I am pleased and proud to write these words for the opening of our very own research newspaper. When SCE- Shamoon College of Engineering was founded fifteen years ago, this would have seemed a dream. But today, SCE is the largest engineering institution in Israel, and is able to attract quality staff, dedicated to leading innovative and beneficial research work. The presence of top notch researchers at our college is crucial for the maintenance of a high level of engineering education and opening up opportunities for our graduates. We aim to supply our students with an in-situ scientific environment by supporting excellence and innovation in research led on campus, thus, increasing the scientific importance and weight of the peripheries, and encouraging our graduates to remain and work in the area. We are committed to achieving these remarkable goals, and determined to overcome the serious obstacles facing us along the way: changing the social perception of the peripheral zones in the eyes of our students, potential staff, and potential funding institutes and gaining external support and grants. Nevertheless, the ship has set sail, our R&D is high on track towards excellent achievements and is receiving recognition and appreciation world wide. I am sure that this issue of SCE science is just the first in a long line of issues filled with reports and summaries of our prosperously evolving research, innovation, and development.

Prof. Jehuda Haddad.
President

2010 is a momentous year for education and research at SCE. At the end of the first decade of this new millennium, we have achieved two flourishing campuses, over 4000 students, and a remarkable number of active researchers working on cutting edge research and development. Faculty research grants are an existential necessity, without which we cannot maintain the lead in engineering education and training. The challenges facing us are complex and the obstacles formidable: lack of government funding, the geographic distance from major research centers, and a limited ability to attract outstanding faculty members. Nevertheless, we at SCE are determined to enhance our work in R&D. The college’s leading researchers have won external research grants from national and international foundations. This proves the relevance of Herzl’s famous phrase: “If you will it – it is not a legend.” This first issue of Science SCE introduces you to the breakthrough research taking place at SCE and provides a profile of the college’s resident researchers.

I look forward to a year of exciting discovery in research and development and I hope that together we can build our future on past achievements as far as to exceed expectations for the next decade.

Dr. Miri Yemini
EIC Director
PC PC on the desk, tell us, Who Spoke? When? please do your best!

As the information traffic becomes increasingly loaded, it becomes very hard to handle. One of the most natural information sources is speech data. Most of the data comes from conversations recorded during meetings, telephone conversations, conferences, and many other scenarios. The speech data is of much interest in information retrieval, as Google does with text and images, but not only. Commercial applications, such as call centers; video annotations; speech translation; and smart meeting room annotations are important issues as well as many forensic applications.

The problems of interest are what was said (speech recognition); who spoke (speaker recognition); the gender; mental and physical conditions of the speakers; language of the speech parts (the language may change during the conversation); and the age of the speaker.

All existing applications can assume (speaker recognition as an example) or perform with a higher accuracy (like speech recognition) if each speech segment belongs to one speaker only. For this reason it is very important to perform speaker diarization of the conversations, i.e. create a diary of “Who spoke when?” and use the data which belongs to each speaker independently. Of course for meta-data it is important to use the dependencies in the conversation flow, but it is out of the scope of this paper.

So far, much of the diarization/annotation work is done manually by human experts. This work is very exhausting and time consuming. A large number of qualified experts need to listen to the conversations in order to achieve precise annotation. With the fast information growth, it becomes unmanageable, and a much more efficient strategy must be applied. The most natural solution is to switch from human diarization to computer-based diarization.

In the last fifteen years, the speaker diarization area grows constantly, but the obtained results are still far from human performance. In spite of the flaws in the technology, the quality of results achieved so far is sufficient for some applications.

Speaker diarization presents many challenges: The participants are usually unknown; the number of participants is usually unknown as well; the environment (transmission channels and the environmental noise) may change from one conversation to another; at times non-speech events are hard to detect during conversation (background noise during the pauses); and overlapping speech occurring in a natural conversation has a very negative influence on the diarization performance.

Despite all the above, the change detection points should be found and the Indexing between the speaker clusters, the overlapping speech cluster, and the non-speech cluster should be defined. At times, some prior information such as the number of speakers, is provided.

