Speaker Abstracts

Session I: Big Data

Humans, machines and data: Understanding challenges and opportunities
Enrico Bertini, NYU, United States

One of the most interesting trends of our times is our capacity to leverage data and computing to help people make progress with complex scientific, economic and societal problems. As we gather more and better data and develop more computational methods to process them, we also need to figure out how to help humans interact with them. In this talk, I am going to discuss the role humans play in computer-supported data processing, analysis and presentation. The focus will be on showing what challenges and opportunities lie ahead and why it is crucial for us to develop a better understanding of how humans can and should interact with data and data processing machines.

Towards a unifying theory of learning and information
Ibrahim Alabdulmohsin, Saudi Aramco, Saudi Arabia

The notion of "learning from data" is closely connected to the notion of "information." On one hand, one can only learn from data if it carries "enough information" about the target concept that one would like to learn about. On the other hand, over-fitting occurs if the learner memorizes "too much information" about the data itself. Despite this, the field of statistical learning theory, which answers when learning is successful, has been quite disconnected from the field of information theory. In this talk, I will show how the two fields can indeed be unified. I will introduce a new notion of over-fitting, called "uniform-generalization," and show how it bridges the gap between the two fields. Unlike previous notions of over-fitting in the literature, "uniform generalization" has three equivalent characterizations: (1) statistical, (2) algorithmic, and (3) information-theoretic. I will describe why it captures the phenomenon of over-fitting is its full generality and list some of its favorable properties. After that, we will use it to establish an equivalence characterization between the Shannon channel capacity and the Vapnik-Chervonenkis dimension, which are the two most central concepts in learning theory and information theory. Finally, I will discuss some of the applications of this work for model selection and big data.

Computational social science: Using big data as a societal microscope
Kinga Makovi, NYU Abu Dhabi, United Arab Emirates

Computational social science entered the social sciences as a “measurement revolution” – like the microscope, or the telescope of its time. Cellphones measure our behaviors and movements, and credit cards record our preferences through our purchases. The penetration of digital technologies allows us to access a much broader pool of individuals to answer surveys – the measurement device of the 20th century – but also to run experiments, and link these observations to various other records.

But, has the “big data revolution” delivered on its promise of new theoretical insights? As a social scientist with a deep interest in social mechanisms, trained in causal inference, I tend to think that we understand social (or any) phenomena when we are able to intervene in it, and foresee the outcomes of our interventions. On the surface, it looks like I would be interested in the accuracy of predictions, but in

fact, I am interested in human behavior and actionable change in it. I will describe some strategies to "mine" such actionable change from data – strategies that differ from the toolkit of machine learning, and related methods. First – using large scale experiments both in the field, as well as using the crowed sourced platforms combined with other data, either on the context in which individuals are embedded in, or "meta data" that measures hard-to-access aspects of behavior helps us uncover why people act the way they do. In the context of contemporary American society I demonstrate that there is ample diversity in discrimination, and suggest that this helps us design better interventions to counteract it. Second – using linkages of large-scale administrative data sources helps us establish previously unseen social facts, for instance variation in the level of discrimination against racial minorities in the United States by the police.

Third – making big data small for targeted comparisons and using techniques of causal inference are also tools to help us make sound claims about the social world. To demonstrate these tools at work, we look at population level data on the German labor market, from which we construct the occupational networks of individuals as they move through firms through their careers in Berlin for a 3-decade period. With these data we investigate if women indeed use their networks differently compared to men, and the benefits of behaving in the same way.

