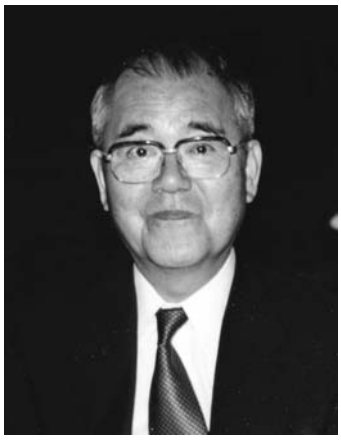
IEEE Information Theory Society Newsletter

Vol. 57, No. 2, June 2007 Editor: Daniela Tuninetti ISSN 1059-2362

In Memoriam of Tadao Kasami, 1930 - 2007

Shu Lin

Information theory lost one of its pioneers March 18. Professor Tadao passed away after battling cancer for a couple of years. He is survived by his wife Fumiko, his daughter Yuuko, and his son Ryuuichi.



Tadao was born on April 12, 1930 in Kobe, Japan. His father was a Buddhist monk at a temple on Mount Maya above Kobe. Tadao was expected to follow in his father's footsteps, but his interests and abilities took him in a different direction. Tadao studied Electrical Engineering at Osaka University. He received his B.E. degree in 1958, the M.E. degree in 1960, and the Ph.D. in 1963. At about that time he became interested in information theory and in particular in error-correcting codes. He then became a faculty member at Osaka University, where he taught until 1994. He was Dean of the Faculty of Engineering Science 1990-1992 at Osaka University. He was a professor in the Graduate School of Information Science at the Nara Institute of Science and Technology from 1992 until 1998. From then until 2004, he was a professor on the Faculty of Information Science at Hiroshima University. After retiring for the third time, he continued to work part time at the Nara Institute of Science and Technology until a few months before his death.

For his significant contributions to coding theory, he was awarded the Shannon Award for the year 2000, the highest honor given by the IEEE Information Theory Society.

In 1975 he was named a Fellow of the Institute of Electrical and Electronics Engineers for his contributions to coding theory, automata theory, formal languages, and engineering education. In 1987, he received the Achievement Award from the Institute of Electronics, Information, and Communications Engineers of Japan.

From 1963 until very recently Tadao has continuously been involved in research on error correcting codes and error control, and usually on some other subject related to information. He discovered that BCH codes are invariant under the affine group of permutations. He found bit orderings for Reed-Muller codes that minimize trellis complexity. He and his students found weight distributions of many cyclic codes. He discovered relationships between BCH codes and Reed-Muller codes. He discovered some bit sequences with excellent correlation properties, now known as Kasami sequences, and they are used in spread-spectrum communication. Recently he has continued working on rearranging the bits in block codes to make a trellis structure, thereby making decoding more efficient—in fact he is a co-author of a 1998 book on that subject. He has also worked, and published research results recently, on efficient sub-optimum maximum likelihood decoding. Many of these results have impacted practical communication and data storage systems. His continuous production of first quality research over this period of over 40 years is what is most impressive.

Tadao is best known for the work on error-correcting codes, but he has made significant contributions on formal languages and computer languages and on formal description of algorithms and communication protocols that makes it possible to analyze them and prove their correctness.

Tadao was above all else a teacher. He had a deep concern for his students and they revered him. Tadao was always a kind, gentle and considerate person and a person of great ability. It was always a real pleasure to work with him. We will always consider ourselves truly fortunate to have known Tadao as a friend and colleague.

From the Editor

Daniela Tuninetti

Dear IT society members,

We sadly mark here the passing of Tadao Kasami (1999 Shannon Lecturer), who for so many years played a central role in the IT Society. At the time this letter went to print, we were also informed of the sudden death of Bill Root (1986 Shannon Lecturer). They will be sorely missed.

On the one hand, I am happy to announce that in this issue you can read the reflection on "Universal Discrete Denoising: Known Channel," from the DUDE's dudes, recipients of the 2006 Joint IT/ComSoc Paper Award, and that the next issue will have a detailed description of the ideas developed by Dr. Ahlswede at his memorable 2006 Shannon Lecture in Seattle last year.

On the other hand, I must apologies to the readers and the article's authors for the several typos the previous issue went to print with. Please refer to the Errata Corrige at the end of this issue. I will not blame it on anyone else because I am ultimately responsible for the quality of the newsletter. However, as from the next issue, in order to avoid changes close to the printing deadline, I will strictly enforce the submission's deadline. Do not worry: late articles will be kept for the subsequent issues.

In this issue, you will also find the regular columns by our president Bixio Rimoldi, our historian Anthony Ephremides, our puzzle maker Sol Golomb, and NSF program manager Sirin Tekinay. You will also find the announcement of prestigious awards recently won by members of our society, and the English translation of an interesting Russian article about David Middleton. I hope you will also enjoy the update on the activities of the student committee, the minutes of the Board of Governors at Allerton, and the report on the 2007 Winter School that took place in the south of France last winter.

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 (please notice that the deadlines have been moved forward by about a week with respect to the past):

Issue	**Deadline**
September 2007	July 10, 2007
December 2007	October 10, 2007
March 2008	January 10, 2007

Electronic submission in Ascii, LaTeX and Word formats is encouraged. Potential authors should not worry about layout and fonts of their contributions. Our IEEE professionals take care of formatting the source file according to the Newsletter style. Electronic photos and graphs should be in high resolution and sent in as separate file.

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Looking forward to seeing you all in Nice, regards
Daniela Tuninetti

IEEE Information Theory Society Newsletter

IEEE Information Theory Society Newsletter (USPS 360-350) is published quarterly by the Information Theory Society of the Institute of Electrical and Electronics Engineers, Inc.

Headquarters: 3 Park Avenue, 17th Floor, New York, NY 10016-5997.

Cost is $1.00 per member per year (included in Society fee) for each member of the Information Theory Society. Printed in the U.S.A. Periodicals postage paid at New York, NY and at additional mailing offices.

Postmaster: Send address changes to IEEE Information Theory Society Newsletter, IEEE, 445 Hoes Lane, Piscataway, NJ 08854.

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President's Column

Bixio Rimoldi

Bixio Rimoldi

As I was getting ready to write this second President's Column, I picked up the March Newsletter issue to recall what I had written then. To my surprise, only the first of over two pages that I had written had made it to press. Is someone trying to get even with me for the newly introduced five-page-limit for Correspondence Items of the Transactions? (No, it was not my idea).

The part that did not make it into the March Newsletter was about this year's highlights. I'll pick up from there. (The good news is that I can use some of what I had written then and be out earlier to enjoy the last day of skiing of the season. I am writing during Easter break from a little chalet at 1900m in the Swiss Alps, with the Matterhorn in the distance.)

IEEE Review of the IT Society: This is a quinquennial review that took place at Universal City, CA, on February 15. I am very grateful to all of those who helped putting together the two reports that totaled over 75 pages, namely Marc Fossorier, Andrea Goldsmith, Steve McLaughlin, Nick Laneman, Muriel Medard, Dave Neuhoff, Vince Poor, and Daniela Tuninetti. Working with these people reminded me once more of the great spirit of collegiality that makes our society so special. Both the Society and the Transactions were reviewed. The Transactions' review went quite well. The panel found the impact factor to be fantastic and the citation life to be excellent. We were expecting some "heat" for what we thought to be a relatively high delay to publication, but we were praised as it had dropped significantly since the previous review and is now within the IEEE norm. The Society review was a bit less smooth. With hindsight this was not surprising, given that the larger panel and the lack of clear metrics made the Society review more of a subjective matter. I'll come back on the review once we receive the written feedback from both panels.

Awards and Recognitions: Members of our society continue to receive important awards. This year Tom Kailath will receive the IEEE Medal of Honor; Norman Abramson the IEEE Alexander Graham Bell Medal; Abraham Lempel the IEEE Richard W. Hamming Medal. Michael Luby and Amin Shokrollahi are co-recipients of the IEEE Eric E. Sumner Award. Bob Gray, P.R. Kumar, John Tsitsiklis, and Sergio Verdú have been elected to the US National Academy of Engineering and Kees Schouhamer Immink has become a Foreign Associate of the same. Raymond Yeung received the Friedrich Wilhelm Bessel Research Award of the Alexander von Humboldt Foundation. Congratulations!

Web: In 2006 Nick Laneman became the first Online Editor of the Society. In a very short time Nick created a much appreciated development site (http://dev.itsoc.org/) so that selected members of the society (mainly members of the board and committee chairs) can add content directly to the web. This is still an underutilized facility. I encourage every concerned person to help speed up the process of making the web the repository of choice for all material of archival value.

Conference Co-Sponsorship: Adding to the IEEE Electronic Library the proceedings of conferences that are of interest to our members is a win-win. The Society can make this happen by becoming a technical co-sponsor. The experience accumulated in the past shows that negotiations with the conference organizers and IEEE can be time consuming. Dave Neuhoff is finalizing a Memorandum of Understanding that will facilitate the process.

Student Committee: The Board of Governors is very much supportive of the Student Committee. I am looking forward to hearing new initiatives from the students and to seeing even more student involvement in the Society. The chair of the Student Committee has been handed over to Sergio Servetto. I would like to thank Andrea Goldsmith for her vision and passion in creating and running the committee until now.

Conferences: The 2007 International Symposium on Information Theory (ISIT) will take place in Nice, France (June 24-29). (It may be over by the time you read this column). Among the novelties for an ISIT is the Best Student Paper award. Also, for the first time in history, the Shannon lecture will be given by someone under 50. Bravo Sergio! After ISIT there will be an Information Theory Workshop (July 1-6) in Bergen, Norway, and one in Lake Tahoe, CA (Sept. 2-6). As of this writing there is still no bid for ISIT 2010. Suggestions should go to Alex Grant, chair of the Conference Committee.

Membership: In 2006 the membership has declined once again, but overall only by 3% compared to 6.9% during 2005. Unfortunately the drop was still significant in the student category (12.4% vs. 14.9% in 2005). Most likely this is a consequence of the fact that students have online access to all of our publications through their university. If this is a purely financial decision then there is no reason to worry about negative implications. Surely it would be preferable to see an increase in student membership, as it would be a strong indication that the field is attracting a larger pool of students. It would be good to hear from students how to make the membership more attractive.

Transactions: The volume of the Transactions has grown since 1990 at an average yearly rate of over 7.5%. This per-se positive trend has been a source of recent concern: at this growth rate the size of the Transactions will soon be unwieldy for paper publication. It was somewhat a relief to see that the growth seems to have taken a pause this year.

As these lines get to your desk, Vince Poor will be reaching the end of his three-year term as the Transactions Editor in Chief. Vince deserves all of our gratitude for his dedication for what is by far the most valuable product of our Society. His professionalism and responsiveness have undoubtedly played a role in the recent glowing review. I take the opportunity to welcome on board his successor, Ezio Biglieri, who will take the reins of the Transactions starting July 1.

Finances: The reserves are slightly larger than the annual budget. This is a comfortable position, and we can now be more open to new initiatives. Suggestions are welcome.

Board of Governors Meetings: The second Board of Governors meeting will be on June 25 at ISIT'07 (Nice); The third on Sept. 26 at Allerton (Monticello). Board meetings are open to all members.

The Historian's Column

Anthony Ephremides

As time marches on, events that seemed contemporary turn gradually to history. I was thinking the other day about how quickly the ISITs, one after the other, fade into the past. In fact, as we grow older, the time period of one year becomes a progressively smaller percentage of our life and thus has a tendency to appear shorter. So, the 1995 ISIT in Whistler, British Columbia, seemed to have taken place only yesterday and yet, I bet that a substantial number of the participants in our most recent Symposia had not yet graduated when it took place. I thought of that particular Symposium because, from many points of view, it was one of the most successful and memorable ones.

First of all, the setting was one of the most spectacular ones that can be found on our planet. Those who haven't been in Whistler should immediately take corrective actions. Nestled in a valley at about 2000 feet of altitude, Whistler is a resort that is towered by two massive mountains, its namesake and Blackcomb respectively, that rise up to 9000 feet (or close to 3000 meters for our metric-minded members). In the winter, the place becomes a fabulous ski resort, but in mid-September, when our Symposium took place, it was basking in late summer glow with mild temperatures, plenty of sunshine, spectacular scenery, and dozens of outdoor activity opportunities.

The mid-week traditional excursion included a ride up the Whistler gondola and a voluntary trek to the peak of the Whistler Mountain. That afternoon saw a large file of Information Theorists walking up the trail in a colorful assortment of attires that ranged from shorts and bare chests to full mountain gear and mittens. The hotels were scattered through the village but the majority of the attendees chose to stay in the "grande dame" Chateau Whistler which is a hotel the likes of which adorn every single major Canadian city. It has old-world elegance with a spacious lobby, vast corridors, excellent service, and as good meals as one can find anywhere in Canada.

The Symposium itself had record attendance. It will remain in the annals of History as the one in which almost all past Shannon lecturers were present and got recognized in a uniquely festive celebration that ended with all of them being together on the ballroom stage in which the banquet was taking place. Dave Forney was the most recent Shannon Awardee who gave a truly memorable lecture that should be the standard by which Shannon lectures should be judged.

On a personal note, I recall that I had the time of my life. On Saturday, after the conclusion of the Symposium, I rented a bike and toured the beautiful lakes and back roads of the village. The weather had touched total perfection. After a seemingly endless day of bliss I went to the Araxi restaurant where I had a wonderful meal that I washed down with, yes, a good portion of a bottle of British Columbia Chardonnay. My paper, earlier in the week, was presented in one of the very few sessions that focused on communication networks at that time. It had to do with scheduling packets in a queueing system and I still remember the comments of the anonymous referee who had reviewed my paper. It said "this paper makes some contribution to a problem of some interest"! The meeting of the Board of Governors had taken place on September 19. The reason I remember this is that it was on my birthday. Vijay Barghava, who was the "force majeure" behind the Symposium and a most gracious host, had kindly arranged even for a birthday cake to be delivered at the meeting.

Several other people had a wonderful time at that meeting. A good example is Dave Forney. In addition to enjoying the glory of a standing ovation after his Shannon lecture, he also received word of the birth of his grandchild. Another example is a colleague, whom I shall not name, who after a day of happy mountain-biking took a tumble on a steep down slope but never lost his good spirits.