In our work we combine Self-Organizing Maps (SOM) with statistical methods, such as Hidden Markov Models (HMM) under a minimum duration constraint, to model the speakers and perform the change detection in one phase (see figure 1). We have found a remarkably fast and efficient way to detect most of the overlapping speech in a conversation. Unlike most of state of the art systems, which require preliminary off-line training with an enormous amount of data in order to compensate the channel variability, and may be vulnerable in case of new channels, our system does not require any preliminary, off-line training and performs well regardless of the changes in channels. The algorithms we apply, in comparison with others, are of low complexity, and as such, are very fast. Our system is able to perform almost in real time. It would take about 8 seconds to analyze five minutes of speech on a PC. The developed technology was easily converted into on-line and incremental variants, with a small degradation in performance, but with a diarization supplied in less than 0.2 Sec after the conversation has ended.

In our lab at SCE, in collaboration with the BGU University of the Negev, we work on diarization of telephone conversations, assuming that the number of speakers is always two. This assumption is not always valid, but as a first approximation it is a sufficient and reasonable one. In our work we combine Self-Organizing Maps (SOM) with statistical methods, such as Hidden Markov Models (HMM) under a minimum duration constraint, to model the speakers and perform the change detection in one phase (see figure 1). We have found a remarkably fast and efficient way to detect most of the overlapping speech in a conversation. Unlike most of state of the art systems, which require preliminary off-line training with an enormous amount of data in order to compensate the channel variability, and may be vulnerable in case of new channels, our system does not require any preliminary, off-line training and performs well regardless of the changes in channels. The algorithms we apply, in comparison with others, are of low complexity, and as such, are very fast. Our system is able to perform almost in real time. It would take about 8 seconds to analyze five minutes of speech on a PC. The developed technology was easily converted into on-line and incremental variants, with a small degradation in performance, but with a diarization supplied in less than 0.2 Sec after the conversation has ended.

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Role of radicals in the lipid peroxidation products of commercial infant milk formula

Dr. Ariela Burg, Department of Chemical Engineering
Dr. Dorith Tavor, Department of Chemical Engineering
Dr. Jeanine Blumenfeld, Department of Chemical Engineering
Dr. Oshra Saphier, Department of Chemical Engineering

Dr. Tali Silberstein, Department of Gynecology and Obstetrics, Soroka University Hospital, Ben-Gurion University of the Negev, Beer-Sheva, Israel.

Dr. Guy Yardeni, Nuclear Research Center-Negev, Chemistry Department, Ben-Gurion University of the Negev, Beer-Sheva, Israel.

Dr. Israel Zilbermann, Nuclear Research Center Negev, Chemistry Department, Ben-Gurion University of the Negev, Beer-Sheva, Israel.
Role of radicals in the lipid peroxidation products of commercial infant milk formula

Infant formulas on the market today should be aimed at providing the best alternative to breast milk for the babies of women who are unable to continue breastfeeding until 6 months of age. The aim is to mimic the functional outcome of the breastfed infant (e.g., growth and development) and not to copy the composition of human milk. To that end, the following compounds have been added to formulas: long-chain polyunsaturated fatty acids (LCPUFA) for brain composition and neurodevelopment, probiotics and prebiotics for the fecal flora and the local intestinal defense, and nucleotides for promoting the immune response.

The formulation, handling, and storage of baby foods are important in order to maintain both the nutritional quality and the physicochemical properties of these foods. During storage, some reactions and interactions occur that change the physicochemical and nutritional properties of baby foods. Monitoring of these and their by-products must be conducted in the preparation and storage of baby foods.

In examining the effect of breast milk on antioxidants and oxidation levels it was found that breast milk is a better antioxidant than formula milk. Exposure to light during tube feeding increases lipid peroxidation in infant formula but not in human milk. It has been observed that supplementing infant formulas with LCPUFA does not affect lipid peroxidation in the plasma of healthy, preterm infants.

An investigation of the extent to which formula milk and stored breast milk, both commonly used in hospitals, could be pro-oxidant sources for newborn babies, found that there were notable differences in the oxidation parameters of several formula milk brands, particularly concerning the levels of lipid peroxides and total antioxidant capacity. No difference was found in the mean total antioxidant capacity between formula and breast milk. Some of the effects of lipid peroxidation include the development of off-flavors and odors, changes in texture, and a loss of nutritive value. In addition, lipid peroxidation products seem to be directly involved in the development of atherosclerosis, cancer, and aging processes.

Malondialdehyde (MDA) is one of the end products of lipid peroxidation (Figure 1). MDA is in fact known to be a mutagenic species, a suspected carcinogen that can react with DNA to generate mutagenic adducts. The aim of our study was to compare MDA levels of soybean- and dairy-based baby milks, both commonly used in Israel, naturally and under conditions of oxidative stress, such as ionizing radiation.

