Research Day 2017

March 28, 2017

Annette Caldwell Simmons School of Education & Human Development

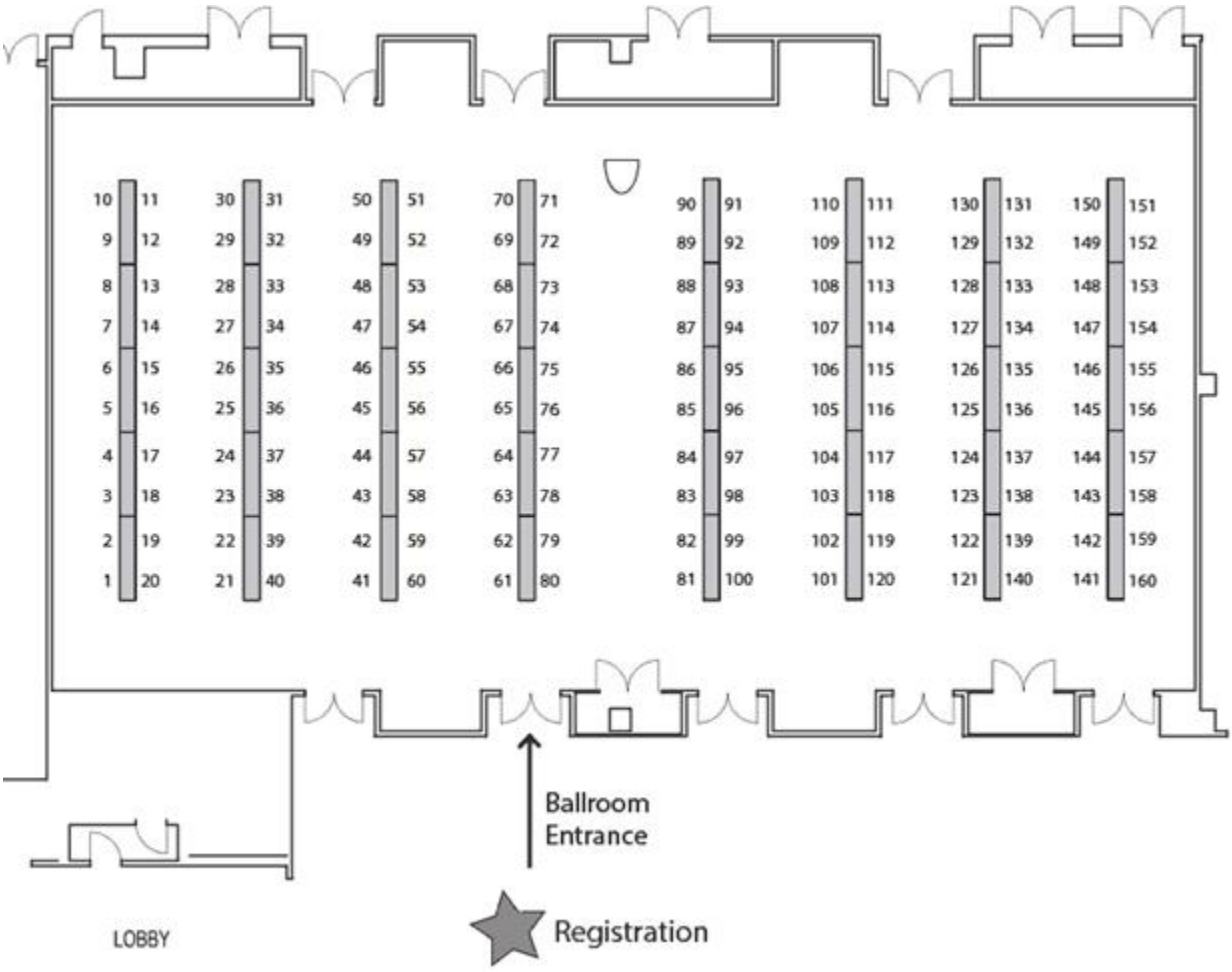
Bobby B. Lyle School of Engineering

Dedman College of Humanities and Sciences

SMU Guildhall

SMU | GRADUATE STUDIES

Map of Research Day: Hughes-Trigg Ballroom



Research Day Departments

Computer Science and Engineering

Adel Alharbi (#1)
Advisor: Mitchell Thornton
Computer Science and Engineering, Lyle School of Engineering

DEMOGRAPHIC GROUP PREDICTION BASED ON SMART DEVICE USER RECOGNITION GESTURES

We propose a novel demographic group prediction mechanism for smart device users based upon the recognition of user gestures. The core idea of our proposed approach is to utilize data from a variety of the internal environmental sensors in the device to predict useful demographics information. In order to achieve this objective, an application with several intuitive user interfaces was implemented and used to capture user data. The results presented here are based upon the data from fifty users. These captured data are integrated or fused, pre-processed, analyzed, and used as training data for a supervised machine learning predictive approach. The data reduction methods are based upon principal component analysis (PCA) and linear discriminant analysis (LDA). PCA/LDA were implemented to reduce the data feature dimensions and to improve the k-nearest neighbors (KNN) supervised classification predictions. The results of our experiment indicate that high accuracy is achieved from this method. To the best of our knowledge, this is the first research that uses user recognition gestures to predict multiple demographic groups.

Description of Commercial Viability:

Demographic group prediction, machine learning, PCA, LDA, and KNN classification model.

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Soha Alhelaly (#2)
Advisor: Jennifer Dworak
Computer Science and Engineering, Lyle School of Engineering

DETECTING TROJAN DIE IN 3D STACKED INTEGRATED CIRCUITS

3D integrated circuits introduce both advantages and disadvantages for security. Among the disadvantages unique to 3D is the potential insertion of a Trojan die into the stack between two legitimate dies. Such a die could be used to snoop information traveling between dies, alter the data, or otherwise interfere with stack operation. In this paper, we explore a Trojan detection technique and in-stack circuitry needed to detect an extra die through delay analysis even in the presence of process variations.

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Abdullah Bokhary (#3)
Advisor: Jeff Tian
Computer Science and Engineering, Lyle School of Engineering

MEASURING CLOUD SERVICE RELIABILITY BY WEIGHTED DEFECTS OVER THE NUMBER OF CLIENTS AS A PROXY FOR USAGE

Cloud computing has become a major resource for fulfilling people's computational and storage needs. Investing in these services requires measuring and assuring its reliability. However, using traditional reliability models can be challenging because of the environmental constraints and limited data availability. This paper proposes a framework to measure reliability with alternative available information that most cloud providers offer in three stages: 1) Defects are extracted and weighed from issue report based on its validity. 2) Workload is measured by the number of clients as a new proxy to estimate daily clients usage. 3) Both results are linked together to examine the defect behavior over time. Software reliability growth models (SRGMs) are used to analyze this behavior to assess current reliability and to predict future reliability. Google Maps APIs is used as a case study to demonstrate the applicability and effectiveness of our new framework.

Description of Commercial Viability:

Cloud reliability, usage measurement, clients count, weighted defects.

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Xinyi Ding (#4) Amanda Doyle; Kevin Donahoo; Eric Bing; Radhika Rajgopal; Eric Larson
Advisor: Eric Larson
Computer Science and Engineering, Lyle School of Engineering

EDUAWARE: PREDICTING LEARNING MODULE PERFORMANCE USING NAVIGATION GESTURES

Predicting student performance provides a way of early intervention for those at risk students and has long been a research topic in the computer and education community. In this paper, we develop a context-aware, tablet-based learning module for adult education. Specifically, we focus on adult education in healthcare--teaching learners to perform cervical cancer screening and identify precancerous lesions. Based upon how learners navigate through the learning module (e.g., swipe-speed and click duration), we use machine learning to predict what comprehensive test questions a user will answer incorrectly. Compared with other context aware learning applications, this is the first time navigation gestures have been used to support learning assessment. We conducted a 21 participant user study, showing the system can predict user performance with near 90\% accuracy (without user specific calibration data). Such techniques could be used to enhance retention of knowledge, dynamically change learning module content, and provide real-time assessment. We also analysis which attributes are most responsible for making such predictions and discuss the generalization of our methodology.

Description of Commercial Viability:

Personalized education system.