Driving up to Whistler from Vancouver (a drive that follows for the most part the shoreline of a beautiful fjord) one sees the serendipitously named "Shannon Falls." Is that too much of a coincidence or was it preordained in the fashion of "Forza del Destino"?

All in all, it was the kind of meeting that all ISITs aspire to be: well attended, technically excellent, and a mixture of work and "play". There was one other ISIT in Canada in 1984. It was held in St. Jovite in the Quebec province, just north of Montreal. I sang its praises in a previous column. And it so happens that the next ISIT in 2008 will also take place in Canada, this time in the city of Toronto. As our symposia grow in size, we tend to hold them in big cities where there is a choice of adequate facilities. I am afraid that the days of "resort" revues, like Whistler, St. Jovite, Les Arcs, or small cities like Grignano, Ithaca, Ann Arbor, (O.K., the last two are not exactly resorts) etc., may be gone. But I would like to use this opportunity of reminiscing about our Canadian experiences to pay tribute to this wonderful country. It is a vast land of unique beauty. It has a welcoming society of diversity and international good will. It is a country of two languages and cultures. And it is a country that is never overshadowed by the large neighbor to its south. It has nurtured its own generations of exceptional Information Theorists and has always shown its grace and love for peace. It even makes surprisingly good wines from the classic varietals of the Ocanagan Valley in the west to the fabulous, if overpriced, ice-wine of Ontario. And the food quality is getting better every day. It is a great country and the Symposium in Whistler proved to be worthy of it.

Believe me, it was only like yesterday!

Reflections on the 2006 IEEE Joint Communications/ Information Theory Paper Award

E. Ordentlich, G. Seroussi, S. Verdú, M. J. Weinberger, and T. Weissman

Dude:

1. *An inexperienced cowboy.*
2. *(slang) A man.*
3. *(slang) A term of address for a man.*
4. *(archaic) A dandy, a man who is very concerned about his dress and appearance.*
5. *(slang) A cool person of either sex.*
6. *(algorithm) Discrete Universal DEnoiser*

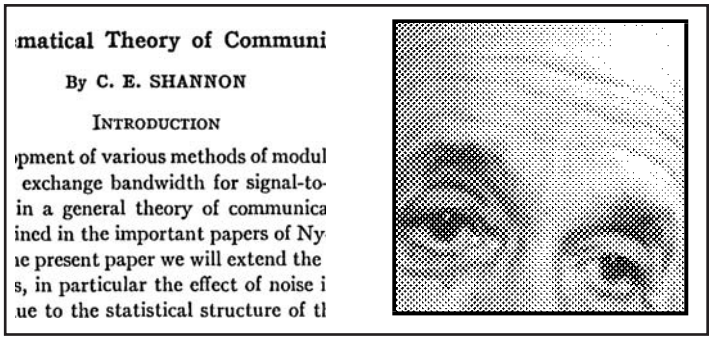
1. Denoising

Suppose the binary images shown in Figure 1 were transmitted over a binary symmetric channel (BSC). What could be done to clean up or denoise the resulting noisy images? A quick scan of the image processing literature suggests the use of such algorithms as median filtering and morphological filtering. In the binary case a median filter replaces each pixel in the noisy image by the color of the majority of pixels in a neighborhood about that pixel, while a morphological filter carries out dilation and erosion operations to denoise a pixel, again based on the values of nearby pixels. Indeed, many of the simplest and most practical denoising algorithms in the image processing literature are of this form. They denoise any given pixel by applying a function to the pixel values in a nearby neighborhood. The denoising scenario above, however, raises an important issue with this class of algorithms, namely that a neighborhood function that works well for denoising one image may be disastrous for another. For example, a median filter would be an excellent choice for denoising the text image side of Figure 1, but would obliterate the half-toning in the Einstein image, and thereby actually amplify the distortion. Thus, in general, we are faced with the following problem: Given a noisy binary image and a neighborhood size of k, which of the 2^{2^k} binary valued denoising functions should be used? If a genie were to reveal the underlying clean image we could determine the "best" function that would lead to the smallest distortion between the denoised and clean images. Can we hope to even come close to this level of performance with access only to the noisy image? It turns out that with the additional knowledge of the BSC cross-over probability, the answer is yes in a very strong sense, and, further, that it can be done using an eminently practical algorithm, which we call DUDE, as defined and analyzed in our paper [1].

Beyond binary images, denoising is a problem that permeates just about all branches of science and engineering involving some form of inference on a phenomenon of interest, based on noisy or incomplete observations. As we say in [1], denoising "has received significant attention for over half a century…Wiener…Kalman…Donoho and Johnstone…the amount of work and literature in between is far too extensive even to be given a representative sample of references", and we shall certainly not attempt to do it any more justice here.

In contrast to the majority of these works, our paper [1] approaches denoising from a universality perspective, as motivated by the above image denoising scenario. Indeed, one can view the framework of [1] as a broadening of the rich information theoretic framework of universality formalized in such works as [2], [3] on the Lempel-Ziv compression algorithm, [4] on universal modeling and arithmetic coding for tree sources, [5] on universal prediction, or more general decision problems as surveyed in [6]. The notion of universality in information theory, particularly the so called individual sequence formulation exemplified above, has much in common with work from the 1950's on the compound decision problem (starting with the seminal work [7]), its sequential version (e.g., [8], [9], cf. [10] for a comprehensive account of this literature), and on the repeated play of games [11].

In addition to the individual sequence notion of universality pertaining to the scenario above, we can motivate the DUDE in a distributional setting as well. Suppose that the noiseless source is stochastic and suppose first that its distribution is given. In order to come up with its reconstruction sequence, the denoiser minimizing the expected cumulative loss (as measured by the given loss function) needs to compute the posterior distributions of each of the sequence components, given the noisy sequence it observes. Two salient aspects of the computation of these posterior distributions are their dependence on the distribution of the noiseless source, and the high complexity (exponential in the data size) associated with their computation. Thus, in general, beyond simple situations where the noiseless source distribution is memoryless or Markov (in which case the posterior distributions can be practically computed via "forward-backward" dynamic programming [12]), it is impractical to implement the optimal denoiser for a given fully specified source. A seemingly logical conclusion then, which seems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By C. E. SHANNON

INTRODUCTION

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Figure 1: Binary images.

to have been implicit in the literature prior to our work, is that it is a fortiori not practical to attain optimum performance for large data size when the noiseless source is *not* specified. Fortunately, this conclusion turns out to be false, as long as we are willing to settle for *asymptotic* optimality: the DUDE (described below) does not depend on the source distribution (it is universal) and is practical (having linear complexity), while attaining the performance of the optimal denoiser for large data size.

2. DUDE

A. Problem Setting

Our setting for the discrete denoising problem is shown in Figure 2 for one-dimensional data. A discrete source emits a *clean* sequence $\mathbf{X} = X_1, X_2, \ldots, X_n$ of data symbols over a finite alphabet A. The clean sequence is transmitted over a discrete memoryless noisy channel, characterized by a matrix of cross-over probabilities $P(\text{output} = z \,|\, \text{input} = x)$ for each pair (x, z) of symbols from A (here we assume, for simplicity, that the channel input and output alphabets are the same; a more general setting is considered in [1]). The channel output is a *noisy* sequence $\mathbf{Z} = Z_1, Z_2, \ldots, Z_n$, which is fed to a *discrete denoiser*. The denoiser, in turn, produces an estimate, $\hat{\mathbf{X}} = \hat{X}_1, \hat{X}_2, \ldots, \hat{X}_n$, of the original clean sequence. Denoising performance is measured with a given (but otherwise arbitrary) single-letter *loss function* which judges how close the reproduction $\hat{\mathbf{X}}$ is to the clean sequence $\mathbf{X}$. For example, if the loss function is the normalized Hamming distance between $\mathbf{X}$ and $\hat{\mathbf{X}}$, the overall loss incurred by the denoiser is the fraction of symbols of $\mathbf{X}$ that were not reconstructed perfectly. The goal of the denoiser is to produce an estimate $\hat{\mathbf{X}}$ that minimizes the per-symbol loss.

To carry out its task, the denoiser has access *only* to the noisy sequence $\mathbf{Z}$. It has no information whatsoever on the clean sequence $\mathbf{X}$, its probability distribution, or even whether it has one.

On the face of it, the problem appears particularly difficult, or even ill-posed, as the denoiser must minimize a loss it cannot measure. This hurdle distinguishes denoising from problems such as prediction or compression, where the data processing algorithm (predictor or compressor) can keep track of how well it is performing. But appearances are deceiving, and it turns out that a fairly simple algorithm can perform the denoising task very well, in fact, optimally well.

B. The Algorithm

The DUDE makes two passes over the data. In the first pass, it slides a window of length $2k+1$ over the sequence $\mathbf{Z}$, where k is a nonnegative integer we assume given for the time being. At time t, and ignoring border effects, the window contains the string $Z_{t-k} \ldots Z_{t-1} Z_t Z_{t+1} \ldots Z_{t+k}$. The symbol Z_t is said to appear in (*two-sided*) *context* $\mathbf{C}_t = [Z_{t-k} \ldots Z_{t-1} \square Z_{t+1} \ldots Z_{t+k}]$. The DUDE keeps counts of symbol occurrences in each context, incrementing, at time t, the count corresponding to the symbol Z_t in context $\mathbf{C}_t$. If the sequence is sufficiently long, symbol patterns will repeat, and we will have $\mathbf{C}_{t'} = \mathbf{C}_t$ for other (hopefully, many) values t. At the end of the pass, we will have obtained a *conditional empirical distribution* $\hat{P}(Z|\mathbf{C}_t)$ for each context pattern encountered. Consider, for example, the noisy text in Figure 3. The figure shows all the occurrences of the $k = 1$ context pattern $\mathbf{C} = [\sqcup \square \mathrm{i}]$ ($\sqcup$ represents a space). The corresponding conditional empirical distribution is

$$\hat{P}(\mathrm{w}|\mathbf{C}) = 3/7, \quad \hat{P}(\mathrm{g}|\mathbf{C}) = 2/7, \quad \hat{P}(\mathrm{y}|\mathbf{C}) = 1/7,$$
$$\hat{P}(\mathrm{m}|\mathbf{C}) = 1/7, \quad \hat{P}(\text{other}|\mathbf{C}) = 0.$$

As in other applications of context modeling, the goal of collecting conditional statistics is to capture high-order dependencies, which reveal structure in the data. The statistics collected in the first pass of the DUDE estimate the conditional probability of *noisy* symbols Z_t given their *noisy* contexts $\mathbf{C}_t$. Our goal is to estimate *clean* symbols X_t, given the observed sequence $\mathbf{Z}$. An important step towards this goal would be to obtain, for each t, an estimate of the conditional probability of the clean symbol X_t given the noisy window $\mathbf{C}_t^+ = [\mathbf{C}_t, Z_t]$ (the context plus the center sample). What we hope for is that the conditional statistics gathered from $\mathbf{Z}$ still allow us to glean some of the structure present in $\mathbf{X}$ (if any), which in turn could help us make good denoising decisions. But how reliable can the estimate of the conditional distribution of clean symbols be? The conditional structure of $\mathbf{X}$ is fogged by the noise in two ways: on one hand, we are taking counts of corrupted samples ("counting the wrong symbol in the right context"), and on the other hand, symbols that were in the same context in $\mathbf{X}$ might be scattered in different contexts in $\mathbf{Z}$, since the context patterns are also noisy ("counting the right symbol in the wrong context"). As it turns out, by requiring a mild non-degeneracy condition on the channel, the estimates of conditional distributions of clean symbols that can be derived from the statistics collected in the first pass are "reliable enough," in a well defined mathematical sense. The crux of the proof of optimality and universality of the DUDE in [1] lies in establishing this fact.

In the second pass, the DUDE scans the noisy data, again using a sliding window of size $2k+1$, and generates, at each instant of time t, the estimate $\hat{X}_t$ corresponding to the sample at the center of the window. In deciding on the estimate, the algorithm receives two types of "advice": the estimated conditional distribution $\hat{P}(X_t|\mathbf{C}_t)$ derived from the first pass informs about the likelihood of values of the clean symbol given the structure observed globally in the whole data sequence; the noisy symbol Z_t observed in the current location, and the known channel parameters, on the other hand, also provide information about

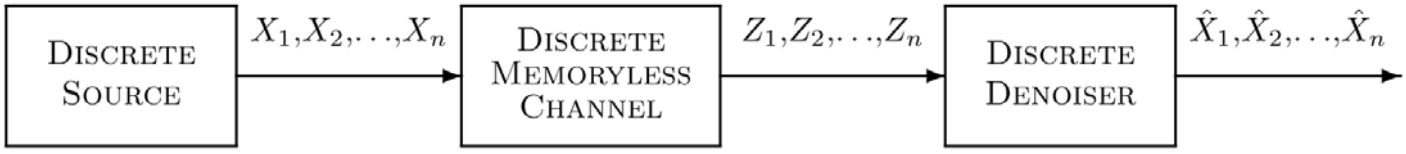

Figure 2: Discrete denoising setting.

the likelihood of clean symbol values, independently of other observations. Clearly, when the noise level is low, more weight should be given to Z_t, whereas at higher noise levels the global information might be more reliable. The two types of advice can be combined in the conditional distribution $\hat{P}(X_t|\mathbf{C}_t^+)$, which is a good estimate of the posterior distribution of X_t given the observed data. The DUDE uses a decision rule that takes into account the estimated probability distributions, the channel parameters, and the loss function, to determine $\hat{X}_t$. The decision rule is, in essence, a MAP estimator based on the estimated posterior of X_t, weighted by the loss function.

Example 1. Suppose the data is binary and is transmitted through a binary symmetric channel (BSC) with crossover probability p, and that the loss function is the Hamming distance. Define the threshold $T = (2p(1-p))^{-1} - 1$, and assume the current noisy sample is $Z_t = b$, where b is a binary value whose complement will be denoted $\bar{b}$. The DUDE's decision rule is: if $\hat{P}(\bar{b}|\mathbf{C}_t)/\hat{P}(b|\mathbf{C}_t) > T$ then flip Z_t, else leave it alone. Notice that the threshold T tends to infinity as p tends to zero—the denoiser will be unlikely to flip Z_t when p is small, since it trusts the "advice" of Z_t in that situation. Conversely, T tends to one as p tends to 1/2—the denoiser gives more credence to the global information when the channel is very noisy.