Lipid peroxidation measured in shelf products

The first aim of the study was to learn more about the oxidative status of the dairy based formula in comparison with the soybean based formula. For this purpose, levels of MDA were determined in A-d, A-s, B-d and B-s, as mentioned above. The results are summarized in Figure 2. The study revealed notable differences in the levels of lipid peroxides in A-d and A-s compared to those levels in B-d and B-s. The levels of MDA in A-d and A-s exceeded those in B-d and B-s. The question is what conditions accelerate lipid peroxidation in milk powder?

The results displayed in Figure 2 seem to correlate well with the higher levels of unsaturated fats, vitamin C, and the presence of LCPUFA (ARA and DHA) in the milk powders from “A”. These factors are known to enhance peroxidation. The lower amounts of MDA in B-d and B-s correlate with the higher vitamin E content, known to be a strong reducing agent (antioxidant), in the latter. The elevated levels of MDA in the soy formula (A-s and B-s) versus the dairy formula (A-d and A-s) support the hypothesis that soy milk is more sensitive to oxidative stress than cow milk, as the vegetarian brands contain more unsaturated fats and iron than the dairy powder.

Lipid peroxidation induced by ionizing radiation

When solutions containing the four brands of formula were subjected to an oxidizing medium produced by ionizing radiation (hydroxyl radicals), lipid peroxidation and the amount of MDA increased as a function of the irradiation dose, as expected (Figure 3). The differences in slopes correlate to the relative amounts of unsaturated fats in the infant formulas: A-s=B-s>A-d>B-d. The larger amounts of iron and vitamin C, which are known to induce oxidation (via Fenton or Fenton-type reactions), in the vegetarian brands (A-s and B-s) also help explain the greater amounts of MDA formed in B-s.

Formate anions, which react quickly with oxidizing radicals, producing CO2 radicals, which are strong reducing reagents (-1.7 V vs. NHE), were added to the different powders. The results show unequivocally the effect of radical scavenging by it.

Conclusions

Commercial milk powder for babies that is based on soybean fats is more susceptible to oxidative damage due to the relatively high levels of unsaturated fatty acids and a combination of high concentrations of vitamin C and iron. The results also suggest that milk formulas containing added ARA and DHA (A-d, A-s) are even more susceptible to oxidation. The extraordinary protection against oxidative damage provided by the formate anion, even at the highest concentrations of hydroxyl radicals (ionizing radiation), suggests that adding a biological lipid soluble antioxidant such as lycopene to the milk powder may also prevent oxidative damage to the lipids, thus benefiting the infant.

Figure 1: A scheme of lipid peroxidation and malondialdehyde end product.

Figure 2: Amount of MDA formed as a function of [OH].

Figure 3: MDA levels for the 4 brands of formula milk—A-d, A-s, B-d, and B-s (data shown are average ± standard deviation) before irradiation and/or the addition of formate.
Like a Bridge over troubled Water

Hydraulic Modeling improves Water Systems

Hydraulic modeling is a form of physical modeling widely used to investigate design and operation issues in hydraulic engineering. It entails, with a degree of sophistication that varies with the objective of investigation, the use of a scaled model for replicating flow in diverse natural flow systems and evaluating the performance of hydraulic structures. The following cases are common subjects for modeling: water movements; the hydraulic performance of water intakes, spillways and outlets; flow around various objects; flow regulating devices and many other systems.

An advantage of a hydraulic model is its potential capacity to replicate many features of complicated flow situations. In many situations, there is little recourse other than hydraulic modeling for making designing or operational decisions, regarding expensive and complex hydraulic works. Such situations arise in particular, when, for a variety of reasons, complex flow patterns are involved and reliable answers cannot be obtained mathematically. For example, hydraulic bridge structures are of very expensive construction and maintenance. It may become very hard at times, for a design or a field engineer to understand the proper functioning of the structure during operation, therefore it is essential to hydraulically test the model of such structure in the laboratory before its construction.

Sami Shamoon College of Engineering (SCE) operates a well-equipped hydraulic laboratory, where different models of practical hydraulic structures are tested. It employs a team of experienced engineers for the construction of hydraulic models and carrying out the analyses.