Machine learning driven biomarker discovery in the era of big data
Bobbie-Jo Webb-Robertson, Pacific Northwest National Laboratory, United States

Machine learning is a broad term to describe a large class of computational models that are focused on extracting knowledge from data. Machine learning methods can tackle multiple big data challenges, such as dimension reduction, pattern recognition, estimation or classification. Thus, machine learning has become a necessity in the analysis of big data for many domains. The goals of various analyses of big data, and consequently the output of machine learning, are numerous and are driven by the domain. In many cases, the goal is to generalize to new data with the purpose of classifying previously unseen data not used in the training of the model into a category. For example, your email program is most likely using a machine learning model to determine if a new email is Spam. The how and why it makes the decision are usually not of interest to the typical email user. However, in many scientific application areas with big data, the how and why are needed to extract information that can be used to either better understand the domain or to build lower dimensional and interpretable models that can be used in a practical setting. These methods are devised to take advantage of the scale of the data to find complex relationships between features and outcomes that can promote translational research.

A highly active domain in machine learning is the field of biomedical research. High-throughput biomedical data is being generated at an unprecedented rate as instruments become faster and cheaper, which is allowing larger and more complex cohorts to be analyzed. These large experiments offer tremendous hope to better understand underlying mechanisms of etiology. In particular, experts expect that the computational exploration and integration of this data will identify core biological drivers of disease that will enable improved diagnosis, prognosis, and treatment of complex diseases. These molecular high-dimensional datasets are also changing the manner that scientists approach studying disease. Many scientists are moving from a paradigm of domain-driven knowledge focused on a single hypothesis-based study of a small number of biomolecules to discovery-based science that identifies systems-level changes. This presentation will cover the place of machine learning in these large-scale molecular studies, including the challenges, gaps and opportunities.

Session II: Water Systems

Sustainable reuse options of wastewater in Oman

Mahad Baawain, Sultan Qaboos University, Oman

This study aims at providing decision makers with the complete picture about the current situation of wastewater treatment effluents in different areas in Oman. It also focuses on ranking the beneficial reuse options of wastewater in Muscat. The study concentrated on six possible options for reusing the effluents from wastewater treatment plants: urbane reuse, agriculture reuse, industrial reuse, groundwater recharge, and energy generation. The guiding goal for this research work is to promote the conservation of the country's water resources by recycling treated municipal wastewater for different potential uses. This should lower demand on finite water resources; support business and growth; and introduce reliable and potentially lower cost water sources for industry in the long-term.

The study characterized the wastewater (raw and treated) from different areas though field sampling. The total number of samples exceeded 1500 samples and the number of conducted tests exceeded 35000 tests ranged between physical, chemical and biological parameters. All obtained results for water, wastewater and sludge samples showed high variation. However, the produced treated effluents have met most of regulatory limits stated by Omani Standards except some parameters such Nitrate, E coli and TSS in certain plants.

According to the conducted field analysis and available guidelines along with environmental, social and economic consideration, the following ranking for treated effluent reuse is suggested for the six options: 1) agricultural reuse, 2) urban reuse, 3) industrial reuse, 4) groundwater recharge, 5) potable reuse (indirect), and 6) power generation.

The who, where, and (somewhat) why of the drinking water microbiome

Ameet J. Pinto, Northeastern University, United States

Every liter of regulation compliant drinking water contains tens of millions of phylogenetically diverse microbial cells, which constitutes the complex drinking water microbiome. This drinking water microbiome migrates daily from water treatment plants into our built environment and can mediate a range of impacts – from public health risks to infrastructure damage. Managing the drinking water microbiome is not only limited to minimizing its detrimental impacts, but also extends to exploiting these microbial communities for beneficial purposes. This approach of managing the drinking water microbiome is transformative, as it shifts our focus from eliminating microbial communities in drinking water systems to exploiting them. Delivering on this outlook requires that we first systematically observe, accurately describe, and clearly elucidate fundamental mechanisms shaping microbial community in drinking water systems. This talk will highlight recent critical insights into factors regulating microbial communities at the tap across multiple drinking water systems and how these insights may be exploited by integrating with ecological and physiological theories that attempt to capture fundamental mechanisms shaping microbial communities.