Example 2. The text of Figure 3 is part of a complete noisy version of a famous literary piece. The full piece was DUDE-denoised with $k = 2$, and the denoised passage corresponding to Figure 3 is shown in Figure 4. Only two out of fourteen original errors are left.

C. Properties and Highlights

Universality. In [1], the DUDE is proven to be universal in two different settings. In the *stochastic* setting, it is assumed that the clean sequence $\mathbf{X}$ is emitted by a probabilistic stationary source, and is transmitted through a probabilistic channel. It is proved that, with a choice $k = k_n$ that grows with n, but such that $k_n < c \log_{|A|} n$ for $c < 1/2$, the DUDE will denoise the input sequence $\mathbf{Z}$ asymptotically (as $n \to \infty$) as well as the *best* denoiser designed with full knowledge of the probability law governing $\mathbf{X}$. In the *semi-stochastic* setting, it is assumed that $\mathbf{X}$ is an individual sequence, with no governing probability law, while the channel remains probabilistic as before. Universality, in this case, is established by comparing the DUDE's performance with that of the class of kth order sliding window denoisers. Each such denoiser scans the data with a sliding window of size $2k+1$, as the DUDE does, and replaces the sample at the center of the window with a function $f_k : A^{2k+1} \to A$ of the $2k+1$ samples in the window. Each such function defines a denoiser. Notice that, in particular, one of the denoisers in the class is the one that we would obtain, in principle, if we had full knowledge of the clean sequence $\mathbf{X}$ (in addition to the noisy $\mathbf{Z}$), and we exhaustively tried all possible functions f_k and picked the one giving the least loss for the given pair $(\mathbf{X}, \mathbf{Z})$. It is proved in [1] that for a choice of $k = k_n$ as specified above, the DUDE performs, asymptotically, no worse than the best k_n-th order sliding window denoiser. Notice that most useful denoisers used in practice are of the sliding window kind, e.g., the median filter mentioned in our motivating binary image denoising example.

The universality of the DUDE in both the semi-stochastic (individual sequence) and stochastic settings is analogous to that established, in the case of data compression, by the original Lempel-Ziv algorithms [2], [3]. As in LZ and in other cases in information theory, the individual-sequence ("pointwise") universality result for the DUDE is the stronger one, and the result for the stochastic setting follows as a corollary.

Choice of the parameter k. From the asymptotic point of view, the choice of $k = k_n$ as described above guarantees convergence of the DUDE's performance to the optimum denoising performance. This statement still leaves a very broad range of choices for k, so broad in fact, that the statement is not very useful in practice when we are faced with the task of denoising a given data sequence of finite length. In the latter setting, it makes sense to ask the question "what is *the best* value of k for *this particular* sequence?" Notice that analogous questions have well defined answers, for example, in data compression, and the answers can be found efficiently. For example, in various settings, we know how to implement the MDL principle and find the best Markov model order, or more generally, the best context tree to compress a given sequence [4]. For denoising, the question remains formally open. The most obvious difficulty is that since we cannot measure denoising performance directly, we have no direct way of telling whether one value of k is better or worse than another, a task that is easy in data compression. Nevertheless, various heuristics for choosing the best value of k for the DUDE have proven very effective in practice. These heuristics are based on using an observable parameter as a proxy for the denoising performance, and optimizing the value of k based on the proxy. A heuristic described in [1] suggests using the *compressibility* of the denoised sequence (using a universal compressor), and is based on the empirical observation that when the sequence is denoised with the optimal value of k, the denoised sequence exhibits a local maximum in compressibility. This heuristic has proven effective, in practice, in finding the best values of k for a wide range of practical data sets. More principled approaches are discussed later in this note.

Practicality. Aside from its asymptotic theoretical properties of optimality and universality, the DUDE is a very practical algorithm. It can be implemented to run in linear time complexity, with simple data structures. The scheme has been tried on a variety of data types—experiments on synthetic sources, bi-tone images, and text are reported on in [1] for a "plain-vanilla," ver-

"Whar[ ][g][i]ants?" said Sancho Panza. "Those thou seest theee," snswered[ ][y][i]s master,[ ][w][i]th the long arms, and spne have tgem ndarly two leagues long." "Look, ylur worship," sair Sancho; "what we see there zre not[ ][g][i]anrs but[ ][w][i]ndmills, and what seem to be their arms are the sails that turned by the [ ][w][i]nd make rhe[ ][m][i]llstpne go."

Figure 3: Contexts in noisy text, with $k = 1$ ([a][z][b] : sample z in context (a□b)).

batim implementation of the algorithm. Adaptations to other, more difficult data types have been reported on in the literature and are discussed later in this note. It has been said that "the DUDE is very practical despite being optimal."

Soft output. The estimated posterior $\hat{P}(X_t|\mathbf{C}_t^+)$ is used in [1] as a means to produce a "hard" decision on the denoised sample $\hat{X}_t$. The distribution, however, is valuable on its own as "soft output" from the algorithm. Applications of this soft-output DUDE (termed sDUDE) are discussed later in this note.

3. History

In February 2002, Sergio Verdú started a research sojourn at the Mathematical Sciences Research Institute (MSRI) at Berkeley, California. As part of his appointment, funded by HP Research Labs, he also started a weekly collaboration with Gadiel Seroussi and Marcelo Weinberger of the Information Theory group at HP Labs. Shortly thereafter, in March 2002, Erik Ordentlich and Tsachy Weissman joined HP Labs, and at once became involved in the research efforts of the group.

Searching for research areas of common interest led to the consideration of problems of universal statistical inference based on the noisy observation of finite-alphabet redundant signals such as text or images. Gadiel and Sergio organized a workshop at MSRI on February 25th through March 1st of 2002, in which David Donoho presented "The Kolmogorov Sampler," a work that adhered to the principle of choosing the signal realization that can be explained by the noise realization with least "complexity". Donoho proposed a scheme that, while not practically implementable, exhibits asymptotic performance within a factor of the optimal nonuniversal Bayesian scheme. This factor represented a penalty for universality that is not incurred in other problems in information theory, such as lossless compression and prediction.

We quickly zeroed in on the issue of assessing the fundamental penalty for universality, i.e., the asymptotic performance penalty incurred by the optimal universal scheme over the optimal non-universal Bayesian scheme. Our progress was hampered by an overly ambitious goal of allowing statistical uncertainty in both the signal and the noisy channel. However, in many cases, the noise mechanism is far easier to accurately model than the signal, whose redundancy structure is often quite intricate and unknown. So, at some point, we narrowed our scope to the case of a known channel. In addition to the problem of theoretical limits, we also became interested in the more practically-minded problem of coming up with implementable algorithms for discrete universal denoising. Our literature search did not discover much beyond B.K. Natarajan's work, developed also at HP Labs in the early 90's [13]. In this work, lossy data compressors such as JPEG are used as noise filters.

Despite being preoccupied primarily with the 2002 World Cup, we came up with the idea of estimating the individual letter probabilities of the noisy signal conditioned on the noisy contexts which could then be projected back to the input (thanks to the assumption that the channel matrix is invertible). We were then delighted to discover that not only we could implement that idea with a linear-complexity algorithm, but it paid no asymptotic penalty for universality: with large enough data size and a certain context length growth with the data size the scheme was able to perform as well as the optimal Bayesian algorithm. We filed a patent for the algorithm [14] and came up with its acronym (DUDE) after narrowly defeating alternatives such as DUD or STUPID (STatistical Universal Probabilistic Inversion Denoiser).

We first presented our results in November 2002 at the IEEE Information Theory Workshop that took place in Bangalore. Despite this previous presentation, we were fortunate that our submission to the 2003 ISIT was not rejected, and presented the paper in Yokohama.

The IT Transactions paper was submitted in February 2003 and suffered the excruciatingly long refereeing delays for which this journal is notorious. We were relieved to finally see the paper in print in page 1 of the 2005 volume. Unfortunately, the IT Transactions printing process of our image denoising examples rendered them so different from what we could see in the pdf version of the paper that they must have raised quite a bit of skepticism about the usefulness of the DUDE for image denoising.

4. Subsequent Work

The DUDE has motivated a growing body of related research, which has proceeded in roughly three directions: generalizing and relaxing some of the assumptions made in the original DUDE setting, optimizing context selection, and addressing applications. Next, we overview some of this work.

Two of the defining steps of the DUDE algorithm are computing the conditional distribution of a clean symbol given its noisy context through a simple matrix multiplication involving the corresponding conditional distribution of the noisy symbol, and estimating the latter using context-dependent counts. These operations are tied very closely to the assumptions of finite signal alphabets and memoryless channels. For example, the very notion of noisy context-dependent counts breaks down for continuous valued channels, where, with probability one, a context value may occur at most once. These two assumptions have been relaxed in more recent work and several corresponding extensions of the DUDE have been proposed. A common tool in these approaches is the processing of signals in overlapping super-symbols, consisting of the noisy symbol and its context. Joint probability distributions of such super-symbols are estimated from the noisy signal and computed for the clean signal using super-symbol versions of the matrix multiplication step. In [15], [16], this tool is combined with techniques from non-parametric density estimation, quantization, and convex optimization to extend the DUDE algo-

"What giants?" said Sancho Panza. "Those thou seest there," answered his master, "with the long arms, and spne have them nearly two leagues long." "Look, your worship," said Sancho; "what we see there are not giants but windmills, and what seem to be their arms are the sails that turned by the wind make the millstone go."

Figure 4: Denoised text (the two errors remaining out of the original 14 are underlined)

rithm and the corresponding optimality results to discrete and continuous signals corrupted by continuous-output channels. In [17], [18] the super-symbol approach is applied in the finite alphabet setting to handle certain channels with memory. One emphasis in these latter works is on exploiting symmetries in the super-symbol channel transition probabilities to more efficiently compute the super-symbol version of the matrix multiplication step.

Another key assumption of the DUDE, namely that the channel transition matrix is known, has also been relaxed [19], [20]. When both the channel and source distribution are unknown, strong universality results of the type in [1] are no longer possible since, in general, the source and channel distributions are not identifiable from the channel output distribution alone. Nevertheless, as shown in [19], [20], a notion of minimax universality can be defined which leads to efficient and robust generalizations of the DUDE that continue to work well even under channel (and source) uncertainty.

In a different direction, the notion of a two-sided context has been generalized from the fixed length symmetrical kind considered in [1] to two-sided analogues of the context tree models from the universal compression literature. The challenge in the denoising setting is to determine, in a data dependent fashion, a good set of two-sided contexts, without, as in the case of compression, actually measuring the performance of a choice of contexts. As mentioned, the latter is impossible here since the performance or loss can only be assessed with certainty using the unavailable clean signal. In [21], a loss estimator is combined with a dynamic programming pruning technique for selecting a good choice of contexts, while in [22] modeling techniques from universal compression are used to build two-sided context models from single sided models. These approaches can also be used to select the fixed context length k of the DUDE in a data dependent fashion more efficiently than the compressibility heuristic mentioned in [1]. The selection of k is also addressed in [23] and [24]. The first of these references also proposes an alternative linear time implementation of the DUDE, based on merging suffix arrays.

On the applications front, [25] elaborates on the binary image denoising application described in [1], formally extending the DUDE to two-dimensionally indexed data. A further extension to achieve practical results with gray-scale images is not straightforward, since the theoretical guarantees of the baseline DUDE in terms of convergence to optimal performance are tied to obtaining a sufficient number of occurrences of sufficiently many contexts for the law of large numbers to "kick-in." For useful context sizes and the large alphabet size (256 for 8 bit gray scale images), this calls for signal sizes significantly larger than the nominal resolutions of mainstream digital imagery. In fact, we encountered some initial skepticism in the image processing community. However, once we pose the key problem as one of modeling a distribution of the noisy symbol given its noisy context (not necessarily by means of just counting symbol occurrences in a given context), as mentioned, this challenge is not too different from the "context dilution" problem encountered in image compression. In [26], denoising of gray-scale images corrupted by various noise processes is considered. The approach taken in [26] is inspired by work in image compression [27] and is based on exploiting prior knowledge about digital images to "merge" statistics from multiple contexts to denoise in any given context. The exploitation of prior knowledge can be seen as partially "backing away" from universality, or as a reduction in the model class for which universality is claimed. The denoising performance of such an image-informed DUDE is found to be competitive with state-of-the-art approaches based on wavelets, but unlike such approaches, which are tied fairly closely to additive Gaussian noise, it can be more easily tailored to handle different noise processes. In particular, the image-informed DUDE has unsurpassed performance for salt-and-pepper noise.

An alternative DUDE-based approach to gray scale image denoising is taken in [28], which treats digital images as real valued signals and applies the continuous alphabet DUDE [16] mentioned above. Though arrived at from completely different principles, the resulting algorithm bears a striking resemblance to the recently introduced non-local means (NL means) algorithm of [29] (see also [30]), which has been reported to achieve remarkable denoising performance.

The DUDE has also been applied [31] in an error correction setting to enhance the decoding of systematically encoded uncompressed sources. The idea is to run the DUDE on the noisy information symbols aggregated from multiple received codewords so that the corresponding denoised codewords are more likely to belong to correct decoding regions than the original noisy codewords. Depending on the "denoisability" of the source, which is closely related to its redundancy, such a DUDE enhanced communication system may be able to operate correctly under significantly noisier conditions than a DUDE-less approach. The universality of the DUDE allows the approach to work with a variety of source types, without requiring additional side-information from the encoder. It is thus "backward compatible" with deployed systems. Soft-input-soft-output extensions of the DUDE are also introduced in [31] to improve performance with soft channel decoders and to allow further iterations between the decoding and denoising stages.

Additional DUDE-inspired works which we have only space to mention briefly include converse results [32], which show that the convergence rate of the performance of the DUDE to that of the optimal sliding window denoiser is the best possible up to a constant factor; the definition, analysis, and estimation of erasure entropy [33], [34], which is closely linked to asymptotic denoisability over an erasure channel in the limit of zero erasure probability; and universal versions of the filtering or causal denoising problem [35], aka causal DUDE.

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AWARDS AND RECOGNITIONS

IEEE Medal of Honor

Thomas Kailath, Hitachi America Professor of Engineering at Stanford University, Stanford, CA, has been awarded the IEEE Medal of Honor. He was cited "For exceptional development of powerful algorithms in the fields of communications, computing, control and signal processing."

