
# The 15th Interdisciplinary Research Conference

Kfar Blum
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# Book of Abstracts



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# Contents

# Plenary Speakers

### The mathematics of multi-a(ge)nt interactions or How to coordinate a swarm of simple robots

**Alfred M. Bruckstein**
Department of Computer Science, Technion – Israel Institute of Technology

An ant colony is a marvel of cooperation and coordinated, purposeful work carried out by simple a(ge)nts with very limited capabilities. Ants do not have GPS systems, compasses or odometers. They do not use laser range finders, and neither do they have good memories or extraordinary computational resources, nor employ sophisticated long-range sensing or communication equipment. Yet they rule the earth, in terms of numbers and resilience, and by some evolution-developed local response algorithms, that rely on pheromone-mediated myopic interactions. For them the environment is a huge, shared resource covered with chemical memory signals. The paradigm of swarm robotics is an attempt to mimic this phenomenal success of nature. In the attempt to analyze the abilities of colonies of small and limited robots to perform a variety of tasks, one encounters formidable mathematical difficulties. The direct problem of analyzing the emergent global behavior that results from a set of local interaction rules of is tractable in a few interesting cases, such as for example, in gathering and region covering or patrolling missions. The inverse problem of deriving local rules of behavior, based on the ant-like robots' limited sensing and communication capabilities, is far less approachable. Several examples illustrating the mathematical tools available for analyzing the behavior of swarms of myopic agents will be discussed in my presentation.

## Short biography

**Professor Alfred M. Bruckstein**, born in Transylvania, Romania, in 1954, received his BSc and MSc degrees at the Technion, Haifa, in 1976 and 1980, respectively, and then earned a Ph. degree in Electrical Engineering at Stanford University, California in 1984, his advisor being Professor Thomas Kailath.

He has been with the Technion since 1984, where he now holds of the Ollendorff Chair in Science, in the Department Computer Science. His research interests are in Ants and Swarm Robotics, Signal and Image Processing, Image Analysis and Synthesis, Pattern Recognition, and various aspects of Applied Geometry. Professor Bruckstein has authored and co-authored over one hundred and fifty journal papers in the fields of interest mentioned.

Professor Bruckstein has held visiting positions at MIT, USA; Groningen University, Holland; Stanford University, TsingHua University, China, and Evry University and at CEREMADE, Dauphine University, France. He was a visiting Member of Technical Staff at Bell Laboratories at Murray Hill, from 1987 to 2000, working with Dr. Arun Netravali and several colleagues there on Image Processing and Computer Vision topics. Since 2009 he has also been a Visiting Professor at Nanyang Technological University in Singapore, at the School of Mathematical and Physical Sciences.

From 2002 till 2005 he served as the Dean of Technion's Graduate School, and from 2006-2011 as the Head of Technion's Excellence Program for Undergraduate Studies.

Professor Bruckstein is a member of the AMS and MAA, and is a SIAM Fellow for contributions to Signal Processing, Image Analysis, and Ant Robotics. He and received SIAM's 2014 SIAG-Imaging Science Prize (with David Donoho and Michael Elad, for their paper, "From Sparse Solutions of Systems of Equations to Sparse Modeling of Signals and Images"), as well as IEEE's Signal Processing Society's 2018 Sustained Impact Paper Award for the K-SVD Dictionary Design (jointly with Michal Aharon and Michael Elad). He also received an Honorary Doctorate from Agora University in Oradea, Romania.

Professor Bruckstein is happily married to Rita and they have one son, Ariel, with whom they wrote and illustrated a bestiary of imaginary animals of Ariel's invention called "The Knocktopus and His Friends", published by Panopticum Press in 2013. He also illustrated several books published by

his late father Ludovic Bruckstein, in Romanian, Hebrew and French, and a collection of comical verse in Hebrew, by Professor Irad Yavne, entitled "Comical Relief", describing Academic Life in general, and at the Technion, in particular.

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### Targeted delivery of drugs and gene therapy

**Joseph Kost**
Department of Chemical Engineering, Ben-Gurion University

Nanotechnology has the potential to revolutionize cancer and other therapies. Advances in protein engineering and materials science have contributed to novel nanoscale targeting approaches that may bring new hope to patients. Several nanocarriers have been approved for clinical use. To date, however, there are only a few clinically approved drugnanocarriers that can selectively bind and target cancer cells. Nanoparticles used as drug delivery carriers consist of different biodegradable materials such as natural or synthetic polymers, lipids, or metals. The specific cell targeting is of utmost importance in gene therapy where the main goal is the development of efficient, non-toxic gene carriers that can condense and deliver foreign genetic materials into specific cell types. Viral and non-viral carriers have been developed and some have already been approved for cancer and eye disease treatments. Still in many studies, the transfection efficiency is too low due to biological barriers in the transfection process. Physical approaches to increasing efficacy and targeting of specific tissues have also been studied. In the presentation, the drug delivery aspects of nanomedicine, the molecular mechanisms underlying the interactions of nanoparticles with cell-surface receptors, biological responses and ultrasound as a targeting tool and its effect on cellular transport will be discussed.

Short biography

**Joseph Kost D.Sc.** is a University Distinguished Professor. He holds The Abraham and Bessie Zacks Chair in Biomedical Engineering, and was the Dean of the Faculty of Engineering Sciences at Ben-Gurion University of the Negev (BGU). Kost completed his undergraduate and graduate degrees in Chemical Engineering at the Technion - Israel Institute of Technology, before earning a doctorate in Biomedical Engineering at the same institution. Later he also earned an M.B.A. from BGU's Department of Management. He is a Fellow of the American Institute for Medical and Biological Engineering, a Foreign Member of the United States National Academy of Engineering (NAE), an Honorary Fellow of the Israel Institute of Chemical Engineers, a Member of the Controlled Release Society College of Fellows, and a Member of the Israel Academy of Sciences and Humanities.

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## Broad scale spatio-temporal organization of animals and plants in the service of conservation

**Uri Roll**
The Jacob Blaustein Institutes for Desert Research, Ben-Gurion University

The world is in the midst of the sixth mass extinction event. In the next century we are predicted to lose about half of the life forms on earth due to human actions. Structural societal changes will be needed to turn the tide on these trends. Nevertheless, there are still major knowledge gaps regarding the structure, dynamics, and mechanisms underlying the spatio-temporal organization of earth's various life forms. Moreover, we also need much better information on the best ways to protect biodiversity and how to promote its conservation in the general public. The scientific fields of macroecology and conservation sciences have been progressing in the past couple of decades to fill in these knowledge gaps. New insights in these fields enable the promotion of sound conservation policies and management actions.

In my lecture, I will review several key advancements in these fields in

recent years that strive to help us prioritize regions and species for conservation as well as better understand human interests in nature and environmental problems. Specifically, I will explore how to incorporate the non-random global distribution of animals from different taxonomic groups into formal prioritization of regions for conservation. I will look how different metrics of biodiversity change our perceptions of nature and its protection; how knowledge gaps can be modelled to help in identifying species needing greater conservation attention. Finally, I will discuss how large online repositories of human engagement with nature or nature related topics could help in enacting lasting conservation policies. Turning the tide on the impeding biodiversity crisis necessitates rapid and sensible actions and big data repositories and approaches may provide key insights to enable this.

## Short biography

**Uri Roll** is a newly appointed senior lecturer at the Mitrani Department of Desert Ecology, The Jacob Blaustein Institutes for Desert Research, based at the Sede-Boqer campus, of the Ben-Gurion University. He received his Bachelor's in life sciences and his M.Sc. in ecology and the environment (under the supervision of Prof. Tamar Dayan and Prof. Daniel Simberloff) from the Tel Aviv University. He conducted his Ph.D. studies in the Biomathematics Unit, Department of Zoology, of the Tel Aviv University under the supervision of Prof. Lewi Stone. He conducted his post-doc research at the School of Geography and the Environment, and the Department of Zoology at the University of Oxford. Uri is interested in the intricate interactions between humans have nature, how they affect it, and are affected and interact with it. To explore these patterns, he uses theoretical and statistical models, data analyzed at scales ranging from local to global, as well as data of various organisms collected in the field. This is done using an array of approaches from purely theoretic perspectives, all the way to studies linked to on-the-ground implementation of conservation action. He is also interested in the arrangement and organization of natural phenomena in space at different scales.

# Braude Plenary Speakers

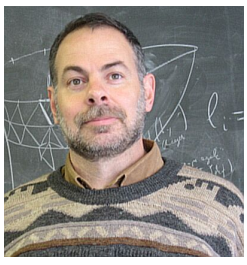
### Persistent homology of networks and hypernetworks via discrete Morse theory

**Emil Saucan**
ORT Braude College

**Keywords:** Persistent homology; complex networks and hypernetworks; Forman Morse theory; Banchoff Morse theory; combinatorial curvature; Formans Ricci curvature

In recent years, the field of Topological Data Analysis (TDA) has grown rapidly and now provides a set of powerful tools to analyze various important features of data. Persistent Homology (PH) has played a key role in bringing TDA to the forefront of modern data analysis. It not only offers a way to visualize data efficiently, but also provides a method to extract relevant information from both structured and unstructured datasets. As PH is based on Morse Theory, it is natural to look, in the case of complex networks, for a discrete version of Morse Theory. An efficient version was developed by Robin Forman and is by now well-established. We show how to apply Forman's discrete version to complex networks and their clique complex. We demonstrate this on an unweighted model and real-world networks. We also develop a PH for hypernetworks, viewed as polyhedral complexes. To this end, we use another type of discrete Morse Theory developed by Thomas Banchoff. In addition, we show the connection between this type of PH and Formans combinatorial Ricci curvature. Further, we show the relation between the two types of PH.