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Saurabh Gupta (#5) Al Crouch; Daniel Engles
Advisor: Jennifer Dworak
Computer Science and Engineering, Lyle School of Engineering

DOES YOUR LOCKING SIB HAVE A BACKDOOR?

Locking Segment Insertion Bits (LSIB) have been proposed to secure access to on-chip embedded instruments in IEEE 1687 networks. We assess the vulnerability of the key logic used to determine if an LSIB can be opened to simple power analysis attacks at an early design stage by simulating gate-level netlists. We show that the key logic is susceptible to power analysis attacks when the key bits for each LSIB are disjoint. However, when the key logic is shared among multiple LSIBs, there is significantly lower correlation between the power drawn by the key logic circuit and the values of the LSIB keys—even when the key logic circuit is isolated and is the only part of the scan network switching. Sharing key logic also reduces the scan area overhead. Thus the suggested design changes are a good starting point for designing side channel resistant LSIB key logic circuits. Our method of using fast gate-level simulations also helps in the early evaluation of these designs before resorting to post-layout SPICE simulations for further detailed analysis of their resistance towards power-analysis attacks.

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Naseer Jan (#6) Jeff Tian
Advisor: Jeff Tian
Computer Science and Engineering, Lyle School of Engineering

Usability Issues Classification in Safety Critical Systems

Safety critical systems whose failure could result in disastrous accidents, including loss of life, environmental disaster, property damage or financial loss. Application of these systems can be seen in different domains such as nuclear industry, health sector, space industry and aviation etc., Usability plays a significant role in safety critical systems. Although there are some general classification schemes to address usability problems. There is no framework so far to take usability of safety critical systems into consideration. In this study, we present a classification and analysis framework to address usability issues in safety critical systems. The findings of 39 software related airline accidents show usability issues such as error messages, alarms, input validations and lack of displays as contributory factors in these accidents. By addressing usability issues in aviation industry using our framework, similar accidents in future could be prevented or mitigated.

Description of Commercial Viability:

Loss of control in flight is a major contributing factor in nearly half of general aviation accidents as reported by National Transportation Safety Board (NTSB). Moreover, Federal Aviation Authority (FAA) FAA highlights different areas in aviation safety that needs improvement. Some of the areas related to our research are as follows: Aircraft safety technology, aircraft catastrophic failure prevention, aviation safety risk analysis that requires attentions to prevent catastrophic failure. To prevent unintended departures from flight, take off, climb off, descending, approaching, landing and better manage stalls at cruise level, pilots need more effective and efficient user interface design that can help prevent these accidents.

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Patrick Leopard (#7) Eileen Guo; John Politz
Advisor: Eric Larson
Computer Science and Engineering, Lyle School of Engineering

SENSOR RELEVANCE FOR AUTOMATIC CARDIOPULMONARY MEASUREMENTS

Current methods of accurately calculating measurements like heart rate, breathing rate, blood pressure, and blood oxygen saturation require specialized equipment which deter the general population from monitoring them on a regular basis. To address this, we are evaluating how embedded mobile phone sensors and wearable electronics can measure cardiovascular-related health measures when compared to medical-grade devices. Though a number of recent studies have compared measurements obtained through mobile devices to traditional FDA-approved devices, there has yet to be a study comparing the reliability of different methods over a large sample of people.

The number of sensing modalities explored is large, including in-ear microphones, a smartwatch, a camera placed against finger, an at-a-distance camera, and phonocardiogram through commodity microphone. Additionally, we evaluate three iPhone apps that are currently available on the App Store. We are researching algorithms that can use the embedded sensors to infer quantities from the medical gold standard devices. The cardiovascular measurements targeted by this study are heart rate, breathing rate, blood oxygen saturation, and blood pressure.

This study is a work in progress.

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Nibhrat Lohia (#8) Raunak Mundada
Advisor: Eric Larson
Computer Science and Engineering, Dedman College

AIRWARE: AN ADVANCED IN-AIR HAND-GESTURE RECOGNITION SYSTEM USING ULTRASONIC DOPPLER SIGNATURES LEVERAGING DEEP NEURAL NETWORK ARCHITECTURES

We introduce AirWare, an in-air hand-gesture recognition system that uses the already embedded speaker and microphone in most electronic devices, together with low-cost infrared proximity sensors. Gestures identified by AirWare are performed in the air above a touchscreen or mobile phone. AirWare leverages deep neural networks to identify complex hand gestures using the Doppler effect. This work is an improvement on present-day systems which use high frequency doppler radars or depth cameras to uniquely identify in-air gestures. Our algorithm achieves 45% accuracy on 21 complex gestures, and can be improved to 91% accuracy on a reduced gesture set of 9 gestures. User preference also reveals that 9 gestures are easier to recall and use. In our experiments, we use openly available APIs to interface with the Samsung Galaxy S4 audio and proximity sensors.

Description of Commercial Viability:

One of the major advantage of this system over other present methods is the commercial viability. Since AirWare uses the already embedded speaker and microphone, it can be implemented without any add-ons. This makes the system completely viable and sustainable in long term. This is one of unique gesture recognition systems that has been built to reduce carbon footprint by reducing other sensors.

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Arya McCarthy (#9) Sunjoli Aggarwal
Advisor: Eric Larson
Computer Science and Engineering, Lyle School of Engineering

OPENCYCLE: A MACHINE LEARNING PIPELINE FOR PREDICTING OVULATION AND FERTILITY

Predicting the day of ovulation allows for effective natural family planning (NFP). Conventional fertility awareness methods only identify ovulation days after the fact, which poses a risk to couples intending to avoid pregnancy, while couples intending to conceive can miss their most fertile window. We present OpenCycle: a neural network model that predicts the date of ovulation from a participant's age and the first ten basal body temperature (BBT) measurements in the menstrual cycle. Without hyperparameter tuning, our model achieves a mean squared error (MSE) of 15.5. This compares favorably against existing literature using BBT for fertility prediction, which achieves an MSE of 16.2, though the literature is not clear in its cross-validation. We expect that incorporating greater personalization, by analyzing an individual's previous cycles and clustering participants with similar BBT trends, will further reduce our error. Although these results do not meet the use case, because users need predictions accurate to within a day, tuning may bring our error closer to that target. Further, future work that includes broader demographic and activity information may also increase performance.

Description of Commercial Viability:

The long-term goal of this work is a medical mobile app, providing users with predictions about their fertility. In its present condition, OpenCycle does not achieve low enough prediction error to satisfy the expressed needs of users (Epstein et al., 2017). Nevertheless, this exploratory work invites the possibility of using Apple ResearchKit for a larger user base, gathering more information and eventually seeking FDA approval for a mobile app that uses demographic, activity, and simple at-home measurement data to predict fertility.

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Bhagwat Pandya (#10)
Advisor: Daniel Engels
Computer Science and Engineering, Lyle School of Engineering

MITIGATION OF DDOS ATTACK ON SDN CONTROLLER USING TWO-CONTROLLER ARCHITECTURE

In this paper, we present the two-controller architecture to mitigate Distributed Denial of Service (DDoS) attacks on Software Defined Network (SDN) controllers. The controller manages and controls the entire network. Distributed Denial of Service (DDoS) attacks on the controller can prevent the operation of the network. We present, in this paper, the two-controller architecture where the secondary controller will be activated in the network once the DDoS attack is detected and the mitigation process will take place from

both the controllers. This method will mitigate the DDoS attacks carried out on the SDN controller by almost 50%.

Description of Commercial Viability:

It can be used in Cyber security, network security organizations.

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Yi Sun (#11)
Advisor: Jennifer Dworak
Computer Science and Engineering, Lyle School of Engineering

USING EXISTING RECONFIGURABLE LOGIC IN 3D DIE STACKS FOR TEST

We propose an architecture for an FPGA-based tester for a 3D stacked IC. Our design exploits the underlying structure of the FPGA, allowing it to be used to efficiently store and apply predefined test patterns at a high bandwidth, reducing the FPGA resources required and often reducing scan shift toggling. The proposed approach and its advantages can generally also be applied to 2.5D multi-die circuits containing FPGAs.