A potential collaboration with Water Research Center of Kuwait Institute for Scientific Research on innovative desalination technologies

Mansour Ahmed, Kuwait Institute for Scientific Research, Kuwait

The State of Kuwait is facing a truly difficult challenge of supplying freshwater in a sustainable way for domestic and for the development of various activities. This is due to lack of natural resources for freshwater and the increasing population growth rate associated with urban expansion as well as increasing growth in commercial, industrial, and agricultural activities. Accordingly, desalination facilities must be rapidly expanded to alleviate the freshwater shortages and to meet the country's freshwater needs. However, conventional desalination technologies (CDT) are prohibitively expensive, energy-intensive, and not environmentally friendly process. As a result, there is a substantial need for innovative and new advanced desalination technologies to resolve challenges involving pricing, energy and environmental issues. Therefore, Water Research Center (WRC) of Kuwait Institute for Scientific Research have remarkably developed a number of promising innovative technologies for various applications, including: seawater desalination, brine concentration, salts and minerals extraction, and treatment of produced oil water, in order to bring the technology into developing competitiveness on the commercial level. The research projects under WRC offered a unique opportunity for international collaboration between KISR and the international technology developers to achieve a breakthrough in the innovative desalination technologies. These collaborative research projects provided technology solutions to global challenges and severe limitations of innovative desalination technologies such as forward osmosis (FO) technology.

The FO technology offers several technical and economic advantages over the CDT. The main benefits that could be gained from the FO system are cost savings, as well as providing higher water recovery, higher brine concentration, higher boron rejection, and reducing the desalination plant's facility footprint. These benefits will contribute substantially to provide an opportunity for increasing the existing permeate capacity of the Ministry of Electricity and Water (MEW) desalination plants. Accordingly, WRC has adopted Forward Osmosis (FO) for desalination applications in the State of Kuwait since 2013. WRC has scaled up the research on FO technology from laboratory scale to pilot scale level by 2016 through fruitful international collaboration between WRC and process and membrane developers. WRC's future vision is to develop FO technology to successfully achieve its benefits on commercial level in Kuwait. If these advantages are successfully achieved on a commercial scale, then Kuwait and the whole Gulf region as well as the international scientific community would benefit tremendously from the outcome of this applied research.

Based on experience gained through collaborative projects, implementation of any research project through the international collaboration will be an added value to any party since it will contribute to enhance capacity building in terms of human resources and research facilities. Accordingly, this session will provide all participants a great and unique opportunity to enhance the scientific exchange and dialogue among researchers in Arab countries and the United States, thereby facilitating interactions that will promote new synergies and collaborations among participants.

Sustainable bioinspired water purification

Manish Kumar, Penn State University, United States

Nature presents excellent ideas for engineering solutions for several challenges facing humanity. Lack of access to clean drinking water is a challenge that has emerged around the globe with increasing pollution, uncertain weather patterns, and overdraft of freshwater sources. One approach to obtain clean water is to create innovative technologies for treating marginal water streams to make them drinkable by utilizing technologies inspired by biological systems.

This talk will first present a quick overview of bioinspired ideas that could be relevant to treatment of marginal water sources such as seawater, brackish water, polluted surface water, and recycled wastewater. It will then focus on two specific examples of such ideas currently being studied in our group. The first example will discuss the use of cationic antimicrobial peptides used by plant seeds to protect themselves from microbial attach and discuss its relevance to developing a scalable low energy filter for off-network applications. The second example, inspired by water filtration conducted by cellular membranes will describe the progress made in the area of biomimetic membranes that utilize proteins or protein mimics to create a highly efficient desalination membrane.