#### Short biography



**Emil Saucan** received his BSc from the University of Bucharest, Romania, and the MSc and PhD from the Technion, Haifa, all of them in Pure Mathematics. He was a Viterbi postdoctoral fellow as well as senior research fellow at the Electrical Engineering and Mathematics Department, at the Technion and a senior research fellow at the Mathematics and Computer Science Department, The Open University, Raanana; a visiting researcher at MSRI, Berkeley, USA and, for a more

extended period at the Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany; as well as a maître de conférences at EPF Lausanne and a visiting professor (Hai-Tian scholar), Dalian University of Technology, Dalian, China. He defines himself as a "geometer at large" and his broad research interest lies in the field of "Applicable Mathematics", more precisely in the use of Geometry, Topology and Geometric Function Theory for modeling in a variety of applied fields, mainly in (Medical) Imaging and Complex Networks.

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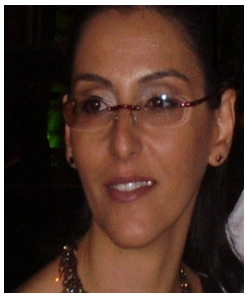
**Liposomes as effective biolubricants for friction, wear and pain reduction in human synovial joints**

**Sarit Sivan**
ORT Braude College

Osteoarthritis (OA) is a debilitating joint disease affecting over 100 million people world-wide. One of the symptoms of OA is wear of the articular cartilage (AC) lining the synovial joints. In healthy adults, AC provides a smooth, tough, elastic and flexible surface that facilitates bone movement. In addition to the extremely low coefficient of friction obtained during the sliding of the two cartilage surfaces, AC also demonstrates compressive strength and wear-resistance. Among factors other than age and gender, failure in lubrication is thought to be one of the major causes of the development of OA. Deficiency of surface-active phospholipids has been demonstrated in osteoarthritic knees.

Articular cartilage is a challenging tissue to reconstruct or replace. Its avascular nature, and hence low cellularity and turnover, impede healing processes. There is no efficient nonsurgical cure for OA; thus, new and effective non-surgical solutions are needed. Inspired by the natural composition and organization of AC, a biolubricant, based on micron-sized liposomes has been developed. This biolubricant reduces friction and wear in ex-vivo models and, in a first-in-man study, has been shown to alleviate pain for OA knee sufferers. A detailed description of this study will be presented.

## Short biography



**Sarit Sivan, Ph.D.** is an Associate Professor in the Department of Biotechnology Engineering at ORT Braude College. Dr. Sivan completed her B.Sc. in Life Sciences, M.Sc. and Ph.D. in Biomedical Engineering, all at the Technion, Israel Institute of Technology. Following a three-year post-doctoral position at the Technion, she spent two years as a Senior Marie-Curie fellow at the University of Oxford (2006-2008). Her research focuses on the biophysics of load-bearing tissues and its translation into therapeutic and diagnostic strategies. Dr. Sivan was awarded the EU Marie-Curie Prize for Entrepreneurship and Innovation in Science (2012). She has been a Principal Investigator on several major research grants, including from Marie-Curie (IRG, ERG); FP7; and the ISF. Dr. Sivan has co-authored over 40 scientific publications and is the holder of five patents. From 2013-2018, she was the chairman of the Department of Biotechnology Engineering until assuming her current position as Vice President for Academic Affairs at ORT Braude College.

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Yitzchak Yifrach (Department of Mechanical Engineering)

# ABSTRACTS

### Endophytes, originating from chickpea seeds, as a solution against diseases caused by phytopathogenic fungi

**Adi Zeevi[1], Samah Alkoot[1], Heba Moadi[1], Shahal Abbo[2], Omer Frankel[3], Avraham Gamliel[3], Maya Lalzar[4] and Lilach Iasur Kruh[1]**

[1]ORT Braude College, [2]The Hebrew University, [3]The Volcani Center, [4]Haifa University

**Keywords:** Fusarium; endophytes; hummus

Chickpeas (hummus, Cicer arietinum) are an annual legume (plant family Fabaceae). Chickpea seeds contain many proteins and nutrients. The average annual chickpea yield is 13 million tons and demand for this crop is increasing. Fusarium is a phytopathogenic fungus that damages chickpea roots and causes plant wilt. Fusarium wilt leads to 10%–90% crop losses per year. We looked at endophytes, microorganisms that exist in plants' inner tissues, as possible biocontrol agents to combat Fusarium. The majority of endophytes are bacteria with beneficial trade-offs to their host plant such as growth promotion and reduction of biotic and a-biotic stress, making them good potential biocontrol agent candidates. The current study sought to develop a biocontrol agent based on endophytic bacteria for chickpea Fusarium wilt. The bacterial community composition was examined and endophytes from chickpea seeds were isolated. These endophytes were tested for Fusarium suppression *in vitro*. Endophytes exhibiting potential as biocontrol agents were identified by 16S rRNA gene sequencing. In addition, Fusarium suppression in plants was examined using selected isolates. During this study, the composition of bacteria population in wild chickpea plantlets showed a high diversity between different locations and even between seeds that were collected from same location. Bacillus, *Paenibacillus* and *Sphingomonas* were identified as dominant endophytic communities in the plantlets. Sixty endophytes were isolated from wild chickpea plantlets, but only five of these suppressed Fusarium *in vitro*. These endophytes were tested for suppression of Fusarium in greenhouse experiments. Four plants, containing the tested bacteria, showed an improvement in disease symptoms. These endophytes belong to the *Bacillus* genus. Future research will examine the inhibition mechanism of these endophytes.

### On the stability of Laminar flows between plates

**Yaniv Almog**
ORT Braude College

**Keywords:** Hydrodynamic stability

We prove that a two-dimensional laminar flow between two plates $(x_1, x_2) \in \mathbb{R}_+ \times [-1, 1]$ given by $\mathbf{v} = (U, 0)$ is linearly stable in the large Reynolds number limit, when $|U''| \ll |U'$ (nearly Couette flow) or when $U'' \neq 0$. We assume no-slip conditions on the plates and an arbitrarily large (but fixed) period in the $x_1$ direction.

Similar results are obtained when the no-slip conditions on the plates are replaced by a fixed traction force condition. This research is a joint work with Bernard Helffer.

### Automatic recognition of speaker's language and age group - comparison of different recognition methods and influence of noise on prediction results

**Nitzan Shitrit, Bar Amsalem and Evgeny Gershikov**
ORT Braude College

**Keywords:** Automatic language recognition; classification to age groups; Gaussian mixture models; support vector machines; neural networks

A speech signal contains important paralinguistic information such as the speaker's age, gender, language, and emotional state. Automatic recognition of this information, when expressed in human speech, is a strong research objective because of its relevance for various commercial, medical, and forensic applications. Generally, humancomputer interaction systems can exploit this information to adapt to different user needs. This paper focuses on automatic recognition of the speaker's age group and language, based on speech processing and machine learning techniques. First, speech signals were pre-processed using techniques such as voice activity detection, normalization and filtering. Then, different classifiers were trained over acoustic features extracted from recorded audio segments. In the recognition stage, these classifiers are used to predict the class of a new audio signal among the classes for which they trained. Training and prediction results

were compared using several combinations of feature extraction methods and classification algorithms. Feature extraction, primarily by Mel-Frequency Cepstral Coefficients and pitch estimators, was used. Different numbers of features, per frame of the speech signal, were taken and the effect on recognition performance was examined. Our classifiers include Gaussian Mixture Models, Support Vector Machines and Neural Networks. The speakers age was classified as one of three categories: children and teenagers (up to 20), adults (up to 60), and seniors (60 and above). Our recognition system was also programmed to recognize five different languages spoken by speakers. Ongoing work includes improving the pre-processing stage of the audio segments. We would like to test the dependence of the recognition performance on the size of the feature vector by aggregating the features of a varying number of frames. We also plan to examine the effect of noise on training and prediction performance.

## Synthesis and characterization of gold-copper nanocomposite for a dual-modal imaging contrast enhancing material

**Or Perlman[1], Alexander Borodetsky[2], Haim Azhari[1] and Iris S. Weitz[2]**

[1]Technion-Israel Institute of Technology, [2]ORT Braude College

**Keywords:** AuCu; nanoparticle; alloy; contrast agent; diagnostic imaging

Nanoparticles have been widely studied and used in diagnostic imaging applications. Because of their ability to provide multifunctional platforms, nanoparticle structures have recently been promoted as contrast-enhancing agents for medical imaging. Moreover, the recent introduction of hybrid scanners into clinical use has created a demand for multimodal contrast agents. Accordingly, a single injection of a contrast material formulation given to a patient, who then undergoes simultaneous imaging of different modalities, yields invaluable complementary information of disease staging.