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Micah Thornton (#12)
Advisor: Theodore Manikas
Computer Science and Engineering, Lyle School of Engineering

SECURING PSEUDO-RANDOM NUMBER GENERATORS WITH CRYPTOGRAPHIC HASH FUNCTIONS

The problem of noise-signal separation has plagued signal analysts since the days of smoke signals. In many instances, the signal is desired. When seeking random values for the sake of security or simulation, the noise is desired. The work in this thesis gives three methods for `harvesting' the noise of a signal, and proves that the first maximizes the definition of information entropy, as given by Claude Shannon. The thesis also investigates the methods through a case study of an arrival time signal given off by the network card in response to packet traffic, as well as using traditional psuedo-random number generators, and investigating the power of using certain hash functions on outputs through means of analysis from communication theory such as entropy, and optimum compression ratios.

Description of Commercial Viability:

As security demands increase to keep up with bolstering cyber criminal populations, random number generators cannot be random enough. The work in the thesis examines methods of producing random numbers (both true, and pseudo), analyzes their randomness (with NIST STS, Dieharder, ENT, and more) potential improvement when using cryptographic hash algorithms. In this work the effectiveness of using certain hashes is researched, and results showing that certain families of hashes improve apparent randomness by larger factors than others, are given. In addition, several methods for generating random numbers from data streams are given, and a PRNG algorithm that works on any machine connected to a network is proposed and analyzed.

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Chatchai Wangwiwattana (#13) Xinyi Ding; Sohail Rafiqi
Advisor: Eric Larson
Computer Science and Engineering, Lyle School of Engineering

PUPILWARE-M: COGNITIVE LOAD ESTIMATION USING UNMODIFIED SMARTPHONE CAMERAS

Cognitive load refers to the amount of information a person can process or hold in working memory. Historically, the psychology community has estimated this quantity objectively by monitoring the involuntary dilations and constrictions of the pupil using medical grade equipment known as pupillometers. At the same time, researchers in the HCI and UbiComp communities have hypothesized how cognitive load sensing might be integrated into context aware computing systems, but limitations of sensing cognitive load ubiquitously and reliably prevent the mass integration of such a technology. Our system, Pupil Ware-M, seeks to begin bridging this sensing gap. We build upon a recent platform, Pupil Ware, which measures a user's sub-millimeter pupil dilation from an unmodified camera. We update the Pupil Ware sensing system with a calibration protocol that brings pupillary responses of a diverse range of people and lighting conditions onto a single 0.0-1.0 scale called CogPoint. Furthermore, we update and optimize the algorithms employed to run in real time from a smartphone. We validate the calibration process using eight users in a controlled experiment where cognitive load is simple to determine from its situational context. Discussion of future work and remaining challenges is then described.

Description of Commercial Viability:

Enhance computer tailor education system. Pain measurement. fatigue detection, psychological research, HCI research, context aware security system.

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Qiao Zhang (#14) Vincent Ng
Advisor: LiGuo Huang
Computer Science and Engineering, Lyle School of Engineering

PREDICTING THE TECHNICAL DEBT LEVEL IN EARLY SOFTWARE DEVELOPMENT LIFECYCLE

Technical debt (TD), which refers to delayed technical work or rework that is incurred when shortcuts are taken or short-term needs are given precedence, is notorious for its possibility of increasing project's development and maintenance cost. The management of TD is very essential to the success of a project from long term perspective. However, project managers might naturally overlook the TD management because of the late manifestation of issues caused by TD. Meantime, if too much efforts were spent on TD management in early phase of software development lifecycle, the development team would have to bear more pressure from schedule or milestones. Hence, this research proposes an automated learning-based approach to train an Early Lifecycle Technical Debt Level Predictor (ELTDLP), as well as, practical advises for TD management from early software development lifecycle point of view. By extracting 44 six-group personnel (i.e., developers) metrics from their previous works and taking advantage of machine learning algorithms, such as support vector machine (SVM), an empirical prediction model can be learned. The

prediction resolves an indicator that can be used for finding the trade-off between spending more efforts on TD management and concentrating on pushing forward the schedule.

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Civil and Environmental Engineering

Sepide Lotfi (#15)
Advisor: Khaled Abdelghany
Civil and Environmental Engineering, Lyle School of Engineering

ON-DEMAND RIDE-SHARING TAXI SERVICES FOR ENHANCED MOBILITY: PROBLEM FORMULATION AND SOLUTION METHODOLOGY

There are increasing calls to develop alternative modes of transportation to enhance mobility in congested urban areas. One emerging transportation mode with potential to achieve this goal is the on-demand ride-share taxi services (e.g., uberPOOl). Passengers can request a taxi for a trip while being willing to share the ride with other passengers along their ways in return of reduced fares. Passengers are also willing to transfer allowing their trips to be covered by multiple taxis. Optimizing the operation of this service involves solving a complex pickup and delivery vehicle routing problem with time windows constraints and transfer (PD-VRP-TW-T). The solution to this problem gives the time-dependent vehicle routes and associated passenger itineraries. This paper presents mathematical formulation and solution methodology for the PD-VRP-TW-T in the context of on-demand ride-share taxi services. Preliminary results that examine the performance of the solution methodology under different operational scenarios are presented

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Jase Sitton (#16)
Advisor: Brett Story
Civil and Environmental Engineering, Lyle School of Engineering

RAPID SOIL CLASSIFICATION USING NEURAL NETWORKS AND STUDYING THE EFFECT OF MIX DESIGN ON CEB PERFORMANCE

Compressed earth blocks (CEBs) represent a cost-effective, sustainable, and environmentally-friendly building alternative to traditional masonry elements. CEB construction comprises low-cement, compressed local soil brick units that are rapidly and efficiently manufactured on site. CEB construction uses local soil as the primary component, which provides advantages over traditional masonry elements including lower cost, increased energy efficiency, and lower environmental impact. One significant challenge with prolific CEB construction is the lack of standardization both in the United States and internationally. This can be largely attributed to CEB as a construction material having a relatively small knowledge base. Traditional masonry elements such as CMU and fired clay bricks are very well understood and are thus comprehensively standardized. This project seeks to help grow the CEB by studying the performance of CEB and how it is affected by different soil types and mix designs. The first step of the project was to develop a system which is capable of rapidly classifying soils based on rudimentary soil analysis tests performed in the field. The second step of the project was to perform strength testing on CEBs with varying mix designs to study the effect of mix design on block performance.

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Anna Rose Wallace (#17) Wenjie Sun; Chunming Su
Advisor: Wenjie Sun
Civil and Environmental Engineering, Lyle School of Engineering

EVALUATION OF NANOMATERIALS ON THE FLUORIDE REMOVAL IN GREEN INFRASTRUCTURE FOR STORMWATER MANAGEMENT

As population continues to rise, urbanization grows, increasing impermeable and semipermeable surfaces. These surfaces contribute to faster flows and higher volumes of stormwater runoff that can contaminate drinking water sources. Fluoride is one of many pollutants that can be found in stormwater run off, as it is a widespread environmental contaminant. Green infrastructure (GI) has become a promising technology for the effective management of stormwater. However, there is a need for cost-effective filter materials to remove fluoride. The main objective of this study is to assess the sorptive capacity of various nanomaterials for fluoride removal. Among the thirteen types of nanomaterial evaluated in this study, ferrihydrite (Fe(OH)3), hydroxyapaite (Ca5(PO4)3OH), and brucite (Mg(OH)2) showed the highest efficiency for fluoride removal in both batch and columns tests. The results indicated that these three nanomaterials have the potential to be implemented in GI matrices for fluoride removal.

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Yasha Zeinali (#18)
Advisor: Brett Story
Civil and Environmental Engineering, Lyle School of Engineering

PERFORMANCE EVALUATION OF BRIDGES USING MACHINE LEARNING AND COMPUTER VISION

Bridge structures decay over their service life. These impairments may change a structure's stiffness and consequently its static or dynamic deformation responses. One of the techniques for monitoring a structure is to measure its deformation responses caused by a given load and then establish the physical conditions (i.e. impairments) for which the response should occur. This is an inverse analysis problem.

In this study, an impairment detection system is proposed in which a novel computer vision method measures a structure's responses and novel machine learning algorithms are used to solve the inverse impairment detection problem.

For monitoring dynamic deformations of a vibrating structure, one off-the-shelf camera, a novel target configuration and computation algorithm are used. Zhang's algorithm is implemented in MATALB for camera calibration Moreover, 3 novel neural network architectures (iterative, deep-counter propagation and competitive probabilistic neural networks) are utilized as robust machine learning algorithms to identify and classify structural impairments.

