

IEEE Information Theory Society Newsletter



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Editor: Daniela Tuninetti

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President's Column

David L. Neuhoff



David L. Neuhoff

I write this message having recently returned from a very successful and enjoyable ISIT 2006. (See www.isit2006.org for details.) More than 800 registered for the conference, including approximately 300 students. The plenary talks by Andrew Yao, Alex Vardy, Brendan Frey, and Donald Geman were quite stimulating, as was the Shannon lecture by Rudolf Ahlswede. Many commented on the sizable number of interesting talks they had attended.

For the first time, the conference included two events for students: a Round Table Research Discussion on Monday on several pre-specified topics, and a Student Committee Meeting and Panel Discussion on Thursday, which focused on "How to Choose, Formulate and Solve an Information Theory Problem". Both were well attended. Indeed the second had 300 or so participants, including some who, while not exactly students, did not want to miss this event.

At the Tuesday Awards Luncheon, it was announced that the 2006 IT Paper Award, to be presented at ISIT 2007, will go to A. Orlitsky, N.P. Santhanam, and J. Zhang for their paper "Universal compression of memoryless sources over unknown alphabets," *IEEE Trans. Inform. Thy.*, July 2004, and the 2006 Joint ComSoc/IT Paper Award, to be presented at a future conference, will go to T. Weissman, E. Ordentlich, G. Seroussi, S. Verdu, and M.J. Weinberger for their paper "Universal discrete denoising: known channel," *IEEE Trans. Inform. Thy.* Jan. 2005. Congratulations to the authors of both papers.

At the Conference Banquet on Thursday it was announced that Sergio Verdu will be the 2007 Shannon Award winner. He will receive the award and present the Shannon Lecture at ISIT 2007. Congratulations Sergio.

At the Chapter Chairs Luncheon it was announced that the 2006 Best Chapter Award goes to Hong Kong.

Congratulations to them, as well.

For an excellent conference, thanks are very much due the organizers, who included General co-chairs Jody O'Sullivan and John Anderson, Program co-chairs Sasha Barg and Raymond Yeung, Local arrangements chair Radha Poovendran, General vice chair Tony Ephremides, Treasurer Amer Hassan, Tutorials chair Mehul Motani, and many others.

ISIT 2006 was also the site of the second and "main" annual meeting of the IT Society Board of Governors (BoG). Our new Online Editor, Nick Laneman, has established a website for BoG -- itsoc.ee.nd.edu. It was used to post the agenda and supporting material. You are welcome to browse this material, most of which is publicly accessible. A few of the documents are BoG readable only.

The following is a summary of the principle items and actions of the BoG meeting. Richard Cox, Director of IEEE Division IX (in which the IT Society resides) attended the meeting and made a few remarks. My President's Report indicated that the state of the Society is quite good, both financially and otherwise -- the only cloud being an approximately 8% decrease in membership relative to last year. João Barros was approved as the new IT Secretary, taking over from Mehul Motani, who stepped down after three plus years as secretary and webmaster. Anant Sahai was approved as the new IT Treasurer, taking over on January 1 from Muriel Médard, who has lead our emergence from financial difficulties in the past three years. ISIT 2009 in Seoul and a 2008 IT Workshop in Porto, Portugal, were approved.

The Board considered, as it had in its March meeting, the possibility of providing online access to all IT sponsored conferences and workshops to IT Members. As you may recall from the June Newsletter, BoG voted in March to include such access as a benefit of basic membership, and we are in discussion with IEEE to see if this is feasible. It has

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From the Editor

Daniela Tuninetti

Dear IT society members, I trust you had a pleasant and relaxing summer.

In this issue, I hope you will enjoy the column of our President David L. Neuhoff, as well as Anthony Ephremides' Historian's column, and Sol Golomb's puzzle.

You will also find an interesting reflection of the value of spatial diversity in wireless networks by the winners of the 2005 IEEE Donald G. Fink Prize Paper Award Suhas N. Diggavi, Naofal Al-Dhahir, Anastasios Stamoulis, and Robert Calderbank.

In addition, there are reports on recent conferences and workshops, an update on the finances of the society by Muriel Médard, and few words from program manager Sirin Tekinay at the National Science Foundation.

Please help to make the Newsletter as interesting and informative as possible by offering suggestions and contributing news. The deadlines for the next few issues of the Newsletter are as follows:

Issue	Deadline
December 2006	October 15, 2006
March 2007	January 15, 2007
June 2007	April 15, 2007

Electronic submission, especially in Ascii, LaTeX and Word formats, is encouraged. Please keep in mind that any electronic photographs should be high resolution.

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Sincerely,
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so far been decided that we will offer this for 2007 as a special promotion. Though BoG reaffirmed its desire to continue this in 2008 and subsequent years, it remains to be seen if IEEE will permit this. If not, online conference access will most likely be offered as a separate item with a separate fee.

BoG also approved several changes to the Best Chapter Award. In the future, to be eligible for the award, a chapter need only fulfill its normal reporting responsibilities; the award will be awarded in the year it is announced, rather than the following year; and the amount of the award will be increased from \$1000 to \$2000 (US).

Alex Vardy presented the very well thought out and crafted report (available on the BoG website) of the Ad Hoc Committee on Transactions Growth, which had been charged last year with considering whether continued growth in the number of pages published per year in the IT Transactions is, or will become, a problem, and if so, what steps to take. The principal recommendation was that the situation is tenable for now. However, if the Transactions continues to grow at the

current rate, then in the not too distant future, definitive action will be needed, for example, splitting the Transactions into two separate journals, or eliminating the printed version, except possibly for libraries. Since no action was deemed essential at this time, no action was taken. However, the sentiment seemed to favor the all-electronic option, if and when the Transactions becomes too large. The Ad Hoc Committee also recommended, and BoG approved, new policies that (a) the Transactions table of contents be divided into sections with each paper being listed under one of several principal topic headings, and (b) correspondences be limited to five published pages. Both changes will be phased in over time. For example, the new limitation on correspondences cannot take effect until it has been suitably announced, for example in the Instructions for Authors in the back cover.

As you read this, fall has most likely begun. For many, this means the changing color of leaves and the beginning of a new school year. No matter what your endeavors, I wish you a pleasant and productive fall, and I welcome your comments and suggestions.

The Historian's Column

Our lives, in the profession we are in, are tightly intertwined with conferences, workshops, and symposia that we all attend and participate in. Actually, things are getting somewhat out of hand lately as their number and frequency is escalating at alarming rates. However, one aspect of conference life that has not changed over the years is the subtle and elusive task of maintaining and enforcing the timing limits of each presentation. Whether it is a one-hour plenary talk, or a twenty-or-thirty minute ordinary presentation, or (in extreme cases) a ten-minute brief talk, the task of staying within the limits (without exceeding them or running substantially short of them) remains a daunting challenge that is rarely met neither by the presenters nor by the session chairs who are charged with enforcing them.

