

IEEE Information Theory Society Newsletter



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President's Column

Emina Soljanin

As I write these words, a majestic Fall of the US Northeast is unfolding, yet again. These days, I go for long walks through parks to think about research, but end up thinking about trees as well, or even more so. I see oaks stubbornly refusing to part from their already brown leaves, maples all too happy to surrender their golden crowns to even a slightest breeze, and pines that seemingly never change. And for a fleeting moment, I understand why some cultures see the Fall rather than the Spring as the season of new beginnings, when the past is being shed and blown away with multicolored leaves. But then again, people as trees have each their ways and timelines for dealing with and letting go of past events. Because *nothing erases the past. There is repentance, there is atonement, and there is forgiveness. That is all, but that is enough* [1].



I will not talk about the past of our Society, not even about the past year, although this is my last column. I have already written about the efforts and achievements of many Society's volunteers and thanked some in particular. I strongly believe that the Society is in good hands of our Board of Governors with its upcoming leadership, and that we have created a strong jumping board to either bounce back to the good old days or fly to new heights, or both; whichever you prefer. And that was my goal, to re-establish a fulcrum. But those who want to move the world (like Archimedes or in their own way) have to find long enough levers for themselves and, even more importantly, *a leg to stand on* [2], [3].

I am looking forward to moving closer to being again a full-time researcher, teacher, and mentor. These are exciting and trying times for our technical field, and its various sub-fields. But that has always been the case, and it is the name of the game called research. Let's consider an example where I have some competence to talk about, that of coding theory, techniques, and practice. We have come a long way from the Shannon's theorem which essentially says that *all codes are*

good, later revised into a folk theorem claiming that *all codes are good, except those that we know of* [4] and its immediate corollary asserting that *any code of which we cannot think is good* [5]. Yet, we still regularly proclaim that coding theory is dead only to see it awaken from the royal slumber again and again, with *a crown to wear in grace and beauty, as is its right and royal duty* [6].

Coding has *traditionally* been used at the physical layer in communication networks to recover from errors and erasures incurred in transmission and storage. There, it is easy to account for the cost of coding (e.g., in bandwidth and energy) and argue for its use. Yet, introducing codes in commercial products has not been easy and has been, well, interesting [7]. Do you know how many bits go into a second of digital music? Do you know what the first mass-market electronics product equipped with fully-fledged error correction and channel coding systems was, and that it came out so recently that it puts in question my use of the word *traditional* in connection with coding?

These days, novel schemes, which transcend the traditional role and place of coding, are being proposed and considered for implementation in real systems. Such schemes (e.g., rateless and network coding as well as coding for cloud storage and computing) impact not only energy and bandwidth, but also network traffic and protocols. They make invalid various independence assumptions and complicate addressing and security schemes in content networking. We thus cannot expect that introducing codes into new products will be an easy journey, and must have at least as much perseverance as our predecessors [7].

The conventional performance indicators of codes are the minimum distance and the code rate. More recently, special codes have been developed that also provide efficient maintenance

(continued on page 4)

From the Editor

Salim El Rouayheb



I hope everyone has had a great year so far, and best wishes for the coming new year. We start this December issue with Emina Soljanin’s column as president of the IT society. Please join me in thanking Emina for her service and welcoming our incoming president Aylin Yener. The past few months have been busy with several schools and workshops. We have reports from the North American School of Information Theory, the African Winter School on Information Theory and Communications and the Munich Workshop on Coding and Cryptography. We also have an update from the the IEEE Information Theory chapter in Japan who won the 2019 Chapter of the Year award. This issue features an article by Robert Gallager on “Claude Shannon’s Creative Thinking”. We continue with the BoG minutes from its last meeting at ISIT in Paris last summer. With sadness, we conclude with an in memoriam

for Jørn Justesen who passed away recently. A full tribute will appear in a forthcoming issue.

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 at the IT Society website <http://www.itsoc.org>. Articles and columns can be e-mailed to me at salim.elrouayheb@rutgers.edu with a subject line that includes the words “IT newsletter.”

The next few deadlines are:

Jan 30, 2020 for the issue of March 2020.

April 10, 2020 for the issue of June 2020.

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.

Salim El Rouayheb

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Report on the North American School of Information Theory (NASIT)

Flavio Calmon and Bobak Nazer

On July 2nd-5th, students and post-doctoral researchers from across the United States gathered at Boston University's Photonics Center for the 2019 North American School of Information Theory (NASIT). The school, offered for the twelfth time, is one of the main educational events in the broader fields of information theory, coding theory, and related applications. This year's school provided young researchers a unique opportunity to present their work in poster sessions, learn from prominent members of the information theory community, and interact with peers from across the globe—all while enjoying the scenic views of the Charles River.

This year's NASIT was attended by more than 80 participants from 46 academic institutions. The school was supported by the National Science Foundation (NSF), IEEE Information Theory Society, the Center for Science of Information (an NSF Science and Technology Center) and by the IEEE Padovani Fund. This year's school also coincided with the US Independence Day, allowing students to enjoy Boston's world-famous 4th of July fireworks in person.

The school was kicked-off with a tutorial by Prof. Tara Javidi from the University of California, San Diego, who lectured about sequential and adaptive information acquisition. The talk covered how problems in active machine learning and multi-modal sensing can be fundamentally understood by extending classical tools found in experiment design, active hypothesis testing, and information utility. Dr. Javidi described how this fundamental perspective can inform many practical applications, ranging from adaptive search strategies for target localization using drones to tuning of large-scale machine learning models.

The Padovani Lecture was given by Prof. Kannan Ramchandran from the University of California, Berkeley. Dr. Ramchandran presented a sweeping overview of the power of codes. Attendees were exposed to several essential coding-theoretic ideas, including the duality between source and channel coding, the connection between encryption and compression, the role of coding in sampling below the Nyquist rate and signal reconstruction, how sparsity can be exploited in learning and inference, and how codes can be applied to distributed computing and machine learning. The Padovani Lecture is one of the awards given by the IEEE Information Theory Society and is generously sponsored by Dr. Roberto Padovani. Dr. Ramchandran officially received the Padovani Lecture Award at the IEEE International Symposium on Information Theory in Paris, France.

The second day of the school started with a lecture by Prof. Adam Smith from Boston University. Dr. Smith focused on the burgeoning research field of differential privacy—a restriction on data analysis algorithms that offers meaningful confidentiality guarantees against attackers with arbitrary side information. Attendees learned about the mathematical underpinnings of differential privacy, how it is motivated by real-world privacy threat scenarios, and its deployment at the US Census Bureau and in industry. The talk also covered how fundamental concepts from this field can be used to study applications in game theory and adaptive data analysis.



Students and post-docs also had an opportunity to participate in an insightful discussion about information theory in industry. The discussion was led by three panelists: Dr. Brooke Shrader (MIT Lincoln Laboratory), Prof. Vivek Goyal (Boston University), and Prof. Flavio Calmon (Harvard University). The panelists shared their experiences working at government and industry research labs, describing similarities and differences with academia. Students also learned about the panelists' trajectories from academia to industry and back. The attendees asked several questions about how to prepare for an industry job, learning from the panelists about resources that can help their job search as well as common misconceptions about working in industry.

The third day of the school opened with a lecture by Prof. Alexander Barg from the University of Maryland, College Park, who presented a survey of recent results on erasure codes for distributed storage and related problems. Dr. Barg explained how the task of node repair in distributed storage gives rise to a range of new problems in coding theory and the related areas of computer science and discrete mathematics. The lecture demonstrated that, over the past decade, research in these problems have led to the emergence of impactful new methods and ideas that can significantly improve the design of distributed storage systems. After the lecture, students had a free afternoon to enjoy the 4th of July in Boston and watch the Independence Day fireworks.

The final day of the NASIT started with a tutorial on information, concentration, and learning by Prof. Maxim Raginsky from the University of Illinois at Urbana-Champaign. Dr. Raginsky focused on how information-theoretic ideas can be used to quantify



different performance aspects of machine learning algorithms. The lecture presented key concepts in machine learning and introduced the information stability property, which allows generalization error of learning algorithms to be bounded using mutual information. Dr. Raginsky demonstrated how this unique perspective can be used to analyze the Gibbs algorithm as well as iterative noisy algorithms such as stochastic gradient descent.

The school concluded with a hands-on machine learning workshop led by Dr. Kalyan Veermachaneni from the Massachusetts Institute of Technology. The tutorial provided an introduction to machine learning in Python. Students had the opportunity to program their own end-to-end machine learning pipeline and test their code on real-world datasets.

Attendees shared their latest research during two poster sessions. These sessions enabled students to train their presentation skills, learn from their peers, and receive valuable feedback on the problems they are working on. Overall, the school provided a supportive environment for professional and academic development in information theory for both the beginner and more senior attendees. The school also included many networking opportunities through a board games and pizza night, a banquet at a local restaurant, and several coffee breaks scattered throughout the program.

NASIT 2019 was organized by Prof. Bobak Nazer (Boston University), with the support of Flavio Calmon (Harvard), Salim El Rouayheb (Rutgers), Arya Mazumdar (UMass Amherst), Muriel Médard (MIT), Yury Polyansky (MIT), and Anand Sarwate (Rutgers). The school would not have been possible without the tireless effort of several student volunteers, administrative support from the Boston University ECE Department, and guidance from Krishna Narayanan (Texas A&M), Aylin Yener (Penn State), Stark Draper (Toronto), and Matt LaFleur (IEEE).

Videos of tutorials as well as photos from NASIT 2019 can be found at <https://www.itsoc.org/conferences/schools/nasit2019>. NASIT 2020 will be held July 8-10 at the University of British Columbia, Vancouver with more information available at <http://conferences.ece.ubc.ca/nasit2020/>.

President's Column *(continued from page 1)*

of storage under node failures. In addition to the standard metrics, the properties of codes that matter in such scenarios are the locality, availability, and update efficiency. Emerging applications, such as distributed learning and fog computing, are adding yet another use for coding. In these applications, the goal is to maximize the number of users that can be simultaneously served by the system as well as to minimize the expected service time. These new goals require new research. Then there are newly proposed models for computing: neuromorphic, cryogenic, quantum; none of which can come to reality without error correction. And if that is not enough, you can turn to the stars and join those who are trying to find out if *spacetime is a quantum error-correcting code*.

When I raise my gaze a little above the almost bare tree tops, I see stars and think about exoplanets. The first definitive detection of an exoplanet orbiting a sun-like star was reported almost a quarter century ago, and has just been recognized by a share of the Nobel Prize in physics. But planetary-mass objects that fascinate me the most do not orbit stars and pulsars, but galactic centers directly. They are called many names including rogue, interstellar, nomad, starless planets, but my favorite is *unbound* planets. It is through that name that I can relate to them. As I think how to use my limited knowledge to engineer new systems and devices, I wonder if information theory has already been used to engineer the universe, and want to find out how.

And there, dear colleague, you shall go, with our technical field and our professional society. Just remember, that it takes lot of work to get there, *per aspera ad astra*, and, by the way, women were

not *given* the right to vote, they *fought and won* the right to vote. But at the moment, dear colleague, to autumn leaves and past presidents, as *to the guests that must go, bid God's speed and brush away all traces of their steps*.

References

- [1] Ted Chiang, "The Merchant and the Alchemist's Gate," in *Exhalation: Stories*. Knopf Doubleday Publishing Group, 2019.
- [2] *Give me a lever long enough and a fulcrum on which to place it, and I shall move the world.* — a quote by Archimedes of Syracuse (c. 287 BC – c. 212 BC)
- [3] Oliver Sacks, A Leg to Stand On, *Touchstone*; reprint edition, 1998
- [4] J. M. Wozencraft and B. Reiffen, Sequential Decoding. Cambridge, MA: MIT Press, 1961.
- [5] J. T. Coffey, R. M. Goodman, "Any code of which we cannot think is good," *IEEE Trans. Information Theory* 36(6): 1453–1461 (1990)
- [6] Clyde Geronimi, *Sleeping Beauty*, Walt Disney Studios Motion Pictures, 1959
- [7] KAS Immink, "Shannon, Beethoven, and the compact disc," *Information Theory Society Newsletter*, December 2007.
- [8] Rabindranath Tagore, "The Gardener XLV: To the Guests".