The method has been applied on a service bridge structure as well as laboratory structures. Experimental results indicate that the combination of computer vison and machine learning methods are adequate and robust enough to capture accurate movements and precisely evaluate the state of structure's member.

Description of Commercial Viability:

1-Eliminating catastrophic bridge failures which save people lives and national assets.

2-Decreasing the bridge maintenance costs by using lower price measurement instruments and reducing the possibility of false diagnosis of impairments detected by conventional methods.

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Mechanical Engineering

Hamidreza Bayat (#19) David A. Willis; Paul S. Krueger; Alexandra Dykeman
Advisor: David Willis
Mechanical Engineering, Lyle School of Engineering

DESIGN AND PERFORMANCE OF A DIRECTIONAL PERMEABILITY MEMBRANE

A directional permeability membrane is designed, fabricated and tested with the potential application of facilitating drug delivery. Membranes were constructed from two porous polyimide sheets with separation in the range of 20-70 μm and bonded with double sided tape on the perimeter. For the upstream sheet, nine holes with diameter of 1 mm were cut in a sheet of thickness of 120 μm and for the downstream sheet, four circular holes with diameter of 0.2 mm were cut in a sheet of thickness in the range of 20-70 μm. The holes were cut in square array with distance of 2 mm from center to center. The membranes were tested under pressure-driven water flow in range of 0.01-0.1 m-H2O and flow rates were measured for two configurations: one with the thicker sheet upstream (forward direction) and one with the thinner sheet upstream (reverse direction). Results show that the ratio of forward/reverse flow rate varies in the range of 2.6 to 2527, depending on the pressure head.

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Alper Celebi (#20) Murat Barisik
Advisor: Ali Beskok
Mechanical Engineering, Lyle School of Engineering

ELECTRIC FIELD CONTROLLED TRANSPORT PROPERTIES OF WATER IN GRAPHENE NANOCHANNELS

In this study, non-equilibrium molecular dynamics (NEMD) simulations are performed for force-driven water flow through electrically charged graphene nano-channels. Main objective of this study is to elucidate the effect of electric field resulted by oppositely charged surfaces on the structural and transport properties of graphene-confined water. We present results of density profiles, molecular orientations, velocity profiles, viscosities and slip lengths after carefully fixing the thermodynamic state. In the meantime, an improved understanding on the density distributions and slip behavior at liquid-solid interface is provided. Multiple simulations are performed for different surface charge densities to clarify the effect of electric field range. Our results suggest that mass and momentum transport of water in nano-scale confinement is strongly affected by the variation of density layering and slip-velocity due to increasing electric field until a critical value. After this point, the domain undergoes a drastic phase change by forming a high-ordered

crystalline structure. Characterization of these macroscopic quantities at molecular level as a function electric field is crucial to utilize them in engineering applications as well as to discover the deviations from their continuum description.

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Ahmad Gad (#21)
Advisor: Xin-Lin Gao
Mechanical Engineering, Lyle School of Engineering

ENERGY BASED CHARACTERIZATION FOR 3D PENATMODE METAMATERIAL WITH CIRCULAR CROSS-SECTIONAL STRUTS ACCORDING TO MICROPOLAR LINEAR ELASTICITY

Pentamode metamaterials are artificial solids with very low density and elastic properties that are approximate to those of isotropic liquids due to their high bulk to shear moduli ratio. Their unique properties led to a wide variety of proposed and achieved applications ranging between elasto-dynamics, transformation acoustics and advanced structural mechanics. In the current work, an energy based homogenization for a 3D pentamode metamaterial is proposed based on micropolar linear elasticity theory. To catch the variation of the effective constant with the strut material elastic constants, Poisson ratio was included in the beam modeling from the start of the formulation. Explicit forms and numerical results revealed that the pentamode classical constants are stretch dominated, while its micropolar constants are twist dominated. Moreover, the obtained results showed that pentamode can construct a rubber-like materials as well as auxetic materials, it is just a matter of compensating axial and bending stiffness's values.

Description of Commercial Viability:

Imagine a micro-structured material with specific unit cell geometry, that has adjustable effective constants to match the physical applications. For example, a car tire made from metallic material like aluminum or steel, and behaving like a rubber!

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Amir Kiaee (#22)
Advisor: José Lage
Mechanical Engineering, Lyle School of Engineering

NUMERICAL STUDY OF SWEEPING CONVECTION

Convection is the most practical and efficient heat transfer mode in engineering. Consequently, scientists and engineers are dedicated to improve the process. Existing strategies to augment convection have considered mainly geometric modifications of the flow channel (such as the inclusion of fins, turbulators, winglets, wall roughness, etc.) and/or fluid modifications (such as the use of additives - surfactants, nanoparticles, etc.). The present study pertains to a new strategy that uses solid particles, flowing with the fluid, to sweep the boundary layers that form along the solid surfaces of a channel and that are responsive for hindering the convection process. The particles are unique insofar as they have dimension very close to the channel dimension; hence, they flow "snugly" with the fluid, in a piston-like fashion, inducing an almost uniform velocity profile in the fluid every time they pass through the channel. The sweeping of the

boundary layer effect yields an increase in the heat transfer coefficient. Preliminary two-dimensional and transient results of fluid convection with discrete circular and rigid particles through a channel with isothermal top and bottom surfaces is presented. The focus is on the start-up of the flow, from rest, and the effect of the particles on the heat transfer between the channel surfaces and the flowing fluid.

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Anil Koklu (#23) Ahmet Can Sabuncu
Advisor: Ali Beskok
Mechanical Engineering, Lyle School of Engineering

ENHANCEMENT OF DIELECTROPHORESIS USING FRACTAL GOLD NANOSTRUCTURED ELECTRODES

Dielectrophoretic motions of Saccharomyces cerevisiae (yeast) cells and colloidal gold are investigated using electrochemically modifed electrodes exhibiting fractal topology. Electrodeposition of gold on electrodes generated repeated patterns with a fern-leaf type self-similarity. A particle tracking algorithm is used to extract dielectrophoretic particle velocities using fractal and planar electrodes in two different medium conductivities. The results show increased dielectrophoretic force when using fractal electrodes. Strong negative dielectrophoresis of yeast cells in high-conductivity media (1.5 S/m) is observed using fractal electrodes, while no signifcant motion is present using planar electrodes. Electrical impedance at the electrode/electrolyte interface is measured using impedance spectroscopy technique. Stronger electrode polarization (EP) effects are reported for planar electrodes. Decreased EP in fractal electrodes is considered as a reason for enhanced dielectrophoretic response.

Description of Commercial Viability:

Separation and concentration of rare cells.

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Yongqiang Li (#24)
Advisor: Xin-Lin Gao
Mechanical Engineering, Lyle School of Engineering

THE UPPER TRIANGULAR DECOMPOSITION OF THE DEFORMATION GRADIENT: POSSIBLE DECOMPOSITIONS OF THE DISTORTION TENSOR AND RELATED CONSTITUTIVE RELATIONS

In the upper triangular decomposition, the deformation gradient tensor is multiplicatively decomposed into a product of an orthogonal tensor and an upper triangular tensor called the distortion tensor. It is shown in this paper that the upper triangular decomposition can be viewed as an extended polar decomposition. The six components of the distortion tensor can be directly related to pure extensions and simple shear deformations. It is demonstrated here that the distortion tensor can be non-uniquely decomposed into a product of matrices for one tri-axial stretch and two simple shear deformations or for one tri-axial stretch and three simple shear deformations. There are six possible decompositions for the former and twenty-four possible decompositions for the latter. Only one of these 30 possible decompositions was examined earlier. The constitutive relations are obtained in terms of the distortion tensor for both unconstrained and

incompressible hyperelastic materials, which are simpler than those based on the invariants of the Green and Finger deformation tensors. Two examples are provided to illustrate applications of these constitutive relations, which give the same results as those based on the polar composition, thereby supporting the alternative method based on the upper triangular decomposition of the deformation gradient tensor.