Our work focuses on the design and synthesis of gold-copper nanocomposite as an imaging contrast agent. A new procedure was developed by simple wet-chemical synthesis. Various analytical measurements were applied to confirm the co-reduction process and characterize the nanocomposites in terms of size, morphology, and composition, including measurements of dynamic light scattering (DLS), transmission electron microscopy (TEM), X-ray powder diffraction (XRD), Fourier transform infrared (FTIR)

spectroscopy, and inductively coupled plasma mass spectrometry (ICP-MS). The oxidation states of gold and copper were determined by X-ray photoelectron spectroscopy (XPS). Imaging evaluation using in vitro and ex vivo experimental models showed that gold-copper nanocomposite had substantial visual enhancements and demonstrated good potential for use as a new contrast-enhancing agent.

### Item response function in antagonistic situations

**Vladimir Turetsky and Emil Bashkansky**
ORT Braude College

**Keywords:** Binary test; ability; difficulty; item response function; antagonistic situation

The binary test model, in which the probability of the object under test (OUT) to successfully overcome the test item (TI) depends on the relationship between the TI difficulty and ability of the OUT, is rooted in psychometrics. Recently, it was shown that similar models are often explored in different fields of statistical engineering. Each specific situation requires its own definitions of difficulty, ability and item/object response function (IRF) describing the probability of "success". Some authors advocate the idea that when ability and difficulty are properly defined on the same scale, the IRF-as a dimensionless quantity-depends only on the ratio between ability and difficulty and not on the difference between them, as in the classic model. An antagonistic situation is one of confrontation, with mutually opposite, conflicting interests. In some cases, a binary test can be considered as an "antagonistic" situation where, formally, side As success may be viewed as side Bs loss. Examples are arm wrestling, radical hypothesis $H_1$ vs. conservative hypothesis $H_0$, pursuit vs. evasion, strength vs. stress relationships, signal vs. noise, competitors vying for the same resource. Some situations can be defined formally as conflicts, even if this is not the case. Examples are a policemans speed / maneuverability challenging a thiefs ability to elude him, with the latters ability (speed / maneuverability) challenging the cop trying to catch him. Are there any restrictions imposed on the IRF in such situations? Our study shows that the family of feasible IRFs satisfying these functional equations is limited and has a number of interesting properties.

## Temperature prediction in the cutting zone and temperature distribution along the cutting tool by slot milling

**Yitzchak Yifrach, Koby Ben Dahan and Erez Dahan**
ORT Braude College

**Keywords:** End milling; cutting tool; tool temperature; temperature prediction; analytical model

Most of the energy of machining that passes from the cutting tool to the raw material is transformed to heat. The heat transfer from the cutting zone depends on the thermal properties of the raw material and on its configuration. Excess heat that is generated during cutting raw material may distort and damage the raw material and wear the cutting tool and limit its life. Control over the temperature at the cutting surface zone is therefore desired, based on the type of raw materials, cutting tool geometry, cutting conditions. Measurement of temperature in the cutting zone during routine operation is not practicable. A numeric analytical program was therefore developed for predicting the temperature at the cutting zone and its distribution along the cutting tool, based on measured power of cutting and some parameters and thermal properties of the raw material and cutting tool. Temperature measurement is required for validation and calibration of the analytic program. The cutting experiments were performed using a CNC vertical milling machine. The measurement of temperature in the experiments along the cutting tool was performed using a pyrometer that measured the temperature at several measurement points along the cutting tool. The measurement of temperature in the raw material was performed using some thermocouples on the upper surface. A good match was found between the results of the experiments and the temperature distribution along the cutting tools. Future research objective is to develop (finite element method) for predicting temperature and forces in cutting zone.

## The due date assignment problem for a single machine with stochastic processing times

**Illana Bendavid**
ORT Braude College

**Keywords:** Due-date assignment; scheduling; stochastic processing times

The problems with due date determination have received considerable attention in the last few decades due to the introduction of new methods of inventory management such as just-in-time (JIT) concepts. In most traditional scheduling models, due dates are considered to be set by exogenous factors, occasionally imposing huge penalties on suppliers. Negotiating due dates with customers can allow suppliers to avoid these penalties, sometimes at the price of losing or declining some customer orders. In a scheduling problem when the job processing times are not deterministic, the advantage of duedate assignment is amplified since we cannot know for sure what the completion time of each activity will be and most objective functions in the stochastic problem are based on optimizing the expectation of some performance measure. Objective functions based on expectations are not robust enough and can still cause the suppliers to incur high penalties. On the one hand, customers may not accept due dates that are assigned too far into the future and may cancel their orders. Alternatively, assigning short due dates may lead to high tardiness penalties. In this research, we try to resolve this trade-off by studying the case of single-machine scheduling with stochastic processing times while taking into account different duedate assignment rules and different penalty costs for the jobs.

## The fate of microplastics in the mainstream of wastewater treatment

**Eric A. Ben David[1], Maryana Habibi[1], Elias Haddad[1], Mahdi Hasanin[1], Dror Angel[2], Andy Booth[3], and Isam Sabbah[1]**

[1]ORT Braude College, [2]Haifa University, [3]Environmental Technology Department, SINTEF Ocean, Trondheim, Norway

**Keywords:**Microplastics; wastewater treatment plant; fibers; sand filtration

Wastewater treatment plants (WWTPs) are part of an important route microplastics (MPs) follow on their way to the open environment. In this study, the efficiency of a municipal WWTP in removing MPs from wastewater was studied by collecting raw, primary, secondary and tertiary treated wastewater samples during a 12-month sampling campaign. The WWTP is a typical conventionally activated sludge (AS)-based process with tertiary treatment using rapid sand filtration and a disinfection step before releasing the effluent for unrestricted agriculture use. The microplastic particles and

fibers in the different units of mainstream water were identified using an optical microscope, FTIR and $\mu$Raman microscopy. Overall, the retention capacity of microplastics in the WWTP was found to be 97.5%. Most of the MP fraction was removed in the secondary stage (before the sand filter). The efficiency of the sand filtration step was also examined. The main related finding is that the sand filtration permeate contained 1.97 MP/L in comparison with the final effluent of the AS process (2.72 MP/L). According to our study, the relative abundance of particles was lower than fibers in treated effluent compared with the raw wastewater. The secondary and tertiary treatment processes removed particles more efficiently than it did the plastic fibers. Total MPs detected in the effluent were significantly higher in winter and spring samples compared with summer and autumn. While most of the fibers were of PET origin, the MP particles consisted mainly of PE, PVC, PC and PP.

### Wheelchair users' views on an automatic assistive device

**Eitan Kribu, Nirit Gavish, Avi Weiss and Uri Ben-Hanan**
ORT Braude College

**Keywords:** Wheelchairs; automation; trust

Wheelchairs limit users freedom of movement over obstacles such as staircases, inclined planes and low-friction terrain (e.g., sand, snow-covered pavement). We recently developed an automatic assistive device in our labs to handle this problem. The device mounts the wheelchair onto a carrier platform capable of carrying out the required maneuvers, providing the user with enhanced maneuverability without the necessity of having to vacate the wheelchair. The user, however, may hesitate to trust and accept the assistive device, since it is different from the known wheelchair in two main ways. First, it automatically stops moving when the incline is too steep, and second, it rotates differently than a wheelchair. Two wheelchair user studies were performed to evaluate users views of this automatic assistive device. In the first study, ten wheelchair users were asked about problems they encounter using their wheelchairs and whether they think this kind of device would be helpful. Their answers demonstrated their desire to have more freedom in movement and their willingness to use the assistive device. In the second study, 30 wheelchair users expressed their confidence in and willingness to use the automatic assistive device after several simulations using it. Participants expressed a higher level of trust when they were exposed

to an automatic stop on a very steep road, but this trust was accompanied with a lower level of willingness to use the simulation. We report about both studies that show us how wheelchairs users will use such an assistive device, alongside demonstrating where they might hesitate using it. These considerations should be taken into account in the design phase.

### The effect of using a familiar interface to operate an unfamiliar system

**Eitan Kribu, Nirit Gavish, Avi Weiss and Uri Ben-Hanan**
ORT Braude College

**Keywords:** Wheelchairs; negative transfer; interface

Today's rapid technological changes and developments are forcing users to adopt and adapt to these systems quickly. This requirement and need are challenging limited cognitive capacities and attention resources. One option for designers is to use familiar interfaces to operate unfamiliar systems, and thus eliminate the need for a user to get used to a new interface. For example, we gave a carrier platform for a wheelchair that was developed in our labs for the purpose of enhanced maneuverability the same operating interface as the wheelchairs users know already. While the advantages of using a familiar interface to operate an unfamiliar system are clear, the possible risk is that the user will experience negative transfer, meaning that non-correct operation will be falsely attributed to the new system. A study was conducted to address these concerns. A simulation of a wheelchair and a carrier platform was developed. The users had to navigate their way to several destinations with their wheelchair and with the platform. Participants were randomly divided into three experimental group: group A navigated the wheelchair and then the carrier platform using the carrier platform's interface; group B navigated the wheelchair and then the carrier platform using the wheelchair's interface; and group C navigated the carrier platform and then again with the same platform using the carrier platform's interface both times. The results will be presented and evaluated.