3rd African Winter School on Information Theory and Communications (AWSITC'19)

Theo Swart

The 2019 African Winter School on Information Theory and Communications took place at Mount Amanzi, a picturesque resort about 80 km outside Johannesburg, South Africa. It was organized by Reolyn Heymann, Theo Swart, Thokozani Shongwe, Allan Emleh, Wendy Smith (all from the University of Johannesburg) and Ling Cheng (from the University of the Witwatersrand). The school was originally planned to coincide with the 65th birthday celebration of Hendrik Ferreira, but sadly it turned out to be in memory of his life, after his passing away last year (as reported in the June 2019 newsletter).

The school is held to stimulate interest in information theory and communications amongst young academics and researchers, as well as to increase co-operation and knowledge sharing between leading international researchers, African students and universities. To this end there were invited lectures by seasoned academics

(and long-time friends and collaborators of Hendrik): Han Vinck (University of Duisburg-Essen) presented “Hendrik Ferreira: In memoriam” and “Information theory and memory systems”, Jos Weber (TU Delft) talked about “Detection and coding for noisy channels with (varying) offset mismatch” and Kees Schouhamer Immink (Turing Machines) discussed “Constrained coding for DNA-based storage”.

However, the main reason for the school was for doctoral and masters students to present their work, with a total of 26 presentations. International participants from the USA, Canada and Singapore also presented in honor of Hendrik, and shared their stories of him. In total 33 attendees enjoyed the proceedings. The social program consisted of tribal dances and music, with attendees also joining the dancing, some freely and others with lots of encouragement, as well as a traditional South African “braai” (barbecue).



Report on the Munich Workshop on Coding and Cryptography 2019 (MWCC2019)

Vladimir Sidorenko, Antonia Wachter-Zeh and Sven Puchinger

Date and location: July 15-16, 2019, Institute for Communications Engineering, Technical University of Munich, Germany.

Over 115 international scientists from 21 countries participated in an exciting and fruitful workshop. The technical program included 14 invited talks made by leading researchers in coding theory and cryptography and 28 posters presented by doctoral candidates, postdocs, and scientists from several academic and industrial institutions.

The workshop was organized by the “Coding for Communications and Data Storage” (COD) group headed by Antonia Wachter-Zeh.



Workshop chairs: Sven Puchinger, Vladimir Sidorenko, Antonia Wachter-Zeh.



Local Organization: Haider Alkim, Lukas Holzbaur, Andreas Lenz, Hedongliang Liu, Georg Maringer, Julian Renner, Nicole Rossmann, Lorenz Welter.

Invited Talks

- Tanja Lange & Daniel Bernstein (Eindhoven University of Technology, Netherlands & University of Illinois at Chicago, USA): “McTIny: McEliece for Tiny Network Servers”
- John Sheekey (University College Dublin, Ireland): “Skew Polynomials in Rank-Metric Coding”
- Peter Beelen (Technical University of Denmark, Denmark) “Decoding Grassmann Codes Using Majority Logic”
- Tuvi Etzion (Technion, Israel): “Domination Mappings Into the Hamming Ball”
- Camilla Hollanti (Aalto University, Finland): “In the Quest for the Capacity of Private Information Retrieval from Coded and Colluding Servers”
- Joachim Rosenthal (University of Zurich, Switzerland): “Code Based Crypto Involving Expanded Reed-Solomon Codes”
- Ronny Roth (Technion, Israel): “Coding for Neuromorphic Computing”
- Pierre Loidreau (IRMAR, France): “Rank Metric Codes Based Encryption Schemes”
- Grigory Kabatyansky, (Skolkovo Institute of Science and Technology, Russia): “A New Code-Based Cryptosystem Based on Full Decoding”
- Jean-Pierre Tillich (INRIA, France): “Wave: A New Code-Based Signature Scheme”
- Bernhard Haeupler (Carnegie Mellon University, USA) “Synchronization Strings: New Codes for Insertions and Deletions”
- Eitan Yaakobi (Technion, Israel): “Codes for DNA Applications”
- Paul Siegel (University of California, San Diego, USA) “Generalized Partial Orders for Polar Code Bit-Channels”
- Alexey Frolov (Skolkovo Institute of Science and Technology, Russia): “A Polar Code-Based Scheme for the Random Access Gaussian Channel”
- In addition, a Mc Eliece Memorial Session was made by Paul Siegel.

Posters

- Nikita Polianskii (Skolkovo Institute of Science and Technology, Russia): “On the duplication distance to the root for binary sequences”



Group photo.

- Francisco Lazaro (German Aerospace Center (DLR), Germany): "Symbol message passing for code based public key cryptosystems"
- Sebastian Stern (Ulm University, Germany): "Multilevel Coding over Eisenstein Integers"
- Julia Lieb (University of Aveiro, Portugal): "Construction of Complete MDP Convolutional Codes"
- Kanagaraj G (Bharathidasan University, India): "Error correcting codes over DNA storage"
- Elena Egorova (Skolkovo Institute of Science and Technology, Russia): "New Broadcast Encryption Scheme Resistant to Collusion Attacks"
- Rawad Bitar (Rutgers University, USA): "Stochastic Gradient Coding for Straggler Mitigation in Distributed Learning"
- Stanislav Kruglik (Skolkovo Institute of Science and Technology, Russia): "On the Secrecy Capacity of Distributed Storage with Locality and Availability"
- JooCho (ADVA Optical Networking, Germany): "Application of Code-based KEMs for Secure Optical Network"
- Yiwei Zhang (Technion, Israel): "Private Proximity Retrieval Codes"
- Renfei Bu (TU Delft, Netherlands): "Detection Schemes in the Presence of Unknown Varying set"



Audience during an invited talk.



Poster session and coffee break.

- Julian Renner (Technical University of Munich, Germany): “Generic Decoding of Interleaved Rank-Metric Codes”
- Kirill Andreev (Skolkovo Institute of Science and Technology, Russia): “Deep-Learning Based Decoding of Short LDPC codes”
- Pavel Rybin (Skolkovo Institute of Science and Technology, Russia): “Concatenated Same Codebook Construction for the Random Access Gaussian MAC”
- Grigory Solomatov (Technical University of Denmark, Denmark): “Fast Encoding of Algebraic Geometry Codes over Good Planar Curves”
- Selcen Sayıcı (Sabancı University, Turkey): “On Linear Complementary Pair Of Abelian Codes”
- Ha Nguyen (Technical University of Munich, Germany): “Vector Network Coding For Generalized Combination Network With 3 Messages”
- Thomas Debris (INRIA, France): “A new code-based signature scheme”
- Valentin Vasseur (INRIA, France): “An Improved QC-MDPC Bitflipping Decoder”
- Wenhui Li (Skolkovo Institute of Science and Technology, Russia): “Merging Algorithm for Convolutional and Trellis Codes”
- Jens Zumbrägel (University of Passau, Germany): “Computation of a record binary field discrete logarithm”
- Kevin Carrier (INRIA, France): “Near-Collisions and Generic Decoding”
- Matthieu Lequesne (INRIA, France): “Ternary Syndrome Decoding with Large Weight”
- Andreas Lenz (Technical University of Munich, Germany): “Upper Bound on the Storage Rate of DNA-based Storage Systems”
- Haider Alkim (Technical University of Munich, Germany): “Error Correction for Partially Stuck Memory Cells”
- Georg Maringer (Technical University of Munich, Germany): “Stochastic Dependence of Decryption Failures”
- Hedongliang Liu (Technical University of Munich, Germany): “On Decoding and Applications of Interleaved Goppa Codes”
- Lukas Holzbaur (Technical University of Munich, Germany): “Private Streaming with Convolutional Codes”

The social program included coffee breaks and lunches. In the Monday evening, the attendees enjoyed the dinner at the Bavarian restaurant Löwenbräukeller.

Funding for the workshop was provided by the German Research Council (DFG) and the European Commission.

Details of the workshop including the Program, list of participants, and more photos are available at the web address:

<https://www.lnt.ei.tum.de/en/events/2019-munich-workshop-on-coding-and-cryptography-mwcc/>

From the Field: IEEE Information Theory Society Japan Chapter

Hiroki Koga and Yuichi Kaji

The IEEE Information Theory Society Japan Chapter received the 2002, 2005 and 2019 Chapter of the Year Award. These successful achievements are due to continuous effort of information theorists in Japan to promote research activities on information theory and its applications. We have about 250 IEEE Information Theory Society members over nine geo-sections in Japan. The chapter was established in 1956 as IT Society Tokyo Chapter, and has changed its name according to several reorganizations of geographic units of IEEE. For a historical reason, our colleagues in Japan commonly call the chapter as IEEE Information Theory Japan Chapter (IEEE ITJC).

In Japan, there are two other organizations related to information theory besides IEEE ITJC; IEICE Technical Committee on Information Theory (IEICE IT) and IEICE Research Society of Information Theory and Its Applications (IEICE SITA), both subsidiaries of Institute of Electronics, Information and Communication Engineers which is a Japan-based academic institute. The two organizations and IEEE ITJC are tightly connected. IEEE ITJC offers five technical meetings in a year together with IEICE IT. More than 100 talks in total (including invited talks) were given in the technical meetings in 2018. We also have collaboration with IEICE SITA for an annual domestic Symposium on Information Theory and its Applications (SITA symposium). We have more than 200 participants and more than 100 talks in recent SITA symposiums.

Even though a domestic meeting offers great opportunity for rapid sharing of new ideas and research results, it is not a final goal in research activities. The key role of IEEE ITJC is to show young researchers a doorway to the world, and encourage them to jump to the global stage. For this sake, IEEE ITJC presented Young Researcher Best Paper Award in ISITA 2012, 2014, 2016 and 2018, where ISITAs are international symposiums sponsored financially by IEICE SITA and technically by IEEE IT Society. In ISITA 2018 the



Awardees of ISITA 2018 and Chair.

first authors of accepted papers, who are 35 years old or younger on the submission deadline and are IEEE members, are eligible to the award. IEEE ITJC chose three winners of the awards via a careful review process. The award ceremony is given in the banquet of ISITA 2018 (see the photo).

Have interest in Japan? Come to 2021 IEEE Information Theory Workshop which will be held in Kanazawa, Japan. Kanazawa is a beautiful city with long history and unique culture. The network of super-express trains (Shinkansen) recently reached Kanazawa, and the city is now easily accessible from Tokyo as well as Osaka and Kyoto. We hope that many people in The Information Theory Society will be interested in ITW in Kanazawa and enjoy Japan!

Chair: Hiroki Koga (University of Tsukuba)

Vice Chair: Yuichi Kaji (Nagoya University)

Information Theory Society Would Like to Encourage K3-K8 Activities

The Information Theory Society would like to encourage K3-K8 activities that highlight basic concepts in information theory, as part of a new initiative that starts in 2020. This could include outreach using age-appropriate approaches that leverage social media, such as cartoon videos, as well as more tra-

ditional development of pedagogical materials to be shared with places such as children museums and summer camps. Limited funding may be available to support such proposals. More information will be posted on the Information Theory Society website.

Claude Shannon's Creative Thinking

Robert Gallager

Abstract

Claude Shannon was one of the greatest creative thinkers of the 20th century. In a 1952 lecture, [1], he presented his views on the process of thinking creatively. In the following note, I try to explain, for myself and readers, both his views from that lecture and how he followed those views in his own research. His approach to research was quite novel and might be used by researchers today to enhance their own creativity.

1. Introduction

Claude Shannon's most important contribution to science was his magnum opus *A Mathematical Theory of Communication*, [2]. This work, which quickly became known as Information Theory, clarified the basic concepts of information, particularly its storage, processing, and transmission. It truly enabled and ushered in the Information Age. Shannon also made many other major scientific contributions, some of which are mentioned in what follows.