Thomas Kailath

The IEEE Medal of Honor is the Institute's highest award. Five years after the formation of the Institute of Radio Engineers, the IEEE Medal of Honor was established as its first award to recognize distinguished service in the then fledging art of radio communications. Following the merger of the Institute of Radio Engineers and the American Institute of Electrical Engineers in 1963, the IEEE Medal of Honor became the highest award of the IEEE, and its scope was correspondingly broadened. It is given for an exceptional contribution or an extraordinary career in the IEEE fields of interest. It is presented only when a candidate is identified as having made a particular contribution which forms a clearly exceptional addition to the science and technology of concern to the Institute. For more information, please refer to http://www.ieee.org/portal/pages/about/awards/sums/mohsum.html

Thomas Kailath received a B.E. (Telecom) degree from the College of Engineering, Pune, India, in June 1956, and S.M. and Sc.D. degrees in Electrical Engineering from the Massachusetts Institute of Technology in June 1959 and June 1961, respectively. From October 1961 to December 1962, he worked in the Communications Research division of the Jet Propulsion Laboratories, Pasadena, CA, and also taught part-time at the California Institute of Technology. Since then he has been at Stanford University, where he is currently Hitachi America Professor of Engineering, Emeritus. He has also held shorter-term appointments at several institutions around the world.

Professor Kailath's research has spanned a large number of disciplines, emphasizing information theory and communications in the sixties, linear systems, estimation and control in the seventies, VLSI design and sensor array signal processing in the eighties, and applications to semiconductor manufacturing and digital communications in the nineties. He has received outstanding paper prizes from the IEEE Information Theory Society, the IEEE Signal Processing Society, the European Signal Processing Society, and the IEEE Transactions on Semiconductor Manufacturing. He served as President of the IEEE Information Theory Society in 1975, and received its Shannon Award in 2000. Among other awards are the Technical Achievement (1989) and Society (1991) Awards of the IEEE Signal Processing Society , the 1995 IEEE Education Medal , and (with A. Sayed) the 1996 IEEE Donald G. Fink Prize Award.

IEEE Eric E. Sumner Award

Michael Luby and Amin Shokrollahi received the IEEE Eric E. Sumner Award with the following citation: "For bridging mathematics, internet design and mobile broadcasting as well as successful standardization."

The IEEE Eric E. Sumner Award was established by the IEEE Board of Directors in 1995. It is presented annually, to an individual or a team of not more than three, for outstanding contributions to communications technology. Recipient selection is administered by the Awards Board through its Technical Field Awards Council. It is named in honor of Eric E. Sumner, 1991 IEEE President, who retired as Vice President, Operations Planning, AT&T Bell Laboratories after a long and distinguished career. In the evaluation process, the following criteria are considered: research, development and application contributions to all aspects of leading-edge communication technology, and the quality of the nomination. For more information, please refer to http://www.ieee.org/portal/pages/about/awards/pr/sumnerpr.html).

Amin Shokrollahi

Michael Luby

Mohammad Amin Shokrollahi received his German Diplom in Mathematics at the University of Karlsruhe in 1988, his PhD in Computer Science at the University of Bonn in 1991, and his Habilitation in Basic Sciences, also at the University of Bonn, in 1997. Since January 2003 he holds a full professor position jointly at the School of Informatics and Computer Science (I&C) and the Faculty of Basic Sciences (FSB) of EPFL, holding the chair of algorithms at I&C, and the chair of algorithmic mathematics at FSB. Prior to joining EPFL, Amin Shokrollahi has held positions as the chief scientist of Digital Fountain, member of the technical staff at Bell Laboratories, and assistant professor at the department of computer science of the university of Bonn. He is a senior member of IEEE, and he was awarded the best paper award of the IEEE IT Society in 2002.

Amin Shokrollahi has worked on a variety of topics, including coding theory, computational number theory and algebra, and computational/algebraic complexity theory. He is best known for his work on iterative decoding algorithms of graph based codes, an area in which he holds a number of granted and pending patents. He is the co-inventor of Tornado codes, and the inventor of Raptor codes. His codes have been standardized and successfully deployed in practical areas dealing with data transmission over lossy networks.

Michael Luby earned a B.Sc. in Mathematics from the Massachusetts Institute of Technology in 1975 and a Ph.D. in Theoretical Computer Science from the University of California at Berkeley in 1983. In 1983 Michael joined the University of Toronto as a Postdoctoral Researcher. In 1988 Michael Luby was promoted to an Associate Professor in Computer Science at the University of Toronto, and in that same year he joined the International Computer Science Institute in Berkeley to become the Leader of the Theory Group and concurrently an Adjunct Professor at UC Berkeley. Michael Luby co-founded Digital Fountain, Inc. in 1998, where he currently holds the position of Chief Technology Officer. He is a recipient of the 2002 IEEE

Information Theory Society Information Theory Paper Award for leading the design and analysis of the first irregular LDPC error-correcting codes, the 2003 SIAM Outstanding Paper Prize for the seminal paper showing how to construct a cryptographically unbreakable pseudo-random generator from any one-way function. He is member of the IEEE and the ACM.

Michael Luby is a world-renowned Theoretical Computer Scientist, and has made breakthrough research contributions in the areas of coding theory, randomized algorithm design and analysis, transport protocols and cryptography. He has led the development of several transport standards within the Internet Engineering Task Force (IETF) that have been adopted by the leading commercial standards such as the 3GPP multimedia broadcast/multicast services standard, the DVB handheld IP datacast standard, and the DVP IPTV standard.

National Academy of Engineering

On February 9th, the National Academy of Engineering announced the election of 64 new members and 9 new foreign associates. Election to the National Academy of Engineering is among the highest professional distinctions accorded to an engineer. Academy membership honors those who have made outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature," and to the "pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education." For more information, please refer to http://www.nae.edu/nae/naehome.nsf.

Newly elected IT members are:

- Robert M. Gray, Lucent Technologies Professor in Communications and Networking, Stanford University, Stanford, CA. For contributions to information theory and data compression.
- P. R. Kumar, Franklin W. Woeltge Professor of Electrical and Computer Engineering, University of Illinois, Urbana-Champaign. For contributions to adaptive control, manufacturing systems, and wireless networks.
- John N. Tsitsiklis, professor, department of electrical engineering and computer science, Massachusetts Institute of Technology, Cambridge. For contributions to the theory and application of optimization in dynamic and distributed systems.
- Sergio Verdú, professor of electrical engineering, Princeton University, Princeton, N.J. For contributions to multiuser communications and information theory.
- Kees A. Schouhamer Immink, president, Turing Machines Inc., Rotterdam, Netherlands. For pioneering and advancing the era of digital audio, video, and data recording.

Robert M. Gray received the B.S. and M.S. degrees from M.I.T. in 1966 and the Ph.D. degree from U.S.C. in 1969, all in Electrical Engineering. Since 1969 he has been with Stanford University, where he is currently the Lucent Technologies Professor of Engineering and Professor and Vice Chair of Electrical Engineering. His research interests are quantization, lossy compression, and statistical classification. He was a member of the Board of Governors of the IEEE Information Theory Group (1974-1980,1985-1988), Editor (1980-1983) of the IEEE Transactions on Information Theory, and Co-Chair of the 1993 IEEE International Symposium on Information Theory. He was co-recipient with L.D. Davisson of the 1976 IEEE Information Theory Group Paper Award and co-recipient with A. Buzo, A.H. Gray, and J.D. Markel of the 1983 IEEE ASSP Senior Award. He received the IEEE Signal Processing Society 2005 Meritorious Service Award, 1997 Technical Achievement Award, and 1993 Society Award. He received the IEEE Centennial and Third Millennium Medals. In 1998 he received a Golden Jubilee Award for Technological Innovation from the IEEE Information Theory Society. He is a Fellow of the IEEE and the Institute of Mathematical Statistics and was a fellow of the John Simon Guggenheim Foundation in 1982. He received a 2002 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM) and the 2003 Distinguished Alumni in Academia Award from the University of Southern California.

P. R. Kumar obtained his B. Tech. degree in Electrical Engineering (Electronics) from I.I.T. Madras in 1973, and the M.S. and D.Sc. degrees in Systems Science and Mathematics from Washington University, St. Louis in 1975 and 1977, respectively. From 1977-84 he was a faculty member in the Department of Mathematics at the University of Maryland Baltimore County, and since 1985 he has been at the University of Illinois, Urbana-Champaign, where he is currently Franklin W. Woeltge Professor of Electrical and Computer Engineering, and a Research Professor in the Coordinated Science Laboratory.

He has worked on problems in game theory, adaptive control, stochastic systems, simulated annealing, neural networks, machine learning, queuing networks, manufacturing systems, scheduling, and wafer fabrication plants. His current research interests are in wireless networks, sensor networks, and networked embedded control systems.

He received the Donald P. Eckman award of the American Automatic Control Council in 1985. He is a Fellow of the IEEE. In 2006, he received the IEEE Field Award in Control Systems.

John N. Tsitsiklis received the B.S. degree in Mathematics (1980), and the B.S. (1980), M.S. (1981) and Ph.D. (1984) degrees in Electrical Engineering, all from the Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A. During the aca-

demic year 1983-84, he was an acting assistant professor of Electrical Engineering at Stanford University, Stanford, California. Since 1984, he has been with the Massachusetts Institute of Technology (MIT), where he is currently Professor of Electrical Engineering and Computer Science. He has served as acting co-director of the MIT Laboratory for Information and Decision Systems (Spring 1996 and 1997), and as a co-director of the Operations Research Center (July 2002-December 2005).

His research interests are in the fields of systems, optimization, control, and operations research.. He has coauthored more than 100 journal papers in these areas, he is coinventor in 5 awarded U.S. patents. He is also a coauthor of several books.

He has been a recipient of an IBM Faculty Development Award (1983), an NSF Presidential Young Investigator Award (1986), an Outstanding Paper Award by the IEEE Control Systems Society, the M.I.T. Edgerton Faculty Achievement Award (1989), the Bodossaki Foundation Prize (1995), the INFORMS Computer Science Technical Section prize (1997), and is a Fellow of the IEEE (1999). He is currently a member of the National Council on Research and Technology in Greece.

Sergio Verdú a Professor of Electrical Engineering at Princeton University where he teaches and conducts research on information theory in the Information Sciences and Systems Group. He received the Telecommunications Engineering degree from the Polytechnic University of Catalonia, Barcelona, Spain, in 1980 and the Ph.D. degree in Electrical Engineering from the University of Illinois at Urbana-Champaign in 1984. Conducted at the Coordinated Science Laboratory of the University of Illinois, his doctoral research pioneered the field of Multiuser Detection.

Sergio Verdú was elected Fellow of the IEEE in 1992. He received the 2000 Frederick E. Terman Award from the American Society for Engineering Education, and the IEEE Third Millennium Medal in 2000. In 2005, he received a Doctorate Honoris Causa from the Polytechnic University of Catalonia. He is the recipient of the 2007 Claude E. Shannon Award.

In 1998, Cambridge University Press published his book "Multiuser Detection." His papers have received several awards: the 1992 IEEE Donald Fink Paper Award, the 1998 Information Theory Outstanding Paper Award, a IEEE Information Theory Golden Jubilee Paper Award, the 2000 Paper Award from the Japan Telecommunications Advancement Foundation, the 2002 Leonard G. Abraham Prize Award in the field of Communications Systems and the 2007 IEEE Joint Communications/Information Theory Paper Award.

Sergio Verdú has served as Associate Editor of the IEEE Trans. on Automatic Control, and as Associate Editor for Shannon Theory of the IEEE Transactions on Information Theory. He served as President of the IEEE Information Theory Society in 1997. He is currently Editor-in-Chief of Foundations and Trends in Communications and Information Theory.

Kees A. Schouhamer Immink, a native of Rotterdam, The Netherlands, obtained his PhD degree from the Eindhoven University of Technology. He is president and founder of Turing Machines Inc. and serves as a guest professor at the Institute for Experimental Mathematics, Essen, Germany, and the Data Storage Institute in Singapore. He served as president of the Audio Engineering Society (AES) in 2003, and as a governor of the IEEE Information Theory Society in 1992.

He has contributed to the creation of a variety of digital recorders such as the Compact Disc, Compact Disc Video, DAT, DCC, DVD, and the BluRay disc system. Immink's research is documented in over 100 technical papers in archival journals, and in over 1000 US and foreign patents. His book "Codes for Mass Data Storage Systems" has become a major reference in recording research, and was translated into Chinese.

Kees Immink has been honored with fellow status in many professional organizations, including the IEEE, AES, IEE, and SMPTE. He received an Emmy award from the US National Television Academy, was inducted into the Consumer Electronics Hall of Fame, and elected into the Royal Netherlands Academy of Sciences. For his part in the digital audio and video revolution, he was bestowed a Knighthood by Queen Beatrix, and honored with the SMPTE Progress Medal, AES Gold Medal, the IEEE Masaru Ibuka Consumer Electronics Award, and the IEEE Edison Medal. The IEEE Information Theory Society awarded him the Golden Jubilee Award for Technological Innovation in 1998.

IEEE Alexander Graham Bell Medal

Norman Abramson, Emeritus Faculty at the University of Hawaii, received the IEEE Alexander Graham Bell Medal with the following citation: "For contributions to the development of modern data networks through fundamental work in random multiple access"

In 1976, the IEEE Alexander Graham Bell Medal was established by the IEEE Board of Directors in commemoration of the centennial of the telephone's invention and to provide recognition for outstanding contributions to telecommunications. It is presented each year to individuals or a team up to three in number, for exceptional contributions to the advancement of communications sciences and engineering. In the evaluation process, the following criteria are considered: value of contribution to communication among people, value of contribution to communication sciences and engineering, evaluation of contributor, evaluation of nominator and references, and the timeliness of the recognition. For more information, please refer to http://www.ieee.org/portal/pages/about/awards/sums/bellsum.html.

Norman Abramson received an A.B. degree in physics from

Harvard, an M.S. degree in physics from UCLA, and a Ph.D. in Electrical Engineering from Stanford University.