In fact, the variety of ways in which authors and session chairs have handled this task range from the mundane to the extreme, and from the ridiculous to the hilarious. As I select a few session-timing vignettes from a rich exposure to countless meetings over the years, I will refrain from naming the people involved in order not to embarrass them. However, they are all true. Any similarity to actual events is not only intentional but absolutely real.

The mundane aspects of the task dominate the majority of presentations. Most authors do a decent job in planning their talks and most chairs use standard tricks of signaling to the speaker by giving them five- and ten-minute warnings. But occasionally, entertaining and embarrassing developments occur that expose the subtleties of the seemingly simple task of keeping time.

Often, speakers run overtime and a technique used by session chairs is to stand up and approach the hapless speaker, as he/she

Anthony Ephremides



scrambles to squeeze as much as possible in the waning minutes of the presentation. But some authors, either by design or inadvertently, render this technique ineffective. On one occasion, the speaker was completely oblivious of the desperate chair signals and went on and on. The chair then started moving his seat closer and closer to the speaker. The audience had noticed, and there were chuckles in the room, but the speaker had not. In the end, amidst rather loud laughter, the speaker turned around and saw the chair right by the podium, a good distance from the rest of the audience and in fact almost stumbled upon him and thus was forced to acknowledge his presence and heed his strong encouragement to wrap up.

On another occasion, a clearly nervous speaker delivered his entire presentation with his back to the audience. He was facing the screen and kept going on a good ten minutes over the time limit. Meanwhile, the chair had stood up, made noises to capture his attention (unsuccessfully), and was getting rather desperately impatient. Of course, there are some passive or intimidated chairs who do not dare challenge the overtime speakers. But this was not one of them. He finally went up to the speaker, tapped him on the shoulder, and told him dryly: "your time is up". The speaker turned around alarmed, with an expression of panic as if the Wolfman had risen behind him and growled, and then turned back to the screen and kept going on! Everyone was in disbelief until the chair became almost physical in urging the speaker off the podium.

On other occasions, there have been rather strong-handed chairs who have threatened the speakers into submission, just like some flight attendants today threaten boarding passengers that the flight is completely full and their luggage may have to be thrown overboard.

Then there is the question of how to handle questions from the audience. Some speakers usurp the chair's authority and directly recognize or select the questioners. And, of course, there is the question of the applause protocol. Should the audience applaud upon termination of the talk or after the question-and-answer period? Sometimes, the audience takes charge and overrides the chair's efforts to enforce a particular protocol.

And as a unique and masterful account of how to handle viewgraph switching (in the old days of overhead projectors) I recall Jim Massey (I am making one exception by naming him) at the

beginning of his talk, during a workshop in Scandinavia, made reference to the fact that often speakers fumble as they mix up their viewgraphs and corrupt their sequence. And since the famous nobleman Peer Gynt was referred to quite often during the workshop, he asked rhetorically, how somebody like Peer Gynt would handle the issue of viewgraph sequence control. And, he answered his question by saying that he would obviously have a peasant do it for him. And, as was prearranged, Rolf Johansson turned out to be the "peasant" who politely agreed to flip the viewgraphs for Jim under joyful laughter.

So, as you see, the simple task of obeying slotted time protocol in our meetings has many unforeseen complications and can lead to interesting and funny situations. As someone said, "there is nothing, no matter how complicated that, if handled properly, doesn't become even more complicated".

The Value of Diversity to Wireless Networks

S.N. Diggavi (EPFL, Lausanne, Switzerland)

N. Al-Dhahir (UTD, Dallas, TX)

A. Stamoulis (Qualcomm, San Diego, CA)

A.R. Calderbank (Princeton, Princeton, NJ)

We are honored to receive the 2006 IEEE Donald G. Fink prize paper award. Our IEEE Proceedings Paper is very much a personal perspective on the value of spatial diversity in wireless networks and we would like to begin by thanking the collaborators who guided our thinking and helped shape the research reported in the paper. These include Christina Fragouli, Xia Gao, Matthias Grossglauser, Hamid Jafarkhani, Muthu Muthukrishnan, Ayman Naguib, Nambi Seshadri, Bill Turin, Vahid Tarokh, David Tse, Vinay Vaishampayan, and Walid Younis. The article was written when we were together at AT&T Shannon Labs (Florham Park) and we remember an extraordinarily collaborative environment with great affection. We would also like to think that the award reflects the growing importance of spatial diversity as a resource in network communications.

Randomness is intrinsic to wireless networks and we broadly define diversity as the means by which information is conveyed through multiple independent instantiations (conduits) of randomness. Diversity is present at the different layers the network: at the physical layer (through multiple antennas), at the link layer (through multi-user diversity), at the network layer (through co-operative diversity and route diversity) and at the application layer (through Quality-of-Service diversity). The theme underlying many significant developments in network communication over the past decade is that of utilizing diversity in its many forms. The specific form that diversity takes depends very much on the application and nowhere is this more true than in the wireless ad hoc and sensor networks that have recently emerged at the frontier of wireless research.

Wireless channels are, in general, characterized by frequency-selective multipath propagation, Doppler-induced time-selective fading, and space-selective fading. The actual diversity captured by the receiver depends on the inherent diversity that is available in the channel, the coding and modulation scheme used for transmission, and the receiver design itself. Broadband wireless communication appears to be converging on Orthogonal Frequency Division Multiplexing (OFDM) technology where frequency diversity in the channel is captured by

precoding the transmitted symbols so that the frequency-selective channel is converted into a set of orthogonal sub-carriers, each subject to a narrowband flat-fading channel. Spatial diversity results from scattering of an emitted signal, so that it arrives at a receiver through multiple paths, each with a different signal energy and angle of arrival, hence the sum of the paths depends on placement of the receiver.

Physical layer: Two antennas at the base station provide two independent paths from the base station to the mobile. By distributing information across the two paths, and by appropriate signal processing at the receiver, we in effect construct a single channel that is better than either path. Superposition of fading on these two paths at the receiver reduces the variation in received signal strength at the mobile. Reduced channel fluctuations allows smoother and more efficient power control, since the base station is continually adjusting transmit power on the basis of reported signal strength at the mobile. At a systems level, this means that the base station requires less power to support existing users, or that more users (as many as 100% more on a CDMA downlink) can be supported for a given constraint on radiated signal power at the base station [12].

Multiple antennas enable reliable high-data rate wireless communications. High rates are achieved through spatial multiplexing as shown in [14] and [7], and high reliability is achieved through space-time codes that correlate signals across the different antennas as shown in [13]. We can combine these two perspectives into the observation that there is a trade-off between rate and reliability (diversity). This was explored in the context of finite-rate (fixed alphabet size) codes in [13] and in the context of information-theoretic rate growth in [16]. Improvements in link reliability translate directly to larger cells and lower infrastructure cost. For example, the WiMax standards body (IEEE 802.16) is counting on multiple antennas to deliver data rates up to 75 MB/s over a 20 MHz bandwidth in a cell radius of 6 miles.