Shannon did research the way that most of us breathe, naturally and without introspection. By 1952, he was world famous and was enticed to give a lecture at Bell Telephone Laboratories entitled *Creative Thinking* [1], explaining his views on how to do creative research. Since he was explaining something that was second nature to him, understanding this lecture will require some discussion.

When I entered MIT as a graduate student in 1956, I joined the Information Theory group, which was a leading center, along with Bell Labs, on the research stimulated by [2]. This group contained many students and young faculty destined to become leaders in information theory and related fields. Shannon was visiting MIT at the time, joined the faculty the following year and was viewed almost as a deity by the group. Whenever Shannon gave a talk, it contained some totally unexpected new insight. He not only saw through all the details with a kind of X-ray vision, but knew instinctively what to look for. The members of the group had many discussions trying to understand his *modus operandi*. Most of us picked up small pieces of his approach by osmosis, but none of us understood how he did it. It was more than just being very bright – he had amazing intuitive insights.

Many years later, I read Shannon's views on creative thinking in his 1952 lecture. This note is an attempt to combine his views there with my observations from a career studying his papers and working with him.

The lecture started with Shannon's description of the basic requirements for creative thinking. He did not restrict the discussion specifically to theoretical scientific research, but that was emphasized. Shannon always loved to build things to illustrate ideas, but he viewed that as simple fun. He was never involved, nor particularly interested, in large experimental projects, and preferred working

alone or occasionally with one or two colleagues on theoretical or system-oriented projects. Thus the focus in his career and his 1952 lecture was on individual conceptual research. After discussing some requirements for creative thinking, he discussed a number of *tricks* that he had found useful. I would call them *principles* rather than *tricks*, but however named, they seem vital for creative thinking. A closely related set of principles (there called heuristics) was developed by G. Polya in his delightful book, *How to Solve It* [3].

Shannon's requirements and tricks are explained in the following two sections and then related to his early research. The purpose is not to verify if he actually followed his own advice, but rather to help researchers today obtain a better understanding of his actual research process.

Those who would like an insightful and readable non-technical biography of Claude Shannon and his impact on our technological age should read Soni and Goodman's book, *A Mind at Play — How Claude Shannon Invented the Information Age* [4]. Soni and Goodman also provide a nice interpretation of Shannon's 1952 lecture in [5]. A recent full-length film, *The Bit Player* [6], about Claude Shannon is not only an instructive and entertaining documentary, but also capably describes both his human side and his impact on civilization. Finally, Shannon's collected works can be found in *Claude Elwood Shannon Collected Papers* [7].

2. Basic Requirements for Scientific Creative Thinking

Shannon began his lecture on Creative Thinking by stating three requirements that he felt researchers must possess in order to do creative theoretical research. These look somewhat mundane initially, but might appear more interesting after some interpretation.

First, a researcher needs training and experience before doing creative work. We have all heard older, well-established researchers denigrating younger and more energetic researchers by insisting on the need for extensive training and experience, but this is not what Shannon meant. The training needed for creative work requires some understanding of the conventional approach but, perhaps more important, some thinking about improved approaches.

Second a researcher needs a certain amount of intelligence. This is vague since intelligence has many aspects, and different aspects are useful in different kinds of research. IQ, for example, measures the ability to solve IQ questions accurately and quickly. These tests provide one measure of mental acuity, but little evidence of ability to ask the critical questions necessary for creative thinking.

Finally, a researcher needs motivation and drive. Shannon describes this as the need to find out *the answer*, to find out *what makes things tick*, the *curiosity* to find answers to questions and *explanations* of why things work. He also refers to this as a *constructive dissatisfaction with the world*, with a desire to make things work better. I will refer to this requirement as *burning curiosity*, i.e.,

curiosity accompanied by a strong drive to understand, especially to understand in the above engineering sense.

It is clear both from Shannon's description and from his research that this requirement was *motivation and drive to understand* rather than *motivation and drive to succeed*. The drive to succeed would naturally include a drive for recognition, a drive to compete in achieving research results, and a drive to publish quickly in areas of current interest. Shannon seemed remarkably free from an urge to gain recognition or compete. He was driven primarily by a burning curiosity to understand. Success is obviously important to researchers, but the drive for success is quite distinct from creativity.

All three of these requirements are necessary for successful creative thinking, but we all know many researchers with lengthy experience, high IQ, and high motivation, whose work lacks sparkle and creativity. Shannon probably intended his requirements to include *experience* with conventional approaches plus possible improvements; *intelligence* to solve problems and formulate better problems; and *motivation* to be curious and also to strive for *AHA moments* (moments when one suddenly says *AHA*, so that is what this is all about). The following tricks help promote these enhancements.

3. Tricks for doing Creative Research

Shannon's six tricks, discussed in turn below, are, 1, *simplification* (eliminate unneeded details); 2, *similarity* (find a similar but more familiar problem); 3, *reformulation* (restate in various ways); 4, *generalization* (solve with fewer constraints), 5, *structural analysis* (break the problem into related pieces), and 6, *inversion* (use properties of the solution).

3.1 Simplification

This is perhaps the most fundamental of these tricks. Many great thinkers have stressed the need for simplicity. Einstein said *Everything should be as simple as possible, but no simpler*. Physicist Steven Weinberg said *In the study of anything outside of human affairs, including the study of complexity, it is only simplicity that can be interesting*. Sculptor Constantin Brancusi said *Simplicity is not an end in art, but one arrives at simplicity in spite of oneself, in approaching the real sense of things*. Finally, mathematician and philosopher Alfred North Whitehead said *Search for simplicity, but mistrust it*.

Whitehead's dichotomy between *search* and *mistrust* is particularly important, since, for example, simplification is a favorite tool of demagogues, propagandists, and dishonest salesmen; they use simple talking points to conceal issues rather than understand them. How do we distinguish simplifications that conceal from ones that elucidate? It helps to search for many potential simplifications and test them against each other. The essence of *search and distrust*, however, is to avoid *emotional* ownership in a new idea. One should search for strong and weak points with equal vigor and take intellectual pleasure in each. This does not limit the pleasure in an AHA moment, but rather allows for subsequent evolution and change.

Paradoxically, finding a good simplification of a problem is often a complex process. This is illustrated by the following important example of simplification given in the second paragraph of Shannon's masterpiece, *A Mathematical Theory of Communication* [2], quoted below:

The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have meaning; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one selected from a set of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design.

This simplification, removing the question of *meaning* from a theory of communication, was essential to the subsequent development of the field. Excluding meaning from communication theory might seem lacking in human values, but a sender expects and deserves privacy when sending messages over a communication system. This means that the system should simply transfer messages with no regard to meaning, thus allowing a focus on the communication system itself rather than the entities using the system.

Omitting meaning makes it natural to clarify the problem by viewing the message not in isolation but as one of a set of possible messages. For example, Morse code is a rule for encoding each symbol of the alphabet into a distinct short string of dots and dashes. Other types of communication systems provide different ways to encode the set of messages or message segments of the user into a set of more convenient symbols or segments of symbols for the communication system. The important thing here is the *mapping* for the set of possible messages rather than any sense of *meaning* for the messages.

3.2 Similarity

Given a problem of interest, Shannon's second trick is to find a similar problem that is already understood. A good example of this is Shannon's recognition that the state of an electrical switch (on or off) can be viewed as Boolean algebra. This might seem obvious to a computer science student today, but when Shannon pointed this out in his master's thesis [8] in 1938, Boolean algebra was taught in philosophy courses and electricity was regarded as an essentially analog quantity. The digital revolution was far in the future, and this thesis was one of its earliest rumblings.

3.3 Reformulation

One can often restate a problem to clarify its meaning, or to emphasize certain characteristics, or to change it in almost any way. First consider precisely-stated mathematical or logical problems (or problems in science, engineering, or economics reduced to mathematical form). There is little ambiguity about the meaning of these problems, and the significant issue is finding a solution (or multiple solutions or lack of a solution). If these problems are reformulated, either the problem remains essentially the same or it is changed in some significant way. Such changes are widely considered to be dirty pool by the uninitiated, and are not treated kindly by graders in examinations. Shannon, however, was usually more interested in broader understanding than in the detailed problem itself. One of his favorite techniques was to replace a problem with a toy problem that would allow some basic understanding with almost no effort. The original problem could then often be solved as a reformulation of the toy problem. Any of Shannon's other tricks could also be used in a reformulation, and again, subsequent reformulations

could lead to a solution of the original problem, often with greater understanding than a direct solution.

Shannon also viewed reformulation of a mathematically precise problem as a trick to avoid getting in a mathematical rut. If the tools of mathematics are not leading to a solution, then a reformulation into a different mathematical form or even an imprecise non-mathematical form might lead to new insights.

Most real-world problems and engineering problems are not precisely stated and often highly ambiguous. A reformulation of such a problem might consist of a clarification or a better organization. It might create a mathematical model for the problem, which might make it precise but perhaps change the intended nature of the problem. Shannon's paragraph on the fundamental problem of communication, discussed above, is a good example of an imprecisely stated problem. The simplification was critically important but was only one step toward clarifying the essential nature of the problem.

3.4 Generalization

If a method can be found to solve some given problem, then a favorite trick of any researcher is to see if that method continues to work if the conditions on the problem are made more general *i.e.*, less restrictive. Note that one form of simplification is to restrict the conditions on a problem to include only simple special cases, so generalization is the opposite of this type of simplification. In other situations, generalizing the conditions on a problem to include all cases that have some interesting set of properties might simplify the problem by focusing only on those properties.

3.5 Structural Analysis

This is essentially the process of breaking a problem into related but simpler pieces so the problem can be solved after all the pieces are solved. The *structure* of a problem refers to how the parts of the problem are related. Given some initial formulation of a complicated problem, it is rarely evident how to break it cleanly into related parts. Thus the trick here is to use analysis, speculation, experience, dreaming, and fantasizing to reformulate into subproblems which strike one's intuition as potentially understandable and related. These subproblems are then analyzed and reformulated with the objective of increased understanding and relatedness. In other words, structural analysis is a *process* which, if successful, leads to subproblems that are solvable and cleanly related.

These subproblems cannot all be worked on at once, so most subproblems must be placed temporarily on a back burner, waiting for some new insight or revealing question. Structural analysis initially sounds very systematic and structured — find the structure in a problem and then analyze the pieces in that structure. As we see, however, finding an appropriate structure requires a great deal of creativity, *i.e.*, repeated use of Shannon's tricks, trying new ideas and new approaches. Throughout this process, as with all of Shannon's tricks, one must constantly search and mistrust in the same way as with simplifications.

3.6 Inversion

Shannon's explanation of *inversion* is a little vague. If the solution to a problem is some unknown function of the data, then some-

times the inverse of the function, finding the data as a function f^{-1} of the solution can be solved. If so, the problem itself might be solved by finding the inverse of f^{-1} . In more general examples, where the data and solution are functions themselves, feedback can sometimes be used as a form of inversion. In other examples, recursion can be used. Inversion has a somewhat different nature from the other tricks since it involves various mathematical techniques to solve a given problem, whereas the other tricks obtain insight by various ways of modifying the problem. We will focus on Shannon's first five tricks in what follows.

4. Shannon's Early Research and Its Implications For Us

Claude Shannon acquired fame and recognition at a very young age with his MIT master's thesis [8], relating Boolean algebra to switching theory. This won a major award from AIEE (the predecessor of IEEE) and has been called (perhaps with slight exaggeration) the most important master's thesis of the twentieth century. His doctoral thesis, on Theoretical Genetics [9], was completed just two years later in 1940, but Shannon never published it nor did any future work in genetics.

Shannon then accepted a one year fellowship at the Princeton Institute for Advanced Study, but it was clear that war was imminent and he felt he could be far more useful doing military research than being drafted and becoming an ordinary soldier. He gave up his fellowship in the middle of the year and spent the war years working on fire control (anti-aircraft fire) and cryptography at Bell Labs. In his spare time, he worked on what was becoming his major interest, his emerging theory of communication.