Session III: The Microbiome

Understanding the gut microbiome as an ecosystem in health and disease
Catherine Lozupone, University of Colorado, United States

The human gut hosts a complex community of bacteria, fungi, and viruses (collectively called the 'microbiome'). Advances in sequencing technology has led to an increased understanding the composition of this community in health and also how it relates to diverse diseases ranging from obesity, to heart disease and depression. Current challenges include integrating novel methods of deeply characterizing the composition and activity of microbes and the human host to generate and test mechanistic hypotheses regarding roles of microbes in disease. Insights into microbiome structure and function are also aided by viewing the microbiome from an ecological standpoint in order to devise strategies to return a microbiome that has been subjected to disturbance (e.g. by antibiotics, poor diet or disease) to a healthy state.

Antimicrobial activity of lactic acid bacteria and antimicrobial peptides from camel milk
Rita Rahmeh, Kuwait Institute for Scientific Research, Kuwait

Camels are multipurpose domestic animals exceptionally well-adapted to long periods of drought and heat. They can survive and reproduce in harsh conditions intolerable to other domestic animals. Internationally, camels have considerable economic importance as many manufacturers of camel milk-based products are spread out worldwide. Camel milk and its byproducts are now promoted in the market for their nutritional value and health benefits. To generate an industrial interest in this milk and to develop an understanding of camel health and disease, all camel milk aspects should be investigated. Information on the microbiology of Camel milk is very limited. Thus, our work aimed to investigate raw camel milk as a source of lactic acid bacteria and antimicrobial agents. Sixty lactic acid bacteria (LAB) were isolated and genetically identified using 16S rRNA sequencing. Among the isolated LAB, twenty-eight exhibited significant antibacterial effects against a broad spectrum of pathogens causing human and animal diseases and food spoilage. Further, the ability of these LAB to produce antimicrobial peptides was evaluated. The produced antimicrobial peptides from four isolates were biochemically characterized as heat tolerant and stable at pH range (2 to 10). Altogether, the isolated LAB and their antimicrobial peptides can lead to improving human and animal health through their potential application as probiotics, natural food preservatives in the dairy industry or as feed additives.

Functionality of the vaginal microbiome

Jennifer Fettweis, Virginia Commonwealth University, United States

Throughout a woman's life, dramatic shifts occur in the structure and function of vaginal microbial communities that coincide with hormonal and lifestyle changes. Particularly during the reproductive years, some bacterial species including lactobacilli can protect against vaginal infections. Conversely, an imbalance in flora, or vaginal dysbiosis, is associated with an increased risk for acquisition and transmission of sexually transmitted infections. The vaginal microbiome plays a particularly important role in maternal and neonatal health. Imbalances in bacterial communities can increase risk for infertility, spontaneous abortion and preterm birth. Moreover, a mother's vaginal microbiome may serve the evolutionary role of seeding the microbiome of her baby at birth, which may influence lifelong microbiome composition and health. Therefore, uncovering the relationship between the vaginal microbiota and early infant microbiome acquisition holds global relevance across generations. We present insights into the functionality of the vaginal microbiome that have been gained from two large projects funded through the National Institutes of Health (NIH)'s Human Microbiome Project (HMP): the Vaginal Human Microbiome Project (VaHMP) and the Multi-Omic Microbiome Project Pregnancy Initiative (MOMS-PI).

Pharmacomicrobiomics: How our microbiome cloud affects precision therapeutics

Ramy Karam Aziz, Cairo University, Egypt

The Human Microbiome Project was launched over a decade ago to explore the diversity of human-associated microorganisms at multiple body sites (skin, mouth, nose, colon, and vagina) and their impact on human health. Pioneering studies highlighted the extent of intra- and inter-individual microbiome variations, and how these variations played key roles in nutrition, health, disease, and immunity. Different models were proposed to describe the human microbiome, likening it, for example, to a missing organ or a second genome. Alternatively, I propose a microbiome cloud model, which better reflects the uncertainty in defining an individual's microbiome in time and space. This cloud concept explains the difficulty in defining static core microbiomes or biome types for different individuals, and offers a dynamic model for the impact of the microbiome on precision medicine and systems pharmacology.

