randić
Drake University

Highly symmetrical graphs (vertex and edge transitive graphs) can be constructed by selected k graph generators from n symmetric permutation matrices. If we use the remaining (n-k) symmetric matrices we obtain a graph supplement G^*. We will examine a number of cases of known graphs and will find their supplements and some of their properties.