In early 1948, *A Mathematical Theory of Communication* [2] was completed. This monumental work formed the conceptual basis for the information age. If one reads this work while imagining the time of origin, one realizes how revolutionary it was, and also sees Shannon's tricks everywhere. We next question how this and Shannon's earlier works met his requirements for intelligence, training/experience, and motivation in thinking creatively.

4.1 The Role of Intelligence in Shannon's Research

Shannon's genius was evident in everything he did, and part of that genius was the blazing speed at which he understood new concepts. Those of us not endowed as geniuses can still create deep understanding, especially by using Shannon's tricks, but working at a much slower speed. I know this to be true from mentoring many generations of MIT doctoral students. Becoming an MIT doctoral student requires intelligence, but certainly nothing close to Shannon's genius. However, even operating at 10% of Shannon's speed, one can do much creative research in a career.

Shannon's genius was also apparent in his intuition, first in sensing how to focus deeply on one problem, second sensing how to look broadly at related issues, and most of all, sensing when to focus narrowly and when to use a wide-angle lens. In his master's thesis, he looked broadly to see the relevance of Boolean algebra to switching, and then focused narrowly to work out the details of switching design. In his theory of communication, there was a nine year research process, looking broadly at all aspects of communication along with focusing narrowly on each important aspect. The trick of reformulating to avoid getting in a mathematical

rut sounds straightforward, but in fact requires excellent intuition and sense of balance between concentration and broad scanning to recognize a rut.

4.2 The Role of Training and Experience in Shannon's Research

Shannon spent nine years acquiring the experience to create his theory of communication and spent perhaps two years (in college and graduate school) to develop the use of Boolean algebra to design switching circuits. He spent less than two years learning the genetics needed for his PhD thesis. At first glance, the role of training and experience is obvious—more training, better results. Should he have gained more training in genetics before or during his PhD thesis? Probably not. He needed a PhD, and the time spent was sufficient to obtain a PhD and to maintain strong career support from his mentors. It is questionable whether the genetics field at that time could have made much use of his mathematical approach, and his intuition probably made that clear.

The conventional academic view is that one should acquire the necessary training and experience *before* starting to do research. Shannon's work rarely followed that path; he started his PhD thesis without the slightest clue about genetics, and being Shannon, he started to construct mathematical models and to build intuition while first studying the field. It appears that he followed this path of simultaneous *study* and *creative thinking* throughout his career, particularly during the 9 years of research on his theory of communication. Shannon could not avoid thinking creatively, and I suspect that no successful creative thinker can avoid it. It is obviously necessary to learn what others have done before publicly presenting, publishing, or teaching in an area, but creative thinking should be used in this learning process.

4.3 The Role of Motivation in Shannon's Research

Shannon's burning curiosity to understand whatever he was working on was characteristic of all his research. When he first started to work on the box of switches at the center of Vennevar Bush's differential analyzer, and then later worked at Bell Labs on switching for the telephone network, he had a burning curiosity about switching circuits. Seeing the relationship to Boolean algebra was a result of this curiosity blended with the intuition that led him to think back to a college philosophy course treating Boolean algebra. Fleshing this out into a thesis developing switching circuit design required curiosity of a more detailed sort.

Shannon started his PhD thesis on genetics with great enthusiasm, learning about the subject and starting to create some mathematical models. He was working largely in isolation, however, without the external stimulation that had worked so well in his switching work. Shannon wrote a letter about his current interests to his mentor, Vannevar Bush, less than a year after starting his doctorate. Remarkably, there was nothing about genetics in the letter, only a fascination with communication systems. Shannon's curiosity about genetics had evidently gone on the back burner. His tricks did not revive interest, perhaps because his intuition was guiding his curiosity toward communication theory. At any rate, he quickly completed writing up his PhD thesis without a great deal of enthusiasm.

During the war, Shannon worked for Bell Labs on a number of projects, including anti-aircraft fire control and cryptography. His

work on fire control, done jointly with other distinguished mathematicians from Bell Labs, was based on emerging ideas from stochastic process theory, and was viewed as important in the war effort. These results led to a number of reports, but he was not highly motivated by this work, perhaps because of the need to coordinate with others and produce results quickly. His early cryptographic work was limited to details of systems classified beyond his scrutiny, but toward the end of the war he used his burning curiosity to develop an integrated theory of cryptography [10].

The role of burning curiosity is clear throughout Shannon's mathematical theory of communication. He maintained this curiosity working in his spare time during the war, and this might partly explain the lack of motivation on the war related topics. We can only imagine the process through which this theory evolved, but it was certainly not 9 years of hard work on an original master plan. Instead it was a trial and error process where the successful trials at one stage led to curiosity, hypotheses, and understanding to create further stages.

4.4 Creative and Unifying Thinking

We have discussed Shannon's requirements and tricks for creative thinking, but have not described creativity itself. Shannon's tricks *create* many *new* variations about any given problem, but newness alone is not sufficient, *e.g.*, creating a new password is not creative. For theoretical research, a creative idea might be one that unifies a set of previously unrelated ideas or it might suggest several approaches for further new ideas. For example, Shannon's switching work unified Boolean algebra with switching design. His mathematical theory of communication contained an almost bewildering set of new ideas which suggested each other, unified earlier ideas, and together formed a fully unified theory.

Unfortunately, new ideas about a problem area require substantial development before unification or creativity become apparent. This means that choosing among variations for initial exploration depends heavily on intuition and insight rather than knowledge alone. Intuition and insight are subject to biases of many types, so one must keep Whitehead's dichotomy, *search but mistrust*, in mind while exploring variations on a problem area in the hope of finding some unification.

A more fundamental difficulty in choosing variations of a problem is that the most promising variations might not pop into mind at all. An interesting example is the use of Boolean algebra in switching design. For someone familiar with both Boolean algebra and design of switching circuits, this seems like a fairly obvious approach, and indeed it is easy to teach people to use Boolean algebra in switching design. However, designing switching circuits was a major engineering task at Bell Labs in the 1930's and neither the engineers doing this work nor the mathematicians familiar with it thought of using Boolean algebra before Shannon's discovery. Why?? Bell Labs was full of brilliant creative people, some of whom must have been familiar with Boolean algebra. Shannon had a genius for thinking of such very simple new ideas, but evidently radically new simple ideas are quite rare even among otherwise creative people.

Shannon's mathematical theory of communication was particularly surprising by the simplicity of many of its component parts. It was the synthesis of all these simple ideas, plus a small number

of very sophisticated ideas, that created his unified theory of communication out of whole cloth. It was a theory that, 70 years later, still provides the right way to view new communication technologies that were not even dreamed of then.

4.5 To Write or Not to Write

The question of when Shannon wrote-up a project was quite different from his decision to continue further research on it. He wrote his master's thesis when he had established the connection between Boolean algebra and switching, but he maintained interest in the subject through several later papers extending the results. His PhD thesis and his wartime results were written in the absence of great curiosity or interest. He disliked writing, but wrote beautifully, in this case more as a duty than an expression of creativity.

His magnum opus on communication was written when the major ideas had all come together in such a cohesive and encompassing fashion that it would have been almost criminal to further delay publication. He continued to pursue new topics in this theory and published 15 major extensions in the following years.

5. Shannon's Later Research

Shortly after publishing *A Mathematical Theory of Communication*, Shannon met his future wife, Betty Moore, who was an analyst in the Math group at Bell Labs. They shared a kindred sense of humor and she listened to (and understood) his nascent ideas about research, wrote up papers from his dictation, edited them, and checked his calculations. On one hand her role as a sounding board greatly enhanced his curiosity about his research. On the other hand, her editing and checking greatly eased his reluctance to write. There is no doubt that his publication list would have been much smaller if it were not for Betty Moore Shannon.

Over his 30 year career of doing research, Shannon's total number of published papers was only 42, which is 1.4 per year. These were concentrated over the years 1948–1958 and most of them became classics that are still widely read. This small publication list illustrates the folly of research supervisors and funders who evaluate researchers by number of published papers or number of citations. When a research area is shared by a large diverse research community, there is obvious merit in many publications with limited progress in each, but one can always strive to share creative ideas

rather than maximize publications. Perhaps less stress to publish would enhance creativity.

People interested in individual theoretical research can still use Shannon's tricks to stimulate the kind of burning curiosity that can lead to AHA moments and unification of ideas. Even in the hyper-active academic areas of today, we can all protect a fraction of our time for unhurried creative thinking. When something has to be written, it should be written carefully and well, but not at the expense of time for creative thinking.

Viva Shannon's research style.

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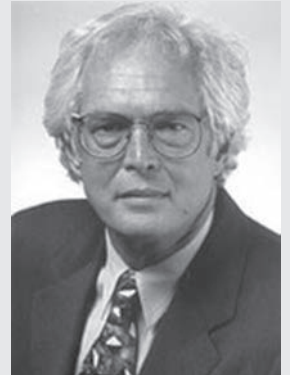


Call for Nominations

(ordered by deadline date)

Thomas M. Cover Dissertation Award

The IEEE Information Theory Society Thomas M. Cover Dissertation Award, established in 2013, is awarded annually to the author of an outstanding doctoral dissertation contributing to the mathematical foundations of any of the information sciences within the purview of the Society including, but not limited to, Shannon theory, source and channel coding theory, data compression, learning theory, quantum information theory and computing, complexity theory, and applications of information theory in probability and statistics. Nomination of underrepresented minorities are encouraged. Eligible dissertations must have been successfully defended during the two calendar years prior to the award year.



NOMINATION PROCEDURE: Nominations and letters of endorsement must be submitted by January 15 using the online form available at <https://www.itsoc.org/honors/cover-award>

IEEE Joint ComSoc/ITSoc Paper Award

The Communications Society/Information Theory Society Joint Paper Award recognizes outstanding papers that lie at the intersection of communications and information theory. Any paper appearing in a ComSoc or ITSoc publication during the preceding three calendar years is eligible for the award.

NOMINATION PROCEDURE: Nominations and letters of endorsement must be submitted by February 15, 2020. All nominations should be submitted using the online nomination forms. Please see <http://www.itsoc.org/honors/comsoc-information-theoryjoint-paper-award/comsoc-itsoc-paper-award-nomination-form> for details. Please include a statement outlining the paper's contributions.



IEEE Information Theory Society Claude E. Shannon Award

The IEEE Information Theory Society Claude E. Shannon Award is given annually to honor consistent and profound contributions to the field of information theory.

NOMINATION PROCEDURE: Nominations and letters of endorsement must be submitted by March 1, 2020. All nominations should be submitted using the online nomination forms. Please see <http://www.itsoc.org/shannon-award> for details.

IEEE Information Theory Society Aaron D. Wyner Distinguished Service Award

The IT Society Aaron D. Wyner Service Award honors individuals who have shown outstanding leadership in, and provided long standing exceptional service to, the Information Theory community.

NOMINATION PROCEDURE: Nominations and letters of endorsement must be submitted by March 1, 2020. All nominations should be submitted using the online nomination forms. Please see <http://www.itsoc.org/wyner-award> for details.

IEEE Fellow Program

Do you have a colleague who is a senior member of IEEE and is deserving of election to IEEE Fellow status? If so, please submit a nomination on his or her behalf to the IEEE Fellow Committee. The deadline for nominations is March 1, 2020.



IEEE Fellow status is granted to a person with an extraordinary record of accomplishments. The honor is conferred by the IEEE Board of Directors, and the total number of Fellow recommendations in any one year is limited to 0.1% of the IEEE voting membership. For further details on the nomination process please consult: <http://www.ieee.org/web/membership/fellows/index.html>

IEEE Information Theory Society Paper Award

The Information Theory Society Paper Award is given annually for an outstanding publication in the fields of interest to the Society appearing anywhere during the preceding two calendar years. The purpose of this Award is to recognize exceptional publications in the field and to stimulate interest in and encourage contributions to fields of interest of the Society.