Recent research results are presented on microbiome alterations in hepatitis C and conjunctivitis patients, as well as the interplay between the human and surrounding environmental microbes among nurses and drug factory workers. Finally, the nascent field of pharmacomicrobiomics, or drug–microbiome interactions, is introduced and discussed in the light of the microbiome cloud model. Key examples of drugs that are dramatically affected by gut and vaginal microbes are presented. Finally, recently developed web resources and big data analysis tools are demonstrated and applied to accelerate drug-microbiome interactions in the hope of customizing therapeutic intervention, minimizing drug toxicity, and improving the therapeutic outcomes of available medicines.

Session IV: Air Quality

Global air quality: Challenges and opportunities
Christine Wiedinmyer, University of Colorado, United States

Air pollution is a global problem that can harm human health, degrade environmental quality, and impact the climate system. Globally, air pollution, which includes particulate matter and ozone, is the 5th highest risk factor for public health (2nd for low and low-middle SDI countries). Air quality is also intimately connected to climate, with important feedbacks that can have immediate and long-term consequences. Reducing air pollution can be a challenging endeavor due to the fact that air pollution is made up of different components that have different sources. Particles, carbon monoxide, and ozone are all examples of air pollutants, and the concentrations of each are determined by different sources and chemistry.

Significant advances in the efforts to understand and mitigate air pollution around the world have been made in recent years. Measurement technologies have improved in important ways to identify more components of atmospheric mixtures, quantify lower concentrations, and lower instrument cost and size. Satellite observations have enabled regional and global characterization of the spatial and temporal trends in air pollutants. These advances provide complementary observations with ground- and aircraft-based in situ measurements to determine the chemical composition of the atmosphere, the sources of air pollution, and the effectiveness of mitigation efforts. Chemical transport and climate models include more processes and have higher temporal and spatial resolutions than ever before. With these various tools, the investigation of the chemistry and impacts of various air pollutants, as well as the exploration of future scenarios, has progressed significantly. However, despite the incredible successes in air quality science made in recent years, uncertainties still exist in our understanding of the sources, chemistry, transport and impact of air pollution. Therefore, there are great opportunities for more advances in the future.

This presentation will give an overview of air pollution: the sources, chemistry, and impacts on global and regional scales. Examples of new innovations that have provided the means to advance our understanding of this important issue will be highlighted. In addition, uncertainties in our current knowledge will be discussed and exciting opportunities emphasized.

Examining the challenges in mainstreaming climate change in development plans: Lessons learned from Lebanon
Lea Kai, Ministry of the Environment, Lebanon

In recent years, there has been a growing momentum to mainstream climate change into development planning, to avoid working at cross-purposes and use resources more efficiently. It is often easier to integrate climate change adaptation and mitigation in existing policies and practices rather than creating new ones. Mainstreaming can therefore save money by making more efficient use of scarce resources, rather than building separate institutions and processes to support climate change action. Development and adaptation are acknowledged as mutually dependent strategies, and efforts to streamline climate-related concerns into the development-planning and decision-making processes are emerging around the world.

However, in the Arab region, environment including climate change is still not a priority on the political and development agenda, making the mainstreaming process difficult. Despite the projected and observed impacts of climate change in Lebanon, there is still not enough momentum to concretely include preventive, adaptive and mitigating measures into sectoral plans. Such integration is not straightforward, and limited knowledge on multi-level governance exists. In addition, when mainstreaming is successful, several barriers hinder proper implementation such as institutional and legal reforms, under –resourcing, unreliable information and lack of technical knowledge.

The intervention in the symposium will discuss the challenges in integrating climate change concepts in development planning and the opportunities that this might bring to policy makers. It will also suggest some concrete steps which may be taken in order to foster a more systematic consideration of climate change matters and to assist the achievement of the Sustainable Development Goals. Lessons learned shared in this intervention are based on real-life examples gathered through 12 years of practice in mainstreaming climate change in the Lebanese development agenda.