### Mechanics of hearing

**Jorge Berger[1] and Jacob Rubinstein[2]**
[2]ORT Braude College, [2]Technion- Israel Institute of Technology

**Keywords:** Cochlea; hair cell; critical oscillator

Hearing in mammals involves a long chain of transductions. Pressure oscillations are collected from the air by the outer ear, and transformed by the middle ear into motion of the perilymph in the inner ear. The wavelength of sound in the perilymph is longer than the entire cochlea, but the partitioned structure of the cochlea extracts from it a travelling wave with shrinking wavelength, which deposits most of its energy at a short segment of the partition. Most of the elastic energy delivered to the cochlear partition resides at the basilar membrane. We consider a simple model of the organ of Corti that senses the vibrations at the basilar membrane and actively transmits them to the auditory nerve. We find that the organ of Corti can extend the range of perceivable amplitudes and enhance frequency selectivity and signal to noise ratio.

## Combinatorial methods in the study of subgroup growth

**Mark Berman**
ORT Braude College

**Keywords:** Group theory; subgroup growth; combinatorics

Subgroup growth is the study and characterization of finitely generated groups via their finite index subgroups. The growth of such subgroups, as a function of index, is of special interest when the ambient group is nilpotent. In this talk I will discuss combinatorial methods of Richard Stanley that have been used in the study of subgroup growth. In particular, I will describe how symmetries of generating functions over lattice points of polyhedral cones in Euclidean space reflect symmetries in the arithmetic structure of subgroup growth functions.

## Superiorization as an acceleration technique for optimization problems and beyond

**Esther Bonacker[1], Aviv Gibali[2], Karl-Heinz Küfer[1] and Philipp Süss[1]**
[1]The Fraunhofer ITWM, [2]ORT Braude College

**Keywords:** Feasible problems; projection methods of models; intensity modulated radiation therapy (IMRT)

The convex feasibility problem (CFP) serves as a modelling tool for many real-world problems. One efficient class of methods for solving CFPs is projection methods. These are iterative algorithms that use projections onto sets while relying on the general principle that when a family of sets is present, the projections onto the given individual sets are easier to perform than projections onto other sets that are derived from the given individual sets. Superiorization methodology is a heuristic tool whose goal is to find certain good or superior solutions to feasibility and optimization problems. In many scenarios, solving the full problem can be rather demanding from the computational point of view, but solving part of it, say, the feasibility part, is often less demanding. In this talk, we present two new results in which a superiorization methodology is used to speed-up convergence of the algorithms as well as generate a practical comparable solution. We consider multi-objective optimization problems with applications to intensity modulated radiation therapy (IMRT).

## A modular effector with a DNase toxin domain and a new marker for type VI secretion system substrates

**Eran Bosis**
ORT Braude College

**Keywords:** Secretion; antibacterial effector; DNase; toxin domain

Bacteria deliver toxic effectors via type VI secretion systems (T6SSs) to outcompete their neighbors. The identity and function of many effectors remain unknown. Here we identify a Vibrio antibacterial T6SS effector and show that it contains PoNe (Polymorphic Nuclease effector), a newly discovered widespread DNase toxin domain. PoNe belongs to a diverse superfamily of PD-(D/E)xK phosphodiesterases and is associated with several toxin delivery systems including type V, type VI, and type VII. PoNe toxicity is antagonized by PoNi, cognate immunity proteins containing DUF1911 and DUF1910 domains. The new effector also contains FIX (Found in type sIX effector), a novel marker for T6SS-substrates. FIX, a domain found adjacent to known toxin domains, is genetically and functionally linked to T6SS and reveals T6SS effector candidates with potentially novel toxin domains. Our findings highlight the modular nature of bacterial effectors harboring delivery or marker domains, specific to a secretion system, fused to interchangeable toxins.

### The sounds of motion

**Navit Roth, Adham Salih and Orit Braun Benyamin**
ORT Braude College

**Keywords:** Motoric rehabilitation; musical system

Music has always been an inseparable part of our daily lives, including entertainment and social activities. Some musical activities involve not only listening to music, but creating music as well. Music creation is also used as a motoric as well as cognitive rehabilitation tool. For people suffering from motoric disabilities in the upper extremities and, in particular, fine motor skills, creating and controlling music using ordinary musical instruments is difficult and sometimes impossible. To the best of our knowledge, most developed systems are intended to function as assistive devices-either acting as a bridge between the existing instrument and the users motoric ability (tailor-made solutions) or as a new instrument. The current study focuses on developing a unique instrument or system that generates and controls music by fluent motion of any part of the body. This study combines both research and development aspects, which will be performed in multiple stages. In the "proof of concept" stage, the feasibility of the suggested concept will be tested using a $2D$ digital surface. The system will track movements of the pen tip over the digital surface and classify movement patterns as different musical notes. In this stage, the mapping rule, from movement patterns into musical notes, will be predefined and the recognition algorithm will combine machine-learning techniques. The long-term objective is to develop an instrument that includes a user-calibration feature. This feature will allow each user to calibrate the pattern recognition and the mapping rule to fit his or her own disabilities. The importance of this project goes beyond creating a new and unique musical instrument, by developing a motoric rehabilitation tool.

### Representations of the Lie superalgebra $W(\infty)$

**Lucas Calixto[1] and Crystal Hoyt[2]**
[1]Federal University of Minas Gerais, Brazil, [2]ORT Braude College
and Weizmann Institute of Science

**Keywords:** Lie superalgebra; category of modules

The set of derivations of the Grassmann algebra is naturally a Lie superalgebra, denoted $W(\infty)$. The Lie superalgebra $W(\infty)$ is the direct limit of the Lie superalgebras $W(n)$ as n goes to infinity. We introduce and study a category $T$ of $W(\infty)$-modules that satisfy a certain annihilator condition related to the category of tensor modules over the Lie algebra $gl(\infty)$. We prove that the simple objects of $T$ can be realized as quotients of modules that are parabolically induced from simple tensor modules of $gl(\infty)$. This is analogous to the finite-dimensional situation where each simple finite-dimensional $W(n)$-module can be obtained as the quotient of a parabolically induced simple finite-dimensional $gl(n)$-module. As a corollary, we find that every simple module in $T$ is a highest weight module with respect to an appropriate choice of Borel subalgebra.

## Analysis of sooting flames using a digital camera in the visual range

**Victor Chernov**
ORT Braude College

**Keywords:** Soot; laminar flames; diffusion flames

Soot is an unwanted product of many combustion systems. It is the second largest contributor to climate change. It is a major health hazard that can cause coronary heart decease, asthma, bronchitis and more. It reduces the lifetime of mechanical parts and is extremely unpleasant and unaesthetic. Fortunately, soot is also an avoidable product it is possible to have combustion without soot. Therefore, in recent years, soot has received increased attention in industry and academia to understand its behavior and find ways to reduce it. Soot comprises aggregates of small carbon spheres, which are usually tens of nanometers in diameter. The aggregate size can vary between a few spheres and several dozens. Soot volume fraction is a function of the fuel used and the flow conditions. There are heavy-sooting fuels (such as acetylene), and there are flow configurations that promote soot creation (such as diffusion flames, found in most combustion applications). In general, soot is created in fuel-rich flame regions. One challenge in trying to reduce soot is the absence of a fast, reliable way to measure soot volume fractions. Low volume fractions and hostile environments make the task non-trivial. This work discusses several methods for using a digital camera operating in the visual range (between 400 and 650 nm) to measure the

volume fraction. Two major implementations will be presented. The first is pictorial reconstructions from the computed results and their comparison to the actual picture; the second is the analysis of soot volume fraction and the temperature without using the Abel inversion, thus reducing the measurement errors.

### Brain modeling of interpersonal synchrony

**Anat Dahan**[1] **and Hila Gvirts**[2]
[1]ORT Braude College, [2]Ariel University

**Keywords:** Interpersonal synchrony; fNIRS; SVM

Interpersonal synchrony is the dynamic and reciprocal adaptation of the temporal structure of behaviors between interactive partners. Although interpersonal synchrony has recently gained attention in psychology, the neural mechanisms underlying our ability to synchronize with others is still largely unknown. The inferior frontal gyrus (IFG) is one of the core regions associated with several behaviors that serve synchrony; it has been shown to play a major role in mimicry, imitation and emotional empathy. This study investigated differences in brain patterns between synchronized movement and individual movement and, specifically, examined the role of the IFG in interpersonal synchrony using functional near infrared spectroscopy (fNIRS). Twenty healthy older adults (13 female, ages 2030) completed a synchrony task: with two conditions (four repetitions each): (I)Alone condition Participants were instructed to freely move and (II) Sync condition Participants were instructed to synchronize their movement with another person (block length: 40 s; separated by 15s rest periods). fNIRS recordings were split into intervals of 1 second (10 samples). We computed correlation coefficients for each interval. Following this, we placed all the different values into one row in the feature matrix, resulting in a feature matrix where each row contained correlation coefficients of each pair of electrodes. We split the matrix randomly into 85% for training and 15% for testing, and then trained an SVM model. To evaluate the contribution of the different features, we extracted the beta coefficients of the trained model, and calculated the corresponding pairs of channels.