Dr. Leonid Grinis and Dr. Uri Tzadka of the SCE Civil Department are studying storm water transportation through bridge culverts with different guide walls. Figure 1, for instance, shows a laboratory hydraulic model of part of the Bokek wadi with a bridge near the Dead Sea. The model is based and constructed according to a dimensional analysis and dynamic similitude.

The guide walls are structures constructed upstream of a bridge in order to improve the uniformity of flow distribution at the culverts section. In this work other types of guide walls were studied in a physical model. Measurements were carried out for different discharges and guide wall types of the culvert.

Observations showed that maximum discharge occurs at the culvert in side-tapered inlet walls with a well-defined angle. The provision of a more gradual flow transition will decrease the energy loss and thus create hydraulically more efficient inlet conditions. The hydraulic capacity of a bridge may be improved by appropriate inlet selection. Figure 2, shows a bridge after reconstruction based on recommendations accepted from the study of the hydraulic model in laboratory.

To confirm the design of structure by a hydraulic model is one of the best and economical methods to ensure the safety of the structure as well as minimize post construction activities like repair and maintenance.

Dr. Leonid Grinis focuses on the investigation of other hydraulic systems as well. For example, he has developed a new method for cleaning pipelines by flow induced vibration. An effective hydrodynamic vibrational device was developed for cleaning sediments from the inner surfaces of pipes. This innovative approach for the cleaning of a pipeline has very good prospects for practical use in different fields.

The SCE group is now working on new models of storm water regulation and the detention of water for human needs. These researches will be able to provide a basis for understanding and solving different problems in complicated flow situations.
Unraveling the mysteries of unknown radioactive sources

The objective of Gamma spectrometry is the exhaustive retrieval of information regarding an unknown radioactive source, i.e. its content and its activity. This is typically done by the following experimental protocol: a mixture of radionuclides emits photons which impinge on a semiconductor detector. Photons interact with this semiconductor to produce electron-hole pairs. The migration of these pairs in the semiconductor produces a pulse of current with a finite duration. Under appropriate experimental conditions (ultra-pure crystal, low temperature), the integral over time of this pulse of current corresponds to the total amount of electron-hole pairs created in the detector, which is proportional to the energy of a given photon and λ, the activity of the source, we aim to estimate the distribution of Y as well as Y. Though improvements have been proposed for the instrumental aspect, the pileup effect is by essence stochastic, and was often considered by practitioners as a nuisance. However, the recent advances made in statistics (penalized L1-regression, results on the M/G/∞ queue) and signal processing (sparse signal representation, compressive sensing) allow to improve the tradeoff between sparsity and estimation precision. In our case y is a signal sampled by a spectrometer, X is a dictionary of known shapes, translated at every point of the discretized interval of time; and we choose r proportional to the noise standard deviation. Simulations show that if the signal stems from a Poisson process (even a non homogeneous one), the LASSO succeeds to recover the beginnings of individual pulses, by finding the correct translated signals involved. Therefore, this leads to a robust activity estimator. Results on real data are similarly promising (figure 2). Validation on more general datasets, as well as theoretical insights on the method and developments of methods for pileup correction in the energy spectrum, are planned for further research.
The quantum Hall effect is a quantum-mechanical version of the Hall effect. It is observed in two-dimensional electron systems subjected to low temperatures and strong magnetic fields. In such systems the Hall conductivity \( \sigma \) takes on the quantized values:

\[
\sigma = \nu e^2/h
\]

where \( e \) is the elementary charge and \( h \) is Planck's constant. The prefactor \( \nu \) is known as the "filling factor", and can take on either integer (\( \nu = 1, 2, 3, \ldots \)) or rational fraction (\( \nu = 1/3, 1/5, 5/2, 12/5, \ldots \)) values. The quantum Hall effect is referred to as the integer or fractional quantum Hall effect, depending on whether \( \nu \) is an integer or fraction respectively.

The integer quantum Hall effect (IQHE) was discovered by K. von Klitzing in 1980, and he was awarded the 1985 Nobel Prize in Physics for this. The integer quantum Hall effect is very well understood, and can be simply explained in terms of single particle orbitals of an electron in a magnetic field (see Landau quantization). The fractional quantum Hall effect was experimentally discovered in 1982 by Tsui and Stormer, and together with the theoretician Laughlin, they were awarded the 1998 Nobel Prize in Physics.