From 1968 to 1996, he was a Professor of Electrical Engineering and a Professor of Information and Computer Sciences at the University of Hawaii. While at the University of Hawaii, he invented the Aloha protocol now widely used for nearly all forms of wireless communications. He is the founder and CTO of skyware, a wireless communications company. He is a Professor Emeritus at the University of Hawaii. He has also been a member of the faculty at Stanford, Berkeley, Harvard and MIT. He has served as Consulting Expert in Communication Systems, Data networks and Satellite Networks for ITU (Geneva), UNESCO (Paris) and the UNDP (Jakarta). He is the recipient of prestigious international awards including the 1995 IEEE Koji Kobayashi Computers and Communications Award and the 2000 Technology Award from the Eduard Rhein Foundation. He holds eight U.S. and international patens.

IEEE Richard W. Hamming Medal

Abraham Lempel, Director of the HP Labs Advanced Studies Program and Director of HP Labs Israel Hewlett-Packard Laboratories, Haifa, Israel, received the IEEE Richard W. Hamming Medal with the following citation: "For pioneering work in data compression especially the Lempel-Ziv algorithm."

The IEEE Richard W. Hamming Medal was established by the Board of Directors in 1986 'for exceptional contributions to information sciences, systems and technology.' The award is named in honor of Dr. Richard W. Hamming, who has had a central role in the development of computer and computing science, and whose many significant contributions in the area of information science include his error-correcting codes. In the evaluation process, the following criteria are considered: scope includes information transmission, coding, storage and recovery, subject areas include information theory, coding theory, data communication, computer networks, data storage and retrieval, image and speech understanding, originality, breadth, impact on technology, patents/publications and the quality of the nomination. For more information, please refer to http://www.ieee.org/portal/pages/about/awards/sums/hammingsum.html.

Abraham Lempel received his BSc, MSc, and DSc degrees from the Technion - Israel Institute of Technology. He has been on the faculty of Technion for more than three decades. He became a full professor there in 1977 and was chairman of the department of computer science from 1981 to 1984. In 1994, with the establishment of HP Labs Israel, he became a full-time HP employee, on special leave from Technion, where he is still a chaired professor of Computer Science, holding the Viterbi Chair in Information Systems. He is director of the Advanced Studies Program at HP Labs and director of HP Labs Israel.

Widely known for his pioneering work in data compression, Lempel is co-inventor of the Lempel-Ziv (LZ) data-compression algorithm, a universal noiseless source-coding technique. The work has won him numerous honors, including the Golden Jubilee Award for Technological Innovation from the IEEE Information Theory Society and the Paris Kanellakis Theory and Practice Award from the Association for Computing Machinery (ACM). He is also an IEEE Fellow.

Dr. Lempel has published over 70 papers in refereed journals and holds 8 US patents. His principal research interests are in the application of discrete mathematics to problems in computer science and information theory.

Friedrich Wilhelm Bessel Research Award

Professor Raymond Wai Ho Yeung has been awarded the Friedrich Wilhelm Bessel Research Award of the Alexander von Humboldt Foundation.

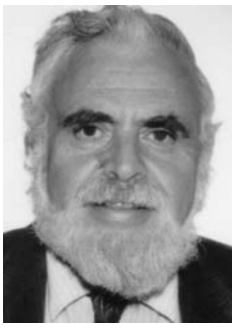
The Alexander von Humboldt Foundation grants approximately 20 Friedrich Wilhelm Bessel Research Awards annually to young, top-flight scientists and scholars from abroad who are already recognized as outstanding researchers in their fields. The research award has been endowed by the Federal Ministry of Education and Research in recognition of their research achievements to date. The award-winners are also invited to work on research projects of their own choice in cooperation with colleagues in Germany for periods of between six months and one year. In spring 2007, Raymond Yeung visited Munich University of Technology. He was hosted by Ralf Koetter and Joachim Hagenauer.

Raymond W. Yeung received the BS, MEng and PhD degrees in electrical engineering from Cornell University in 1984, 1985, and 1988, respectively. He joined AT&T Bell Laboratories in 1988. He joined CUHK in 1991 and has been with the Department of Information Engineering since then, where he is currently a chair professor and Director of the Internet Engineering Programme. He is the author of the book entitled A First Course in Information Theory. His research interest is in information theory and network coding. He was a consultant in a project of Jet Propulsion Laboratory for salvaging the malfunctioning Galileo Spacecraft. Raymond Yeung is a member of the Board of Governors of the IEEE Information Theory Society from 1999 to 2001. He has served on the committees of a number of information theory symposiums and workshops. He was the General Chair of the First Workshop on Network, Coding, and Applications (NetCod 2005), a Technical Co-Chair of the 2006 IEEE International Symposium on Information Theory, and a Technical Co-Chair of the 2006 IEEE Information Theory Workshop, Chengdu. He currently serves as an Editor-at-Large of Communications in Information and Systems, an Editor of Foundation and Trends in Communications and Information Theory and of Foundation and Trends in Networking, and an Associate Editor for Shannon Theory of the IEEE Transactions on Information Theory. He was a recipient of the Croucher Senior Research Fellowship for 2000/01, the Best Paper Award (Communication Theory) of the 2004 International Conference on Communications, Circuits and System, the 2005 IEEE Information Theory Society Paper Award. He is a Fellow of the IEEE and the Hong Kong Institution of Engineers.

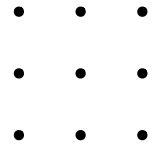
GOLOMB'S PUZZLE COLUMN™

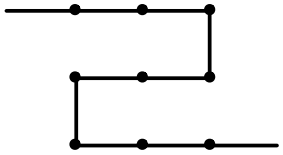
CONNECT THE DOTS

Solomon W. Golomb

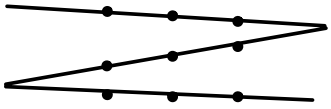


A familiar puzzle presents the solver with a 3×3 square array of dots, and asks for a continuous path ("without lifting the pen from the paper") consisting of only 4 straight-line segments, that goes through all 9 points. An attempt that uses 5 segments is



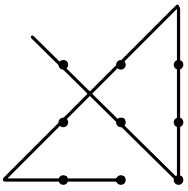


Assume that we are dealing with ideal mathematical points and lines, with no thickness, and that the points are perfectly aligned, to rule out such attempts as



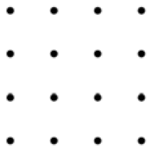
which "succeeds" with only 3 line segments.

The well-known solution to the puzzle problem is as shown, and is unique except for rotations and reflections of the pattern. This solution violates three limitations which many solvers subconsciously impose: line segments are not limited to horizontal and vertical; line segments may intersect (and not even at one of the 9 points); and the solution requires "thinking outside the box" -- quite literally -- in that the segments extend beyond the convex hull of the 9 original points.

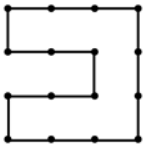


We generalize this puzzle to larger arrays. On an $n \times n$ square array of regularly placed dots, for $n > 3$, we ask for a *closed path* (*a circuit*), consisting of $2n - 2$ segments, which goes through all n^2 points, and returns to the starting point.

1. Find a 6-segment *closed* path that goes through all 16 points of the 4×4 array:



   For full credit, find *all four* inequivalent solutions. (An unsuccessful attempt is



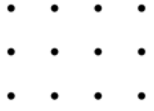
   since it uses 8 segments instead of 6.)

2. Find an 8-segment closed path that goes through all 25 points of the 5×5 square array of dots: How many inequivalent solutions can you find? (There is no requirement that a solution must possess any symmetry.)

3. On the 6×6 array of dots, find a 10-segment circuit. Among your solutions, can you find one that stays within the convex hull of the 36 points?

4. A "queen's tour" of the 8×8 chessboard, in 14 moves, requires a chess queen, starting on one of the 64 squares of the board, making a sequence of 14 "queen moves" (horizontal, vertical, or with slope ± 1) which passes through or lands on every square on the board, and returns to the starting square. Can you find such a queen's tour?

5. Find a closed path (a circuit) of five connected line segments that goes through all 12 of the dots in a 3×4 array and returns to the starting point. The solution is unique (up to symmetries of the rectangle), and the five "turning points", where two segments meet, are all distinct from the 12 points of the array.



A Brief Update on the Work of the Student Committee

Ivana Maric, Amin Mobasher, Lalitha Sankar, Brooke Shrader, and Sergio Servetto

A few things are changing in the student committee, but the work we are doing continues without interruptions.

The committee hosted a Student Roundtable Research Discussion and Lunch at the CISS conference at Johns Hopkins University on Wednesday, March 14. Approximately 60 students attended the lunch and enjoyed pizza and soda. Six discussion topics were chosen and each discussion was led by a student discussion leader. The discussion topics and leaders were: Joint source-channel coding for wireless networks (Deniz Gunduz, Polytechnic), Convex optimization applications (Joy Acharya, Rutgers), Detection and estimation (Anima Anandkumar, Cornell), Distributed source coding (Peiyu Tan, Lehigh), Security and cryptography (Alvaro Cardenas, Berkeley), and MIMO Systems (Mike Tinston, George Mason). Thanks to all of the discussion leaders for making the event a success! Thanks also to K.V. Srinivas (IIT Madras) for taking pictures. Summaries of the discussions and pictures are available on the Student Resources website (http://itsoc-students.ece.cornell.edu/).

The student committee will host TWO events at the upcoming ISIT 2007 in Nice. On Monday, June 25, there will be a Roundtable Research Discussion and Lunch and on Thursday, June 28, a Panel Discussion and Committee Meeting will be held. As always, IT Student Committee T-shirts (in a new color!) will be free to all participants. The panel will deal with funding issues, and how these affect career choices made by students; at the time of this writing, we are in the process of contacting panelists, and we hope to announce our panel composition shortly on our website. As usual, if you have suggestions of topics for future panels, or if you have ideas of things you would like to see happen in this committee, or if you want to volunteer to help, please do send your input to our volunteer coordinator Lalitha, reachable at lalitha@winlab.rutgers.edu.

Finally, a word about some changes in our organization. This committee started under the leadership of Andrea Goldsmith. Andrea was instrumental in getting things under way, and today we have a very efficient operation involving a website continuously under development, the t-shirt contest, regular panels and lunch discussions three times a year. We are indebted to Andrea for her leadership and efforts, without which this committee would likely not exist today. But after her long service, and to enable her to focus on her new responsibilities as 2nd VP of the IT society, Andrea decided to step down, and since March 14th, 2007, our committee has a new chair: Sergio Servetto. Sergio has been involved with the student committee since its inception, and is looking forward to taking a more active role in helping out the student volunteers, as they continue doing the great work they have been doing so far with Andrea. Plus, we have a couple more initiatives under consideration now, on which we hope to have some good news to report in the near future.

Stay tuned for more on our work. Meanwhile, hope to see you in Nice!

Students enjoy pizza and soda at the Roundtable Research Discussion and Lunch at CISS 2007.

Deniz Gunduz leads a discussion on "Joint source-channel coding for wireless networks."

WSIT'007 – 9th IEEE Winter School on Coding and Information Theory

La-Colle-sur-Loup, French Riviera, France March 12-16 2007

Nadia Fawaz, Merouane Debbah

Imagine an azure-blue sky, palm and olive trees, Provencal hills, the sparkling Mediterranean Sea... and many PhD students from all around Europe, eager to interact with each other and with renowned professors! You can open your eyes, you are not dreaming... Welcome to the 9th Winter School on Coding and Information Theory, held in la Colle-sur-Loup, French Riviera, France, on March 12-16 2007.

Following a tradition started over 16 years ago by Han Vinck and Rolf Johanesson, the 9th IT winter school was chaired by Prof. Merouane Debbah and organized by Eurecom in cooperation with INRIA and I3S and with the support of CNRS, UNSA, I3S, GET, IFANY and NXP. The main purpose of the school was to provide an opportunity for graduate students and researchers from different universities to meet and interact on a wide range of research subjects.

Each morning, 100 IT-winterschoolers – record attendance! – had their technical horizon widened thanks to remarkable tutorial talks given by Prof. Giuseppe Caire (USC, USA) on Joint Source-Channel Coding, Prof. Eitan Altman, (INRIA, France) on Game Theory for Wireless Networks, Prof. Aris Moustakas (UoA, Greece) on Applications of Statistical Mechanics to Information Theory, Dr. Olivier Dousse (Deutsche Telecom Laboratories, Germany) on Connectivity and Capacity in Multi-hop Wireless Networks and Prof. James Massey (Copenhagen, Denmark) on Zero error. In the afternoon, participants presented their ongoing research to their peers and received feedback from senior researchers during special working sessions.

Work hard, play hard! The winter school was also a great opportunity for students to get to know each other and build a network of friends through social activities. Who did not notice their enthusiasm for the evening international pétanque contests? Who can forget the bold swimming sessions in 11°C water followed by basket-ball matches or initiation to mini-golf? Arts also inspired our engineers, from the visit of Maeght Arts Foundation to their cozy gathering in the evenings around a common passion for music. Last but not least, nobody can deny that his heart was conquered by the charm of Saint-Paul-de-Vence. The excursion in this pearl of the south of France was followed by a banquet in the prestigious Mas de Pierre where French gastronomy delighted our senses

A warm thank is owed to all organizers (especially Ephie Deriche from INRIA and Corinne Julien from CNRS) and participants, who made this winter school a successful and memorable event. Next edition will be organized in 2009 by Prof. Ralf Mueller from NTNU in Trondheim, Norway. We wish him good luck and a great success for this 10th anniversary!

For additional information:

http://itwinterschool07.eurecom.fr/

WSIT'007 attendees.

David Middleton – A Founder of Statistical Communication Theory

Original in Russian: Mark Bykovsky, March 2005, Moscow
English translation: Julia Bykovskya
Edited English Translation: David Middleton, April 2006, New York
Typist: Svetlana Goncharoff, January 2007, Chicago

Background

This is a somewhat shortened and edited version of the original article by Dr. Mark Bykovsky, Editor of Electrosviaz (History and Modern Times), No. 3, March 2005. Dr. Bykovsky is the Director, Analysis of Electromagnetic Compatibility, of the Radio Research and Development Institute of the Russian Communications Ministry (Moscow). In addition, he is an historian of the Communication Field, author of a recent book, Circles of Memory, published in 2001 in the series "History of Telecommunications and Radio Engineering," Moscow. This contains biographies of distinguished scientists in the field, including among them Wiener, Shannon, Rice, Middleton, Kotelnikov, Stratonovick, Tikhonov, etc., as well as other noted Russians and Americans. Bykovsky has also recently (2005) finished a larger volume with additional essays about these and other distinguished scientists and engineers working in radio science and including concise histories of optimal decision and estimation of signals in noise, as well as other technical aspects of Statistical Communications Theory generally.