### Implications of 3D printing on the spare parts supply chain

**Hussein Naseraldin Eden Davarashvily**
ORT Braude College

**Keywords:** 3D printing; additive manufacturing; inventory management

Industry 4.0 or Industrial Internet of Things (IIOT) is a setting in which the physical and cyber worlds are seamlessly interconnected. This environment creates a potential to streamline communication and thus, the decision-making process. IIOT is no more than a plethora of technologies that take any manufacturing setting to a higher level of productivity, complexity, and control. We focus on additive manufacturing (AM), specifically, 3D printing (3DP) technology, which is a capability enabled by advancements in materials science. 3DP allows the manufacturing of items in an additive rather than a subtractive manner, as has been the case so far. In a 3DP environment, a product is produced using a specialized printer that manufactures the item by adding one layer on top of another. This setting allows the production of complex designs that otherwise could not have been formed. In addition, it allows batches as small as one item to be manufactured. Because of such radical changes, potentially, assembly work and material costs can be reduced by a double-digit number. This technology is of radical importance, in particular for the spare parts niche. Spare parts are characterized by low intensity of demand per part, high volatility, and high uncertainty about the timing when exactly the spare part will be needed, among other aspects. The common practice today is to hold spare part inventories, which obviously is costly, or to go into a state of downtime, when resources are unutilized due to long lead time for spare part supply. We explore proper strategic and analytical models that can help when making optimal decisions in such environments.

### House of quality: Quality by design vs. quality of conformance

**Shuki Dror**
ORT Braude College

**Keywords:** QFD; house of quality; QbD; quality of conformance

The House of Quality (HOQ) by design matrix is the most fundamental Quality Function Deployment (QFD) matrix and its shape matches its

name. It contains walls, a ceiling, a roof and a floor. The HOQ rests on the belief that a product should be designed to reflect customer desires and taste. A multidisciplinary team translates a set of customer desires, using market research and benchmarking data, into prioritized technical characteristics to be met by a new product design. The current work presents an innovative HOQ (of conformance) method that translates the desired improvement in failure costs (internal and external) into controllable efforts (prevention and appraisal costs) and ranks them by relative importance. The relevant controllable efforts and the strengths of the relationships in the new HOQ were determined using a questionnaire. The Analysis of Variance (ANOVA) method supports selection of vital components. A case study for building an HOQ using the above methods in a food processing company is presented. The firm develops, manufactures and markets high-quality products for customers in the local market. The HOQ matrix (by design) reveals three vital customers desires (Freshness, Consistency, and Tastiness), and four product/service characteristics (Shelf life, Delivery time, % variation of solids, and Additives). The HOQ matrix (of conformance) reveals two implications: (1) Traditional quality control is not enough to eliminate quality problems deriving from the production processes; hence, a Hazard Analysis Critical Control Point (HACCP) was implemented. (2) Improving production planning methods can reduce the size of product recalls.

### Coefficient body for non-linear resolvents

**Mark Elin and Fiana Jacobzon**
ORT Braude College

**Keywords:** Coefficient body; semigroup generator; nonlinear resolvent; Schur parameter

We study families of so-called nonlinear resolvents. The nonlinear resolvents are solutions of an important class of functional equations. Being holomorphic functions in the open unit disk, resolvents can be described completely by their Taylor coefficients. The problem we study is how to describe coefficient bodies for these families. In particular, we answer the question of how to determine which functions can be interpreted as resolvents. As an immediate application of our results, we present a sharp estimate for the Shwarzian derivative at zero on the class of resolvents.

## Potential problems on surfaces with or without a boundary, subjected to discrete distributed sources

**Ofer Eyal and Ayelet Goldstein**
ORT Braude College

In this work we derive analytical solutions for potential problems on different types of surfaces such as cylinders, cones and spheres. These solutions complement the solution obtained for a sphere. Besides examining modes of truncation for a sphere, we also provide complete coverage of all modes of truncation for cylinders and cones. Our interest focuses on two-dimensional conducting surfaces, which are fed with point sources of current. Our solution gives the voltage distribution on these surfaces explicitly, results that can straightforwardly be applied to pressure profiles of a fluid flow in a gap between surfaces. Nevertheless, since every physical set-up takes place in the $\mathbb{R}^3$ space, some adjustments were required. We focused on three types of geometric surfaces: cylinders, cones and spheres. Being effectively two-dimensional problems, the use of analytic functions and conformal maps were used to obtain analytical solutions for all these geometries and all are mapped into the complex plane. We gave special attention to examining particular cases of truncated ends, by taking into account boundary conditions and flux considerations. We used reflections on cylinder inversions on cones and explore a spherical version of inversion on a sphere in order to satisfy the boundary conditions.

## Modes of movements of a rigid body with friction

**Ayelet Goldstein and Ofer Eyal**
ORT Braude College

This work deals with minimizing the force that must added to a rigid body to counteract the friction forces acting on it. One interesting method is to add a rotating mass that contributes its forces such that surface forces are reduced and even nullified. The friction force is investigated in respect to different angular velocities and different locations of the rotating mass. The direction of the forces is also considered. We explore $N$ contact points with a planar or inclined surface upon which the rigid body lies. The nonslip condition of the rigid body is dependent on the angular velocity of the rotating mass and its position in the rigid body.

### Spatio-temporal forecasting for renewable energy systems

**Carlos A. Severiano Jr[1], Miri Weiss Cohen[2] and Frederico G. Guimarães[1]**

[1]Universidade Federal de Minas Gerais, UFMG, Brazil, [2]ORT Braude College

**Keywords:** Spatio-temporal forecasting; renewable energy; fuzzy time series; Convolutional Neural Network (CNN)

Renewable energy systems such as solar photovoltaics and wind are sources of energy that are very sensitive to climate variations, which can affect their generation patterns. It is essential to use mechanisms that can help anticipate such variations and enable more informed decision-making. Forecasting methods can contribute to this task and, therefore, their application in this area has been widely studied.

Forecasting methods usually take as input historical data from the time series generated by the point of interest. For further improvement in forecasting accuracy, information available from 3D space has also been added. These approaches, called spatio-temporal methods, make use of all the available data collected from different locations at different times. In renewables, variations observed at neighboring locations may occur in the near future at some point of interest, since many of these events are the result of climatic phenomena. This reinforces the possibility that spatio-temporal data analysis can improve forecasting performance in renewable energy systems. In this work, spatio-temporal forecasting methods are evaluated. Several architectures of Convolution Neural Network (CNN) are examined for improvements of forecasting. .

### Fake edges: an improvement of the protein connectivity network

**Zakharia Frenkel and Zeev Volkovich**

ORT Braude College

**Keywords:** Protein connectivity network; fake edges; protein sequence annotation

The protein connectivity network (PCN) is a very powerful tool, represented by a large graph, directed at prediction of the protein relatedness even of cases of undetectable sequence similarity. The nodes in this graph

represents a plurality of protein sequences. Edges in this graph represent the high sequence similarity between corresponding nodes. The relatedness between the proteins is determined by a connectivity through the network of the correspondent nodes. The connectivity between distant nodes is currently determined using an electrical conductivity network model. Recently, we significantly improved the model by introduction of edge weights (reflecting the level of sequence similarity of the neighboring nodes) and fake edges (reflecting the protein similarity obtained from experimental data). The main goal of our current study is a practical realization of further improvement of the PCN prediction power, proposed earlier, by introduction of the fake edges. The fake edges allow available experimental data for detection of hidden homology between sequence-wise different protein sequences to be used. Two sets of experiments are reported: the first, for using of information concerning to structural relatedness, and the second one, concerning functional relatedness. We develop an approach for calculation of weights of the fake edges. The new system will be tested on multiple data that have recently become available.

### Incorporating Kahoot! in engineering content-heavy courses

**Yael Furman-Shaharabani, Victor Chernov and Sivan Klas**
ORT Braude College

**Keywords:** Kahoot!; engineering education; game-based learning; immediate feedback; continuous assessment

A good learning process requires a combination of several factors. On the students side, the learning must be continuous. On the teachers part, students level of comprehension must be continuously evaluated. In an academic environment, where time is limited, and constant testing is impractical, achieving continuous learning and evaluation is a challenging task. Game-based learning is an efficient tool when trying to increase learning motivation. Kahoot! is a web-based service that enables users (here, teachers) to set up multiple choice quizzes in which students participate using their web devices. In these quizzes, answers are ranked for correctness and speed. The quizzes are short and provide immediate feedback and rankings. This platform allows teachers to conduct many quizzes during the course, thus providing continuous feedback and assessment both for themselves and students. The gaming factor motivates students to participate and prepare for the quizzes.

This work examines different models of incorporation of Kahoot! quizzes in the teaching process of three courses: Fluid Mechanics in the Department of Bioengineering, Thermodynamics in the Department of Bioengineering, and Thermodynamics in the Department of Mechanical Engineering. Kahoot! was used somewhat differently in each course, and at the end of the courses, students were invited to participate in an anonymous survey about various aspects of the Kahoot! quizzes in their respective course. The research results indicate students perspective of the systematic incorporation of these short game-based quizzes as well as their association with end-of-course exam results.