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Masoud Mohammadpour (#25) Nima Yazdian
Advisor: Radovan Kovacevic
Mechanical Engineering, Lyle School of Engineering

LASER WELDING-BRAZING PROCESS OF DISSIMILAR MATERIALS

Application of dissimilar joints composed of lightweight Al alloys and galvanized steels is one of the best solutions to reduce the car weight as well as improvement of fuel efficiency. In this investigation, joining of the two types of galvanized steel and Al6022 aluminum alloy in coach peel configuration was carried out using laser brazing-welding process in dual-beam modes. The feasibility of this method to obtain the sound and uniform brazed bead with high surface quality on high welding speed was investigated by employing of AlSi12 as consumable material. The conducted comprehensive study on the microstructure of joints by means of scanning electron microscopy and EDS showed that changing dual-beam laser shape and high scanning speed could control the thickness of IMC as thin as 3 μm and alter the failure location from steel-brazed interface toward the Al-brazed interface. The numerical simulation of thermal regime at the interface of the steel-brazed joint was conducted by Finite element method (FEM), and simulation results was validated through comparative experimental data.

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Ben Wise (#26) Vahid Eghbalifarkoosh
Advisor: Volkan Otugen
Mechanical Engineering, Lyle School of Engineering

A COMPACT ATMOSPHERIC ENTRY SPEED SENSOR FOR MARS MISSIONS

A miniaturized laser-based velocimetry system is being developed to measure space vehicle entry speed through planetary atmospheres at hypersonic speed. The LIDAR-based system collects back-scattered Rayleigh light and analyzes its Doppler shift to determine the relative speed of the entry vehicle. The Doppler shift is determined using the whispering gallery modes of spherical microresonators, rather than the Fabry-Perot interferometer typically used in the conventional LIDAR systems, allowing the miniaturization of the detection system. The Rayleigh scattered light is either free-space or fiber coupled (using single mode optical fiber) to the polymer microresonator. The resonator diameter is modulated by a scanning piezo stack allowing shifts in the optical modes to be analyzed for Doppler shift detection, resulting in near real time calculation of atmospheric entry speed.

Description of Commercial Viability:

Improving measurement sensitivity, physical size, and weight of super- and hypersonic LIDAR systems by replacing Fabry-Pérot interferometer technology with cutting edge WGM microresonators, allows for

smaller, less expensive, and more accurate sensors, which allow LIDAR systems to become more ubiquitous as new applications are explored.

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Gongye Zhang (#27)
Advisor: Xin-Lin Gao
Mechanical Engineering, Lyle School of Engineering

A NON-CLASSICAL MODEL FOR AN ORTHOTROPIC KIRCHHOFF PLATE EMBEDDED IN A VISCOELASTIC MEDIUM

A non-classical model for an orthotropic Kirchhoff plate embedded in a viscoelastic medium is developed by using an extended version of the modified couple stress theory and a three-parameter foundation model. The equations of motion and the boundary conditions are simultaneously obtained through a variational formulation based on Hamilton's principle. The new plate model contains three material length scale parameters to capture the microstructure effect, one damping coefficient to account for the viscoelastic damping effect, and two foundation moduli to represent the foundation effect. The current non-classical orthotropic plate model includes the isotropic plate model incorporating the microstructure effect and the classical elasticity-based orthotropic plate model as special cases. To illustrate the new model, the static bending and free vibration problems of a simply supported orthotropic plate are analytically solved by directly applying the general formulas derived. For the static bending problem, the numerical results reveal that the deflection of the simply supported plate predicted by the current model is smaller than that predicted by the classical model. Also, it is observed that the difference in the deflection predicted by the new model and that by its classical counterpart is large when the plate thickness is small but diminishes as the thickness becomes large.

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Zhe Zhang (#28)
Advisor: Radovan Kovacevic
Mechanical Engineering, Lyle School of Engineering

LASER CLADDING OF 420 STAINLESS STEEL WITH MOLYBDENUM ON MILD STEEL A36 BY A HIGH POWER DIRECT DIODE LASER

Laser cladding, as one of the most promising surface modification technologies, is being widely applied in industry to improve the wear and corrosion resistance of components. The high energy input and high cooling rate during the cladding process lead to severe metallurgical reactions that determine the microstructure and properties of the cladded layer. In this study, a 3-dimensional (3-D) finite element (FE) model was developed to study heat transfer during laser cladding of 420 stainless steel + 4% molybdenum on mild steel A36. In this model, the effects of laser-powder interaction, temperature-dependent material properties, latent heat, and Marangoni flow were considered. A method based on mass balance was adopted to predict the clad geometry. The thermal results such as the temperature history, temperature gradient, and solidification rate were investigated. Based on the simulated thermal results, the microstructure and Mo distribution in the clad layer were studied. In order to verify the established model, a series of experiments was conducted by using an 8-kW high-power direct diode laser (HPDDL). Thermocouples and a CCD

camera were used to monitor the temperature history and molten pool size. The predicted clad height and width showed a good agreement with the experimental results.

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Engineering Management, Information, and Systems

Peter Furseth (#29)
Advisor: Eli Olinick
Engineering Management, Information, and Systems, Lyle School of Engineering

PREDICTING B2B SALES WITH DATA MINING

Data mining has gained traction in many industries over the past decade, however, there is a noticeable lack of adoption across sales organizations. Sales forecasts still rely heavily on spreadsheets and gut feels. In business-to-business (B2B) sales organizations there is a wealth of data stored in customer relationship management (CRM) systems. We demonstrate how to leverage this data to consistently:

- Predict if a sales opportunity will win or lose.
- Predict if a sales opportunity will win in the current quarter.
- Forecast the quarterly value of a sales pipeline.

Sales leaders will gain confidence in their quarterly forecasts by applying data mining to their CRM data. They will be able to identify shortfalls earlier and can avoid the inconsistencies that come with sales reps that are holding back opportunities, or are overly optimistic.

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Zahra Gharibi (#30) Zahra Gharibi; Michael Hahsler
Advisor: Michael Hahsler
Engineering Management, Information, and Systems, Lyle School of Engineering

EFFECT OF REGULATORY OVERSIGHT ON TRANSPLANT CENTER'S KIDNEY SELECTION AND SUBSEQUENT PATIENT OUTCOMES

Report card programs collect and publicize information on patient outcomes as a means of improving quality. However, it is unclear whether behavioral responses to such programs improve patient outcomes. We study the report cards as an incentive mechanism to induce socially-optimal medical decisions in the context of kidney transplantation.

Description of Commercial Viability:

This has a direct tie to commercial application. By predicting whether or not a sale opportunity will win or lose a business can accurately predict revenue.

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Hossein Kamalzadeh (#31)
Advisor: Michael Hahsler
Engineering Management, Information, and Systems, Lyle School of Engineering

INDIVIDUALIZED SCREENING POLICY FOR DIABETES PATIENTS USING MARKOV DECISION PROCESS

One out of every $3 of medical expenditure is spent on diabetes care and treatment and ten percent of the US population are currently suffering from type 2 diabetes. Almost 40 percent of the US population is in the pre-symptomatic stage of the disease which over time will develop into diabetes. Screening can be used to identify pre-symptomatic individuals in order to perform interventions to prevent the development of diabetes. Population-based screening is an expensive task and thus whom to screen and how often to screen becomes of interest from a decision-making point of view. We develop a Markov Decision Process (MDP) to model the progression of the disease in patients using discrete states and to identify the optimal set of decisions called a policy. The transition probabilities for the MDP are estimated using a Hidden Markov Model. To identify in which state of the MDP a patient is, Naïve Bayes classifier is applied to the dataset to identify the most important risk factors associated with diabetes. We will present results for electronic health record data from the Parkland Health & Hospital System.

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Mamdouh Mubarak (#32) Halit Uster; Khaled Abdelghany; Mohammad Khodayar
Advisor: Halit Uster
Engineering Management, Information, and Systems, Lyle School of Engineering

NETWORK DESIGN FOR IN-MOTION WIRELESS CHARGING OF ELECTRIC VEHICLES IN URBAN AREAS

We present a model to optimize the location and power capacity of in-motion electric charging stations. We formulate the problem as a MIP and we propose a Benders-decomposition-based algorithm to solve it efficiently. We present the computational results of testing the algorithm on large-scale grid networks.