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I need to act as I would like to make
Each and every day of my life – immortal
Like a shadow of a great hero.
And I cannot comprehend meaning of having a rest.
There is constantly something in my mind
That boils and ripens.

Mikhail Lermontov

Introduction

To the specialists in the field of communication theory worldwide, the name of David Middleton is as well-known as the names of many prominent scientists of the Twentieth Century. He belongs among the major figures in science of the Twentieth Century. A tremendous number of his first-class research results in various areas of communication theory make him unique. He is also unique in the duration of his active creative work in the fields of Statistical Communication Theory and Radiophysics, which captured the entire epoch. His first fundamental research results were produced in the mid-40's, with a major volume 1 in 1960 (two volumes in Russian), and other more important results in the period 1960 to the present, with another major volume scheduled to be published in 2008 for the IEEE.

Problems, which he has been working on his entire life, emerged during World War II in the years when fundamentals of statistical radioengineering were developed. Those problems were concerned with the necessity to improve receivers of radar stations by increasing their sensitivity. Radar receivers became one of the most important elements of military engineering used for detections and elimination of enemy planes and ships. These receivers contain a number of filter and non-linear elements (mixers, detectors, etc.). Further, the algorithms of signal processing, particularly in the presence of random noise, are quite complicated. Many of the brightest scientists were involved in solving these problems. In the United States, research in this field was conducted by such prominent scientists as Norbert Wiener (the father of cybernetics, a new direction in science), and Stephen Rice, who was one of the first who achieved fundamental results in this direction (these were published in 1944 and 1945 in two of his famous articles in the "Bell Systems Journal"). (In the Soviet Union, many important results also in this area were obtained by Professor Bunimovich, who worked in the Institute of Radioengineering and Electronics of the Academy of Sciences, and by Professors Stratonovich of Moscow State University and Tikhonov of the Zhurovskiy Airforce Academy.)

Another focal area of Dr. Middleton's research work (in particular for weak signals) is the development of a methodology for solving problems of optimal signal reception in the presence of noise and the evaluation of their performance. Theoretical fundamentals of this field were also formulated by Academician Kotelnikov in 1947 . In 1954, independently of Kotelnikov, Middlteon developed a theory of optimal signal reception based on certain methods of mathematical statistics. Many fundamental results in this theory stem from this work.

David Middleton was born on April 19, 1920 in New York. Science was never in the family history. Middleton's youth fell in the period of the Great Depression in the U.S. and world economy. Although the family had some savings, they had to sell his mother's violin (the work of a famous Italian master, Guarneri) to help him finish high school and Harvard University. He graduated from Harvard in 1942 with a Bachelor's degree (summa cum laude).

At the beginning of the U.S. entry into World War II, Radio Research Laboratory (RRL) was set up at Harvard, under the direction of Professor Terman. This laboratory focused in the development of radar countermeasures, specifically active and passive radar jamming systems. The research section was head-

ed by the distinguished physicist Professor John H. Ban Vleck (Nobel Prize in 1977). Here, David Middleton stated his scientific career.

As television served as a technical basis for the creation of radar technology, the development of problems of signal extraction from noise, on which Middleton started working, was a precondition of advances in today's Informational Era. He conducted pioneering research in this field by creating methods for the analysis of systems of signal reception in the presence of noise. (After the end of the war, Middleton continued his education at Harvard. In 1945, he received his Master's degree and his PhD in 1947. Subsequently, he worked as a postdoctoral researcher with the famous French physicist Leon Brillouin, who wrote one of the first books on the Information Theory from the physicist's viewpoint.

Until 1954 Middleton worked at the Harvard Laboratory, continuing his research work and also teaching at the Department of Applied Physics and Engineering. During the period from 1942 to 1954, he conducted intensive studies and analyzed work of various systems with amplitude (AM) and frequency modulation (FM) in the presence of random noise and developed methods of design and optimization of signal reception systems. Later, he obtained major scientific results in communication theory, by developing studies of optimal signal reception in various communication channels with not only Gaussian noise, but also other types of interference with various statistical characteristics. Middleton's results were widely published in the leading scientific journals and were presented at numerous international conferences. He has published more than 170 scientific articles and several fundamental monographs. He also stayed in touch with the Soviet scientists. During the period of 1973-1984, he visited the USSR four times at the invitation of the Institute of Acoustics of the Academy of Science. (In 1978, the publishing house "NAUKA" ("Science") published a book of the Soviet scientists V. V. Olshevky, "Statistical Methods in Hydrolocation" under Middleton's technical Editorship.)

David Middleton is a member of the National Academy of Engineering and a Fellow of the American Physical Society, The Acoustical Society of America, the American Association for the Advancement of Science, and of the International Institute of Electrical and Electronics Engineers (IEEE), as well as the New York Academy of Science. Additionally, he has received awards from the National Telecommunications and Information Administration (NTIA), the Electromagnetic Compatibility Society of the IEEE, and other organizations for his scientific work.

In 1943, during World War II, Middleton, using methods suggested by S. O. Rice, began the analysis of signals and noise passing through nonlinear devices. Such methods are necessary for the evaluation of jamming of radar stations. These methods are now included in the textbooks on communication theory and have become necessary elements in the education of a modern communication engineer. He also obtained results for the detection of weak AM and FM signals in the presence of noise. In particular, it appears that he was one of the first to study a threshold effect of FM signal reception by using strict mathematical methods.

Van Vleck and Middleton in 1944 developed the "matched filter" concept (also obtained independently in 1944 by the distinguished scientist D. O. North (of RCA)). This concept helps to minimize the effects of (Gaussian) noise in signal reception. It then became particularly important in the design of radar and other communication systems.

In 1954, together with his student and colleague Dr. Van Meter, he formulated a statistical theory of optimal signal reception in Bayesian terms, based on the methods of Wald's Statistical Decision Theory. (It is worth noting that the ideas of the synthesis of devices of optimal signal reception in the presence of noise were also studies in the Thesis of Academician Kotelnikov in 1947). David Middleton did much for the development of this theory. Subsequently in 1965, he developed the canonical approach of threshold detection and signal parameter estimation with various non-Gaussian types of noise, with a broad spectrum of statistical characteristics. Later (in 1968 and 1970), together with his colleague Dr. R. Esposito, he developed a Bayesian theory of joint detection and estimation of signals under a priori uncertainty.

In 1970 Middleton started to actively develop a new scientific direction – statistical models of non-Gaussian noise and interference. These models allowed, with appropriate selection of parameters, statistical characteristics of man-made and natural noise interference, where noise can have both Gaussian and impulsive components.

Middleton's two-volume book (in Russian) "An Introduction to Statistical Communication Theory," which he started writing in 1949 and finished working on in 1958, was published in 1960 and became a significant event in the world of science. This book included material from a number of courses which he taught at the Department of Applied Physics at Harvard University, as well as from research projects originally supported by Harvard University and the Massachusetts Institute of Technology under Department of Defense contracts with those institutions. This monograph was widely popular and was translated in many languages. It became the main source for specialists working in the field of statistical radioengineering, as well as in other adjacent areas. (It is worth noting that this work was not the first book in this field. In 1951, a quite complete book "Fluctuation Processes in Radioreception Devices" by Bunimovich was published in the USSR and books "The Theory of Random Functions and Its Application to Automatic Control Problems" by V. S. Pugachev and "Theory of Random Functions and Its Application in Radioengineering" by B. Levin were also published in the USSR in 1957. The book "An Introduction to the Theory of Random Signals and Noise" by W. B. Davenport and W. I. Root was published in the U.S. in 1958 and later translated and published in the USSR. Middleton's book, however, was more comprehensive than any of those previously published.)

According to the author, his book is addressed to engineers, physicists, and applied mathematicians. When writing this book, he had three aims: (1) to outline a systematic approach to the design of optimal communication systems of various fundamental types, including an evaluation of performance and a comparison with non-optimum systems for similar purposes; (2) to incorporate within a framework of a unified theoretical approach the principal results of earlier work, as well as to indicate some the more important new ones; and finally (3) to be used as a text at various levels, as an instrument for the research worker in current

problems, and as a starting point for new developments. This monograph played a major role for the implementation of statistical methods in the education of engineers in communication, radiolocation, and other adjacent fields. (The book was translated and published in the USSR in 1962 and 1963 under the Editorship of the prominent Soviet scientist Prof. Boris Levin.) A small but quite complete monograph "Topics in Communication Theory," was also published in 1965 and it was published in Russian in the USSR, again under the Editorship of Prof. Levin in 1966. The book contains concise descriptions of some of the main ideas in communication theory developed by that time.

Both of these books were destined to last: "An Introduction to Statistical Communication Theory" (1960-1972) was reprinted in the U.S in 1987 and 1996, and "Topics in Communication Theory" was reprinted in 1987.

The scientific interests of David Middleton are exceptionally broad and not limited just by the field of statistical communication theory. He has written a number of fundamental works on wave propagation in random inhomogeneous media and their scattering from rough surfaces. Additionally, he developed a statistical theory of reverberation and clutter (1965), which gave a theoretical foundation for synthesis and analysis of optimal radio- and hydrolocation signal reception in channels with strong echo-signals, created due to their scattering in inhomogeneous media. In 1988, he published original research results on vector field detection. He also obtained results with Professor D. P. Peterson on multidimensional generalization of the Wittaker-Kotelnikov-Shannon sampling theorem (1962-1965) . He also conducted important research of signal distortion due to amplitude-phase conversion effects. These effects often exist in satellite retranslators in satellite communication (1986).

Middleton's creative instinct in not weakening with the years. He continues to work actively and publish on a regular basis results of his scientific research in solving problems of communication theory and statistical physics. His article "Models of Non-Gaussian Noise and Signal Processing in Telecommunications – New Methods and Results for Models of Types A and B" (Information Theory, No. 4, pp. 1129-1140) was published in 1999. This work was a development of the results of his (1970--) work on models of non-Gaussian noise. For the two canonical types of model he proposed methods of determining probability distributions of non-Gaussian noise affecting a receiver.

Middleton's work "New Results in Applied Scattering Theory: A new Physical-Statistical Approach, Including Strong Multiple Scatter Versus Classical Statistical-Physical Methods and the Born and Rytov Approximations Versus Exact Strong Scatter Probability Distributions" was published in 2002 by the Institute of Physics (Waves in Random Media, 12, pp. 99-144). This fundamental article contains the synthesis of his methods for determining the statistical characteristics of non-Gaussian noise affecting signal reception, which were applied to the solution of problems in wave scattering theory. This work was a substantial new leap forward in the solution of quite complicated problems in the theory of scattering (the problems on which the most prominent scientists have been working for many decades).

Conclusion

During more than the 60 years of Middleton's active creative work, he has generated methodologies for the analysis of various systems of signal processing in the presence of noise. These methods have been widely applied to solve a broad range of various practical problems.

Middleton belongs to the scientific elite of the Twentieth Century who founded communication theory and identified major patters of optimal processing of signals, whose transmission through communication channels is accompanied by significant distortion, and where reception is realized in the presence in intensive noise and interference. A unique characteristic of this person is his unlimited intellectual power, which has not weakneded for more than a half a century. This power showed itself in the quantity, depth and variety of his scientific research. Middleton was not seeking celebrity or popularity – his goal in life is still scientific creativity.

Usually, after 50 years, the creative ability of scientists has substantially diminished. David Middleton is one of the few exceptions to this rule. What is the secret of his creative longevity? I believe this can be explained by his drive, in the first place, and by tremendous interest and love of the work to which he has dedicated his professional life. He is also driven with a clear understanding of the fact that any advances in the field of his research have potential significance for the community.

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[1] Introduction to Statistical Communication Theory, McGraw-Hill, Int'l. Series in Pure and Applied Physics, New York, 1960, with subsequent editions (1987-1996), IEEE Press, Classic Editions, 1996.

[2] For various political reasons, Kotelnikov's important results were unavailable in the West for a considerable time.

[3] Science and Information Theory, Academic Press, New York, 1962.

[4] Based in the more recent extensions of Miyakawa (1959, J. Inst. Elect. Comms. Engrs., Japan).

IEEE Information Theory Society Board of Governors Meeting Allerton House, Monticello, Il, USA, September 27, 2006

João Barros

Attendees: Alexei Ashikhmin, João Barros, Daniel Costello, Dave Forney, Marc Fossorier, Andrea Goldsmith, Ralf Koetter, Frank Kschischang, J. Nicholas Laneman, Muriel Médard, David L. Neuhoff, Sandeep Pradhan, Anant Sahai, David Tse, Alexander Vardy, Venugopal V. Veeravalli, Ken Zeger.

The meeting was called to order at 19:42 by Society President David Neuhoff. The members of the Board were welcomed and introduced themselves.

1. The agenda was approved and distributed. Board members were also encouraged to look at the agenda and other materials online at the new Society development server.

2. The Board unanimously approved the minutes of the previous meeting.

3. The President presented his report and miscellaneous announcements.

   The President reported on the state of the Society, including the IT Transactions, conferences and workshops, status of various initiatives, and membership.

   The President addressed topics related to the IEEE Technical Activities Board (TAB), including a possible shift of policy with respect to voluntary page charges and hardcopy reprints. The Board did not indicate a desire to eliminate voluntary page charges.

   The President presented for comment a draft of the presentation to IEEE TAB/PSPB PSC in which he will present BoG's previously approved proposal to include online access to IT conference and workshop proceedings as a basic benefit of IT membership.

4. Muriel Médard presented the Treasurer's report.

   The Society's finances were reviewed and found to be healthy.

   The financial activities of the Society conferences and workshops were reported in the Treasurer's report online.

5. The President presented the Editor-in-Chief's report, who submitted a new associate editor appointment.

   The Board unanimously approved the appointment of Lang Tong to one of the two Associate Editor positions for Detection and Estimation.

6. Matters related to Symposia and Workshops were then discussed.

   (a) ISIT 2009 Seoul:
   The President reported briefly on the progress. Preparations are on track.

   (b) ITW 2008 Portugal:
   João Barros reported briefly on the progress. Preparations are on track.