## Some properties of geodesic distance-based preference chain aggregation

**Tamar Gadrich, Yariv Marmor and Emil Bashkansky**
ORT Braude College

**Keywords:** Prioritization; decision making; distance metric; aggregation; robustness

Preference chains are being used widely in task scheduling, quality requirement ranking, expert's risk evaluations, vendor selection, healthcare, customer research, search engines, decision making, voting theory etc. A strict preference chain is a linearly ordered (in order of preference) sequence of a predetermined set of mutually exclusive alternatives. It is absolutely clear that for a given $n$, there are $n!$ different chains. Different measures of similarity or dissimilarity between chains have been proposed and explored, including those based on the concept of a distance metric. Distance-based measures allow chains to be considered as located in a metric space, with all the possibilities that this implies for determining location and dispersion measures for a limited set of chains. Such measures are extremely important in data processing as they allow, for example, the fused/aggregated preference chain/decision, evaluation of consensus between experts, analysis of variation to be conducted, etc. Recently, a new definition of the distance between two chains, represented as points on a multidimensional sphere, based on the length of the geodesic arc connecting these points, was proposed. In line with the traditional approach, the feasible preference chain that minimizes the sum of the distances from it to all other chains in a set was determined to be an aggregated/fused chain. The method for finding

the aggregation and its relative stability/robustness were demonstrated by a real-life example, but the statistical and metrological properties of the proposed aggregation, requiring some assumption about the specific mechanism of creating possible perturbations/errors/mutations in relation to the original/primary preference chain, has not yet been explored. We attempt to fill in this lacuna using a simulation study in which the mechanism of such perturbations follows a popular classical one-parametric Mallows model for generating noisy perturbations.

## The effect of using a virtual reality platform on travel sharing willingness

**Nirit Gavish[1], Eran Shlomi[1] and Eran Reuveni[2]**
[1]ORT Braude College, [2]Technion-Israel Institute of Technology

**Keywords:** Virtual reality; travel sharing; prisoner's dilemma

Continually increasing traffic congestion, along with other problems such as air pollution and scarcity of parking places, led the development of travel sharing applications. Nevertheless, not enough people have registered for and make use of these applications. The root of the decision not to rideshare can be found in the well-known prisoner's dilemma, in which the self-interest of each user conflicts with the mutual interest of the community, and the best equilibrium can be achieved only when a large portion of users choose to rideshare. Theoretically, the use of a virtual reality platform in these applications can be helpful, since the presence of co-users is more realistic, and hence may stimulate the user to consider the mutual interests of the community and decide to rideshare. In the current research, a travel sharing application was developed, and users have to decide whether or not to rideshare. Three platforms were used in the study: a virtual reality platform, in which other users were presented as avatars; a desktop-3D platform, with the same avatar presentation, but without the virtual reality device and experience; and a desktop platform with no avatars. Participants were randomly assigned to one of the experimental groups. The results of the study and their applications will be reported.

### On the global existence of the Nordström-Euler system

**Lavi Karp**
ORT Braude College

**Keywords:** Einstein and Euler equations; global existence; semi-linear wave equations

The Nordström (Einstein-Fokker)-Euler system is a simplified model of the EinsteinEuler system, in which the matter tensor is a scalar function and the Einstein equations are replaced by a wave equation. It is an intermediate model between the Galilean covariant Euler-Poisson and Einstein-Euler systems. Since the Einstein equations are extremely difficult, we hope that the investigation of the Nordström-Euler model will provide better acquaintance with the EinsteinEuler system. We study the global existence of this system in the presence of a cosmological constant. In this situation, the Nordström-Euler system can be written as a semi-linear damped wave equation coupled with the relativistic Euler equations. In these models, it is natural to assume a homogeneous and isotropic spacetime and, therefore, we consider these equations on the three- dimensional torus. In the first stage, we discuss the global existence of the wave equation under a certain smallness condition, and show a blow-up in finite time when the smallness assumption is abandoned. Since the wave equation is coupled to a system of first order equations, we treat it as a symmetric hyperbolic system. The talk is based on a joint work with U. Brauer, University Complutense, Madrid.

### The dynamics of two-stage contagion

**Haggai Katriel**
ORT Braude College

**Keywords:** Two-stage contagion; bistability; periodic oscillations; bifurcation

We explore simple models aimed at the study of social contagion, in which contagion proceeds through two stages. When coupled with demographic turnover, we show that two-stage contagion leads to nonlinear phenomena that are not present in the basic, classical models of mathematical

epidemiology. Such effects include bistability, critical transitions, endogenous oscillations, and excitability. These phenomena, and the bifurcations involved, are studied by a combination of analytical and numerical means.

### Ammonia recovery from livestock housing emissions

**Sivan Klas and Barak Snir**
ORT Braude College

**Keywords:** Ammonia; emissions

Gaseous ammonia is harmful for livestock, asides from being a dangerous greenhouse gas. The present work aims at developing a technology in which the gaseous ammonia is captured in acid, and converted into a valuable fertilizer. Simulation of the process in the lab showed promising results.

### In silico study of the co-assembly of the hydrogelator DBSCOOH and peptide amphiphiles

**Dafna Knani**
ORT Braude College

**Keywords:** Molecular dynamic simulation; low molecular weight gelators; amphiphilic peptides

Peptide amphiphiles (PAs) are molecules consisting of a hydrophobic alkyl tail, an amino acid hydrophobic peptide block, and a bioactive polar epitope head group. When the peptide sequence includes amino acids with a high beta-sheet formation propensity, long cylindrical nanofibers are observed. PA molecule self-assembly is driven mostly by the interplay of hydrogen bonding and hydrophobic forces over a wide range of length scale. This self-assembling property shows great promise in the development of novel materials and can greatly expand the structural and functional space of supramolecular nanostructures. Though hydrogen bonds clearly play a key role in the formation of high-aspect-ratio fibers, the self-assembly process is not fully understood. This research focused on exploiting the role of molecular interactions in PAs self- and co-assembly with the low molecular weight gelator DBSCOOH using computational tools such as dynamic molecular simulation. Various properties were calculated to illustrate the

interactions that govern the self- and co-assembly of the examined compounds. The results of the simulation indicate that intermolecular H-bond interactions are formed between the PA and DBSCOOH. Whereas intermolecular H-bonds between PA molecules are not affected by the presence of DBSCOOH, intermolecular H-bonds between DBSCOOH molecules are affected by the presence of the PA. This appears to signal that PAs undergo self-sorting, a conclusion that is supported by experimental data. The peptide presence causes DBSCOOH to alter its assembly fashion by increasing the intramolecular interactions. This may lead to a more rigid structure of the DBSCOOH molecule. DBSCOOH acts as an additive adsorbed onto the PA nanofibers. The supramolecular interactions between the PA and DBSCOOH facilitate interfacial interactions, which results in improved bulk properties.

### Cloud-based logistics of in-class micro exams

**Samuel Kosolapov**
ORT Braude College

**Keywords:** Active Learning; cloud, in-class exam

Over one year (two semesters), in-class micro exams were given in four courses. To make giving and checking these exams time-effective for the educators, a special logistics was developed. The process went as follows: during a lecture, at some moment (unknown to the students), the lecturer opens a PowerPoint presentation containing three slides (the micro exam). The first slide asks students to write a short code ABCDE-YYYY-MM-DD-MWXYZ in the top left-hand corner of an A4-sized paper or on their tablets using a stylus. Here, ABCDE are the last five digits of the student' ID, YYYY-MM-DD are the year, month and date of the micro exam, and MWXYZ is the micro ID exam code (for example, MW024). The second slide presents the exam problem. It is based on material explained in previous lectures. The time needed to solve the problem must be short  typically 5 minutes  so that lecture time is not shortened significantly. As opposed to multiple choice quizzes, in which students choose from a number of preset answers, here students write out a complete solution, which may include text, mathematical equations, graphs and even simple drawings. When the allocated time is up, the third slide with an email address is shown. Using their smartphones, students photograph the page with the solution, and send it to the specified

email. The subject of the email is the short code. In due time, the lecturer checks his email and the attached micro exam photographs. This logistics minimizes the time needed to collect "pages" and check them. Additionally, the "lost page" problem is eliminated.

### Time series visualizations of emotions

**Julia Sheidin[1], Joel Lanir[2], Tsvi Kuflik[2]**
[1]ORT Braude College, [2]University of Haifa

**Keywords:** Emotion detection; evaluation; visualization techniques; Plutchik wheel of emotion

The growing availability of social media and other online information sources has increased interest in sentiment analysis to understand the emotional opinions of users. Being able to visualize users emotions could help stakeholders better understand the underlying trends behind events or stories. Various techniques have been used to generate time series visualizations of emotions; however, there is no common method in widespread use and no guidelines for the design of visualizations that depict emotions. We report on a controlled user study that compared four common visualization techniques used for the analysis of emotions over time, measuring users performance and preferences under a formal task taxonomy, using data from Twitter about real-world events. Results, although highly task-dependent, showed both an overall performance advantage and higher preference for the line chart, and suggest that the radar chart, despite its popularity in the literature, may not be the best choice to depict such data.

### A "sentimental analysis" of computer-generated papers

**Dan Lemberg and Zeev Volkovich**
ORT Braude College

**Keywords:**Artificial paper detection; text mining; LSTM

The article offers a deep learning procedure intended to distinguish between manuscripts written by humans and those composed by computers. We demonstrate that a common long short-term memory (LSTM)-based deep learning methodology, generally used for sentiment analysis of short

texts such as tweets, is able to distinguish accurately between real and artificially generated manuscripts. The proposed approach emulates "tweets" as short sequential chunks of the considered papers and further follows the acceptable procedure of text data classification via deep learning using an LSTM network. The provided numerical experiments demonstrate the very high ability of the proposed methodology to recognize artificially generated papers.