NOMINATION PROCEDURE: Nominations and letters of endorsement must be submitted by March 15, 2019. All nominations should be submitted using the online nomination forms. Please see <http://www.itsoc.org/honors/information-theory-paper-award/itsoc-paper-award-nomination-form> for details. Please include a statement outlining the paper's contributions.



IEEE Information Theory Society James L. Massey Research & Teaching Award for Young Scholars

The purpose of this award is to recognize outstanding achievement in research and teaching by young scholars in the Information Theory community. The award winner must be 40 years old or younger and a member of the IEEE Information Theory Society on January 1st of the year nominated.

NOMINATION PROCEDURE: The nominee must be a Society member, who on January 1st of the year in which the award is given, is no more than 10 years beyond having their highest degree (up to doctorate) conferred. Nominations and supporting materials must be submitted by March 15, 2020. All nominations should be submitted using the online nomination forms. Please see <http://www.itsoc.org/honors/massey-award/nominationform> for details.

IEEE Awards

The IEEE Awards program pays tribute to technical professionals whose exceptional achievements and outstanding contributions have made a lasting impact on technology, society and the engineering profession. For information on the Awards program, and for nomination procedures, please refer to <http://www.ieee.org/portal/pages/about/awards/index.html>

IEEE Information Theory Society Board of Governors Meeting

Location: Maison de la Mutualité, Paris, France

Date: July 7th, 2019

Time: The meeting convened at 1:00 pm CEST (GMT+2); the meeting adjourned at 5:45 pm CEST (GMT+2).

Meeting Chair: Emina Soljanin

Minutes taken by: Lara Dolecek

Meeting Attendees: Alexander Barg, Andrew Barron, Matthieu Bloch, Suhas Diggavi, Alex Dimakis (*), Lara Dolecek, Stark Draper, Elza Erkip, Christina Fragouli, Andrea Goldsmith (#), Yu-Chih Huang (#), Tara Javidi, Gerhard Kramer (#), Frank Kschischang, Vijay Kumar, Brian Kurkoski (#), Matt LaFleur (#), Olgica Milenkovic, Henry Pfister, Vincent Poor, Gireeja Ranade (#), Parastoo Sadeghi, Lalitha Sankar (#), Anand Sarwate (#),

Igal Sason, Emina Soljanin, Changho Suh (#), Daniela Tuninetti, Tadashi Wadayama (#), Aaron Wagner, I-Hsiang Wang (#), Lele Wang (#), Shun Watanabe (#), Michelle Wigger, Gregory Wornell, Aylin Yener, and Wei Yu.

Remote attendees are denoted by (*); non-voting attendees are denoted by (#).

Business conducted between meetings: The following votes were conducted by email between the Feb. 2019 Information Theory Society (ITSoc) Board of Governors (BoG) meetings and this meeting:

- 1) In April 2019, Parastoo Sadeghi was elected as the new BoG member.
- 2) In April 2019, Special Issue in IEEE Transactions on Information Theory honoring late Vladimir Levenshtein was approved.

- 3) In April 2019, minutes from the BoG meeting at ITA in February 2019 were approved.
- 4) In April 2019, the motion coming from the N&A committee that a public call for nominations for the next IEEE Transactions on Information Theory Executive Editor be made via the the ITSoc web site and the ITSoc email list was approved.
- 5) In April 2019, the motion coming from the Membership committee that the student subcommittee and the outreach subcommittee be combined as the Student and Outreach Subcommittee and that Vincent Y. F. Tan be appointed as the chair of this subcommittee with a term ending 12/31/2019 was approved.

At 1:00 pm local time, ITSoc president Emina Soljanin called the meeting to order.

Next, the attendees introduced themselves, and consent agenda was approved. Consent agenda is available on the ITSoc website.

Emina next started by reviewing the meeting agenda.

Motion: A motion was made to approve the agenda. The motion passed.

President Soljanin presented President's Report. She reminded the BoG that the Fall meeting is less than 3 months away, and that her goal is to discuss the technical part of the society and TAB events. She expressed a few words of caution regarding the state of the society and summarized several challenges that had occurred at the beginning of the year, including the fear that the rift within the society would deepen, the fact that an unusually large number of new officers were appointed, that the budget appeared to be going in red, that ISIT organizers were facing multiple constraints, and so forth.

Despite these mounting challenges, President Soljanin also reminded that there is still an important society that needed to be run, and that there appears to be a lot of enthusiasm at the moment. She congratulated new elected BoG members: Matthieu Bloch, Suhas Diggavi, Stark Draper, Olgica Milenkovic, Prakash Narayan, Henry Pfister, and Parastoo Sadeghi. She also thanked many other BoG members that took on extra responsibilities. She also welcomed new officers and committee chairs: Aylin Yener, Wei Yu, Frank Kschischang, Lara Dolecek, Vijay Kumar, Christina Fragouli, Brian Kurkoski, Antonia Tulino, Dan Costello, Gireeja Renade, and Christina Lee Yu. She also stated that there was a lot of help from many others who previously held these positions.

President Soljanin then summarized 5 new good-news items: Surplus of money for new initiatives; new proposals that will make use of this surplus; record number of registrants at ISIT 2019; many new actionable items from committees; the movie about Shannon that is showing well.

President Soljanin concluded by instructing how/when the presentation of the confidential report prepared by the Awards Committee Chair Aylin Yener will be handled.

Next, Aaron Wagner presented Treasurer's Report. Aaron explained that the IEEE has strict rules on year boundaries and that its fiscal year is the same as a calendar year. He next reviewed IEEE accounting, previously presented at the BoG meeting in February 2019.

Next, he presented 2018 general funds. These were finalized on May 14, 2019. There was a budgeted surplus of \$8K. Surplus was forecast at ISIT 2018 in Vail to be -\$68K, and subsequently was forecast at 2018 Allerton to be +\$81K. Final surplus was announced in May to be +\$292K. Aaron explained what are the sources of the differences between the projected and the final budget, including conference surplus from ISIT 2018, IEEE Transactions on Information Theory surplus, and the reduced "tax" to the IEEE. There was also extra spending on committees, which somewhat reduced this overall surplus.

Despite the +\$147K in surplus, due to the IEEE Transactions on Information Theory surplus, Aaron cautioned that this item line masks other issues, for example that the revenue is consistently decreasing. He explained that the Transactions cost is page count times per page production charge, roughly speaking, and that the IEEE retroactively reduced the cost of the per page production charge. Aaron explained that one potential explanation for why IEEE often reduces per page production charges late in the year. He also pointed out that a major challenge in spending this extra money is that it is reported to the Society May of year n+1 for year n, when the money is already locked into reserves.

Next, Aaron presented annual trends of the IEEE Transactions on Information Theory, plotting revenue, costs, and surplus. Recently, the surplus has held constant, although this is a consequence of decreasing per page production costs, which cannot be expected to continue indefinitely.

Aaron next described 2018 Special Projects that included Brit Cruise videos, children's book, Latin American Week on Coding and Information, and the Web Server upgrade. He thanked the leaders of these special projects and those that turned in their receipts.

After that, Aaron discussed 2019 General Funds. He stated that the budgeted surplus is +\$46K, and explained expected sources of this surplus.

He then discussed 2019 Discretionary Expenditures. A BoG member asked about why no funds are allocated to the web server for 2019. Aaron explained the web server is being upgraded during 2019 and all of the costs associated web server as being recorded as new initiatives.

Next, Aaron presented 2019 Special Projects. He has called out for new initiatives, and has received many excellent ideas. All special projects, except for the student travel grant, have been approved by BoG, president, and/or officers.

A motion to approve the a proposal for a ISIT student travel grant program was presented. It was explained that the support of \$20K for the student travel grant is comparable to the support typically given by NSF and EU. The wording of the

motion led to some discussion regarding the scope of the grant. Upon the input from a BoG member, a revised motion was then issued.

Motion: To approve retroactive student travel grant of \$20K for ISIT 2019 to students attending ISIT 2019 from Regions 8 (Africa, Europe [excluding those students eligible for support under the ISIT EU travel grant], and the Middle East), 9 (Latin America), and 10 (Asia and the Pacific), as eligible under IEEE rules.

The motion passed unanimously.

Next, Aaron presented the 2020 Budget. He clarified that he had revised it based on various inputs from the IEEE. The estimated surplus is +\$88K. He stated the differences relative to the 2019 budget. He next presented the list of 2020 Special Projects along with their requested budgets.

The following motion was issued.

Motion: To approve student travel grant for 2020, as revised for 2019.

In response to a question from a BoG member, Aaron explained that Region 7 (Canada) was not included in this motion.

The motion was moved to the Fall meeting. Aaron concluded by reiterating the charge of the ad-hoc committee on finances.

Next presentation was given by Sasha Barg. In his capacity of the Editor-in-Chief (EiC) of the IEEE Transactions on Information Theory (T-IT) he reviewed the state of the journal. He presented Sub-to-Pub statistics, showing mean and median values by quarters. He stated that the numbers are not bad, but are not ideal either. He stated that the average time from the submission to the first decision has held steady at around 30 weeks. One of the goals of the EiC is to try to reduce this time. He has already discussed possible ways to do so with the editorial board and associate editors. One of the initiatives is to update the system of automatic reminders. Currently, automatic reminders from ScholarOne are sent to late reviewers only for the first 1-2 months after the due date of the report. As a result, Associate Editors and Editor-in-Chief need to do more follow up work, in particular EiC needs to act on every 2 weeks on 120 papers, creating substantial burden. Sasha also stated that these issues will be further discussed at the Editorial Board meeting on July 9th, 2019 at ISIT 2019.

Sasha next presented the statistics for the journal citations. The decrease of the impact factor (IF) in 2018 was due to citations in the ISIT 2017 papers that had not been accounted for at the time when IF was determined. To address this problem, submissions to ISIT2019 were scanned using an automated script developed by Alex Dimakis. He also stated that in regards to the impact factor T-IT has returned to Q1 tier in Computer Science journals, although it is still in Q2 tier in EE, and that this could be an issue for promotion in academic positions. In response to a question from a BoG

member, Sasha also explained that IF has also increased for IEEE T-Wireless, T-Comm, and T-SP.

Next, Sasha discussed IEEE and Open Access (OA). He presented his impressions from the IEEE Panel of Editors meeting in April 2019. The message from the IEEE is "to dominate the Open Access community in engineering/technology while mitigating risk to revenues from subscription packages." He presented the reasons for switching to the OA model, including changing business model and comprehensive initiatives of major European publishers. Sasha stated that there is a multitude of actions stemming from switching to the OA model. Library funds at universities may have to be directed to OA expenses as proposed by the Director of Libraries of the University System of California.

A BoG member asked about the financial impact of switching to the OA model. Sasha responded by saying that he does not have all the information to provide a meaningful answer at this time. Another question was about the usage of a hybrid model, and Sasha explained that T-IT authors tend not to choose this option. He also stated that it is presently unclear whether the OA profits go back to the society or to the IEEE, or even how are they split.

Next, Sasha discussed a special issue in T-IT dedicated to the scientific legacy of V. Levenshtein. Submission deadline is October 1st 2019. The special issue will consist of invited and contributed papers. Lead Guest Editor is Olgica Milenkovic. Sasha clarified that the publication cost of the special issue can be absorbed in the budget.

Another new initiative Sasha discussed was the invited papers in T-IT. These papers are cross-cutting, interdisciplinary, and focused on new applications of information theory. There are currently 5 papers that are being processed and they were invited by Prakash Narayan. In response to a question from a BoG member, Sasha clarified that invitations are extended by the EiC, taking into account multidisciplinary nature of the work, visibility of the authors and results, among other factors.

Next, Sasha presented candidates for editor positions. Their biographies are available online. For the position of Executive Editor, a multi-stage procedure led by the N&A Committee (open call for nominations) is in place. Proposed candidate will be announced by the N&A Committee. For the position of Associate Editors, Stephane Boucheron, Mari Kobayashi, and Mohammad Ali Maddah-Ali were nominated.

The 3 candidates were approved by the board.