   (c) ITW 2007 Lake Tahoe:
   William Ryan put forth a proposal for a ITW Workshop in 2007.

   The Board unanimously voted to approve the proposal, conditioned on approval of the budget by the Treasurer.

   (d) ITW 2007 Norway:
   A report was posted online. Everything is on track.

   (e) ISIT 2007 France:
   Marc Fossorier reported briefly on the progress of the organization of the annual Symposium, including sponsoring.

   Andrea Goldsmith described a proposal put forth by the TPC of ISIT 2007 for a Best Student Paper Award at ISIT 2007.

   The Board unanimously approved the proposal.

   The goal is to make it a regular award, handled by the IT awards committee.

   (f) ISIT 2008 Toronto: Frank Kschischang reported briefly on the progress.

   (g) ITW 2006 China: Dan Costello reported briefly on the progress, including the workshop's acceptance rate.

   (h) ISIT 2006 Seattle: Jody O'Sullivan's report was displayed and discussed.

   (i) ITW 2006 Uruguay: No report was submitted.

   (j) ISIT 2005 Australia: Alex Grant's report was displayed and discussed. It indicated that the conference had closed with a considerable surplus.

7. The President reported on the current status of technical co-sponsorships by the Society.

8. Marc Fossorier reported on the report of the ad-hoc conference committee, which supported the creation of a conference committee and recommended changes to the bylaws.

   The Board discussed the role of this committee and made suggestions with respect to the proposed bylaw changes. One goal is to increase the efficiency of Board of Governors activities.

   There was a motion to approve a conference commitee along the lines of the proposal. The committee should have at least

three members, whose names are to be put forth by the President and approved by the Board. This is to be an ad-hoc committee until modifications to the bylaws to create a standing conference committee are proposed and adopted.

The Board unanimously approved the motion.

9. The President and the Second Vice-President discussed several of the proposed bylaw changes contained in the report of the bylaws committee.

   A motion was made to change the bylaws with respect to the schedule of activities related to the Joint Information Theory and Communications Societies Paper Award.

   The Board unanimously approved the motion. This will now be proposed to the Communications Society.

   A motion was made to change the bylaws to include the Chapter Award. The Board unanimously approved the motion.

   A motion was made to change the bylaws to incorporate into the bylaws the renaming of the Distinguished Service Award as the Aaron D. Wyner Distinguished Service Award.

   The Board unanimously approved the motion.

   The Board discussed the quorum definition for Board of Governors meetings. A mato change the definition of a quorum to a majority of the Board of Governors. The Board voted 8 against 3 in favour of the motion.

   Marc Fossorier raised the issue of terminology in the bylaws, in particular the distinction between voting members and elected members.

   The President discussed the possibility of extending the size of the Nominations and Appointments Committee. The discussion will be referred back to the bylaws committee.

10. Andrea Goldsmith reported on the activities of the Society Student Committee, including financial aspects.

    Frank Kschischang suggested that successul Student Committee activities, such as the panel discussion and the research round table at ISIT, be used to increase the number of Society members.

    There was a motion to increase the budget of the Society Student Committee to 10,000 USD. The Board unanimously approved the motion.

11. The Society Online Editor, Nick Laneman, gave an update on the IT Society website.

    A dedicated media server was purchased and put in operation.

12. An apparent decrease in the amount of NSF funding for the information theory research community was discussed. Some members of the Board believe that the NSF funding of research in information theory has declined significantly in recent years.
    The Board discussed the need for an increased effort in promoting information theory at NSF and at other funding bodies. Alexander Vardy reported on a similar effort currently underway in the ACM Special Interest Group on Algorithms and Computation Theory (ACM-SIGACT).

    A motion was made and approved to have the President appoint an ad-hoc committee that will investigate funding for information theory research, at NSF and in general.

13. Sandeep Pradhan raised the issue of difficult access to out-of-print information theory books and older journals. The Board discussed possible solutions to make these works more easily available.

    Sandeep Pradhan will contact editors and investigate this issue further.

14. There was no new business.

15. The next Board meeting will be held at CISS in Baltimore.

16. The meeting was adjourned at 23:33.

Errata Corrige

The previous issue went to print with a number of typos. My sincere apology to the authors and the readers.

The second page of Dr. Rimoldi's Presidents' Column was cut.

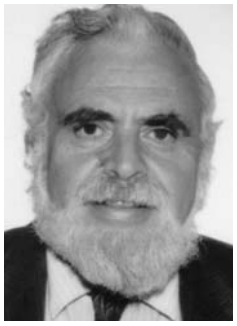
Dr. Ephremides' Historian's Column had the following typos:
-- second paragraph, second line: heuristically should be virtually
-- third paragraph, fourth line: Grignano was misspelled
-- sixth paragraph, fifth line: Fragrant Hill's should be Fragrant Hills
-- last paragraph: 8th line: Halian should be Italian

Dr. Golomb's The "3X+1" Problem had the following typos:
-- first line: deine --> define
-- item 3: these to f --> the set of
-- item 4: amultiple --> a multiple
-- item 4: $3 \cdot 2^k + 1 \cdot v$ -->$3 \cdot 2^{k+1} \cdot v$
-- item 5: easyto --> easy to
-- item 5: any predecessor --> many predecessor
-- item 6, twice: 2^{k+1} -->2^{k+l}
-- reference: Jerey --> Jeffrey

GOLOMB'S PUZZLE COLUMN™

Calculator Magic Solutions

Solomon W. Golomb



1. $2^{29} = 536,870,912$ contains every digit except 4. (For $n > 33$, 2^n has more than ten digits, so they cannot all be distinct.)

2. (a) $2^8 = 256$; $5^8 = 390,625$; $7^8 = 5,764,801$. (For $n > 17$, n^8 has more than ten digits.)

   (b) $6^8 = 1,679,616$; $8^8 = 16,777,216$; $15^8 = 2,562,890,625$ are the examples where the first two digits match the last two digits (in order).

   (c) $6^8 = 1,679,616$ and $8^8 = 16,777,216$ both begin with 167... and both end with ...16.

3. With $A = 81619$, $A^2 = 6,661,661,161$ having only the digits 1 and 6. (If A is turned upside down, to get 61918, we must add a tiny amount to get either $61918.00088^2 = 3,833,838,833$ or $61918.00092^2 = 3,833,838,838$ or $61918.00128^2 = 3,833,838,883$, where only the digits 3 and 8 appear.)

4. $\sqrt{1362} = 36.90528417$. (Note that the digits 3, 6, 9, 0 which are multiples of 3, come first; then 5, 2, 8 which are +2 (mod 3); and finally 4, 1, 7 which are +1 (mod 3).)

5. With $n = 80$, $n/(n+1) = 80/81 = 0.987654321$, with the digits in descending order. The result is again "pan-digital" when this number is multiplied by $k = 1, 2, 4, 5, 7$ or 8. Interesting patterns result.

6. Among the values of $(10n/9)^2$, we have:

   (a) At $n = 3$, $(30/9)^2 = 11.1111111$; at $n = 6$, $(60/9)^2 = 44.44444444$; at $n = 30$, $(300/9)^2 = 1111.111111$.

   (b) At $n = 2$, $(20/9)^2 = 4.938271605$, where the even positions in ascending order are 0, 1, 2, 3, 4, and the odd positions in ascending order are 5, 6, 7, 8, 9.
   At $n = 4$, $(40/9)^2 = 19.75308642$, where the odd digits precede the even digits.
   At $n = 8$, $(80/9)^2 = 79.01234568$, a cycling of 0 through 9 with 8 out of place.
   At $n = 13$, $(130/9)^2 = 208.6419753$, where the even digits precede the odd digits.
   At $n = 14$, $(140/9)^2 = 241.9753086$, where the odd digits (19753) are flanked by the even digits.
   At $n = 20$, $(200/9)^2 = 49.38271605$, the same pattern as at $n = 2$.
   At $n = 26$, $(260/9)^2 = 834.5679012$, a cycling of 0 through 9 with 8 out of place.

7. If rounded to the nearest digit, a/b with $0 < a < b < 30$ is never "pandigital". However, on my Radio Shack 10-Digit Scientific Calculator EC-4032, I read $5/19 = 0.263157894$.

8. $(2143/22)^{\frac{1}{4}} = 3.141592653$, the first ten digits of π.

News from the communications program at the National Science Foundation

by Sirin Tekinay, Program Director

Dear reader,

In this space I write about relevant NSF programs and news. As I was writing a draft of this column, the seventh in the series, a horrific tragedy happened on the campus of Virginia Tech. So I put aside the usual format and use part of this space to offer my mind and heart to the university community- our extended family. Every bullet fired that day hit us all. The day after the unthinkable, Nikki Giovanni, University Distinguished Professor, said in her convocation address [1], "We will continue to invent the future through our blood and tears and through all our sadness ... We will prevail ..." We are one when it comes to inventing the future.

On April 16, around noon, a couple colleagues and I sat in my office watching the death toll rise with that feeling of getting punched in the stomach, gasping for air. I tried to contact friends and colleagues at Virginia Tech. I was not able to reach any of them by phone, so I resorted to email. Within a couple of hours, and through the evening, email responses started to trickle in. They all expressed disbelief, and a need for time to fully absorb what happened.

I don't, and chances are, I won't, understand this tragedy, despite the repeated airing of the murderer's crazed ramblings by insensitive, sensationalist TV stations catering to morbid curiosity. I would rather see the beautiful faces of the faculty and students we lost. I wish their names would become familiar names. I refuse to pay a disproportionate amount of attention to the psychoanalysis of a killer; instead, I want to know more about the victims. I want to honor their hopes and dreams. I want to help lengthen threads of their lives into the future.

I conclude this portion of the column by offering my deepest condolences to all of our community, and my hand towards the healing process.

New and Upcoming Solicitations

Soon after we conclude the TF07 competition, we will receive our CAREER proposals. The deadline for the CAREER program [2] is July 17 for CISE, July 18, or 19 for other directorates.

I continue to serve as the representative of our directorate on the Interdisciplinary Graduate Education Research Traineeship (IGERT) program coordination committee. IGERT 2006 has barely reached its conclusion and IGERT 2007 program [3] is now in its preliminary review cycle: the submission window for preliminary proposals has closed on April 5, so we are gearing up to run the review panels in June. Based on the recommendations of the review panels, full proposals will be invited in July, with a deadline of October 5.

News on Communications Research

At the time of writing, our Theoretical Foundations 2007 (TF07) [4] Program is within its review period. The deadline was February 19, 2007. Roughly speaking, we have received around four hundred and fifty submissions to the program. Out of these, over one hundred and fifty are in information theory, communications, signal processing and theory of networking. In TF07, a researcher can be an investigator on only one proposal: this limit that was introduced last year. Next year, the limit is likely to go up to two. We are targeting late June for finalizing most, if not all, funding decisions for this cycle.

Science for Internet's Next Generation (SING) was introduced last year as part of the TF Program. Its scope is decidedly more focused this year, on the interaction related aspects of the Internet such as the theory of networking, theory of networked computing, large scale wireless networking. I am proud to announce that SING will become a CISE-wide program, cutting across all three divisions of the directorate [5]. This will ensure the broad scope that the program deserves, along with the financial and human resources it needs, beyond the Theoretical Foundations Cluster. The CISE/SING team is formed of representatives from all three directorates. I am serving as the coordinator of this team in scoping the solicitation, in order to present it to our upper management to obtain the budget for the program. We do have the commitment to fund the program from all three division directors.

Another exciting activity I am participating in is the Interagency Task Force on Advanced Networking. Several federal agencies, including Department of Defense, Department of Energy, NASA, NOAA, NIH, and NSF have joined forces to write a report on the needs of advanced networking research, addressed to policy makers. The objective is to obtain research funding for all relevant areas so that the networking landscape in the year 2015 will look much different than it is predicted without this funding. As an NSF representative, one from the Theoretical Foundations for Communications at that, I am happy to say our communities are well represented as follows: the crowded chart classifying ITFAN areas has three sections: foundations, systems level research, and applications. We are the foundations block cutting across (i.e., supporting) all others at the bottom of the bottom-up taxonomy. Information Theory, Communication Theory, Signal Processing, Theory of Networking, Theory of Networked Computing, Complexity, and other pertinent theoretical research, along with modeling and simulation, are represented in this block.

I am serving as a member of the newly formed team for Cyber-Enabled Discovery and Innovation (CDI), led by CISE/CCF Division Director, Dr. Mike Foster. It is natural for Mike to take the lead for this activity as a big portion of this NSF-wide investment plan in the 2008 budget [6] was formulated in our division; which I had reported on earlier as the "Science of Interaction."

Recently, along with two other colleagues from NSF, I started to communicate with the army's Dr. John Parmentola about Network Science, which will also draw strength from our communities. Dr.

Parmentola Army's director of research and laboratory management. He ordered the report, Network Science 2006 [7] prepared by the National Research Council's Committee on Network Science for Future Army Applications, and now we are working with him to organize a workshop to define this new transdisciplinary field of research and education.

On a Personal Note

My tenure at the NSF has been extended for another year; i.e., until September 2008, so that I can see the new activities I have taken up to fruition. However, I may need to spend more on my home institution's needs starting January 2008. As I like to repeat, I am looking forward to paying forward the efforts of my predecessor in recruiting and smooth-transitioning the job to my successor. Please let me know of your interest in this unique, humbling privilege to serve our community.

NSF People

The new Assistant Director for CISE, Dr. Jeannette Wing [8], will officially take office vacated by Dr. Peter Freeman, this summer. Here's her brief bio. Wing is an alumna of the Massachusetts Institute of Technology, where she earned bachelor's and master's degrees in electrical engineering and computer science in 1979, and a doctorate in computer science in 1983. She began her career as an assistant professor at the University of Southern California and joined the Carnegie Mellon faculty in 1985. She has worked or consulted for AT&T Bell Laboratories, Xerox Palo Alto Research Laboratories, Digital Equipment Corp., USC/Information Sciences Institute, the Jet Propulsion Laboratory and Microsoft Corp.

Along with all colleagues at CISE, I am anxiously looking forward to her arrival.

The "Social Scene"

"CISEmology," the socialization of CISE program officers by getting together for a theme-evening, was something I had heard about in the context of "the golden times," from the "old timers" here. Well, it was revived in February, in the form of Chinese New Year celebration. Last month, we celebrated spring with an Easter/Passover undercurrent. Next time will be a reunion with folks from the Office of Cyber Infrastructure, a recent spin off from CISE.