### Leaky coupled plasmon-waveguide modes for enhanced light-matter Interaction

**Fadi Sakran[1], Said Mahajna[1] and Atef Shalabney[2]**
[1]Beit Berl College, [2]ORT Braude College

**Keywords:** Light-matter interaction; leaky optical modes; surface plasmon polaritons; optical sensing; molecular detection

When electromagnetic radiation is confined within tiny regions of the space, its interaction with matter becomes very interesting from both the fundamental point of view as well as for many optical engineering applications. This radiation confinement, usually accompanied by an extraordinary enhancement of the electric field intensity, accounts for many effects such as surface enhanced Raman scattering, enhanced optical transmission, and enhanced absorption and emission of light. The outstanding potential of optical modes for sensing and molecular detection stems from the interaction volume of the optical field with the medium to be sensed. This interaction volume is determined by the combination of the field enhancement and penetration depth inside the studied material.

Here, we demonstrate experimentally the generation of leaky optical modes in planar multilayer structures and investigate their potential for enhanced light-matter interaction. These modes originate from the coupling between a high loss surface plasmon polaritons and low loss planar waveguide modes. We show that the dispersion of the leaky modes can be engineered to boost the interaction volume between the optical fields and the material near the waveguide surface. We test the properties of these leaky modes in the near infrared region and show that the enhancement in the field's intensity and the penetration depth result in an extraordinary interaction volume with the studied material. We demonstrate the potential of these modes for enhancing optical phenomena by using them for sensing

and detection. They show at least one order of magnitude larger sensitivity with respect to other techniques for molecular detection. Our findings hold out promise of this potential in the context of light-matter strong coupling where interaction volume plays a key role in the alteration of material properties as a result of their coupling with confined optical fields.

## Cloning expression and characterization of Galectin-14, a key player in pregnancy

**Sammar Marei**
ORT Braude College

**Keywords:** Galectin-14; preeclampsia; pregnancy

Galectins are potent immune-modulators that regulate maternal immune responses in pregnancy and prevent the rejection of the fetus. Galectin-13 (Gal-13) and Galectin-14 (Gal-14) genes are localized on chromosome 19 and are expressed only by the placenta. Although Gal-13 has been studied intensively, Gal-14 has not. Gal-13 induces the apoptosis of activated T lymphocytes, possibly contributing to a shift in maternal immune balance in pregnancy. The placental expression of Gal-13 is decreased in preeclampsia, a life-threatening obstetrical syndrome partly attributed to maternal anti-fetal rejection. This study attempts to reveal the bio- and immune-chemical characteristics of Gal-14 and its possible physiological role in healthy and pathological pregnancies compared to Gal-13. Gal-14 was cloned, expressed in E. coli and then the recombinant His-Gal-14 was purified by affinity chromatography. The His-Gal-14 was characterized by its recognition and immunoreactivity with a wide panel of mono- and polyclonal antibodies. Gal-14 expressed in placentas collected from elective termination and at term deliveries was examined by qPCR. Among the tested reagents, our study revealed that Gal-14 and Gal-13 are both recognized by several antibodies (clones 27.3, 534, and J67) with different IC50. Unlike Gal-13, however, Gal-14 was not recognized by 215.3.2 monoclonal antibody. Immunohistochemistry revealed that Gal-14 was expressed in the syncytiotrophoblast of human and baboon placentas. Gal-14 was localized both in the cytoplasm and nucleus of the cells. Gal-14 was absent in the cytotrophoblasts. The expression of Gal-14 in the placenta of normal pregnancies and pre-eclampsia will be tested and results will be presented.

## Many-objective topology and weight evolution of artificial neural networks

**Adham Salih**[1] **and Amiram Moshaiov**[2]
[1]ORT Braude College, [2]Tel-Aviv University

**Keywords:** Artificial neural-networks; neuro-controller; TWEANN, evolutionary robotics; MOEA

There is an increasing interest in using evolutionary algorithms for the design of artificial neural networks (ANNs), and, in particular, neuro-controllers (NCs). A major advantage of this approach is its ability to simultaneously search for the optimal topology (structure) and weights. This approach is known as TWEANN (Topology and Weight Evolution of ANN). Most TWEANN algorithms are restricted to single-objective optimization and there is a need to develop TWEANN algorithms that will handle many objectives. For autonomous robots, for instance, it is very important to find controllers that can cope with various environments. Today, biological neural networks inspire the development, by an evolutionary process, of NCs with such generalization capabilities. The development of such evolutionary tools promoting generalization capabilities, however, is in its infancy stage. The main goal of this research is to substantiate the hypothesis that TWEANN algorithms, designed to handle many-objectives, will enhance generalization. The main idea is that one may view the optimization to a specific environment as one objective of the optimization. Namely, when given many environments, one should use many objective optimization to evolve NCs with generalization capabilities. The research hypothesis will be substantiated by demonstrations using various robot navigation problems.

## Film cooling of a blunt body in supersonic high-enthalpy flows

**Segoula Solomon**[1] **and Avishag Pelosi**[2]
[1]Elbit Systems, IMI Division, [2]ORT Braude College

**Keywords:** Film-cooling; supersonic flow; high enthalpy

During atmospheric re-entry at hypersonic speed or at very high-speed flight in the atmosphere, vehicles experience extremely high thermal loads

for relatively long times. Classical thermal protection materials do not survive in such conditions and need to be replaced by lightweight actively cooled components. This work investigates experimentally film cooling of a blunt body in a supersonic high-enthalpy flow. The coolant, injected in the stagnation zone of the blunt body surface against the free stream, operates as a thin, cool, insulating layer, creating a thickening of the boundary layer and reducing the heat flux to the surface. The experiments were performed in the Technion's Aerothermodynamics Laboratory, where a 5-MW arc plasma tunnel enables simulation of high-enthalpy flows. Two models (with and without injection) were exposed to a Mach 2.2 freestream with a total enthalpy of 1.7 MJ/kg. Nitrogen and helium were used as coolant gases. A parametric study shows the influence of coolant physical properties and mass flow rate on the characteristics of the flow surrounding the model and on the resulting temperature reduction at different locations on the test model. The results, obtained from temperature measurements and video recording of the tests, show the effectiveness of film cooling. Surface temperature was reduced by up to $400^{o}C$ when the coolant was injected. The use of helium yields the best cooling performance with the lowest coolant mass flow rate due to its thermodynamic properties. Low coolant mass flow rates result in better cooling performance. When the gas mass flow rate is increased over a critical point, the bow shock bulges out and the main airflow separates ahead of the model, resulting in poorer cooling. Variation of the coolant mass flow rate yields cooling effect optimization.

## When in Rome, manage accordingly: The cultural intelligence effect

**Hilla Peretz**
ORT Braude College

**Keywords:** Organizations; culture; management

Despite globalization and the development of new technologies, the world is as complex as ever. Leaders from different cultures are finding that they need to work together even more. Crossing the divide between people in cities and, increasingly, across the world is the only way we can begin to address the big complex problems we face on a daily basis. Cultural Intelligence (CI) is a measure of a person's capacity to function effectively in a multicultural environment. In other words, CI constitutes the capability to relate

and work effectively across cultures. Employers and organizations apply CI as a way to foster tolerance and enhance cross-cultural interactions. In a set of three studies, CI was found to have positive effects on organizations operating in different countries. Specifically, CI was found to improve understanding of effective performance appraisal, staffing practices, employee engagement and technology use, to the point that it increased organizations productivity levels. Specifically, in a study examining 4,790 organizations from 22 countries, the results indicate that cultural awareness could modify the use of employee appraisal and, as a result, decrease turnover and absenteeism levels. In a second study, conducted in 2,918 organizations across 11 countries, the results demonstrate the importance of applying CI when making staffing decisions such as selection and staffing practices. Only when staffing practices match the culture was the turnover rate low. In the third study, using a sample comprising 5,991 organizations from 21 countries, the results demonstrate how CI contributes to understanding how the level of fit between country and use of technology tools relates to organizational performance indicators. In sum, I will present the results of a series of studies examining the effect of cultural understanding on managerial practices and organizational performance.

### How mathematics lecturers encourage students to understand

**Ira Raveh**
ORT Braude College

**Keywords:** Mathematical understanding; mathematical teaching; higher education

Understanding is a central concern of good teaching and an aim of mathematical teaching and learning. This research sought to characterize expert mathematicians' ways of encouraging students' understanding of the material taught. Five mathematicians, all of whom are experienced lecturers of mathematics courses in an academic college of engineering, participated in the study. The research tool was a semi-structured interview. The data were analyzed according to a qualitative methodology. Results show two themes that are related to promoting students' understanding. They are focused on encouraging mathematical thinking and planning teaching. Encouraging mathematical thinking includes: asking profound/implementation questions, refraining from explaining every bit of the material and enabling

the students to understand some parts of it by themselves, stressing the importance of understanding the theory; explaining where formulas come from; avoiding "recipes"–instead, asking for a variety of possible answers; requesting to explain the answers (explaining why); calling for figuring out a definition after dealing with some examples, asking to prove or to refute a claim, asking to draw (to visualize) a concept. By conducting an initial analysis of the results, it seems that this theme includes aspects associated with active learning. Planning teaching comprises two aspects–general planning and particular lesson planning. General planning is related to decreasing the amount of the material; planning and addressing possible difficulties connected to the material; mixing subjects, spiral teaching and giving challenging homework. Particular lesson planning consists of pausing and asking the students questions, checking for understanding of subjects that were previously taught, building and presenting mathematical models of everyday situations, using software. The implications of the findings and future research directions will be discussed during the presentation.

