

# IEEE Information Theory Society Newsletter



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I started writing this column while on  
vacation at the beautiful Kailua beach

## From the Editor

Tara Javidi

Dear IT Society members,

In the third issue of 2014, in addition to our popular and regular contribution by our historian Tony Ephremides and our puzzle master Solomon Golomb, we have an important contribution by Aylin Yener on the financial state of the society and two school/workshop reports. We are also featuring an article highlighting the mentoring activities and call for participation in the program. I thank Vitaly Skachek, Vincent Tan, Vijay Bhargava, and Jeorg Kliever for their contributions. I would also like to thank Amos Lapidot for providing our latest Teaching IT column. As most of our readers remember, the teaching IT column started a few years back with occasional (invited) and excellent contributions by some of the most distinguished members of IT Society.

As a reminder, announcements, news and events intended for both the printed newsletter and the website, such as award announcements, calls for nominations and upcoming conferences, can be submitted jointly at the IT Society website <http://www.itsoc.org/>, using the quick links "Share News" and "Announce an Event." Articles and columns also can be e-mailed to me at [ITSocietynewsletter@ece.ucsd.edu](mailto:ITSocietynewsletter@ece.ucsd.edu) with a subject line that includes the words "IT newsletter." The next few deadlines are:

Issue	Deadline
December 2013	October 10, 2014
March 2014	January 10, 2015
June 2014	April 10, 2015

Please submit plain text, LaTeX or Word source files; do not worry about fonts or layout as this will be taken care of by IEEE layout specialists. Electronic photos and graphics should be in high resolution and sent as separate files. I look forward to hear your suggestions (especially regarding the new column) and contributions.

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## The Historian's Column

Anthony Ephremides

Information Theory is reaching the mature age of 66 this year. So, it is time to consider the human aspect of its historical thread. What about those men and women who have embraced the field and by their presence and devotion have actually imprinted their identity on the field itself?

The turnover in 66 years is substantial, if not transformational. Shannon's figure continues to loom large and unperturbed by the mere time-scale of less than a century. But how about all others who have helped sculpt the face of Information Theory? The pioneers clearly emerged from the epicenter of the revolution of 1948, namely MIT and Bell Labs. Fano, Elias, Slepian, Wyner, and then people like Gallager, Massey, Cover, Kailath, Sloane and so many others who populated the early years of the field and whose presence in the Transactions and Symposia were the staples of the Society's activities.

As time has gone by, the "faces" that dominate our field have also been evolving. Some passed away, others faded away for different reasons, and many newcomers and bright new stars have risen in the horizon. Has the texture of the human crowd in our field retained constancy? Sixty-six years is a long time. The old faces are becoming scarcer. Every year at the ISIT the silent absence of yet someone else is noted. Those who were thought to be irreplaceable are being replaced. The new faces are numerous. Is there a common thread? Does the collective image of our members retain some form of time-invariance? That is, do we believe in the same things as our "forefathers"? Do we behave the same way? Do we have the same values?

To answer this question it helps if we draw a composite sketch of the "classical" Information Theorist. Not obviously in terms of the work they do because that naturally keeps evolving. Rather, how is their attitude and style? The profile of an Information Theorist consists of some "core" elements. The legacy of the pioneers calls, first of all, for a devotion to the field. It calls for the earnest belief that this is a vibrant, challenging, and enduring field that has sprung from innovation in its purest and most fascinating form, namely simplicity and clarity. Secondly, it calls for a scientific attitude that transcends banality and over-eagerness. In other fields I often see overzealous researchers touting their work in almost childish ways. Like, "this is the first time anyone has done this", or "we are the first to have done so and so". By contrast, in our field I recall some unusual and contrasting scenes. I recall Slepian announcing just before his talk that the subject he would present "had no applications whatsoever"! Or others mentioning that the previous evening they discovered a mistake in their work, or admitting that because the last moment they had misgivings about their results they would change the content of their presentation. Self-effacing remarks have been the mark and the norm for most of the best contributions in our field. Not that our members do not have big egos. Some of them have...huge ones! I do not want to mention names but we all know some. It is that the style of presentation is more confident and detached and does not need defensiveness.

Another trait of the legacy of the early pioneers has been the intellectual depth of their work. The scientific aesthetics of Information Theory have established intellectual merit as the highest measure of a contribution. Is there scientific beauty in the work? Is there innovativeness, imagination, beauty? Yes, usefulness, utility, relevance are all important. But they come AFTER the fact. It is the fallout of the fundamental work. The main significance is not a 3 db improvement but how that improvement is obtained. It is the ideas that matter. And they should be fresh, interesting, attractive, and inspiring. If we cannot inspire the younger members, there is no future. And inspiration comes from these virtues of the legacy contributions.