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Farnaz Nourbakhsh (#33) Farnaz Nourbakhsh; Olga Bountali; Sila Cetinkaya; Vishal Ahuja
Advisor: Sila Çetinkaya
Engineering Management, Information, and Systems, Lyle School of Engineering

RELIEVING HOSPITAL CONGESTION AND IMPROVING CARE DELIVERY: THE CASE OF COMPASSIONATE DIALYSIS

End-stage renal disease (ESRD) is a catastrophic illness for which dialysis is typically the only available treatment. ESRD patients who are un-/under-funded are particularly vulnerable to suffer and predominantly rely on safety-net hospitals for their care, typically funded by state or local governments. Since there is no national funding to provide dialysis to this population, their only option is to receive dialysis under "emergency" conditions, e.g., the acute severity is such that in the absence of immediate medical attention in the Emergency Room (ER), the patient's health is in serious jeopardy. However, this practice, commonly known as "compassionate dialysis" leads to severe congestion and treatment delays,

thereby imposing a significant health and financial burden, both on patients and the hospital. We analyze the compassionate dialysis process in one such hospital. We employ process flow mapping to gain a better understanding of patient flow as well as to identify inefficiencies and bottlenecks in the process. Further, we use simulation modeling to examine and estimate various congestion metrics as a function of stochastic arrival rates and stochastic service times. Ultimately, our goal is to propose practical solutions that are easily implementable by hospital administrators and staff.

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Pimprapai Thainiam (#34)
Advisor: Michael Hahsler
Engineering Management, Information, and Systems, Lyle School of Engineering

LOCAL SEARCH STRATEGIES FOR THE SERIATION PROBLEM

The seriation problem is an important problem in combinatorial optimization. The goal of seriation is to find a linear order for data objects in order to reveal structural information given a loss or a merit function as an objective function. For the seriation problem, finding an optimal solution within polynomial computation time is possible for problems no greater than 35 by implementing branch-and-bound. Therefore, local search approaches, such as hill climbing and metaheuristics, are alternative approaches capable of solving the seriation problem to near optimal solutions within acceptable computation times. In this praxis, five different local search algorithms are investigated to maximize the gradient measure objective function: hill climbing algorithms, tabu search, iterated local search, and memetic algorithms. Moreover, parameter tuning via design of experiments approach is employed to find the best parameter setting for each algorithm in terms of effectiveness, efficiency, and robustness. The results indicate that the most effective and efficient algorithm is stochastic hill climbing with insertion, and the most robust algorithm is tabu search.

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Electrical Engineering

Nafiseh Aflakian (#35) Tim LaFave Jr; Kenneth K O; Solyman Ashrafi; Duncan MacFarlane
Advisor: Duncan MacFarlane
Electrical Engineering, Lyle School of Engineering

VORTEX DIELECTRIC THZ WAVEGUIDE

A dielectric THz vortex waveguide is designed and fabricated for a chip-to-chip communication system. The holey core/cladding configuration is designed for a low loss transmission of orbital angular momentum (OAM) endowed Laguerre-Gaussian beams, with a straightforward fabrication process. The fabricated THz waveguide successfully supports an OAM-endowed beam which was generated by a novel stepped spiral phase plate. The helical beam was demonstrably unwrapped and its azimuthal phase gradient erased by a second spiral phase plate at the output of the waveguide.

Description of Commercial Viability:

A square vortex waveguide may be used to increase the capacity of a physical chip-to-chip channel by a at least factor of four.

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Akshay Arora (#36) Bradley Lega
Advisor: Bradley Lega
Electrical Engineering, Lyle School of Engineering

MACHINE LEARNING BASED CLASSIFICATION FOR PREDICTING RECALL AND NON RECALL PERFORMANCE IN EPILEPTIC PATIENTS

This paper presents a machine learning based classification technique which helps in the prediction of recall and non recall memory performance of the epileptic patients. It compares the different classifier performances with features of iEEG(intra-cranial) power , mutual information and mutual information alone as a predictor. This study shows that there is a significant increase in the classifier performance with mutual information feature. It also explains what power frequency band is significantly responsible for predicting memory recall.

Description of Commercial Viability:

DARPA RAM (Restorative Active Memory) project for memory enhancement.

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Saeed Dehghan Manshadi (#37)
Advisor: Mohammad Khodayar
Electrical Engineering, Lyle School of Engineering

EXPANSION OF AUTONOMOUS MICROGRIDS IN ACTIVE DISTRIBUTION NETWORKS

This paper presents an approach to transform the active distribution network with distributed energy resources (DERs) into multiple autonomous microgrids. The distribution network consists of several generation resources and demand entities, that are clustered into autonomous microgrids. The proposed problem is formulated as a bi-level optimization problem that leverages the Eigen decomposition in the graph spectra of the distribution network to determine the boundaries for microgrids and a mixed-integer programming problem that minimizes the expansion cost within microgrids. The presented approach is evaluated in a case study for a distribution network considering the imposed reliability constraints. The outcomes indicate the effectiveness of the proposed algorithm to determine the expansion strategies to form autonomous microgrids in active distribution networks.

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Rita Enami (#38)
Advisor: Joseph Camp
Electrical Engineering, Lyle School of Engineering

PRE-CROWDSOURCING: COMPARING MOBILE PHONE PROBES TO ADVANCED DRIVE TESTING EQUIPMENT

Conducting in-field performance analysis for wireless carrier coverage and capacity evaluation is extremely costly in terms of equipment, manpower, and time. However, there is a growing number of opportunities that exist for crowdsourcing via smart applications, firmware, and cellular standards that offer carriers feedback about user-perceived wireless channel quality. Crowdsourcing provides the ability to rapidly collect feedback with dense levels of penetration using client smartphones. However, mobile phones often fail to capture the fidelity and sampling rate of more advanced equipment (e.g., a channel scanner) used when drive testing for analysis of such channel factors as small- and large-scale fading. In this work, we study the impact of various effects induced by user equipment (UE) when sampling signal quality such as averaging over multiple samples, imprecise quantization, and non-uniform and/or less frequent channel sampling. Two flexible and low-complexity modeling techniques are widely-used in capturing the small-scale and large-scale fading in a particular environment: (i) the Nakagami distribution uses a shape factor commonly referred to as the m-parameter which accounts for the received envelope of the small-scale fading, and (ii) log-distance propagation modeling uses a path loss exponent and shadowing factor to account for the large-scale fading.

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Han Gao (#39)
Advisor: Carlos Davila
Electrical Engineering, Lyle School of Engineering

A COMPUTATIONAL STEREO MODEL BASED ON COINCIDENCE DETECTOR: EYE MOTION EMBEDDED

Random dot stereogram (RDS) is one of the most famous tools to study human vision system. Focusing on solving RDS matching problem, we proposed a biology inspired binocular vision model based on coincidence detector and in this model vergence eye motion is considered. Several simulation outcomes will be given.

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Muralidhar Madabhushi Balaji (#40) Prasanna Rangarajan; Duncan MacFarlane; Marc P. Christensen
Advisor: Marc Christensen
Electrical Engineering, Lyle School of Engineering

LOOKING AROUND THE CORNERS

Information of objects hidden behind scattering surfaces is extracted in this work using adaptation of heterodyne interferometry. Interferometry is an optical technique used to extract three-dimensional information of objects by combining the reference beam with a beam that interacts with the object. The scattering surfaces, scatter light in all directions causing a large power mismatch between the two

interfering beams. We use the principle of heterodyning to overcome the large power mismatch between the interfering beams. We change the optical frequency of one of the beams slightly to get the temporal envelope of the interference signal oscillate at a beat frequency. By doing synchronous demodulation at the beat frequency, using a lock-in camera, the interference information is extracted even in the presence of a large background signal.

Description of Commercial Viability:

This method can be used in can be used in developing non line-of-sight image sensors.

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Mar McCreary[UG] (#41)
Advisor: Ahmet Can Sabuncu
Electrical Engineering, Lyle School of Engineering

VIRTUAL IMPEDANCE BIOPSY: SURVEYING A RANGE OF BODY DEMOGRAPHICS TO IMPROVE NEUROMUSCULAR DISEASE DIAGNOSTICS

Current techniques for assessing muscle quality are lacking. Virtual impedance biopsy has shown potential to apply bioelectric impedance analysis on the skin surface level to analyze muscle quality below. There is a need for a comprehensive range of background data on normal patients that can then be used to assess future disease or injury states. By using the biceps brachii, an accessible, cylindrical muscle in the upper arm, normalized impedance data is gathered on a wide range of body demographics. Registered parameters of height, weight, BMI, body composition, disease or injury history, and muscle temperature and circumference have yet to be explored concomitantly. By scattering or conflating this data, we can screen for minutia that will improve the accuracy and precision of impedance profile diagnostics.