The quantization of the Hall conductance has the important property of being incredibly precise. Actual measurements of the Hall conductance have been found to be integer or fractional multiples of \( e^2/h \) to nearly one part in a billion. It has allowed for the definition of a new practical standard for electrical resistance, based on the resistance quantum given by the von Klitzing constant \( R_k = e^2/h = 25812.80757(18) \) \( \Omega \). Since 1990 a fixed conventional value \( R_k \sim 26 \) is used in resistance calibrations worldwide. The quantum Hall effect also provides an extremely precise, independent determination of the fine structure constant, a quantity of fundamental importance in quantum electrodynamics.

After the discovery of the IQHE it was soon realized that the inter-plateau transition can be considered as a critical phenomenon (localization-delocalization transition), and can be described by the semiclassical picture, where electrons move along the lines of a constant potential. This semiclassical picture was the basis for constructing the original Chalker-Coddington model, where the network model of nodes and links was proposed. Each node represents a saddle point and each link is an equipotential line of the random potential. When an electron moves on the link, it picks up a random phase. When an electron approaches a node, it can either turn right (staying on the same equipotential line) or left (tunneling into another equipotential).

Professor Kagalovsky is doing research by use of various network models. With his collaborators, he has studied a two-channel generalization of the network model, addressing the dependence of the critical energy on the random magnetic field. They have found that the critical energy deviates from Landau level (up) in agreement with a levitation scenario. Levitation scenario was suggested in 1983 by Khmelnitski to explain the behavior of critical states, which are necessary for the IQHE at strong magnetic fields, but do not exist in two dimensions at the zero magnetic field. The results of this research have definitely confirmed the levitation scenario. The ultimate goal now, is to construct a unified model which will describe levitation scenario at any magnetic field. In the framework of the same project a triangular network model analogous to the original CC model, and its generalization, were studied as well, these also supporting the levitation scenario.

In his other works Prof. Kagalovsky has studied various generalizations of the network model, corresponding to novel symmetry classes, related to disordered superconductors. Those studies allowed him and his collaborators to predict two novel quantum Hall effects: the spin quantum Hall effect and the thermal quantum Hall effect. In contradistinction to the original charge quantum Hall effect, the quasiparticles in those effects, carry a unit of magnetic moment (spin) or a unit of thermal energy. In recent years he has also addressed a very nontrivial question of influence of nuclear spins (or magnetic impurities) on the propagation of electrons. This work has already produced a few interesting results and it opens a broad field for further investigation.
New Density-Based Empirical Likelihood Methods in Nonparametric Statistical Inference

The likelihood principle is arguably one of the most important concepts for inference in parametric modeling. In particular, likelihood ratio tests provide a useful blueprint for various applied and theoretical statistical problems. Likelihood ratio tests also have a wide variety of applications, spanning medical, engineering and social science experiments. However, it is not always possible, or optimal, to use parametric likelihoods. For instance, when density functions depend on many unknown parameters, maximum likelihood estimators might be inconsistent in the case of multidimensional parameter estimates, or when forms of densities cannot be assumed to be known. Thus, in a nonparametric context, the empirical likelihood (EL) is one of a growing array of artificial or approximate likelihoods currently in use in statistics. Over the last two decades, the empirical likelihood (EL) construction relative to ordinary parametric likelihood ratios, resulting in an efficient test based on samples entropy. The proposed and examined distribution-free two-sample test is shown to be very competitive with well known nonparametric tests. For example, the new test has high power when detecting a nonconstant shift in the two-sample problem, whereas Wilcoxon’s test may break down completely. This is particularly true in the cases where there is a non-constant shift under the alternative or the data distributions are skewed. Theoretical support is obtained by proving consistency of the EL ratio type test.

Considering retrospective change point problems, we utilize the proposed method to obtain nonparametric forms of the CUSUM and Shiryaye-Roberts detection policies that are known to be powerful parametric likelihood tests for detecting a change in distribution. A Monte Carlo study demonstrates that the density-based EL method provides very efficient tests when comparing with the classical change point procedures.

The method developed in our work can be modified to be applied to various nonparametric problems. For example, a one-sided version of the two-sample problem can be the point of interest, say $x > y$ under $H_1$. We plan to address the use of information regarding ordered alternative hypotheses in the context of the nonparametric approximations of parametric likelihood functions, which needs substantial mathematical details. Another potential application of the density-based EL approach can be formulated in the form of sequential control procedures. Further studies are needed to test the approach in other contexts.