In his concluding remarks, Sasha stated that T-IT remains a high-quality, highly regarded publication, and that this quality is supported by dedicated Associate Editors and the wonderful IEEE support team, Lisa Jess and Megan Hernandez. He has requested funds to support their travel to the ISIT 2020.

Next, Christina Fragouli provided the report of the Magazine Steering Committee. She went over the motivation to introduce

an IT Magazine, and what its goals and scope would be. She stated that there would be several possible sources and formats of published articles. She then presented a possible launch timeline. Letter of intent was submitted in Fall 2017. Next deadline is to submit Phase I proposal by September 15, 2019. She presented major highlights from the Phase I Proposal, and she stated the intended scope of the magazine. She also reviewed readership survey, whose findings regarding the launch of this magazine were encouraging. She next presented a table of the issue frequency and page counts for the years 1-3. She explained the rationale behind the page counts and why the breakdown needs to be finalized now. She discussed submissions of the tutorial articles and technology trends that would be included in the magazine. Next, 3 candidates for the magazine title were presented.

The following motions were issued.

Motion 1: To approve Submission of Phase I proposal by Sep. 15, 2019.

Motion 2: To approve magazine title.

Motion 3: To approve travel funding for a steering committee members to attend TAB meetings in November 2019 and February 2020.

Motions 1 and 3 were passed unanimously.

It was decided that Motion 2 will be decided later, as another candidate for the magazine title was presented during the meeting.

A BoG member asked about the cost of running this magazine. Christina clarified that the IT magazine will be operationally on the smaller side, so the loss, if any, would be expected to be smaller.

Next report was given by Frank Kschischang, on behalf of the Nominations and Appointments Committee. He presented the society bylaws regarding the nomination to the board.

The following motion was issued.

Motion: To elect Erdal Arkan as the next Executive Editor of the IEEE Transactions on Information Theory, effective January 1st, 2020.

The motion passed unanimously.

Next, Frank Kschischang, presented a report on behalf of the Constitution and Bylaws Committee. Several housecleaning changes were presented. At this meeting they are informational, and will be voted upon in the next meeting.

They presented 6 IEEE must-haves for governing documents, as well as the IEEE proposed “nice to have” items. These items are for now informational and will be voted upon later. A BoG member asked about the clause regarding “removal with or without cause”, which was then clarified. IEEE suggests creating Conflict Resolution Committee. It

was also suggested that the Ethics Committee for the Society be created. A BoG member stated that that even though IEEE has recommendations, it does not have a precedent of success here. It was concluded that the society should be careful here. A suggestion by a BoG member was to also include an ombudsperson outside the society.

Frank next explained the roles of the appointed officers of the society, and discussed pros and cons of removing secretary’s vote. He then explained the positions of the ex-officio members of the board. Next, he presented the role of the Diversity and Inclusion Committee, as well as the roles of the Cover Award Committee and the Massey Award Committee. He also presented a reorganization of the Membership Committee and of the Publications Committee, and the motivation behind these proposed changes. He also presented the revised Journal Steering Committee, Selection of EiC and Executive Editor (EE) for T-IT, and the rationale behind the proposed changes.

All the changes to relevant bylaws are redlined in the presentation available on the Information Theory Society website.

There was some discussion regarding these changes. A BoG member asked if the ITSoc website could include a visualization of the committees and members. Some BoG members, including Elza Erkip, who is on the committee, expressed concern regarding the proposed policies for selecting the next EE.

In summary, Frank stated that the formal approval on the proposed changes listed above will be requested at the next BoG meeting. He added that the comments and suggestions are welcome.

Next, Aylin Yener reported on behalf of the Awards Committee. She presented the members of the committee and discussed the procedure for selecting each of the three annual paper awards. First, she summarized the procedure to select the finalists of the Jack Keil Wolf Award and added that the award would be decided after the session in which the finalist papers would be presented on Tuesday July 9th at ISIT 2019. She next discussed the joint Communications-IT Award, explaining that each of the two societies takes the lead in alternate years. She noted that this year Communication Society was the lead. She explained that future revisions to the bylaws for the Communications-IT Award should include the papers published in JSAIT. She next discussed the IT Paper Award. Per our bylaws, the report describing the multi-step procedure on the award selection was sent to the BoG (except members with a CoI) three weeks prior to the annual meeting. The report was just accepted in the consent agenda. She has subsequently made the following motion:

Motion: 2019 IT paper award to go to “Phase Retrieval via Wirtinger Flow: Theory and Algorithms,” by Emmanuel Candes, Xiadong Li and Mahdi Soltanolkotabi, published in IEEE Transactions on Information Theory, Volume 61, Issue: 4, April 2015.

The motion passed unanimously.

After a short break, the next report was presented by Vijay Kumar, on behalf of the Conference Committee. Vijay started by thanking committee members. In particular, he thanked Brian Kurkoski for agreeing to serve an additional year for continuity purposes.

Next, Vijay, summarized the status of the upcoming IT Symposia. In particular, the status updates are as follows. Additional detail on ISIT 2020 in Los Angeles appears below. ISIT 2021 in Melbourne has submitted its budget for approval, vetted by the conference committee and is part of the Consent Agenda for this BoG. ISIT 2022 in Helsinki has nothing to report at this time. ISIT 2023 in Taipei was preponed from 2024 to 2023 per BoG/Conference Committee request at the ITA 2019 BoG meeting as well as its aftermath. A presentation by the ISIT 2023 team was made that included presenting the BoG with a choice of 3 venues as well as the conference budget. For 2024, it was noted that there is an expression of interest from the New York team led by Anand Sarwate and Jeorg Kliewer to hold ISIT 2024 in New York as opposed to an earlier plan to hold it in New York in 2023. This change was made in response to a request from the proposed organizers of ISIT in New York. Vijay re-iterated that decision concerning an ISIT venue is typically made no earlier than 4 years in advance.

With regard to ISIT 2020 in Los Angeles, Vijay reported, based on information received from conference co-organizer Salma Avestimehr, that

- a contract with Westin Bonaventure Hotel as the venue has been signed and executed by IEEE;
- a contract with Universal Studios for the ISIT 2020 banquet on Wednesday is awaiting IEEE approval and signing of contract; the negotiated contract with Universal Studios includes admission to the park (~\$100 value), so that ISIT attendees can spend the day in Universal Studios ahead of the banquet;
- the organizers were getting quotes for AV setup at the hotel;
- they are approaching sponsors, and have heard positive response from Intel and Qualcomm, and hoping to get more sponsors lined up;
- flyers should be ready for distribution at ISIT 2019.

Next, Vijay summarized the status of the upcoming Information Theory Workshops. ITW 2019 will be in Visby, Sweden in August. Conference planning is on track. ITW 2020 will be held in Garda Lake, Italy, September 13-17, based on updates received from Enrico Paolini. The CFP would be distributed at ISIT 2019; call for sponsors is ready; the website is also ready; organizing committee is finalized. Last budget details are being discussed with the IEEE.

A proposal for holding ITW 2021 in Kanazawa, Japan has been received and vetted by the Conference Committee and the proposal will be presented to the BoG at this meeting; planning is on track. A preliminary expression of interest for holding ITW 2022 in India was received from Lalitha Vadlamani of the International Institute of Information Technology (IIIT) Hyderabad.

Vijay then passed on to the BoG, a request from Aaron Wagner that ISIT conference organizers ensure that suitable arrangements are made for the various activities of the IT Society that take place at an ISIT such as the BoG meeting, WITHITs, mentoring roundtable, meet the Shannon lecturer, and the AE meeting. While the costs of these events is borne by the IT Society, it was strongly suggested that the respective conference organizers include these costs in their budget negotiations with the conference venue; the reason being that when these events are separately budgeted, the costs tend to be far higher. While the Awards Ceremony/Awards luncheon is an ISIT event, it is paid for by the conference organizers. The society pays for the cost of the award plaques and for shipping them to the ISIT venue etc.

Next, Vijay discussed the status of the ISIT 2019 student travel awards. He stated that student travel awards were given out this year only to students from US & EU because the ISIT organizers were able to obtain sponsorship only from the US NSF and two EU organizations supporting students from their respective geographic regions. A concern about lack of support to ISIT from non US-EU regions was voiced by Vinod Prabhakaran (TIFR, Mumbai, India), and was shared by others. Vijay provided country-wise breakdown of registered non-US-based students. Vijay appreciated the proposal put forward by Aaron Wagner and approved by the BoG to provide support to students, to the extent of \$20K, under new initiatives. Application for the travel grant can either follow the procedure adopted for ISIT EU and US student in full, or follow a simplified procedure. The decision was left here to the conference committee. Vijay also mentioned that Tara Javidi had raised the issue of support for students from Iran, and perhaps elsewhere. It was decided that this issue could be addressed by the Committee on Diversity and Inclusion.

Vijay concluded the presentation with a summary of planned actions, some immediate and some to be carried out over the term of his tenure. These include updating the IT Society website (in conjunction with the ITS Online Committee), identifying new Conference Committee Members for 2020, and identifying Organizers for the ISIT and ITW conferences down the road. It was discussed that ISIT and ITW be hosted on the IT Society website, as too much of a burden was being placed on the Online Publication Committee Chair, as pointed out by one BoG member.

BoG also briefly brainstormed ideas on how to support students and colleagues from embargo countries. BoG wants to find good ways to accommodate these special circumstances, and the details on how to do this will be discussed at a later time.

The next presentation was given by Gerhard Kramer on behalf of the ISIT 2023 organizing committee. He summarized the key facts about the symposium and thanked the organizing team and Po-Ning Chen in particular for doing a great job. Gerhard went over the motivation for choosing Taipei, and listed recent related conferences that were successfully held there. He also provided the numbers of the sizeable and active IT community in the region. He presented an estimated cost for the registration, in the amount of \$848, which is comparable to recent ISIT conferences. Next, he discussed

tourist attractions and transportation systems in Taipei. He went over the members of the organizing committee. He then presented a detailed program schedule table, including special sessions.

Next, Jerry and I-Hsiang presented options for the conference venue in detail. There were 3 choices, with budget details provided in the longer report. Estimated income the same for all 3 options. Next, they went over the pros and cons of each options. First option is National Taiwan University Hospital International Convention Center. It is centrally located but it is a smaller venue. Second option is Taipei Nangang Exhibition Center. It is a brand new center, opening in December 2019. The concern is that it is expensive. Option 3 is Taipei International Convention Center. This option is new, whereas the former two were presented at the last BoG meeting. The only concern is that the venue was built in 1992. On the plus side, a low venue cost has been negotiated. Also, this center will be the conference venue for Globecom 2020. Organizing committee carefully compared all three options and recommends Option 3 for the overall balance.

A BoG member suggested that for special sessions bigger rooms can be split. BoG also requested to be mindful of student cost registration and lodging. Organizing committee also clarified that there are many open spaces for networking and breaks, and that the renovations will be ready by 2023. Based on the input from a BoG member, organizing committee will look into the possibility of reducing the registration cost by \$100. A BoG member asked about the implications of conversion fees and taxes. Gerhard explained that there will just be a one-time currency exchange.

Next, the following motion was issued.

Motion: To vote on Taipei as the location of ISIT 2023 and venue Option 3.

The motion passed unanimously.

Next presentation was given by Brian Kurkoski, who discussed the proposal for ITW 2021 in Kanazawa, Japan in the period October 17-21, 2021. Brian explained that Kanazawa is a historical town and is accessible from Tokyo on a high speed train in 2 hr 37 min.

Kanazawa has a unique historical element, including an exemplary garden and tea house district, and is popular for excursions and sushi. Brian stated that both the Organizing Committee and TPC are in place. He then went over the statement on gender diversity for ITW 2021. He next stated that 4 focus research topics are planned: low latency communications; information theoretic security; machine learning for communications; and codes in the cloud. Proposed program spans 4 days, and adding tutorials on Sunday as in ITW 2018 is being considered. Proposed venue is Kanazawa Bunka Hall, which is centrally located. Brian next stated that the estimated registration fees are favorable relative to past ITWs, as is the preliminary budget. He stated that the venue cost is low, as it is run by the city. He also said that there are many affordable hotel options in the vicinity. October date being close to Allerton appears not to be an issue.