Yet another trait of the "best" amongst us is a unique sense of humor that permeates even the most serious discourse. Board of Governors meetings are generally dreary affairs. Yet in the Information Theory Society they could be really entertaining events. The intellect and playfulness of most of our members would shine through the mundane agenda of these meetings. Nothing is (or should be) so serious that it causes melancholy. Just recall how that treasure of a movie (for those who were lucky to have seen it) called "Life is Beautiful" with Roberto Benigni found and displayed comedy amidst grave tragedy. I recall Aaron Wyner, after the very good financial picture reported by the Treasurer regarding the wealth of our Society in the '80's remarking that we were like Kuwait (small but rich!). Or when it was announced that we would have a workshop in New Zealand where the Lord of the Rings had been shot, someone propose to have a session on the Lord of the algebraic Rings. Or when there was a debate whether to have a workshop in Ireland or Scandinavia, a proposal was made (tongue-in-cheek) to hold the workshop, as a compromise, in Northern Ireland. And, on-and-on they went all kinds of nuggets of wit which would also surface in the presentations and the general atmosphere of jolliness that permeated our meetings. An apex has been reached in this regard with the hilarious ideas of the recognized genius of the form, Alon Orliitsky, with the ITA format. Here is a meeting that emerged shyly from nothing to earn the respect of our members through its content AND through the jolliness of its tone. There is probably no other meeting in the world that accepts without review the papers in its program and has, on average, one of the highest-quality



and, thus, using the Sandwich Theorem,

$$P \frac{1}{T} A^2 \quad K \quad R \quad T$$

By substituting 0 for  $\tau$  in (13) and by recalling the definition of power (2), we obtain that if  $(X(t))$  is a centered SP of power  $P$  and of average autocovariance function  $\bar{K}_{XX}$ , then

$$P = \bar{K}_{XX}(0). \quad (14)$$

An example of a SP that has an average autocovariance function is the PAM signal (3). In fact, the calculation of its average autocovariance function is very similar to the calculation of its power.

The following theorem provides an operational meaning to the average autocovariance function and shows that if it is integrable, then its FT is the OPSD. Thus, for stochastic processes having an integrable average autocovariance function, our definition of the OPSD and the definition in the literature of the operational PSD as the FT of  $\bar{K}_{XX}$  coincide.<sup>2</sup> It also provides a method for computing the operational PSD: compute  $\bar{K}_{XX}$  and take its FT.

**Theorem 1 (The OPSD and the Average Autocovariance Function).** Let  $(X(t))$  be a centered SP of average autocovariance function  $\bar{K}_{XX}$ .

1) If  $h$  is the impulse response of some stable filter, then

$$\text{Power in } X \text{ through } h = \int_{-\infty}^{\infty} \bar{K}_{XX}(\tau) R_{hh}(\tau) d\tau. \quad (15)$$

2) If  $\bar{K}_{XX}$  is integrable, then its Fourier Transform is the OPSD of  $(X(t))$ :

$$\bar{K}_{XX}(\tau) \xrightarrow{FT} S_{XX}(f). \quad (16)$$

## 6 The OPSD and Power

Intuition suggests that the OPSD should integrate to the power. To see why, recall that if  $X$  is of OPSD  $S_{XX}$ , then

$$\text{Power in } X \text{ through } h = \int_{-\infty}^{\infty} S_{XX}(f) |\hat{h}(f)|^2 df, \quad h \in L_1. \quad (17)$$

Suppose we now substitute for  $h$  the impulse response of a filter whose frequency response resembles that of an ideal unit-gain lowpass filter of very large cutoff frequency  $W \gg 1$ . In this case the RHS of (17) would resemble the integral of  $S_{XX}(f)$  from  $-W$  to  $W$ , which is approximately the integral from  $-\infty$  to  $\infty$  when  $W$  is very large. And as to the LHS, if  $W$  is very large, then intuition suggests that  $X$  will hardly be altered by the filter, and the LHS would approximately equal the power in  $X$ .

This intuition is excellent, and for most stochastic processes of in-

the random variables  $X(t)$  and  $X(t')$  are uncorrelated. For  $t$  inside this finite interval the correlation between  $X(t)$  and  $X(t')$  is upper bounded by 1. Consequently, when we average  $E X(t)X(t')$  over  $t$ , the contribution of  $t$ 's inside this interval washes out and the result is zero.





from IEEEExplore downloads which is our major source of income. We knew this was going to happen, so the Board approved two very important proposals last year which not only had their own merit for our membership, but also ensured the financial health of the society for the next few years. The first

were given on Thursday. In the morning, Ruediger Urbanke gave a talk on spatially-coupled LDPC codes. In the afternoon, Venkatesan Guruswami spoke about list decoding. The school was concluded on Friday by Yuval Ishai, who spoke about information-theoretically secure multi-party computations.