New high-resolution global composition forecast

Emma Knowland, National Aeronautics and Space Administration, United States

Every day, weather prediction models communicate with satellites, weather balloons, and surface monitoring networks, ingesting millions of observations to make the best possible forecast. Now, because of advances in computing and software engineering, these same weather forecasting models can be used as the foundation for forecasting air pollutants, including particulate matter, ozone and nitrogen dioxide, which have health impacts on humans and vegetation. Currently, surface air pollutant observations are sparse, leaving vast areas of the globe unobserved. Air pollutant concentrations can be inferred from satellite observations; however, overpasses may be infrequent and it is often difficult to infer the 'nose-level' concentrations that air quality managers need. Global models with state-of-the-science atmospheric chemistry equations help fill in the gaps left by observations and provide insight on future conditions.

Forecasting air quality has typically been performed at the local-scale, either for an individual city, state or country. Simulating the emission, transport, and chemical evolution of air pollutants globally and at high spatial resolution requires a powerful supercomputer, such as the one at NASA Goddard Space Flight Center, in Greenbelt, Maryland. Here, NASA's Global Modeling and Assimilation Office is using its weather forecasting model "GEOS" to develop a global, high resolution atmospheric composition forecast capable of providing air quality forecasts in near-real time. This model uses a complex atmospheric chemistry model and is run on NASA's Center for Climate Simulation supercomputer, using the computing power equivalent to 3500 personal computers. This forecast has the highest resolution of a global atmospheric composition forecast to-date, providing information at 25 km (16 miles). At each time step, the atmosphere is represented by 75 million data points, with a horizontal resolution 10 times higher than conventional global atmospheric chemistry simulations.

Air quality can vary dramatically by region and time of day. With this new global air quality forecast, we can give the best information to those making decisions regarding human health and agriculture while providing support to NASA flight campaigns and satellite missions.

Putting air quality data to work – opportunities and challenges of fine-grained spatial and temporal air quality information.

Karim Tarraf, Hawa Dawa and Cairo University, Egypt

In the 9th century A.D. a Persian physician and polymath by the name of Ar-Razi lived in Baghdad. He is considered now to be one of the most important figures in the history of medicine of his time. He was asked to choose the right spot for building Baghdad's main hospital. His first step was to have pieces of fresh meat placed at various parts of the city of Baghdad to determine the best location. He chose the place where the meat remained freshest, and thus, the ambient pollution was lowest. Almost one millennium later a mining tradition included the use of canaries in coal mines to detect toxic air quality before it could harm human miners.

The notion of air quality data-based decision making in health management, city and traffic planning is not new, rather has been applied throughout history. What is new is that in no other period in human history have technological advancements been shaping the way we do things more rapidly than today. It is estimated that by 2020 more than 31 billion devices will be connected to the internet, generating trillions of bytes of data. IoT-based technologies promise to merge both digital and physical worlds by transcending spatial and temporal barriers. To use these technologies combined with information from satellites and other measurement methods to better understand urban air quality is self-evident. However, this approach does not come without its limitations: Questions on data reliability, accuracy, rights-of-use and commercial applicability arise.

This talk will discuss the opportunities and challenges of combining low-cost sensors with Earth Observations in predicting comprehensive air quality information in urban centers. It will also demonstrate practical use-cases for the commercial use of air quality data. Finally, the talk will present an outlook for future developments in this field and demonstrate ways in which collaboration could shape the future of Environmental IoT (EIOT).