Next, the following vote was issued.

Motion: To vote for ITW 2021 in Kanazawa for Oct 17-21, 2021.

The motion passed unanimously.

Next presentation was given by Stark Draper, on behalf of the ITSoc Schools Committee. He stated that the following schools are taking place in 2019, and are already approved: Australia, European School of Information Theory, India, and North American School of Information Theory. For 2020, European School of Information Theory in Stuttgart, Germany, was approved in February 2019. At today's BoG meeting, the following will be presented. A proposal for the NASIT'20 in Vancouver, Canada, and a proposal for E.Asia'20 in Seoul, Korea.

Afterwards, Lele Wang presented the details of the proposed NASIT 2020 at the University of British Columbia, Vancouver, Canada. She went over the organizing committee, and provided the list of 5 confirmed speakers, along with their tentative talk titles. Next, she went over the location options; location has not been finalized and there is a back up option. Proposed dates are July 8-10, 2020 to avoid overlaps with other conferences. She went over the proposed program, budget and requested contribution.

The following motion was issued.

Motion: "The BoG authorizes 10K USD to be allocated from the ITSoc 2020 budget to support the North American School in Information Theory (NASIT) to be held in Vancouver, Canada."

The motion passed unanimously.

She clarified that the cost for lodging will be around \$89 CAD per night in a double room.

Next, Changho Suh of KAIST presented on behalf of Youngchul Sung of KAIST, a proposal for East Asian School in Information Theory (EASIT). He motivated that EASIT would be successful due to a large percentage of IT student members. EASIT was organized as a new initiative in 2018, and it is the goal of the organizing committee to make it a regular event. The following places are planned for the upcoming years: 2020 Seoul, South Korea; 2021 Hong Kong; 2022 Shenzhen, China. Changho went over the organizing committee and the program outline, stating that it would follow the template of the Taiwan School. There will be tutorials and lectures, the latter focusing on more advanced and interdisciplinary topics. Cost estimates were presented. Suggestions from BoG were to make the program more balanced and spread student posters more evenly. He also presented cost estimates, including lodging and travel support for students and international speakers. Changho stated that the venue is still tentative. He also stated that is no registration fee for this school, but that there is lodging fee. He asked for a budget to support international students. BoG suggested adding a small registration fee to ensure commitment. There was a short discussion regarding travel support.

The following motion was issued.

Motion: “The BoG authorizes 20k USD in 2020 new initiative funds to be allocated to the East Asian School in Information Theory (EASIT) to be held in Seoul, South Korea.”

The motion passed unanimously.

The next presentation was given by Wei Yu, on behalf of the Membership Committee. Wei went over the list of members of the committee. He then went over the committee budget, pointing that the committee will be able to fund the ITA event as the new initiative. Next, he went over the Distinguished Lecturers (DL) Program, listing DLs from the last and from the current year. He stated that the call for DL 2020 will be around October 2019. He then stated that the Chapter-of-the-Year Award is given to the Japan Chapter. He also stated that new chapters are formed in Estonia and in Qatar. He then summarized the activities of the Student and Outreach Subcommittee, and the Women in Information Theory Society (WITHITS), whose event with 170 registrants will take place on Monday July 8, 2019 at ISIT. The event was advertised by Gireeja Ranade.

The following presentation was given by Brian Kurkoski, on behalf of the Online Committee.

Brian reported on the recent activities of the committee and thanked Anand Sarwate for his help. Brian explained that the ITSoc website was upgraded from Plone 4 to Plone 5 system, and that in the process of doing so, new costs emerged.

Brian stated that “ITSoc Recent News and Events” is the society’s new mailing list, and that there will be a web site for the new JSAIT journal.

Regarding the server upgrade, Brian expressed concerns with continuing with the current vendor due to mounting costs. His suggestion was to freeze the developer for now and reevaluate the cost, version options, etc. in order to keep the cost within the budget. Based on the questions from BoG members, Brian clarified that the current online version is based on Plone 5, due to enhanced security.

Regarding the questions about the cost, Brian clarified that there is a plan to gather additional quotes. A BoG member pointed out that some on-line logins are not working. Brian explained that these are being resolved, but that he needs more volunteers on the committee to help with these issues. Next, Brian presented a proposal for Subsite Design and General UI Improvements, that would also support the on-line version of JSAIT, in the amount of \$4K. He showed what the front page for JSAIT would look like, and that it could include space for a distinctive logo.

The following motion was issued.

Motion: To approve \$4K budget for ITSoc website improvements.

The motion passed unanimously.

After Brian, the next presentation was given by Andrea Goldsmith. In her capacity as EiC, she updated on the status of JSAIT. She presented the executive summary, and provid-

ed updates since the last BoG meeting. In particular, senior editorial board was finalized in March 2019. Steering Committee and the Industrial Advisory Board were also recently finalized. The first issue of JSAIT will be on Deep Learning: Mathematical Foundations and Applications to Information Science. Lead guest editor will be Alex Dimakis. Submission deadline is October 1st, 2019. Notification of paper acceptances is March 15th, 2020. Expected publication is in April/May 2020. The second issue of JSAIT will be Quantum Information Science. The lead guest editor will be Andreas Winter. The rest of the editorial board is being formed now. The current goal is to issue Call For Papers in September/October 2019, with the submission deadline being in December 2019/January 2020. Andrea then went over the launch plan and the logistics for JSAIT in the steady state, explaining that there will be initially 3-4 issues per year, and increasing to 6 issues per year by Year 3. Further discussion on the JSAIT leadership structure was saved for a later time.

Next presentation was given by Elza Erkip, on behalf of the ITSoc Inclusion and Diversity Committee. She advertised Diversity, Equity and Inclusion Event, taking place on Monday, July 8th, at ISIT 2019. The event will overview the activities of the committee. Jose Moura, President of the IEEE, and Andrea Goldsmith, Chair of the IEEE (TAB and Board) Committee on Diversity, Inclusion and Professional Ethics, are speakers. Next, Elza, reported on the activities of the ITSoc Inclusion and Diversity Committee, including gathering relevant data and statistics, identifying best practices, specifying ITSoc code of conduct, and summarizing the NASEM Report on Sexual Harassment of Women in Academia. She also presented the statistics on gender distributions amongst the authors of the best paper awards at major CS conferences. The data was collected by Jingyan Wang and Nihar Shah. She pointed out that less than 4% of best paper awards at ISIT have female authors, and that these percentages are low across the board.

The next presentation on Diversity and Inclusion in the IEEE was given by Andrea Goldsmith, in her capacity as the Chair of the IEEE Technical Activities Board (TAB) Committee on Diversity and Inclusion, and as the Chair of the IEEE Board Ad-Hoc Committee on Diversity, Inclusion, and Ethics. She went over the recent IEEE survey that found that female technologists face unequal treatment and sexist workplaces. She went over the activities of the TAB committee and the committee’s accomplishments to date. She also went over the IEEE Diversity and Inclusion Activities outside TAB, as well as the plan for 2019 of the Committee on Diversity and Inclusion. She then reported on the activities of the IEEE Ad Hoc Committee on Diversity, Inclusion, and Professional Ethics, and discussed activities of various subcommittees. She presented recent progress highlights and IEEE Board of Directors Motions. She concluded by stating that more work is needed to make better the road ahead for the next generation of women in EE and STEM. This work entails collecting statistics, raising awareness, tracing diversity/inclusion progress, recruiting advocates of both genders, and activities taking place in professional organizations (particularly the IEEE), universities and companies.

After Andrea, the next presentation was given by Lalitha Sankar, on behalf of the Women in Information Theory

Society. Lalitha's presentation was in a quiz format, highlighting very low percentages of female representation in the society's leadership roles and various awards. She concluded that there is much work left to do to improve these numbers, and invited meeting attendees to participate in the society events including WITHITS and diversity events.

The next presentation, given by Elza Erkip, and prepared by Elza Erkip and Wei Yu, was the proposal for the "Goldsmith Lecturer". Elza stated that the initial proposal was presented at the last BoG meeting, where it was viewed favorably. She next provided further background information. Andrea Goldsmith won the 2019 IEEE Eric E. Sumner Award. Elza explained that Andrea wants to give back to the ITSoc by donating her prize money to endow an award for junior women at a time when it could be a real catalyst in their career trajectory, akin to the existing Padovani Lecturer Award. Elza also explained that Andrea will also help prepare and execute a funding plan for additional funding. Next, she went over the scope of the "Goldsmith Lecturer" award. At first, Andrea's endowment will be used to create a "Goldsmith Lecturer". Award will be given to a junior woman researcher. The awardee will give a lecture at an IT School. She next explained eligibility criteria for the award, and the nomination and selection procedures. She also described professional benefits of having received this award, funding amount and sources for the award, and she presented a list of potential industry donors for the continuation of the award.

The following motion was issued.

Motion: To approve IEEE Information Theory Society Goldsmith Lecturer.

The motion passed.

There was some discussion regarding how the Padovani Lecturer award was funded. It was explained that the initial \$10K was from him and there were subsequent matching funds. A BoG member asked how is the presentation of a Padovani Lecturer at an IT School organized between American and non-American schools. It was suggested that there could

be additional fundraising efforts for the schools. Elza also explained that there will be a coordination between Padovani Lecturers and Goldsmith Lecturers across different IT schools.

Next item on the agenda was new business.

The first open discussion was regarding the process of selecting the incoming Executive Editor (EE) for the IT Transactions.

Some meeting attendees and BoG members commented that the proposed appointment procedure of the EE gives too much weight to the opinion of the incoming EiC. Others pointed out that accounting for EiC's preferences is an indispensable part of the procedure given the need for daily interactions between the EiC and EE, which requires establishing good working relationship. Other BoG members, while being in favor of supporting a productive relationship, did not support the procedure for succession proposed earlier in the presentation of N&A Committee Chair Frank Kschischang. Some BoG members have stated that no veto practices are adopted by other journals and professional organizations. It was also suggested that senior editors be introduced to help distribute the work load.

Next presentation was given by Christina Fragouli. She reported on the status of the book "Information In Small Bits: Information Theory for Kids," written by Christina Fragouli, Anna Scaglione, and Dawn Faenar. The book is available for purchase on Amazon. Christina asked for colleagues to provide book reviews.

Regarding the new IT magazine, on behalf of the Magazine Steering Committee, Christina also explained that the Phase 2 proposal will be due on December 15, 2019, provided that Phase 1 is approved by the IEEE. Further information will be provided at the next BoG meeting.

There was a brief discussion regarding the spending of the reserves, and how much per year of the reserves can be spent. It was suggested that a separate Finance Committee be formed.

The meeting adjourned at 5:45 pm local time.

In Memoriam: Jørn Justesen (1944–2019)

Jørn Justesen, a well-known expert in coding theory, communications, and data compression, passed away on October 27, 2019 in Washington, DC at the age of 75. His notable results include the construction of low-complexity, asymptotically good error-correcting codes (1972), a discovery of fast decoding algorithms of Reed-Solomon and algebraic-geometric codes, as well as research into construction and properties of convolutional codes.

Jørn Justesen was born on January 31, 1944 in Copenhagen, Denmark. He earned his Ph.D. from the Technical University of Denmark in



1975, and was subsequently appointed Professor in Communication Theory at the same university. He spent his entire career at TUD, retiring from that position in 2009. Justesen published a textbook on coding theory (2004, jointly with Tom Høholdt) as well as the book "Two-Dimensional Information Theory and Coding" (2009, with Søren Forchhammer). He received the 1974 IEEE Browder J. Thompson award and the 1991 IEEE Information Theory Society Best Paper Award, and was awarded the title of Professor Honoris Causa by the Institute for Problems of Information Transmission, Moscow, Russia, in 2004.