The most famous space-time code is the Alamouti code for which coherent and non coherent detection are remarkably simple. The

introduction of algebraic structure makes it possible to separate the data streams transmitted from the two antennas using only linear processing at the receiver, so that the end to end complexity of signal processing (channel estimation, coding and equalization) is essentially the same as single antenna systems. Codes built out of Alamouti components have been adopted in wireless standards such as UMTS, IEEE 802.11n and IEEE 802.16 in part because it is possible to implement end to end receiver functionality without going beyond the capabilities of the DSP used in baseline second-generation GSM systems. In terms of bits/second/Hz, the Alamouti code takes the baseline rate of 1-1.5 b/s/Hz to 2-2.5 b/s/Hz, and it is possible to achieve 4-4.5 b/s/Hz by adding a second antenna at the mobile and applying interference cancellation to two independent Alamouti-coded data streams.

Link layer: Since the wireless channel is inherently a shared medium, an important insight in [10], was that one can utilize the independent symmetrically fading channels of the multiple users to enhance overall system performance. Thus, by scheduling the users with “good” channels, one can increase throughput. However, this might introduce significant unfairness in the system by penalizing the users with consistently poor channels. To address this issue, opportunistic scheduling strategies have been developed that balance fairness and increased system throughput. This design philosophy is seen in two modern commercial high data-rate wireless systems (the Qualcomm 1xEV-DO system [2] as well as the Flash-OFDM system [15]).

An interesting contrast arises in the use of diversity in the physical and link layers. At the physical layer, the goal is to present to the link-layer a more reliable channel by smoothing channel fluctuations. In contrast, at the link layer, opportunistic scheduling schemes take advantage of channel variability to increase system throughput. Perhaps the way to resolve the conflict is to involve a higher layer; for applications with hard delay constraints (like real-time traffic), it might be more important to have a reliable physical layer than to take advantage of multi-user diversity at a larger time-scale. In contrast, for applications with a more elastic delay constraint (like data traffic) it might be sufficient to take advantage of multi-user diversity. It is natural to ask what should be the characteristics of physical layer links in a wireless network that supports diverse traffic types with heterogeneous requirements. In particular, if we were to construct links to a fixed rate-diversity operating point, we might be over-provisioning a resource which could be flexibly allocated to different applications. This way of thinking leads to the view that diversity (reliability) is a systems resource that should be allocated judiciously to satisfy the QoS requirements for the different traffic types. It motivates the design of a physical layer that can simultaneously provide multiple rate-reliability points which can be allocated to the applications appropriately. This was our philosophy in designing diversity-embedded codes [5], [6].

Network layer: In the network layer, the main issue is that of routing packets through multiple hops from a source to a destination. The randomness in link reliability immediately suggests using diversity to enhance the reliability of the network layer. Co-operative diversity inherently routes the information through multiple paths (perhaps using the term “paths” generously) to increase reliability (see [8]). Co-operative relay mechanisms can be also be studied from the perspective of network coding or distributed space-time codes, bringing together ideas from the physical layer to the network layer.



From left to right: N. Al-Dhahir, S.N.Diggavi, and A.R. Calderbank at ISIT2006 in Seattle.

Routing diversity is another resource in mobile wireless networks, where users encounter different relays to hand off packets and one can utilize node mobility to increase the overall source-destination throughput, albeit at the cost of increased delay. In fact, multi-path routing to protect against path failure is an old topic (see for example [11]), and in wired networks, with multi-homing strategies, multipath (diversity) routing schemes are being implemented for routing reliability. Clearly, diversity is important not just at the physical and link layers, but also in the design of network layer protocols.

Application layer: Algorithms for resource allocation make it possible to simultaneously satisfy the requirements of different traffic types. We have already seen how spatial diversity can be used to meet the QoS requirements of real-time traffic and more elastic data traffic. It is also possible to design new applications that take advantage of route diversity. For example, the aim of multiple description source coding is to provide graceful degradation (measured in terms of distortion) in the presence of route failures. Multiple description compression is particularly suited to real-time traffic applications such as IP video.

Cross-layer design: We have seen several forms of diversity that operate within different networking layers and operate at different time-scales. It is natural to ask if it is possible to optimize end-to-end performance by integration across networking layers. Here it becomes critical to identify the information that needs to be exchanged between the networking layers, and in fact this was already the case in the examples described above.

Opportunistic scheduling makes use of link information at the physical layer, path diversity requires interaction between the network and link layers, and even multiple description source coding may be viewed as interaction between the network and application layers.

There is no shortage of ideas for how to improve the performance of any particular network layer. What is needed is a mathematical framework for fair comparison of cross layer designs, fundamental limits on performance, robustness, and a set of principles describing how to and how not to layer. Layering as optimization decomposition is such a framework (see [3]). It starts from a set of utility functions that capture the interests of users and possibly operators and views network protocols as carrying out an asynchronous distributed computation over the network to implicitly solve a global optimization problem. This framework may make it possible to quantify the value of exchanging information between layers and to arrive at fundamental understanding of how to and how not to layer.

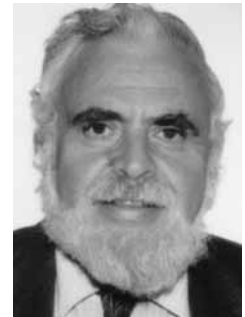
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GOLOMB'S PUZZLE COLUMN™

Classic Mathematical Quickies

Solomon W. Golomb



We consider the following four quadratic matrix equations.

- A) $M^2 = M$
 B) $M^2 = -M$
 C) $M^2 = I$
 D) $M^2 = -I$

where M is an $n \times n$ matrix with elements from a field F . Here F may be the real number field R , the complex number field C , or the integers modulo p , Z_p , for any prime number $p > 2$.

The following questions should be answered separately for each of the four matrix equations.

1. What are the possible values of $|M|$, the determinant of M ?
2. If $M = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$, what are the possible values of $Tr(M)$, the trace of M ?
3. If $M = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$, what are the possible characteristic polynomials for M ? What are the corresponding eigenvalues? (The eigenvalues will either lie in the field F , or a “quadratic extension” of F .)
4. With $M = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$, find the general solution for M that satisfies the given equation. This solution should be given as explicitly as possible. (For example, the general solution of $M = -M^T$ would be $M = \begin{pmatrix} 0 & b \\ -b & 0 \end{pmatrix}$, where M^T is the transpose of M .) The general solution may be a union of two or more cases.

Workshop Report: NETCOD 2006, Boston, MA, USA

Muriel Médard

Netcod 2006, the second Network Coding Workshop, took place in Boston on April 7, in conjunction with WiOpt. The TPC members were Phil Chou, Christina Fragouli, Tracey Ho, Baochun Li, Raymond Yeung and Ken Zeger, with Ralf Koetter and Muriel Médard serving as co-chairs. The workshop had a healthy attendance of 37 people, the highest of any of the workshops. We had 11 contributed papers, with one invited paper, "Can Network Coding Help in P2P Networks?" by Dah Ming Chiu, Raymond W. Yeung, Jiaqing Huang and Bin Fan. The papers spanned a wide area of applications and theory of network theory, mirroring well the devel-

opments that are occurring in the field. Many papers considered new areas of network optimization stemming from network coding, reflecting a growing interest in network coding from the networking community. The workshop indeed helped to bring together, in an informal manner, researchers from information theory, complexity theory, optimization and networking systems. There was also a healthy attendance from local research labs whose members took advantage of Netcod to investigate the area of network coding.