Air quality data and awareness in Kuwait

Bader Albusairi, Kuwait University, Kuwait

Poor air quality has become a critical environmental, economic, and health problem around the world as industrial growth and economic development have caused massive increases in air pollutants. Determining the quality of the breathed air indoors is essential for good health and productivity even in work places. Air quality forecasts and indexes are also important public communication tools. They can help people plan activities to avoid exercise and strenuous work outside when the pollution is high, and help hospitals prepare accordingly for a potential increase of patients with cardiovascular and respiratory complications. The main objective of the presented study is to identifying pollution sources and patterns, empowering people to protect their health and raising awareness about air quality in Kuwait. This study provides the training around 1000 No's of students from schools & universities and 500 No's of citizens on the full functionality of air quality monitoring devices; especially air visual device. This device provide AQI, CO2 level, humidity, 2.5 pm level, and temperature. It has many functions to increase the awareness, where it can be transmitted the information by several means to the public. Also, it is a good platform for the researcher to collect data about air quality indoor and outdoor in a simple and cheap way. These data would help in various scientific research activities.

Session V: Next Generation Buildings and Infrastructure

Scalable architectural visions!
Raya Ani, American Institute of Architects-Middle East, United Arab Emirates

Rapid population growth, strained resources and the urgency to preserve natural lands have pushed architects to consider sustainable living solutions. Buildings and environments have become visions of complete ecosystems on earth and their requirement to be smart and responsive to environmental and external stimuli has become essential. Smart buildings incorporate parametric design in conjunction with engineering to ensure building performance, efficiency, and aesthetics while still embracing a holistic sustainable approach. Our urban landscape and daily lifestyle is demanding smart solutions without compromising on the spirit of a space or an environment. This evolution could redefine what habitable spaces could mean to us in the near future.

In her presentation, Raya Ani will present two projects she designed as part of her practice / research work. She introduces visions that are ambitious yet achievable, scalable and useable in different conditions / contexts. The underlying principle behind these two projects is a holistic intelligent approach to design as part of a context whether the project is a master plan, an architectural building or a mixed-use project and whether it is a vertical or a horizontal development.

Controlling thermal radiation for large scale energy applications
Xiaobo Yin, University of Colorado, United States

Micro/nano-structured materials offer significantly new opportunities for high efficiency devices and systems for energy harvesting, conversion and storage. Fundamental understanding at the small scale enables us to design structures and materials with unprecedented performances. However, there is a tremendous gap between the proof-of-principle demonstration at small scale and the intrinsically large scale real-world thermal and energy systems. As one example, energy use for cooling and air conditioning is poised to increase dramatically over the next several decades driven by population, climate and economics. In this talk, I will give an overview on our research progress and, more specifically, present our recent development on thermal radiation control for large scale radiative cooling applications. We demonstrated the scalable manufactured micro-optical composites with extreme light-material interaction provides a 24/7 continuous cooling power of 110 W/m2 at no additional cost for electricity nor water.

Reimagining heritage and public space in Fez, Morocco
Aziza Chaouni, University of Toronto and Aziza Chaouni Projects, Morocco

Aziza Chaouni Projects has been involved in two major rehabilitation projects in Fez, Morocco: the restoration of the Qarawiyine Library built by Fatima el Fihrya in the 8th century, and the Sidi Harazem Thermal Bath, Morocco's first public leisure infrastructure project after its independence, a brutalist masterpiece erected in the 1960s.

Although reflecting different periods in the city of Fez's history, both projects provide crucial public arenas for the city of Fez. By integrating the project stakeholders within all phases of the design and

rehabilitation process through various tools and by initiating new programs, we extended the role of the architect to include that of citizen. Our lecture will cover strategies for integrative design and also the relationship between heritage, memory and public space in contemporary Moroccan cities.

Programmable skins: A hygromorphic approach for low-cost adaptive building façades
Sherif Abdelmohsen, American University of Cairo, Egypt

According to the US Department of Energy, buildings in the US are responsible for approximately 40% of the primary energy demand. The heating (23%), cooling (15%) and lighting (14%) of spaces are dominant energy uses, making up almost 50% of the overall energy consumption. As building skins are filters between the interior and exterior of a building, they can regulate the energy flow between these two environments. If controlled correctly, conventional shading devices can decrease the building's annual cooling load by as much as 20%. These systems however exhibit performance deficiencies and clearly demonstrate the need for adaptive building skins that respond to multiple variables including weather, context and space occupancy.