The social program created opportunities for networking and collaborations among the participants. Multiple events were included in the program, including three informal dinners, one official dinner and one dinner for invited speakers and organizers. A guided walking tour into Tallinn old town took place on Wednesday afternoon.

After the event, many attendants reported their satisfaction both with the organization and with the scientific contents. The team of organizers consisted of Vitaly Skachek, Helger Lipmaa, Dominique Unruh, Sven Laur and Juri Lember from the University of Tartu. The organization benefited from the advisory board that included Gerhard Kramer, Petar Popovski and Deniz Gunduz. The advisory board also included Marcus Greferath and Mario Pavcevic, who greatly helped with issues related to the COST Action support. The local organization in Tallinn was efficiently handled by Kerli Kangro from Tallinn University Conference Center. In Tartu, the project management was handled by Kairit Shor. Special thanks to Ivo Kubjas for taking care of video recording.

The preparations for ESIT 2015 in the Netherlands are under way. We are looking forward to next year's event.

## Organizers:

Marco Tomamichel (Center for Quantum Technologies, NUS)

Vincent Y. F. Tan (Dept of ECE and Dept of Math, NUS)

Stephanie Wehner (Center for Quantum Technologies, NUS)

A group of approximately 60 classical and quantum information theorists converged to the National University of Singapore on the sunny island of Singapore in mid-May 2014 for the second edition of the Beyond IID in information theory workshop. This workshop is a follow-up on the first edition held in Cambridge, U.K. on 8–11 Jan 2013.

Information theory has found a very large range of applications

## IT Society Member Honored

Vijay Bhargava of the University of British Columbia, Vancouver, was this year's recipient of the Canadian Award for Telecommunications Research. This is a career award recognizing distinguished contributions made by an individual in Canada to research in the field of Telecommunications and was made at the 27th Queen's Biennial Symposium on Communications held in Kingston, Ontario during 1–3 June 2014. A long time member of the IT Society, Vijay's current

research interest is spectrum and energy efficient design of wireless systems.

Vijay was on the organizing committee of ISIT'83 (St. Jovite, Quebec) and ISIT'95 (Whistler, British Columbia) and ITW 2002 (Bangalore, India). He has served as the President of the IT Society (2000) and of the IEEE Communications Society (2012, 2013). He is a recipient of the IEEE Haraden Pratt Medal "for meritorious service to the Institute, particularly in regional and section activities, and for his efforts to improve relationship with technical and professional organizations worldwide".

GOLOMB'S PUZZLE COLUMN™

### Words With Repeated Letters

Solomon W. Golomb

Your challenge this time is more verbal than numerical. For each letter of the alphabet (from A to Z) and for each positive integer  $k$ , what is the shortest word you can find containing  $k$  copies of the given letter? (E.g., the word unusual contains the letter u three times.)

You may use any English word listed in a good collegiate dictionary, or, as second choice, familiar geographic names or brand names. Also, if no "normal" word can be found with  $k$  copies of the given letter, you may use a hyphenated near-reduplication term, like hocus-pocus or wishy-washy. Finally, if nothing else is available, you may use a familiar word from a

foreign expression, such as either word from *sacre bleu* or from *guten Morgen*.

Only a very few letters (e.g. I and S) can be found as many as seven times in a single word. Your words may include endings (or prefixes) that can normally be attached to a given part of speech, e.g. lengthening the verb *vacate* to *vacationing*, or changing the adjective *happy* to *unhappiness*.

You are very likely to find improvements over your first attempts. Good hunting!

## President's Column

continued from page 1

The Annual Meeting of the Society took place on Sunday before ISIT. Among the highlights of this meeting was the presentation by Frank Kschischang of the report from the ad hoc committee on online supplements recommending allowing for peer-reviewed online-only supplementary material to be posted on Xplore together with each IT Transactions paper, entirely at the authors' discretion. Details will be posted in the Information for Authors. Muriel Medard presented the final report of the ad hoc

committee on future directions. The full report will be published in the Newsletter.

Finally, the next important event of our society is the 2013 Information Theory Workshop, which will be held in Hobart, Tasmania, in November. I hope you enjoy the rest of the summer and please do not hesitate to email me your suggestions and comments at: [abbas@ee.stanford.edu](mailto:abbas@ee.stanford.edu).

GOLOMB'S PUZZLE COLUMN™

## Counting Necklaces Solutions

Solomon W. Golomb

- 1) The number of  $n$ -bead necklaces in  $c$  colors, distinct under cyclic rotation, is

$$\frac{1}{n} \sum_{d|n} \phi(d) c^{n/d}$$

where the summation is over all divisors  $d$  of  $n$ , and  $\phi(\cdot)$  is Euler's phi-function.