We look forward to seeing you at Netcod 2007 in San Diego!

Workshop Report: Spaswin 2006, Boston, MA, USA

Massimo Franceschetti

The art of modeling networks is ideally placed at the crossroad where mathematics meets engineering. It combines random graph theory and spatial probability with information theory, combinatorics, performance analysis, and network protocols. Recently, a special focus of this inter-disciplinary field has been on networks composed of small and relatively simple devices that can be randomly deployed and ad-hoc organized into a communication network using radio links. The second edition of the workshop on Spatial Stochastic Models for Wireless Networks, chaired by Prof. Patrick Thiran and myself, was held in Boston last April, and served as a venue for discussion among two representative communities working in this specific field.

The workshop opened with two keynote addresses, representative of the two communities, by P.R. Kumar, professor of Electrical and Computer Engineering at University of Illinois, Urbana, and Ronald Meester, professor of Mathematics at the Vrije Universiteit Amsterdam, the Netherlands. They gave a perspective on recent advancements and future directions of the field. Prof. Kumar revisited capacity and connectivity results of ad-hoc wireless networks, and emphasized the important role of the theory in providing guidelines on architectural prescriptions. Prof. Meester gave an historical overview of rigorous mathematical results from statistical physics, and discussed their possible application in the context of communication networks. The opening talks generated much discussion and were followed by eleven contributed talks, whose papers are available on-line at <http://spaswin.org/2006/tech-prog.htm>.

Two additional invited speakers contributed to enrich the program further, opening the afternoon session: David Aldous, professor of Statistics at UC Berkeley, and Francois Baccelli, professor of Informatics at the Ecole Normale Supérieure, Paris. Prof. Aldous considered an abstract model of transportation for communication networks, in which one needs to simultaneously

route flows between each source-destination pair, in an optimal way subject to various cost and capacity conditions. He illustrated the statistical physics viewpoint, which is to study properties of the optimal flow instead of algorithms for finding it. In particular, he considered curves giving some quantitative measure of network performance as a function of the overall traffic demand, and showed how to relate qualitative properties of such curves to structural properties of the network. Prof. Baccelli gave a talk of more applied flavor, considering the possible self organization of interfering 802.11 wireless access networks. He proposed a set of distributed algorithms that allows multiple access points to select their frequency in a way that minimizes co-channel interference, and also allow clients to choose their access point so that the bandwidth of the whole network is shared optimally. His proposed algorithms relied on Gibbs' sampler and optimized global network performance based on local information and decisions.

In conclusion, the objective of the workshop was to investigate how the language of mathematics can be used to describe and provide insight into the operation of ad-hoc wireless networks. It has served as the opportunity for two communities to learn from each other tools and novel problem formulations needed to achieve this objective. Clearly, much remains to be done and additional interaction is certainly desirable. We hope to have raised enough interest on both sides so that this will likely occur in the future.

We are not the first to draw a parallel between applied mathematics and the arts, but even risking such lack of originality, we wish to conclude with the words of American experimental music composer, writer, and visual artist John Cage: the function of Art is to imitate Nature in her manner of operation. Our understanding of "her manner of operation" changes according to advances in the sciences.

Workshop Report: MSRI Workshop on the Mathematics of Relaying and Cooperation in Communication Networks, Berkeley, CA, USA

Gerhard Kramer

Mathematical Sciences Research Institute (MSRI), Berkeley, California, April 10-12, 2006.

A workshop on the Mathematics of Relaying and Cooperation in Communication Networks was held from April 10-12, 2006, in the brand new and beautiful Simons Auditorium at the Mathematical Sciences Research Institute (MSRI) in Berkeley, California. The workshop was sponsored by MSRI, the National Science Foundation, and Intel, and was organized by Michael Gastpar (University of California at Berkeley), J. Nicholas Laneman (University of Notre Dame), and Gerhard Kramer (Bell Labs).

The workshop brought together mathematicians and engineers from Asia, Europe, and the Americas to motivate further activities in the area of information theory for networks. The topics covered included historical perspectives on relaying, physical-layer modeling, code design, resource allocation, diversity analyses, network coding, game theory, and multi-terminal information theory. The workshop consisted of 3 plenary lectures by Edward van der Meulen, Abbas El Gamal, and Frans Willems, 22 invited talks by several of the world's leading researchers in relaying and cooperation, 30 student posters in two poster sessions, and an industry panel representing Intel (Sumeet Sandhu), Beceem Communications, Inc. (Bertrand Hochwald), Motorola (Roger Peterson), and Qualcomm-Flarion (Sundeep Rangan). The invited speakers, in order of appearance, were Elza Erkip, Vahid Tarokh, Junshan Zhang, Tony Ephremides, Edmund Yeh, David Tse, Venu Veeravalli, Gregory Wornell, Urbashi Mitra, Sriram Vishwanath, Liang-Liang Xie, Helmut Boelcskei, Randall Berry, Babak Hassibi, Ashutosh Sabharwal, Anders Host-Madsen, Andrea Goldsmith, Mehul Motani, Behnaam Aazhang, Massimo Franceschetti, Piyush Gupta, and Hesham El Gamal. A total of 111 participants registered for the event, including a host of university students.

A special moment of the workshop was the plenary lecture of Professor Edward van der Meulen who paid tribute to his advisors and mentors at Berkeley, David Blackwell and Aram Thomasian, who were in attendance. There were other exciting



Berkeley statisticians, from left to right: Edward van der Meulen and his advisors David Blackwell and Aram Thomasian.

moments as well, including the industry panel question period where the workshop participants were constructively challenged to consider all aspects of network communication in their work.

For more information on the workshop, including talk titles, abstracts, slides, and photographs, please see the following links:

- 1) <http://www.eecs.berkeley.edu/~gastpar/MSRI/>
- 2) http://www.eecs.berkeley.edu/wireless/photos_relay.html
- 3) http://www.msri.org/calendar/workshops/WorkshopInfo/325/show_workshop

This article is also available at <http://itsoc.ee.nd.edu/Members/jnl/msri-relay-workshop/>. Photos courtesy of Bobak Nazer.



Group photo of workshop attendees on Tuesday, April 11, after the Industry Panel discussion.

Workshop Report: 4th International Symposium on Turbo Codes and Related Topics, and 6th International ITG-Conference on Source- and Channel Coding, Munich, Germany

Nicolas Dütsch and Joachim Hagenauer



Symposium Opening.