The purpose of adaptive building skins is to actively moderate the influence of weather conditions on the building's interior environment. Current adaptive skins rely on rigid body motions, complex hinges and actuation devices. These attributes are obstacles to their broader adoption in low-carbon buildings. The core idea of soft adaptive skins is that they exploit the systems' elasticity to respond to stimuli. However, designing such a skin is a challenging task due to the interaction between geometry, elasticity and environmental performance. Recent research has shifted to low cost smart materials like bilayer composites, thermal bimetals, and hygromorphic materials, where the focus is on using bio-inspired systems and material properties to address sustainable adaptive façades.

This research utilizes the hygroscopic behavior of wood as a low tech smart material with a naturally responsive mechanism that exhibits different shrinkage and expansion values when exposed to different humidity levels. Wood is known for its low environmental impact, low embodied energy, carbon impact and its ability to change volume passively under certain stimuli. Originally inspired by the Islamic Mashrabeya, the research focuses on the design and application of a material-based system that is programmed to passively sense stimuli and respond in a controlled setting in hot arid climates. Experiments are conducted to deduce the design parameters affecting wood behavior, including type of wood, moisture content, thickness, grain orientation, aspect ratio, and lamination.

These parameters are seen to collectively control the morphing behavior and response time of wood to changes in humidity. Material fabrication and design parameters are studied to encode the direction and deflection value of the programmable wood system. For a more controlled and accurate responsive behavior, a combination of these parameters is necessary to achieve any given desired response. This is demonstrated in the lamination process, where unlimited variations are conducted to test all parameters in conjunction, relying on the concept of using passive and active layers. Lamination typically uses the difference in shrinkage value for each layer to account for difference in wood response to humidity, where the active layer is responsible for motion, and the passive layer accounts for resistive behavior. The combination of hardwood and softwood is usually used in the lamination process, where hardwood acts as the active layer and softwood as the passive layer. The implementation of this concept of passive and active layers to wood allows for a passive 'programmable' shape-shifting building façade system that potentially replaces highly mechanistic digitally controlled systems.

NASEM Program

Join the Global Movement—Develop Grand Challenge Scholars

Ruth David, National Academy of Engineering, United States

The Grand Challenge Scholars Program (GCSP) aims to inspire young engineers across the globe to address the biggest challenges facing humanity in the 21st century. The program was motivated by the Grand Challenges for Engineering, identified by a diverse committee of experts from around the world and published in 2008 in the NAE Grand Challenges for Engineering. The GCSP is an outcomes-based program that gives wide flexibility to institutions on the best ways of offering appropriate and relevant experiences to students. It has the structure of a movement in which inspiration is driven by the power of the idea and execution is made within the local ecosystem.

Regional and Global Funding Opportunities

Importance of international collaborations in research and innovation programs: Examples from Oman

Ali Al Shidhani, The Research Council, Oman

The Research Council (TRC) of Oman was established in 2005 to support and fund research and innovation activities in the country. TRC has launched several programs targeting wide spectrum of beneficiaries and scientific disciplines. Two of TRC's flagship programs will be highlighted in the talk; they are; Ejaad and Upgrade. Ejaad is a solution accelerator program to match industry needs to local academic research capabilities. Some industry aspirations and challenges requires skills, competencies and capabilities that might not be available locally; thus collaboration with international researchers becomes necessary to complement the missing qualities. Upgrade is a program to transform ICT graduation projects to startups. Winning projects receive seed funding, incubation and business development, in addition to international training. International exposure is important for startups for the purposes or knowledge transfer and sharing experience. In the first edition of the program, winning startups visited silicon slopes, Utah, USA. There are opportunities of collaborations between TRC and international organizations to help advance Ejaad and Upgrade programs.