I am getting ready to leave my office at NSF for the beautiful Washington Union Station, where I will catch the train up to NJ, to participate in the panel session of the Open Partnership Conference [8] titled, "Harnessing the Power to Cross-Sector Collaboration."

Till next time, dream big, and keep in touch!

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[3] http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07540

[4] http://www.nsf.gov/pubs/2007/nsf07525/nsf07525.htm

[5] http://www.nsf.gov/dir/index.jsp?org=CISE

[6] http://www.nsf.gov/about/budget/fy2008/pdf/39_fy2008.pdf

[7] http://www.nap.edu/catalog.php?record_id=11516

[8] http://www.njit.edu/academics/provost/openpartnership/

[9] http://www.nsf.gov/news/news_summ.jsp?cntn_id=108322

FORTY-FIFTH ANNUAL ALLERTON CONFERENCE

ON COMMUNICATION, CONTROL, AND COMPUTING

September 26 – September 28, 2007

The Forty-Fifth Annual Allerton Conference on Communication, Control, and Computing will be held from Wednesday, September 26 through Friday, September 28, 2007, at Allerton House, the conference center of the University of Illinois. Allerton House is located twenty-six miles southwest of the Urbana-Champaign campus of the University in a wooded area on the Sangamon River. It is part of the fifteen-hundred acre Robert Allerton Park, a complex of natural and man-made beauty designated as a National natural landmark. Allerton Park has twenty miles of well-maintained trails and a living gallery of formal gardens, studded with sculptures collected from around the world.

Papers presenting original research are solicited in the areas of communication systems, communication and computer networks, detection and estimation theory, information theory, error control coding, source coding and data compression, queueing networks, control systems, robust and nonlinear control, adaptive control, optimization, dynamic games, large- scale systems, robotics and automation, manufacturing systems, discrete event systems, intelligent control, multivariable control, computer vision-based control, learning theory, neural networks, VLSI architectures for communications and signal processing, and automated highway systems.

Plenary lecture: Professor John Tsitsiklis of the Massachusetts Institute of Technology will deliver this year's plenary lecture. It is entitled "Decentralized detection with a tree of sensors." It is scheduled for Friday, September 28, 2007.

Information for authors: Regular papers, suitable for presentation in twenty minutes, as well as short papers, suitable for presentation in ten minutes, are solicited. The purpose of the short paper category is to encourage authors to present preliminary results of their work. Both Regular and Short papers will be published in full (subject to a maximum length of ten 8.5" x 11" pages) in the Conference Proceedings.

For reviewing purposes of regular papers, a title and a five to ten page extended abstract, including references and sufficient detail to permit careful reviewing, are required. For short papers, a title and a three to five page summary are required. Manuscripts that are submitted as regular papers but cannot be accommodated in that category will be considered in the short paper category, unless the authors indicate otherwise.

Manuscripts must be submitted by Sunday, July 1, 2007, following the instructions at the Conference website: http://www.comm.csl.uiuc.edu/allerton.

Authors will be notified of acceptance via e-mail by August 3, 2007, at which time they will also be sent detailed instructions for the preparation of their papers for the Proceedings.

A final version of presented papers must be submitted electronically prior to the end of the Conference.

Conference Co-Chairs: Christoforos Hadjicostis and Pierre Moulin

Email: allerton@csl.uiuc.edu URL: http://www.comm.csl.uiuc.edu/allerton

COORDINATED SCIENCE LABORATORY AND THE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

University of Illinois at Urbana-Champaign

NETCOD 2008
Fourth Workshop on Network Coding, Theory, and Applications
January 3 – 4, 2008
The Chinese University of Hong Kong

http://NetCod2008.ie.cuhk.edu.hk

Multiuser information theory has been an important research area since the 1970's. In the past few years, there has been a surge in research activities in the area due to its vast potential in applications in the foreseeable future. In particular, the recent theory of network coding reveals the surprising fact that unlike what was believed in the past, information should not be regarded as a commodity in a network. Since its inception, network coding has emerged as a new paradigm that has influenced information and coding theory, networking, wireless communications, computer science, cryptography, graph theory, and matrix theory.

NETCOD 2008 will be organized around the following themes:

- Network Coding Theory and Algorithms
- Multiuser Information Theory
- Applications of Network Coding

General Co-Chairs: S.-Y. Robert Li and Raymond W. Yeung (CUHK)

7th International ITG Conference on Source and Channel Coding (SCC'08)

VDE ITG Ulm, Germany 14-16 January 2008 IEEE

SCC'08 is organized by the ITG (Information Technology Society) expert group 5.1 (Information and Systems Theory)

Co-Chairs:
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Department of Telecommunications and Applied Information Theory, University of Ulm

Prof. Dr.-Ing. Gerhard Fettweis
Institute for Communications Engineering, Vodafone Chair Mobile Communications Systems Technical University of Dresden

Technical Program Chair
Prof. Dr.-Ing. Dr. rer. nat. Holger Boche
Institute for Telecommunications Technical University of Berlin

Local Arrangements
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Siemens AG, Ulm

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Prof. Dr.-Ing. K.-D. Kammeyer, University of Bremen
Prof. Dr.-Ing. B. Lankl, BW University, Munich
Dr.-Ing. S. Lechner, Siemens AG, Munich
Prof. Dr.-Ing. R. Mathar, RWTH Aachen
Prof. Dr.-Ing. P. Noll, TU Berlin
Prof. Dr. J. R. Ohm, RWTH Aachen
Dr.-Ing. M. Oerder, Philips GmbH, Aachen
Prof. Dr.-Ing. Ch. Ruland, University of Siegen
Prof. Dr. B. Schmauß, University of Erlangen-Nuremberg
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Topics of interest include but are not limited to:

- Classical Information Theory
- Network Information Theory
- Multi-user Information Theory
- Source Coding and Compression
- Speech, Audio, Image and Video Coding
- Channel Coding and Coded Modulation
- Joint Source and Channel Coding, Error Concealment
- Multiple Access (e.g. CDMA)
- MIMO Systems and Space-Time Coding
- Synchronization
- Cryptography
- Quantum Information Theory
- Applications

Invited key notes will be held to aspects of new developments in Information Theory and Estimation Theory.

There will be oral presentations of 25 minutes and short plenum presentations of posters.

Submission

Authors are invited to submit a full 6-page paper before **July 21, 2007**. Only electronic submissions will be accepted. Further details can be found on the conference website **www.mk.tu-berlin.de/scc08**

At least one author of the accepted paper must be registered for the conference by **October 15, 2007** in order to be published in the proceedings.

Presentations and papers should be in English.

For information regarding registration, accommodation and transport please check the conference website www.mk.tu-berlin.de/scc08

Deadlines

Submissions due:	**July 21, 2007**
Notification of acceptance:	**September 15, 2007**
Camera-ready papers due:	**October 15, 2007**

Call for Papers

2008 International Zurich Seminar on Communications

March 12 - 14, 2008

The 2008 International Zurich Seminar on Communications will be held at the Hotel Zürichberg in Zurich, Switzerland from Wednesday March 12 through Friday March 14, 2008.

High-quality original contributions of both applied and theoretical nature are solicited in the areas of:

Wireless Communications	UWB Communications
Information Theory	Fundamental Hardware Issues
Coding Theory and its Applications	Network Algorithms and Protocols
Detection and Estimation	Network Information Theory and Coding
MIMO Communications	Cryptography and Data Security

Invited speakers will account for roughly half the talks. In order to afford the opportunity to learn from and communicate with leading experts in areas beyond one's own specialty, no parallel sessions are anticipated. All papers should be presented with a wide audience in mind.

Papers will be reviewed on the basis of a manuscript (not exceeding 4 pages) of sufficient detail to permit reasonable evaluation. Authors of accepted papers will be asked to produce a manuscript not exceeding 4 pages that will be published in the Proceedings and on IEEE Xplore. Authors will be allowed twenty minutes for presentation.

The deadline for submission is **October 8, 2007**.

Additional information will be posted at

`http://www.izs2008.ethz.ch/`

We look forward to seeing you at IZS and to celebrating its 20th jubilee with you.

Amos Lapidoth and Hans-Andrea Loeliger, Co-Chairs.

ITW 2008 PORTO

IEEE Information Theory Workshop | May 5-9, 2008 | Porto, Portugal

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Luísa Lima
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Administration:
Sílvia Ribeiro

The 2008 IEEE Information Theory Workshop (ITW 2008) will take place on May 5-9 in Porto, Portugal. The chosen venue is the magnificient Palacio da Bolsa, right by the River Douro, in the heart of the World Heritage Site of Porto.

Invited sessions will take a brief look into the recent information theory past to commemorate the 60th anniversary of Shannon's landmark paper, and then proceed to explore opportunities for information theory research in quantum computation, biology, statistics, and computer science. A large majority of papers will be contributed, and are solicited in (but not limited to) the following areas:

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

Contributions by authors new to the information theory community are particularly encouraged. Abstracts of up to 5 pages should be submitted by **November 16, 2007** following the guidelines on the workshop web page. Authors will be notified of acceptance decisions by **February 16, 2008**. The final version, to be published in the workshop proceedings, will be due by **March 7, 2008**.

Information regarding the technical and social programs, final manuscript format, workshop registration, and hotel accommodations will be posted on the workshop website at:

http://www.dcc.fc.up.pt/~itw2008/

IEEE Transactions on Information Forensics

Special Issue on Statistical Methods for Network Security and ForensicsRecently, probabilistic methods have gained importance in various aspects of network security and forensics. Such methods are at the forefront of recent advances in intrusion detection, but also underlie distributed detection and estimation for sensor networks and information-theoretic approaches to network security. In the context of intrusion detection, statistical pattern recognition is a core problem which can be addressed using methods from Bayesian theory, learning theory, graphical models, and data mining. Data acquisition, processing, and inference in sensor networks also leverage a substantial body of literature on statistical estimation, detection, and classification theory.

At the same time, new developments in network information theory have led to renewed interest in classical aspects of information-theoretic security, such as wiretapping, as well as new areas of work, such as network coding applications to security. Many advances in network information theory revolve around wireless networks and sensor networks, areas in which a shared medium and rich, variable topologies, create particularly challenging problems. Information theory has proven useful both for determining the fundamental performance limits of such systems, including jamming and novel countermeasures, e.g., coding techniques in networks.

The goals of the special issue are to provide the reader with an overview of the state of the art in this field, and to collect significant research results. Possible topics for papers submitted to the special issue include, but are not limited to:

- Intrusion, masquerade, and anomality detection
- Network scaling issues
- Network surveillance
- Dynamic models for mobile ad-hoc networks
- Distributed sensing, estimation, detection, and classification
- Information theory for secrecy in wireless networks
- Advances in the wiretap channel
- Eavesdropping and jamming in wireless networks
- Network information theory for Byzantine attacks
- Security aspects of network coding

INSTRUCTIONS FOR MANUSCRIPTS

Manuscripts should be submitted electronically by following the information for authors at http://www.ieee.org/organizations/ society/sp/tifs.html.

Both the manuscripts and cover letter should be clearly marked to indicate that they are being submitted for consideration for this Special Issue.

They will be logged and sent to the Special Issue Editors for review.

Both full-length regular papers and short papers will be considered, subject to the normal Transactions page limits. Papers must not have been published previously or submitted for publication elsewhere. All papers will be reviewed by following the guidelines of the transactions.

IMPORTANT DATES

Oct. 1, 2007: Paper submission deadline

Jan. 2, 2008 Completion of first round of reviews

May 1, 2008 Final review and selection of papers

June 1, 2008 Final manuscripts to IEEE

Sept.1, 2008 Publication of the Special Issue

Conference Calendar

DATE	CONFERENCE	LOCATION	CONTACT/INFORMATION	DUE DATE
May 20-23, 2007	**2007 IEEE Communication Theory Workshop (CTW 2007)**	Sedona, AZ, USA	http://www.ece.utah.edu/~ctw2007/	March 15, 2007
June 17-20, 2007	**IEEE International Workshop on Signal Processing Advances for Wireless Communications (SPAWC 2007)**	Helsinki, Finland	http://wooster.hut.fi/spawc07/	January 26, 2007
June 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, 2006
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
July 15-20, 2007	**9th International Symposium on Communication Theory and Applications (ISCTA '07)**	Ambleside, Lake District, UK	http://www.hwcomms.com/iscta07.htm	TBA
August 29-30, 2007	**12th International OFDM-Workshop 2007 (InOWo'07)**	Hamburg, Germany	http://ofdm.tu-harburg.de	April 13, 2007
Sept. 2-6, 2007	**2007 IEEE Information Theory Workshop (ITW 2007)**	Lake Tahoe, CA, USA	http://www.ece.tamu.edu/itw2007/	April 1, 2007
Sept. 26-28, 2007	**The Annual Allerton Conference on Communication, Control and Computing (Allerton 2007)**	Monticello, IL, USA	http://www.comm.csl.uiuc.edu/allerton/	July 1, 2007
Oct. 1-3, 2007	**2007 IEEE 65th Vehicular Technology Conference VTC2007 (VTC 2007 Fall)**	Baltimore, MD, USA	http://www.ieeevtc.org/vtc2007fall/index.php	Feb. 10, 2007
Nov. 26-30, 2007	**2007 IEEE Global Communications Conference (GLOBECOM 2007)**	Washington D.C., USA	http://www.comsoc.org/confs/globecom/2007/	March 15, 2007
Nov. 4-7, 2007	**The Asilomar Conference on Signals, Systems, and Computers (Asilomar 2007)**	Monterey, CA, USA	http://www.asilomarssc.org/	June 1, 2007
May 5-9, 2008	**2008 IEEE Information Theory Workshop (ITW 2008)**	Porto, Portugal	http://www.dcc.fc.up.pt/~itw2008/	March 7, 2008
April 13-19, 2008	**2008 IEEE Conference on Computer Communications (INFOCOM 2008)**	Phoenix, AZ, USA	http://www.ieee-infocom.org/2008/	March 7, 2008
May 25-28, 2008	**2008 IEEE International Conference on Communications (ICC 2008)**	Beijing, China	http://www.ieee-icc.org/2008/call4paper.htm	September 15, 2007