For the first time in its nine year history, the International Symposium on Turbo Codes and Related Topics it was not held in Brest. Prof. Claude Berrou (ENST Bretagne, France) asked Prof. Joachim Hagenauer (TU Munich, Germany) to organize the event in Munich, another center of Turbo research. Moreover, the Symposium was held jointly with the International ITG-Conference on Source- and Channel Coding.

The venue of the conference was the Bavarian Academy of Sciences and Humanities. Both the royal ambiance – the Academy is part of Munich Residence – and also the good technical equipment promised a successful conference.

The technical program committee chaired by Prof. Johannes Huber of the Friedrich-Alexander-University at Erlangen-Nuremberg, Germany, selected 156 papers of high quality from 230 submitted contributions. Moreover, the committee arranged the varied program with joint sessions in the plenary hall and some parallel sessions in the boardrooms of the Bavarian Academy.

Besides oral sessions, poster presentations were also arranged. Following the concept of the last ITG-conference, the authors of a poster presentation had the possibility to advertise their posters in five minute talks in the plenary hall.

Furthermore, the program was padded with invited speakers; amongst others were Prof. Benedetto (Turin, Italy), Prof. Loeliger (Zurich, Switzerland) and Prof. Urbanke (Lausanne, Switzerland). Also Prof. Kötter (Urbana-Champaign), Prof. Verdú (Princeton) and Dr. ten Brink (Irvine), all coming from the USA, gave interesting invited talks.

Prof. Wolfgang Koch, from Friedrich-Alexander-University in Erlangen-Nuremberg, Germany, acted as publications chair. The



Prof. Hagenauer.

organizers decided to distribute the electronic version of the proceedings not on a CD as usual, but to store it on a USB stick. The idea received a very positive feedback from the participants.

At the entrance of the Academy a formula one turbo engine of BMW was exhibited. Prof. Roland Bulirsch – vice president of the Bavarian Academy of Sciences and Humanities – welcomed the international guests in the decorated plenary hall, followed by words of welcome from the general chairs. The details of the program can be found at www.turbo-coding-2006.org.

The social program was mainly organized by Angela Günther. On Monday morning a sightseeing tour was arranged for spouses. In the evening the Bavarian Minister of Sciences, Research and the Arts, Dr. Thomas Goppel held a state reception in the Emperor's Hall of the Residence. He pointed out the Bavarian initiative to promote the universities and their importance for science and economy. The reception was entertained by a brass ensemble, where Prof. Huber, the technical program chair, plaid the trombone.

On Tuesday evening the participants were invited to a classical concert at the Allerheiligen-Hofkirche. Many people listened to music of di Lasso, Barber, Mozart and others. The compositions were performed by the Symphony Orchestra of Munich-Andechs. Furthermore, a presentation on the history of the church of the Residence was given.

On Wednesday afternoon the participants – equipped with lunch bags – explored some attractions of Munich and the surrounding area. They had the choice between four different tours. Those who were interested in sports inspected the new football arena, where later the opening match of the soccer world cup took place, and the BMW museum. On another tour the participants visited the

castle of Nymphenburg. Other tours targeted the aeronautical museum in Oberschleißheim, the German Aerospace-Center and the popular technical “Deutsche Museum”.

On Thursday another highlight was the traditional conference banquet arranged by Berthold Lankl, Professor at the University of the German Armed Forces in Munich. It was held in the famous beer hall of the Augustinerkeller. After acknowledging the work of the organizers, who were dressed in local Bavarian costumes, by presenting beer mugs of the brewery of Weihenstephan, which belongs to the Technical University of Munich, Prof. Hagenauer tapped the barrel of beer and cheered “O’Zapft is!”. The banquet speech was given by Prof. James Massey after some traditional brass composi-

tions performed by the Waller Tanzl Musi. The guest of honor gave a lecture on the “true” history of the turbo principle.

On the following day the participants, despite being tired from the beer, listened to the last talks of the conference. Finally the general chairs bid farewell to them and invited them to the next turbo symposium in Lausanne and the next ITG-conference in Ulm.

To conclude, we would like to thank all organizers of the event as well as the sponsors – France Telecom, NTT DoCoMo Euro-Labs, Infineon, Qualcomm, Rohde & Schwarz, Siemens und Vodafone – for their support which resulted in a smoothly running event.

Workshop Report: The 2006 IEEE Communication Theory Workshop (CTW 2006), Dorado, Puerto Rico

Elza Erkip



Communication theorists work hard....

The 35th Annual IEEE Communication Theory Workshop was held on May 21-24, 2006 at Hyatt Dorado Beach Resort, Dorado, Puerto Rico. The general chair of the conference was Behnaam Aazhang, the technical program co-chairs were Elza Erkip and Phil Schniter. Jeff Andrews was the publicity chair, Sundararajan Sriram handled the finances, and Mandy Nevin was in charge of the local arrangements and the web site.

Historically, Communication Theory Workshop has been successful because of its informal and highly interactive atmosphere, in contrast to more formal conferences. The 2006 Workshop continued the tradition, with a single track of invited presentations, panel discussions and an evening poster session. The beautiful setting of the workshop and the beach attire also contributed to the relaxed atmosphere.

This year’s workshop focused on the interplay between communication theory and networking. Each day started with small groups of participants gathering at the beach for swimming, running, walking or simply relaxing, and proceeded with a plenary talk. The plenary talks were:

- “What’s in Sensor Networks for Communication Theorists?” by Anthony Ephremides,
- “Clocks in Wireless Networks” by P.R. Kumar,



... and play hard!

- “Energy and Inference in Wireless Sensor Networks” by H. Vincent Poor.

The technical program included invited sessions on “Cross-Layer Design” (organized by Andrea Goldsmith), “Cooperative Communications” (organized by Hesham El Gamal), “Sensor Networks” (organized by Greg Pottie), “Network Information Theory” (organized by Gerhard Kramer) and “Network Coding” (organized by Emina Soljanin).

In addition to invited talks, the sessions on cooperative communications, network information theory and network coding contained panel discussions led by the session organizer. The panel sessions provided an open forum for the panel members and the audience to discuss the past, present and future of each field. The lively panel discussions would have continued into the evening if it weren’t for the well-attended beach volleyball and soccer sessions.

Monday evening featured the poster session containing 21 contributed papers (organized by Robert Heath and Sriram Viswanath). The workshop banquet was held on Tuesday evening where the winners of the Communication Theory Technical Committee (CTTC) Outstanding Service Award were announced. Robert Lucky, Jack Salz, and Don Schilling received the award for their vision in initiating the communication theory workshop and

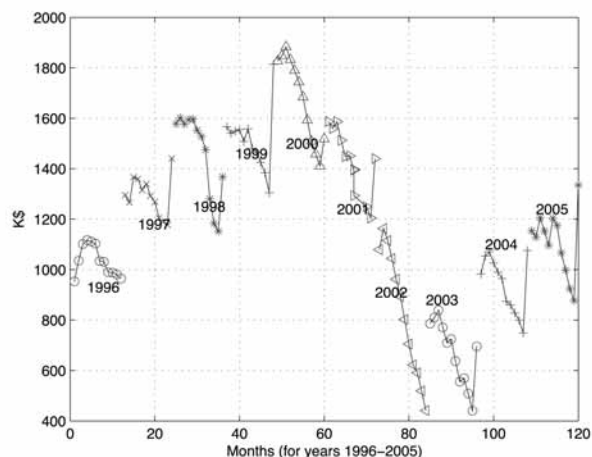


Young Turks of communication theory: (from left to right) Serap Savari, Sennur Ulukus, Elza Erkip, Sirin Tekinay, Aylin Yener.

their long-standing service and contributions to the communication theory community.