- 2) The number of such necklaces which are also distinct relative to reflection ("flipping over") is given by

$$\frac{1}{2n} \left( \sum_{d|n} \phi(d) c^{n/d} + n \cdot c^{\frac{n+1}{2}} \right) \text{ if } n \text{ is odd,}$$

and

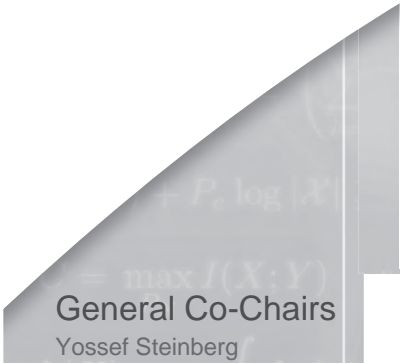
$$\frac{1}{2n} \left( \sum_{d|n} \phi(d) c^{n/d} + \frac{n}{2} c^{\frac{n}{2}} + \frac{n}{2} c^{\frac{(n+2)}{2}} \right)$$

## IT Society Mentoring Network: Call For Participation

Do you need advice whether you should postdoc for another year? Do you need someone to help with your first proposal? Do you need someone to talk about whether you should move to this new exciting research direction?

Then you should consider joining the IT Society Mentoring Network. A typical mentor/mentee pairing is a faculty member or professional in industry mentoring a graduate student or postdoc, or a senior faculty or industry researcher mentoring a junior faculty or researcher. We strongly encourage mentees to become also mentors currently or in the future.

A mentor/mentee relationship will be a priori a two year one. A mentor will agree to communicating with his/her mentee roughly a few times per year to provide professional advice and feedback, e.g., by helping the mentee with proposal writing or by introducing him to potential collaborators. The only requirement for our mentoring program is that a mentee should be part of the IEEE



## General Co-Chairs

Yossef Steinberg  
Technion, IIT  
Ram Zamir  
Tel Aviv University  
Jacob Ziv  
Technion, IIT

## TPC Co-Chairs

Alexander Barg  
University of Maryland  
Meir Feder  
Tel Aviv University

## Local Arrangements

Call for Papers

Schedule

Plenary Speakers

Paper Submission

## Conference Calendar

DATE	CONFERENCE	LOCATION	WEB PAGE	DUE DATE
September 14–17, 2014	2014 80th Vehicular Technology Conference (VTC2014-Fall)	Vancouver, Canada	<a href="http://www.ieeevtc.org/vtc2014fall/">http://www.ieeevtc.org/vtc2014fall/</a>	Passed
October 1–3, 2014	52nd Annual Allerton Conference on Communication, Control, and Computing	Monticello, Illinois, USA	<a href="http://www.csl.uiuc.edu/allerton/">http://www.csl.uiuc.edu/allerton/</a>	Passed
October 26–29, 2014	2014 International Symposium on Information Theory and its Applications (ISIT A 2014)	Melbourne, Australia	<a href="http://www.isita.ieice.org/2014/">http://www.isita.ieice.org/2014/</a>	Passed
November 2–5, 2014	Asilomar Conference on Signals, Systems, and Computers (ASILOMAR 2014)	Pacific Grove, CA, USA	<a href="http://www.asilomarssconf.org/">http://www.asilomarssconf.org/</a>	Passed
November 2–5, 2014	IEEE Information Theory Workshop (ITW 2014)	Hobart, Tasmania, Australia	<a href="http://itw2014.jaist.ac.jp/">http://itw2014.jaist.ac.jp/</a>	Passed
December 3–5, 2014	IEEE Global Conference on Signal and Information Processing (GlobalSIP 2014)	Atlanta, Georgia, USA	<a href="http://www.ieeeglobalsip.org/">http://www.ieeeglobalsip.org/</a>	Passed
December 8–12, 2014	2014 IEEE Global Communications Conference (GLOBECOM 2014)	Austin, Texas, USA	<a href="http://www.ieee-globecom.org/">http://www.ieee-globecom.org/</a>	Passed
April 26–May 1, 2015	34th IEEE International Conference on Computer Communications (INFOCOM 2015)	Hong Kong	<a href="http://infocom2015.ieee-infocom.org/">http://infocom2015.ieee-infocom.org/</a>	Passed
June 8–12, 2015	IEEE International Conference on Communications (ICC 2015)	London, United Kingdom	<a href="http://icc2015.ieee-icc.org/">http://icc2015.ieee-icc.org/</a>	September 15, 2014
June 14–19, 2015	2015 IEEE International Symposium on Information Theory (ISIT 2015)	Hong Kong	<a href="http://www.isit2015.org/">http://www.isit2015.org/</a>	TBA

Major COMSOC conferences: <http://www.comsoc.org/confs/index.html>