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Nahid Mirzaie (#42)
Advisor: Gyungsu Byun
Electrical Engineering, Lyle School of Engineering

RESILIENT DESIGN OF DATA CONVERTERS USING A MULTIPLE-OBJECTIVE TRANSISTOR LEVEL APPROACH

The Integrated Circuit(IC) industry not only demands finding optimal design solutions over an efficient process, but also requires the address of increased reliability challenges and elevate the overall system robustness. We proposed a methodology for data converters to map their specificatins onto transistor sizes and improve their performance, parametric yield as well as lifetime reliability through the state of the art evolutionary tools and reliability simulator.

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Mehdi Nouri (#43) Sahil Sakpal; Tim LaFave Jr.; Hiva Shahoei; Solyman Ashrafi
Advisor: Duncan MacFarlane
Electrical Engineering, Lyle School of Engineering

DEMULTIPLEXING SPATIALLY ORTHOGONAL MODES

Spatial division multiplexing (SDM) is a well-studied new degree of freedom used to increase the capacity of optical data links in fiber and free space. This method allows multiple beams (channels) of the same wavelength to be propagated in the same medium without interfering with each other, increasing the spectral efficiency of the links by allowing for more data to be transmitted at the same time. There are many methods that can be used to separate such communication channels at the receiving end and here a method for sorting spatially multiplexed modes using a single spatial light modulator (SLM) with superimposed correlation holograms is presented. In each case the two multiplexed modes are from one of the three orthogonal basis sets of Laguerre-Gaussian, Hermite-Gaussian or Ince-Gaussian modes.

The crosstalk between modes of these basis sets are compared with each other to identify which of these modes can be separated with lower crosstalk. How well the modes are separated by demultiplexing largely depends on how little they spatially overlap when multiplexed. Therefore, a judicious selection of modes, as well as the fidelity of the phase and intensity distribution of the multiplexed beam with its correlation hologram, plays an important role in the amount of crosstalk between channels.

Description of Commercial Viability:

SDM is a brilliant new way of multiplexing channels and increasing the capacity of the communication data links. Since a practical demultiplexing scheme has yet to be developed the work done in this area will have a large impact on the efficiency of data transmission and therefore an increase in revenue for datacomm companies as well as faster and cheaper service for the end users.

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Bryan Rodriguez (#44)
Advisor: Dinesh Rajan
Electrical Engineering, Lyle School of Engineering

OBJECT DETECTION AND METROLOGY USING PARAMETRIC MODEL FITTING WITH TIME-OF-FLIGHT RANGE DATA

This research explores the current capabilities of time-of-flight sensors for object detection and metrology in computer vision applications. State of the art time-of-flight sensors are relatively cheap and are able to quickly generate 3D representations (point cloud) of a scene. However, these point clouds are noisy and have a lower resolution than other technologies such as laser scanning and structured light. This research examines the usage of parametric model fitting to accurately identify and measure objects within point clouds that are obtained by time-of-flight sensors.

To this end, we first segment the point cloud data to isolate an object of interest. We then rely on a non-linear least squares estimator to fit a superquadric model to the captured point cloud data. The estimated superquadric model provides a wealth of information including the shape, pose, and dimensions of the object of interest.

The ability to detect and measure objects from point cloud data finds use in autonomous robot control. For example, industrial robots are often employed to identify different objects in order to grasp and move objects. This research provides an analysis of the current capabilities of state of the art time-of-flight sensors for these types of applications.

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Shreyas Ruwala (#45)
Advisor: Scott Kingsley
Electrical Engineering, Lyle School of Engineering

ENERGY HARVESTER

As energy demands are increasing worldwide I have an idea which can be used for Energy Harvesting. Create a floor mat that will absorb the mechanical energy of people walking across it in order to create electrical energy. This can be accomplished by placing piezoelectric materials inside the mat.

Goal is to generate enough energy with our mat, which acts as an energy source for electronic devices.

Description of Commercial Viability:

The final prototype we develop is planned on being implemented at place where there is lot of human traffic for example at office reception, lift corridor, Cafeteria etc. Depending on the durability of our final prototype, we may opt to place our project in an area of less foot traffic. Upon completion of the prototype , we will place it at a location we feel its demonstration and testing the energy harvesting prototype proves concept the best.

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Sahil Sakpal (#46) Giovanni Milione; Ming-Jun Li; Tim LaFave Jr.; Hiwa Shahoei
Advisor: Duncan MacFarlane
Electrical Engineering, Lyle School of Engineering

STRUCTURE LIGHT IN ELLIPTICAL CORE FIBER FOR DATA CENTER APPLICATIONS

The spatial modes of a 100m Elliptical core few mode fiber (EC-FMF) are analyzed by using liquid crystal on silicon spatial light modulators (LCoS-SLMs) to measure the fiber's mode crosstalk matrix in Hermite-Gaussian and Ince-Gaussian spatial mode bases. It is shown that the fiber's natural spatial modes can be described by Ince-Gaussian modes due to their elliptical structure and can propagate 100m over the optical fiber with <-20dB (1%) average mode crosstalk even when the fiber has multiple bends. The use of EC-FMFs for spatial division multiplexing in data centers is discussed.

Description of Commercial Viability:

In space division multiplexing (SDM) the spatial modes of a multimode optical fiber are used as individual data channels. SDM gives another degree of freedom over wavelength for increasing data transmission rates. As a result, SDM is a potential solution for >400Gbit/s requirements in data centers where scaling data transmission rates with parallel single mode optical fibers is currently ubiquitous. However, due to mode coupling, i.e, spatial modes' exchange of power, SDM may require "multiple input multiple output" digital

signal processing (MIMO-DSP) to mitigate resulting mode crosstalk, the cost and complexity of which may be prohibited in data centers. Elliptical core few mode fiber (EC-FMF) obviate the need of MIMO-DSP by reducing mode coupling below the tolerance level of a communication link.

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Jay Shah (#47) Ashalata Hegde; Dushyant Dubariya; Anurag Desai; Mandar Ghogale; Parin Gandhi; Devashree Chandekar; Charmy Thakkar
Advisor: Klyne Smith
Electrical Engineering, Lyle School of Engineering

SDN IN TELECOMMUNICATIONS INDUSTRY

Given the Reliance Jio 4G architecture working along with end-to-end IP MPLS network, there is a need for accommodating the increased demand of voice and data traffic. With the subscriber base of more than 100 million, it is necessary for given 4G networks to operate and function efficiently considering the limited area availability and increased data traffic. SDN could achieve this by replacing the existing infrastructure, with its optimal path routing and traffic management functionality.

We are seeing a tremendous change in the technology used to run the network. And our interest in doing innovation by merging different existing technology which will automate the network services SDN giving us new ways to design, build and operate networks. The reality is that there is an increasing demand for the services provided to the customers. SDN enabled networks are driven by centralized software applications, which would be easier to upgrade the network and reduce company expenditure on the network devices.

Description of Commercial Viability:

SDN could be helpful in energy saving, based on the fact that most network devices are less effective in non-peak time so according to the link capacity, we can redirect the flows of switches and turning them off for saving energy. SDN could address key issues like poor network quality and call drops. SDN helps in replacing several odd purpose-built hardware-centric solutions. As we are going to handle the network with the help of SDN the manpower will get reduced also we can upgrade the network easily. As software is handling the network in this way there will be simplicity in a graphical user interface which in turn will help us to monitor, operate and manage the network with fewer efforts. SDN solution must provide APIs that control aspects of the network such as bandwidth, QoS, compression, optimization, routing, cost, availability, and resilience.