Treasurer's corner

Welcome to the Treasurer's corner. As the graph below indicates, our finances continue to be improving, finally reaching the levels that our Society enjoyed before financial difficulties at IEEE prompted its taking over a substantial portion of our reserves. The significant increase in our reserves can be at least partially attrib-



Bin Yu wins Guggenheim fellowship

Bin Yu, a statistician at the University of California, Berkeley, is among the 187 winners of the 2006 Guggenheim Memorial Foundation fellowship. He was selected from nearly 3,000 U.S. and Canadian artists, scholars and scientists applying for awards totaling \$7.5 million.

Guggenheim fellows are appointed on the basis of distinguished achievement and exceptional promise for the future. Since 1925, the Guggenheim Foundation has granted more than \$247 million in fellowship awards to more than 16,000 scholars. The program enables important research in the arts, humanities and sciences.

The workshop was attended by 82 people, with many new faces to CTW and a large number of young researchers and students, thanks to the financial support from Texas Instruments, Center for Multimedia Communication at Rice University, Wireless Networking and Communications Group at The University of Texas at Austin and Wireless Internet Center for Advanced Technology at Polytechnic University, Brooklyn.

CTW does not have published proceedings but the details of the program, the presentations, the posters as well as photographs of the technical, social and sports events can be found on the CTW 2006 web site <http://www-ece.rice.edu/ctw2006>.

Next year CTW will have another beautiful setting in Sedona, Arizona. Hope to see all of you there!

Muriel Médard



uted to the fact that 2005 was a transition year between accounting for conferences of the previous year and accounting for them as the surplus comes in. Still, our fundamentals remain strong, buoyed by a string of successful conferences.

Our current positive financial outlook has allowed us to undertake initiatives for increasing our membership and offering better value to our members. In particular, we have earmarked money for allowing people to sign up as IT members at ISIT and receiving the lower member rate. We have also allocated money to pay next year for our members to receive electronic access to ITW and ISIT proceedings. Our successful student outreach program, as well as the new ISIT student paper award to commence in ISIT 2007, are also being financially supported by the Society.

As always, if you have any questions about our Society's financial workings, please send me an e-mail.

Your treasurer

Muriel Médard
medard@mit.edu

Guest Column: From the National Science Foundation

News from the Communications Program at NSF

Sirin Tekinay, Program Director



Dear reader, I am delighted to write the fourth column in this series, ten months since joining the NSF. As usual, in this space, I hope to fuel our interaction on ideas, visions, and issues that impact us all as professionals in the communications community as I provide you with insight to relevant NSF programs and news. I am thrilled that I continue to enjoy your ever-increasing “communications:” recently, mostly from researchers submitting proposals; questions, opinions, comments, requests and inquiries for participation in the NSF review process.

A Few Words on Process Flows at the NSF: from Solicitations to Competitions In the last issue, I described how “program solicitations;” i.e., calls for proposals, are made. Having coordinated the writing of this year’s Theoretical Foundations Program Solicitation (TF06), I would now like to present “what happens next.” TF06 [1] was posted for public viewing towards the end of February. NSF rules dictate that the deadline for a proposal submission to a program is set at least ninety calendar days after the posting date. Proposals can be submitted starting thirty days prior to the deadline. This year, researchers were given the option to submit proposals in response to our Program Solicitation via “Grants.gov” or via the good old NSF FastLane [2] system. Grants.gov provides a single government-wide portal for finding and applying for federal grants online [3]. “Proposers” are not the individual researchers, but their institutions; NSF makes awards to institutions and not the individuals. The format and other rules regarding the submission are outlined in NSF Grant Proposal Guide [4], in addition to program-specific requirements listed in the solicitation. For instance, this year, TF06 limited the number of proposals an individual can play a senior role in, to one. It is the responsibility of the proposer institution (in most cases, the Sponsored Research Office) to ensure that these requirements are adhered to. If a proposal does not meet requirements, NSF or program specific, it is returned without review. I continue to serve as the cluster lead for TF, which means I received all five hundred and fifteen proposals in communication theory, information theory, network information theory, signal processing, theory of networking, theory of networked computing, network modeling, optimization, numerical computing, graphical computing, and theory of computing. Then my colleagues and I feverishly worked on finding good homes for these proposals by annotating a master spreadsheet with links to the proposals. For the two hundred and thirty six proposals remaining in “My Work” folder, I set up eight expert panels that will meet late July through August. These generally fall under my two programs within TF: communications and scientific foundations for Internet’s Next Generation (SING). I am simply delighted that SING received one hundred proposals, and our COMM program has a record twenty per cent increase in the number of submitted proposals. These are healthy signs that will help me make the case for increased funding of our area. Panel formation is, technically speaking, tricky business. Researchers who have submitted proposals are disqualified from review panels. We make sure NSF’s diversity requirements are reflected in the panels: in addition to spanning all areas covered by the proposals at hand, there is a balance of junior, up and coming, and senior researchers, researchers from historically underrepresented groups. In addition, we invite international researchers and researchers from industry and other federal agencies. A typical panel is made of fifteen panelists. For heavily loaded programs such as