### A new look at the shortest queue system with jockeying

**Rachel Ravid**
ORT Braude College

**Keywords:** Shortest queue; jockeying

We introduce a Markov queueing system with Poisson arrivals, exponential services and jockeying between two parallel and equivalent servers. An arriving customer joins the shortest line (when the lines are equal, the customer joins any line with probability 1/2). Every transition of only the last customer in line, from the longer line to the shorter line, is accompanied by a certain fixed cost. Thus, a transition from the longer queue to the shorter queue occurs whenever the difference between the lines reaches a certain discrete threshold ($T = 2, 3, \ldots$). In this study, we focus on the stochastic analysis of the number of transitions of an arbitrary customer, during the sojourn time in system.

## Microstructure, thermal stability during creep and mechanical properties study of friction stir processed AA2024-T3 aluminum alloy

**Michael Regev**[1] **and Stefano Spigarelli**[2]
[1]ORT Braude College, [2]Università Politecnica, Italy

**Keywords:** Friction Stir Processing; FSP; AA2024-T3; DRX; aging; creep

Friction Stir Processing (FSP) was conducted on AA2024-T3 aluminum alloy (Al) plates. The hardness and tensile properties of the stir zone were tested and a microstructure study was conducted. A Transmission Electron Microscopy (TEM) study together with a High Resolution Scanning Electron Microscopy (HRSEM) study and Energy Dispersive X-ray Spectroscopy (EDS) analysis were conducted to investigate the microstructure. During the FSP, the coarse elongated grains of the parent material changed into fine equiaxed ones. Two kinds of precipitates were observed in the parent materialvery coarse precipitates tens of microns in size, and evenly dispersed nanosized precipitates. In the material that underwent FSP, the coarse precipitates were broken into uniformly dispersed 0.1–1 micron-sized ones. The microstructure of the processed material was found to be thermally unstable. After 280 hours of exposure to 300 degrees, grain boundary decoration was detected together with the appearance of fine platelet-like precipitates inside the grains. The TEM study of the parent metal revealed a low angle sub-grain structure with dislocation network boundaries. During FSP, these were replaced with fine equiaxed grains having clean boundaries with no dislocation tangles. The high stacking fault energy of Al is assumed to be responsible for Dynamic Recovery (DRV) during the thermo-mechanical processing of the 2024 aluminum alloy in its production stage. In the case of the parent material after rolling, this leads to the arrangement of dislocations into sub-grain boundaries, while the high strain rates of the FSP lead to Dynamic Recrystallization (DRX). Creep tests were conducted both on the parent material and on the friction stir processed specimens. A quantitative TEM dislocation analysis was carried out on specimens that had crept at 250 and 315 degrees. The influence of the microstructure changes occurring during creep on the creep behavior of both materials will be discussed.

## Mapping the characteristics of Essential Tremor and its implications on the functional abilities of individuals' upper limbs

Navit Roth[1,2] and Sara Rosenblum[2]
[1]ORT Braude College, [2]Haifa University

**Keywords:** Essential Tremor; ADL; tremor characteristics

Essential Tremor (ET) is a chronic disease that is the most prevalent cause of movement disorder characterized by tremor. The disease is common in a wide age range. Its prevalence rises with age and may affect different body parts, but mainly the upper limbs. The influence of tremor changes from person to person. It may impair performance of daily living activities and may also cause a socio-emotional deficiency. Clinical evaluation of people with ET lacks detailed analysis of the relationships between the kinetic and kinematic characteristics of tremor and real life daily functional difficulties while performing different tasks. The study attempts to characterize the ET phenomenon and its functional implications, and to propose methods for clinical evaluation focused on identifying task performance characteristics that can improve individual daily functioning. Participants (ET and controls) are invited for an evaluation session that includes a comprehensive assessment, to map the kinetic, kinematic and functional characteristics of each individual. This assessment includes questionnaires and the performance tasks of drawing and writing, carrying a cup and using a computer mouse performed in different characteristics (writing velocity, cup grip configuration etc.). Quantitative measurements are taken using a digital graphic board, COMPET handwriting performance analysis software, an accelerometer-based cup system, a custom-built MATLAB GUI and a laptop. Analysis of these task characteristics, both in frequency and time domains, and their relationships with the functional deficiency will enable researchers to assess whether there are common task parameters influencing tremor and if a personal profile can be characterized. The findings of the study will enable a deeper understanding of the various characteristics of ET among different people and its functional implications. In addition, it will offer a proposal for a customized assessment and treatment scheme that will improve the quality of life of people coping with ET.

### On gradings of finite dimensional semi-simple algebras

**Ofir Schnabel**
ORT Braude College

**Keywords:** Graded algebras; fundamental groups; twisted group rings

Given an algebra $A$, one can associate to it, in many different ways, a fundamental group, depending on the presentation of $A$. It turns out, however, that by considering all the possible connected group gradings of A, we can define an intrinsic fundamental group of $A$, which is not dependent on the presentation of $A$. We give some examples of gradings, present two special families of gradings on matrix algebrasnamely, elementary gradings and twisted group algebras, and explain how this intrinsic fundamental group is constructed from the connected gradings of $A$.

### Essential skills course for engineering students - challenges and opportunities

**Sharon Tidhar and Miri Shacham**
ORT Braude College

**Keywords:** Essential skills; teamwork; problem solving; self-management

The "Essential Skills" course was developed under the auspices of the Entrepreneurship and Innovation Center at ORT Braude. The term essential skills is often used to describe the proficiencies used in developing and maintaining relationships with other people, or are about how one approaches life and work. Hard skills, in contrast, is a term usually used to describe professional skills such as accountancy or medical expertise etc. Many employers report that engineering graduates fresh from college lack essential skills. In response to this lacuna, we decided to make this course a mandatory one for first-year ORT Braude students. The course aims are to boost students employability skills, give them a competitive edge in the workplace and perhaps even in life, enable them to enhance their ability to manage themselves, and cope with ambiguity. The course deals with four main skills: self-management (time, task and stress management), teamwork, effective presentation and problem solving. We analyzed questionnaires distributed to all the students in our pilot, conducted this year at ORT Braude College,

regarding the course relevance, content, format and the experience of working in teams to solve general unstructured problems. In our talk, we will elaborate on our insights for improving this course.

### Learning deterministic variable automata over infinite words

**Sarai Sheinvald**
ORT Braude College

**Keywords:** Automata over infinite words; learning automata

Automated reasoning about systems with innite domains requires an extension of automata, and in particular, nite automata, to innite alphabets. One such model is Variable Finite Automata (VFA). VFA are nite automata whose alphabet is interpreted as variables that range over an innite domain. Aside from their simple and intuitive structure, VFA have many appealing properties. One such property is a deterministic fragment (DVFA), which is closed under the Boolean operations, and whose containment and emptiness problems are decidable. These properties are rare amongst the many different models for automata over innite alphabets. In this paper, we continue to explore the advantages of DVFA, and show that they have a canonical form, which proves them to be a particularly robust model that is easy to reason about and work with. Building on these results, we construct an efcient learning algorithm for DVFA, based on the L $*$ algorithm for regular languages.

### Adaptive scheduling in an FMS environment

**Boris Shnits**
ORT Braude College

**Keywords:** Adaptive scheduling; FMS control; optimization; simulation; multi-criteria decision making

This research deals with controlling flexible manufacturing systems (FMS) operating in volatile production environments. To cope with such environments, most studies recommend some sort of adaptive or dynamic scheduling, which enables the system to better cope with randomness and variability. This type of scheduling is usually based on using simple dispatching

rules. The use of dispatching rules, however, generally leads to myopic decisions based on limited information, and to non-delay type scheduling that does not guarantee the best scheduling decisions. An adaptive scheduling methodology presented in this study is based on local optimization. At every decision point, the local scheduling problem is solved in order to find the best schedule for the next scheduling period based on the current system status. The research focuses on formulating the dynamic scheduling models for different objective functions. These models are integrated in an overall multi-criteria control scheme. The proposed methodology was tested using a simulation-based environment. The results obtained demonstrate the superiority of the suggested methodology.

### Climb your way to the model: Teaching UML to software engineering students

**Naomi Unkelos-Shpigel**
ORT Braude College

Unified Modeling Language (UML) courses are an essential part of software engineering curricula. There is increasing evidence that embedding active learning techniques in courses in general, and in UML courses in particular, increases students' motivation and performance. In this paper, we contribute to this body of work by presenting model for embedding active learning in an undergraduate UML course. The model was used throughout a course, providing interesting results, and promoting students' participation and motivation. We present our insights and plans for further inspection of the model.