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President's Column

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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 hes 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

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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".