COMM and SING, each panel handles thirty to forty proposals. I like to get at least four reviews per proposal, and not assign more than ten proposals to each reviewer, in order to ensure the most efficient review process possible. In order to construct the proposal assignment matrix, I send the list of proposals to a blind-copied list of panelists and let each panelist indicate their level of interest in each proposal. I maximize the total interest in each proposal, while balancing the review load among panelists. I also make sure this process does not produce “sub panels” where groups of proposals are assigned to smaller groups of reviewers. Most importantly, I make note of conflicts of interest between panelists and proposers (while unavoidable, the number of conflicts of interest needs to be as small as possible). Conflicts of interest arise as a result of: 1) affiliations with an institution; i.e., being currently or previously employed (within the last 12 months), or seeking employment; having received an award, honorarium, or travel payment from (last 12 months); serving in an office, or governing board of; having any other financial interest with the institution, or 2) relationships with a person involved in a proposal; i.e., having co-edited journal or proceedings (last 24 months); co-authored a paper or collaborated on a project (last 48 months); being the thesis advisor or student (life-long) of, or being a family member or close friend. Any panelist can declare a conflict of interest with any proposal without declaring the nature of the conflict. Panelists with conflicts of interest cannot access the reviews, nor participate in the discussions of those proposals. All information about the proposals and the review panel are strictly confidential. Panelists may not copy, quote, or otherwise use or disclose to anyone any material from any proposal they are asked to review. In addition to reviews, panels produce a “panel summary” for each proposal. Reviews and summaries have two uses: 1) to provide the program director with advisory input; it is my job to take the reviews and recommendations of the panel into account in making funding decisions and balancing my budget, 2) to give constructive feedback to the proposers. NSF has the “golden standard” in terms of the review process among all funding agencies, although proposers could always use more detailed reviews. We continuously strive to improve our review process by lessening the review load on panelists, adding in mail-reviews, etc. While panel participation is a growing experience that is especially beneficial to younger researchers, as a community, we should be grateful to all panelists who volunteer a tremendous amount of their time and energy to NSF’s review process. Reviewing ten proposals takes about fifty hours, and that’s before the actual intense, two-day panel meeting. I anxiously look forward to the completion of this year’s TF competition. In the meantime, I am gearing up to coordinate the writing of next year’s solicitation. We are shooting for an earlier deadline next year. The NSF Guide to Programs is a compilation of funding for research and education in science, mathematics, and engineering. The NSF Guide to Programs is available electronically at [5]. General descriptions of NSF programs, research areas, and eligibility information for proposal submission are provided in each chapter. Finally, I am thrilled to report on the “Science of Interaction” initiative I formulated: it has taken hold and it is being discussed at the highest administrative levels as the potential next NSF-wide program. Although the vision is in its infancy, I cannot wait to see it in writing in the form of a Program Solicitation.

News on Communications Research: Our programs go through a rigorous review process every three years by a “Committee of Visitors,” (CoV) formed of visionaries in the respective fields, recommended by program officers, chosen by division directors. In June, our Computing and Communications Foundations Division (CCF) went through the CoV review. Professor H. Vincent Poor chaired the Theoretical Foundations sub-committee, which Professor Bruce Hajek also participated in. I am grateful for the Herculean effort that Vince and Bruce have put into scrutinizing three years’ worth data of the communications and computing related programs. I would like to thank them, in addition to the rest of the CoV, not only for reviewing and critiquing our programs, but for the invaluable advisory report they have generated for us to improve our programs. I continue to serve as the enthused GENI representative for CCF [5]. We had the fourth Town Hall meeting for GENI in San Francisco in early July. I am glad to see interest in the theory community is growing in GENI. Please get and stay involved in GENI! This is an excellent opportunity to close the loop between theory and experimentation, as well as bridge the gap between layers of communication systems. We recently received the CAREER proposals. I did the honors as the cluster lead again. The distribution of the two hundred proposals submitted to CCF resulted in thirty proposals in the CAREER competition in the communication program alone, not including signal processing related proposals. It will be my pleasure to run the panel for this exciting bunch of career plans in the late September time frame.

On a Personal Note: The reward for enthusiasm and good work at NSF, I learned, is more work. There seems to be a tacit agreement that I am the cluster lead for Theoretical Foundations, which means receiving and distributing all proposals submitted to the TF cluster, preparing for the CoV, and coordinating the writing of next year’s solicitation. In the last ten months, I learned so much that I feel like an old timer at NSF, but I had so much fun that I feel new every day. My yearly contract has been almost automatically renewed so I will have the pleasure and privilege of serving our community at least until September 2007. On the IGERT [6] front, we completed the first stage of the two-stage competition by running panels to evaluate the pre-proposals. It was a daunting task to put together review panels to handle the seventy plus interdisciplinary proposals that had enough CISE-related material in them to fall in the two CISE panels. Thanks to the excellent work of these panels, we have identified the teams to invite to submit full proposals. The deadline is late in September, and the panels will convene in late November early December timeframe.

NSF People: In every column, I introduce some of the people I work with; who embody the culture and spirit of NSF. This time I would like to present our administrative support staff NSF could not function. Over the last couple of years, CISE has implemented “pilot” management schemes: an experimental administrative support structure has been implemented in the three divisions of CISE. In this structure, our administrative staff has various specialization areas available to them, in addition to opportunities for upward mobility. The administrative director of each division is the “Office Manager,” the OM. Here’s my tribute to Ms Sanya Spencer who was the CCF OM until a couple of months ago. She is as close to super woman as anyone could get, with a calm, beautiful smile on her face through crises, crunches, and deadlines. This must be why she is borrowed from us to support the “front office” of CISE for a few months. If you

take the North Elevators to the eleventh floor and see an elegant lady focused yet relaxed, briskly walk in or out of the front office with a dancer’s fluidity, that’s Sanya. You couldn’t tell she is a mother of four daughters, one of whom works at the NSF. During Sanya’s absence from our division, Ms Velma Lawson, who recently completed her Master’s degree in management, in addition to her many certifications, is running our division. Closely supporting her are our program analysts and project specialists, a young, lively group of ladies who are mothers, Washington DC area natives. Their warmth, care, and seemingly endless energy cushion us, the transient research directors. We are getting ready to celebrate the marriage of Ms Joneka Thompson (one of our high power program specialists), and the arrival of two babies in our division. Our program assistant is Ms Laurin Battle, whose dedication, ambition, sharp intelligence, and enthusiasm makes my job much easier. She is a Master’s student, a mother, and I’m proud to say, a friend. Ms Tracey Wilkinson supports the Signal Processing Program. She is also our precious resident expert on Fastlane. In our division, administrative and scientific staff work in harmony. I do hope the success of this pilot program propagates through NSF...

The “Social Scene”: I attended the Communications Theory Workshop in May. I was glad to offer some student support for this workshop from our program funds. It was simply wonderful in terms of the quality of the presentations. That the workshop took place in gorgeous Dorado Beach, Puerto Rico, helped! Most researchers there were working against the deadline of May 25 to file their proposals, so I felt guilty for the delayed deadline. It was indeed pointed out many times that the deadline should have been earlier. Understanding that deadlines are to be honored the last minute, I did not tell anyone they should have filed their proposal earlier... I also traveled to Istanbul, Turkey, in order to attend ICC’06 in July. The conference was superbly organized, with excellent synchronized opportunities to “session hop.” At the risk of sounding partial to my hometown, I have to say Istanbul was at her prettiest.

I am not traveling till this round of competition, not even back to New Jersey, the next six weeks. No train trips means less leisure reading. However, I did finish “Forty Signs of Rain” I talked about last time. I got many inquiries for such suggested readings since. So here I go: before I go onto my second read in Kim Stanley Robinson’s trilogy, I took up “Science Friction” by Michael Shermer [7]. It is an entertaining, sharp, witty, and most interesting collection of the author’s articles that I trust will speak to the quest for truth in each of us. ... Till next time, dream big, and keep in touch!