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Conference on Information-Theoretic Cryptography (ITC) 2020: Call for Papers

June 17–19, 2020 in Boston, MA USA

The first *Information-Theoretic Cryptography (ITC)* conference will take place on June 17-19, 2020 in Boston, MA USA. ITC is a new conference dedicated to information-theoretic aspects of cryptography, broadly defined. See the website at <https://itcrypto.github.io/> for more information. Areas of interest include, but are not restricted to:

- Randomness extraction and privacy amplification
- Secret sharing
- Secure multi-party computation
- Information theoretic proof systems
- Differential privacy
- Quantum information processing
- Oblivious data structures
- Idealized models (e.g. ,ideal channels, random oracle, generic group model)
- Bounded storage models
- Private information retrieval and locally decodable codes
- Authentication codes and non-malleable codes
- Adversarial and noisy channels
- Information-theoretic reductions
- Information-theoretic foundations of physical-layer security

Important Dates

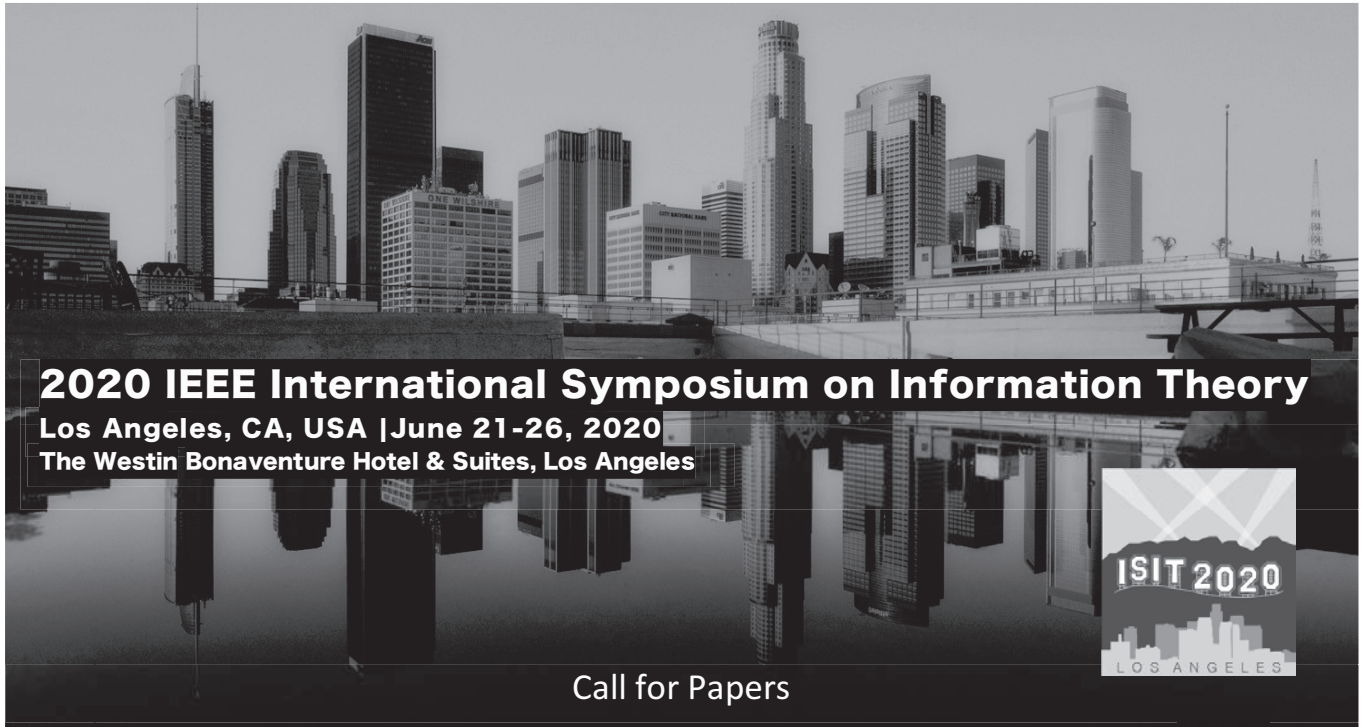
- Paper Submission: Dec 16, 2019
- Greatest Hits Nomination Deadline: Jan 5, 2020.
- Acceptance Notification: March 5, 2020

Conference Organization

General Chairs: Yael Tauman Kalai (MSR and MIT) and Adam Smith (BU)

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2020 IEEE International Symposium on Information Theory
 Los Angeles, CA, USA | June 21-26, 2020
 The Westin Bonaventure Hotel & Suites, Los Angeles

Call for Papers

ISIT 2020
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Interested authors are encouraged to submit previously unpublished contributions in any area related to information theory, including but not limited to the following topic areas:

Topics

- | | | |
|--|--------------------------------------|--------------------------------------|
| ➤ Communication and Storage Coding | ➤ Distributed Storage | ➤ Network Information Theory |
| ➤ Coding Theory | ➤ Emerging Applications of IT | ➤ Pattern Recognition and ML |
| ➤ Coded and Distributed Computing | ➤ Information Theory and Statistics | ➤ Privacy in Information Processing |
| ➤ Combinatorics and Information Theory | ➤ Information Theory in Biology | ➤ Quantum Information Theory |
| ➤ Communication Theory | ➤ Information Theory in CS | ➤ Shannon Theory |
| ➤ Compressed Sensing and Sparsity | ➤ Information Theory in Data Science | ➤ Signal Processing |
| ➤ Cryptography and Security | ➤ Learning Theory | ➤ Source Coding and Data Compression |
| ➤ Detection and Estimation | ➤ Network Coding and Applications | ➤ Wireless Communication |
| ➤ Deep Learning for Networks | ➤ Network Data Analysis | |

Researchers working in emerging fields of information theory or on novel applications of information theory are especially encouraged to submit original findings. The submitted work and the published version are limited to 5 pages in the standard IEEE format, **plus an optional extra page containing references only.**

Information about paper formatting and submission policies can be found on the conference web page, noted below. The paper submission deadline is **Sunday, January 12, 2020, at 11:59 PM, Eastern Time (New York, USA).** Acceptance notifications will be sent out by **Friday, March 27, 2020.**

We look forward to your participation in ISIT 2020!

General Chairs: Salman Avestimehr, Giuseppe Caire, and Babak Hassibi

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<https://2020.ieee-isit.org>





2020 Riva del Garda IEEE Information Theory Workshop

Call For Papers

Monday, Sep. 13 to Thursday, Sep. 17,
www.itw2020.it



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Riva del Garda is situated on the northern shore of Lake Garda. The mild climate favors a Mediterranean vegetation with laurels, lemon, olive and palm trees that frame the great lake and the beauty of the mountains in the backdrop: a true Mediterranean island at the foot of the Dolomites. Boasting a number of lovely bays and ports, Riva del Garda is a popular venue for windsurfers and sailors.

The center of Riva del Garda will fascinate you with its art and architecture, witnessing to ancient history and cultural diversity. The Congress Centre, located in the heart of the town, surrounded by ancient parkland, combines the most extraordinary lake-side setting with a strategic position, making it easily reachable on foot from the hotels.

Topics

Interested authors are encouraged to submit previously unpublished contributions in all areas of coding and information theory. The program will include both invited and contributed sessions, with a particular emphasis on the interface between information theory and other topics including, but not limited to:

- Statistics, Learning, and Deep Neural Networks
- Quantum Computing and Coding
- Coding for Computation and Learning
- Queuing Theory
- Blockchains and Cryptocurrencies
- Computational and Synthetic Biology

Tutorials

The workshop will feature tutorials on interdisciplinary topics of emerging interest. Tutorial speakers will be announced in December 2019.

Papers

Papers for the contributed sessions must be submitted according to the guidelines appearing on the workshop website: <http://www.itw2020.it>

Tentative Dates

Paper submission deadline: April 3, 2020
Acceptance notification: June 10, 2020
Final manuscript and author registration: July 10, 2020



ISITA2020

Kapolei, Oahu, Hawai'i

October 24–27, 2020

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ISITA2020

October 24–27, 2020 in Kapolei, Hawai'i, USA

The International Symposium on Information Theory and Its Applications (ISITA) is a leading conference on information theory. Since its inception in 1990, ISITA has been a forum for interdisciplinary interaction, gathering leading researchers to discuss topics of common interest in the field of information theory. In 2020, the biennial ISITA will be held October 24–27 at Aulani, A Disney Resort & Spa in Kapolei, Hawai'i on the island of Oahu.

ISITA 2020 creates a setting for international exchange with the aloha spirit, to provide a place for individuals, especially students, to know the joy of research, and to share new results in information theory and its applications with the world.

Call for Papers

Interested authors are invited to submit papers describing novel and previously unpublished results on topics in information theory and its applications, including, but not limited to:

- Boolean Functions and Sequences
- Coding for Storage
- Coding Theory
- Communication Theory
- Computation and Complexity in Information Theory
- Cryptography and Information-Theoretic Security
- Data Privacy and Security
- Deep Learning in Information Theory
- Distributed Coding and Computation
- Estimation and Detection
- Formalization of Information Theory
- Group Testing
- Information Hiding
- Information Theory for Biology
- Information Inequalities
- Network Coding and Information Theory
- Pattern Recognition and Machine Learning
- Quantum Information and Coding Theory
- Shannon Theory
- Signal Processing
- Source Coding and Data Compression
- Sparsity and Compressed Sensing
- Statistical Inference and Learning
- Statistical Physics for Information Theory
- Statistics and Information Geometry
- Wireless Communications

Paper Submission

Authors should submit papers according to the guidelines which will later appear at:

<http://isita.net>

This link points to the permanent site <http://www.isita.ieice.org/2020/>. Accepted papers will appear in the symposium proceedings. To be published in IEEE *Xplore*, an author of an accepted paper must register and present the paper. IEEE does not guarantee inclusion in IEEE *Xplore*.

Paper submission deadline April 2020

Acceptance notification June 2020

Further information will be posted on the symposium web site as it becomes available.

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Conference Calendar

DATE	CONFERENCE	LOCATION	WEB PAGE	DUE DATE
December 9–13, 2019	IEEE Global Communications Conference (GLOBECOM)	Waikoloa, Hawaii, USA	https://globecom2019.ieee-globecom.org/	Passed
February 26–28, 2020	International Zurich Seminar on Information and Communication	Zurich, Switzerland	https://www.izs.ethz.ch/	Passed
March 18–20, 2020	54th Annual Conference on Information Sciences and Systems (CISS)	Princeton, New Jersey, USA	https://ee-ciss.princeton.edu/	Passed
April 06–09, 2020	IEEE Wireless Communications and Networking Conference	Seoul, South Korea	https://wcnc2020.ieee-wcnc.org/	Passed
April 27–30, 2020	The 3rd Age of Information Workshop	Beijing, China	https://infocom2020.ieee-infocom.org/age-information-workshop	January 15, 2020
May 25–29, 2020	European School of Information Theory	Stuttgart, Germany	https://www.inue.uni-stuttgart.de/esit2020/	—
June 15–19, 2020	International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless (WiOpt)	Volos, Greece	http://www.wi-opt.org/	January 14, 2020
June 17–19, 2020	Conference on Information-Theoretic Cryptography (ITC)	Boston, Massachusetts	https://itcrypto.github.io/2020.html	December 16, 2019
June 21–26, 2020	IEEE International Symposium on Information Theory	Los Angeles, California	https://2020.ieee-isit.org/	January 12, 2020
June 22–26, 2020	52nd Annual ACM Symposium on the Theory of Computing (STOC)	Chicago, Illinois	http://acm-stoc.org/stoc2020/	Passed
July 08–10, 2020	North American School of Information Theory (NASIT)	Vancouver, Canada	http://conferences.ece.ubc.ca/nasit2020/index.html	—
September 13–17, 2020	IEEE Information Theory Workshop (ITW)	Riva del Garda, Italy	http://itw2020.it/welcome.html	April 03, 2020
October 24–27, 2020	International Symposium on Information Theory and its Applications (ISITA)	Kapolei, Hawaii, USA	http://www.isita.ieice.org/2020/home.html	April, 2020

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