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[1] <http://www.nsf.gov/pubs/2006/nsf06542/nsf06542.htm>

[2] <https://www.fastlane.nsf.gov/a1/newstan.htm>

[3] <http://www.grants.gov/index.jsp>

[4] http://www.nsf.gov/pubs/gpg/nsf04_23/

[5] <http://www.nsf.gov/cise/geni/>

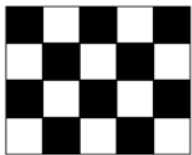
[6] <http://www.nsf.gov/crssprgm/igert/cc.jsp>

[7] Michael Shermer, “Science Friction,” Owl Books, ISBN: 0-8050-7914-9

Classic Mathematical Quickies Solutions

Solomon W. Golomb

1. In an elimination tournament, each match eliminates one player. If N people enter the tournament, $N - 1$ matches must be played to eliminate all but one entrant. (If 163 people entered, 162 matches must be played.)
2. After moving 30 green marbles to the red jar, and then returning 30 marbles from the shaken red jar to the green jar, each jar has the same number of marbles that it started with, so any green marble now in the red jar must have been replaced by a red marble now in the green jar. Thus the two numbers (green marbles in the red jar, and red marbles in the green jar) are equal.
3. The floating ice cube already displaces its own weight in water. When it melts completely, the water will merely occupy the space previously filled by the submerged portion of the ice cube, and no water will spill over the rim of the jar.
4. For every \$100 of your initial investment, you will have \$80 after a 20% decline. When you increase the \$80 by 25%, you are back to exactly \$100, so there is neither gain nor loss. Mathematically, $(\frac{4}{5}) \cdot (\frac{5}{4}) = 1$.
5. John will reach the age that his grandmother was when he was born at exactly the same date that his age is half that of his grandmother's. From the information in the problem, this will occur "next January 16".
6. Because the product $(x - a)(x - b)(x - c) \cdots (x - z)$ contains the factor $(x - x) = 0$, the entire product has the value 0.
7. When the total number of couples is even, it is not possible to seat the host and hostess at opposite ends, and have men and women alternate all around the table, with the same number of guests on each of the two long sides.
8. If we apply a checkerboard coloring to the 4×5 rectangle, we get



, with equally many light and dark squares (ten of each). Four of the five tetrominoes, no matter how placed on the 4×5 "board", will cover two squares of each color:



for a total of eight squares of each color, leaving two squares of each color; but the fifth tetromino,



will cover an unequal number of squares of the two colors; so the assembly is impossible.



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2007 IEEE International Symposium on Information Theory

Acropolis Congress and Exhibition Center
Nice, France

June 24 – 29, 2007



The 2007 IEEE International Symposium on Information Theory will be held at the Acropolis Congress and Exhibition Center in Nice, France, from Sunday June 24 through Friday June 29, 2007. Nice is the main city of the world famous French Riviera (Côte d'Azur). It offers a unique blend of glamour, culture, sports, and recreation.

Previously unpublished contributions across a broad range of topics in information theory are solicited, including (but not limited to) the following areas:

Coding theory and practice	Multi-terminal information theory
Communication theory	Pattern recognition and learning
Compression	Quantum information theory
Cryptography and data security	Sequences and complexity
Detection and estimation	Shannon theory
Information theory and statistics	Signal processing
Information theory in networks	Source Coding

Submitted papers should be of sufficient detail for review by experts in the field. In addition to submitting new results in areas that form the core of information theory, researchers in related fields and researchers working on novel applications of information theory are encouraged to submit contributions. Final papers will be **five pages** in length. The submission deadline is **January 8, 2007**. Detailed information on paper submission, technical program, tutorials, travel, social programs, and travel grants will be posted on the ISIT 2007 web site: <http://www.isit2007.org>



Conference Calendar

Information available at <http://www.ieee.org/conferencesearch/>

DATE	CONFERENCE	LOCATION	CONTACT/INFORMATION	DUE DATE
September 27-29, 2006	The 44th Annual Allerton Conference on Communications, Control and Computing (Allerton 2006)	Monticello, IL, USA	http://www.csl.uiuc.edu/allerton/	July 5, 2006
October 22-26, 2006	2006 IEEE Information Theory Workshop (ITW 2006)	Chengdu, China	http://www.ee.cityu.edu.hk/~itw06/	June 1, 2006
October 29- November 1, 2006	The Asilomar Conference on Signals, Systems, and Computers (Asilomar 2006)	Monterey, CA, USA	http://www.asilomarssc.org/	June 1, 2006
October 29 – November 1 2006	The 2006 International Symposium on Information Theory and Applications (ISITA 2006)	Seoul, South Korea	http://www.isita2006.org/	April 3, 2006
November 27 – December 1, 2006	2006 IEEE Global Telecommunications Conference (GLOBECOM 2006)	San Francisco, CA, USA	http://www.ieee-globecom.org/2006/	March 5, 2006
January 29, 2007	The Third Workshop on Network Coding, Theory, and Applications (NetCod 2007)	San Diego, CA, USA	http://code.ucsd.edu/netcod07/	August 28, 2006
January 29- February 2, 2007	The 2007 Information Theory and Applications Workshop (ITA 2007)	San Diego, CA, USA	http://ita.ucsd.edu/workshop.php	TBA
May 6-12, 2007	2005 IEEE Conference on Computer Communications (INFOCOM 2007)	Anchorage, AK, USA	http://www.ieee-infocom.org/2007	August 1, 2006
March 14-16, 2007	Conference on Information Sciences and Systems (CISS 2007)	The Johns Hopkins University, Baltimore, MD, USA	http://ciss.jhu.edu/	January 31, 2007
May 20-23, 2006	2007 IEEE Communication Theory Workshop (CTW 2007)	Sedona, AZ, USA	http://www.comsoc.org/~comt/workshops.html	TBA
July 1-6, 2007	2007 IEEE Information Theory workshop for Wireless Networks (ITW 2007)	Bergen, Norway	http://www.selmer.uib.no/ITW2007.html	March 16, 2007
June 17-20, 2007	IEEE International Workshop on Signal Processing Advances for Wireless Communications (SPAWC 2007)	Helsinki, Finland	http://wooster.hut.fi/spawc07/	September 15, 2006
July 24 -29, 2007	2007 IEEE International Symposium on Information Theory (ISIT 2007)	Nice, France	http://www.isit2007.org/	January 8, 2007
June 24 – 28, 2007	2007 IEEE International Conference on Communications (ICC 2007)	Glasgow, Scotland, UK	http://www.comsoc.org/confs/icc/2007/index.html	September 25, 2005
April 23 – 25, 2007	IEEE 65th Vehicular Technology Conference (VTC 07 Spring)	Dublin, Ireland	http://www.ieeevtc.org/vtc2007spring/	September 16, 2006
October 1 – 3, 2007	IEEE 66th Vehicular Technology Conference (VTC 07 Fall)	Baltimore, MD, USA	http://www.ieeevtc.org/vtc2007fall/index.html	TBA
November 26-30, 2007	IEEE Global Communications Conference (Globecom 2007)	Washington, DC, USA	http://www.comsoc.org/confs/globecom/2007/	TBA