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Kaitlin Smith (#48) Michael Taylor; Anna Carroll; Theodore Manikas; Mitchell Thornton
Advisor: Mitchell Thornton
Electrical Engineering, Lyle School of Engineering

AUTOMATED MARKOV-CHAIN BASED ANALYSIS FOR LARGE STATE SPACES

Modeling the dynamic, time-varying behavior of systems and processes is a common design and analysis task in the systems engineering community. A popular method for performing such analysis is the use of Markov chains. Additionally, automated methods may be used to automatically determine new system state values for a system under observation or test. Unfortunately, the state-transition space of a Markov chain

grows exponentially in the number of states resulting in limitations in the use of Markov chains for dynamic analysis. We present results in the use of an efficient data structure, the algebraic decision diagram (ADD), for representation of Markov chains and an accompanying prototype analysis tool. Experimental results are provided that indicate the ADD is a viable structure to enable the automated modeling of Markov chains consisting of hundreds of thousands of states due to their ability to provide computation related efficiencies. This result allows automated Markov chain analysis of extremely large state spaces to be a viable technique for system and process modeling and analysis. Experimental results from a prototype implementation of an ADD-based analysis tool are provided to substantiate our conclusions.

Description of Commercial Viability:

Provides efficient method to model Markov Chains for systems analysis.

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Ashwini Subramanian (#49) Prasanna Rangarajan
Advisor: Dinesh Rajan
Electrical Engineering, Lyle School of Engineering

VOLUME MEASUREMENT SYSTEM USING TIME OF FLIGHT CAMERA

The task of accurately measuring the physical dimensions of an object finds numerous applications in areas ranging from manufacturing to logistics. This research seeks to build an inexpensive software-based Volume Measurement System (VMS) using the Texas Instruments OPT8241 3D Time-of-Flight (ToF) camera. A 3D time-of-flight (ToF) camera works by illuminating the scene with a modulated light source, and observing the reflected light. The phase shift between the illumination and reflection is measured and translated to distance. In the ToF sensor, distance is measured for every pixel on a 2D addressable array, resulting in a depth map. The depth map can be rendered in a three-dimensional space as a collection of points called point cloud. This three-dimensional information can then be used to estimate the dimensions of an object in the scene. The proposed VMS will be used to determine the dimensions of freight boxes to within 1% accuracy.

Description of Commercial Viability:

Accurate estimate of dimensions using non-contact measurement can be used to automate logistics operations. Automated volume measurement can be used in automatic sorting, invoicing and assessment of freight damage.

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Aparna Viswanath (#50) Prasanna Rangarajan; Indranil Sinharoy
Advisor: Marc Christensen
Electrical Engineering, Lyle School of Engineering

LOOKING AROUND CORNERS : IMPACT OF SCATTERING

The proposed work is part of a broader effort that seeks to convert a scattering surface into computational holographic sensors. The concept behind the approach is to be able to image an object, which is occluded from the line of sight of a detector, interferometrically using a probe beam. The specific assumption made

here is that the complex reflectivity experienced by the two beams when encountering the rough surface is the same which would only be valid so long as the speckle fields produced by the plane wave components constituting the two beams exhibit a large degree of spatial correlation in accord with the "memory effect". This is where knowledge of the angular dependence of scattered field for different scattering surfaces would be useful to better understand the impact of material properties on the ability to recover latent field information and the consequence of incidence angle on the reflectivity experienced by the two beams. The objective of this work is to be able to experimentally analyze the scattering from a variety of rough surfaces and to make empirical measurements that would help identify materials and configurations for the concept imager by examining the angular decorrelation of speckle field arising from first-surface reflections off a scattering surface interferometrically.

Description of Commercial Viability:

Existing instruments are limited in their ability to obtain complex field data of the scattered light which contains the phase information. Expensive solutions like profilometers can sense this information but over a very small area. The proposed instrument tries to overcome these shortcomings and would prove to be a cost-effective solution that can be used in various applications ranging from material characterization to manipulation of scattered light field.

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Physics

Govinda Dhungana (#51) Robert Kehoe
Advisor: Robert Kehoe
Physics, Dedman College

IMAGE DIFFERENCING METHOD FOR SUPERNOVA CCD PHOTOMETRY

Precise Supernova(SN) photometry has led to the discovery of accelerated expansion of the universe. It is also important to study various dynamic and astrophysical properties of the transient objects. We present a new software on image subtraction as a part of SN data reduction, in the context of the ROTSE SN Program. This code, named ImageDiff, utilizes more than one method to model the temporal and spatial variation of Point Spread Functions (PSFs) across a given field. It is based on Kernel convolution employing three types of kernels, to subtract an image exhibiting a SN from a precursor template image with higher S/N. Optionally Pricipal Component Analysis(PCA) technique can be used to do the subtration on orthogonal basis. We present a study based on Monte Carlo simulation of randomly injecting synthetic objects on the images of varying crowdedness, and accurately extracting them using the ImageDiff code. This study shows the residual scatter to be ~0.1 magnitude, when the object's brightness is close to the limiting magnitude of the observation; while it significantly improves with the increasing brightness. In general, results based on ROTSE images show no preference on the kernel used. No significant bias is observed, while preserving the overall variance of the input image during the subtraction. Finally we show a few ROTSE SNe light curves, based on this method.

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Jasmine Kim [UG] (#52)
Advisor: Caitlin Mueller
Physics, Dedman College

ROBOTIC 3D PRINTING OF LATTICE STRUCTURES

The research focuses on creating computationally optimized structures using new digital fabrication techniques. Using a Kuka Robotic Arm with a modified PLA (Polylactic acid) 3D printer attachment, we print octahedral lattices, initially as small blocks that can be stress tested, and ultimately as something closer to the architectural scale. Although 3D printing may provide a new technological method for fabricating buildings and bridges, it currently faces geometric and stability issues to print lattices reliably. To overcome these challenges, the research focuses on computation, structural design, and load testing.

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Jasmine (Shilun)[UG] Liu (#53)
Advisor: Robert Vega
Physics, Dedman College

SEARCH FOR VARIABLE STARS USING ROTSE-I AND ROTSE-III DATA

Our research group at SMU employs the SMU owned Robotic Optical Transient Search Experiment (ROTSE)-IIIb telescope sited at McDonald Observatory in West Texas to study the most extreme cataclysmic events -- supernovae and gamma-ray bursts. These studies rely on an accurate understanding of the variable star background, which can mimic these stellar death phenomena. Since 2007, the Variable Star Project (VSP) has involved SMU undergraduates in extracting variable star discoveries from the data sample of the ROTSE-I and ROTSE-III telescope. Briefly, we search for potential variable stars and phase light curves of multiple nights together to gain a complete measurement of period and amplitude. When necessary, we augment ROTSE database measurement with additional data from other survey telescopes. The final identification step involves submission of the analysis to the International Variable Star Index (VSX) for referee consideration and potential approval as a variable discovery. VSX is sanctioned by the International Astronomical Union, so resulting discoveries and measurements are publicly available to the astronomical research community. Over the last summer, I successfully submitted three variable stars identified using data from two different telescopes, ROTSE-I and ROTSE-III, for VSX referee approval. These variable stars were all eclipsing binary stars, including one Beta Lyrae (EB) variable and two W Ursae Majoris (EW) variables. An exceptionally rare high amplitude delta scuti triple mode pulastor found by other members of our research group will also be included.

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Ryan Staten (#54)
Advisor: Robert Kehoe
Physics, Dedman College

REAL-TIME DATA QUALITY ANALYSIS OF THE DARK ENERGY SPECTROSCOPIC INSTRUMENT

The Dark Energy Spectroscopic Instrument (DESI) will measure the effect of dark energy on the expansion history of the universe. Over a five year period, it will collect optical spectra for approximately 30 million galaxies and quasars. These spectra will be used to construct a three-dimensional map of the universe out to about 10 billion light years. During this five year survey period, it will be necessary to collect high quality data in order to perform the precise cosmological measurements needed. In order to know that this data is adequate, a QuickLook data reduction pipeline is being implemented to reduce raw data to calibrated, sky-subtracted spectra. This pipeline includes an array of data quality algorithms to assess the detailed performance of the telescope in near real-time. These algorithms include pixel level and extracted spectra examination, ensuring not only image quality, but also the ability to perform necessary scientific analysis. Additionally, they supply a critical feedback mechanism for optimizing the DESI observing strategy, which is needed to achieve sub-percent dark energy measurements. The SMU astrophysics team develops this software for DESI.

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Matthew Stein (#55) Jodi Cooley; Rob Calkins; Ray Bunker; Dan Bauer; Silvia Scorza; Ben Loer
Advisor: Jodi Cooley
Physics, Dedman College

RADON PLATE-OUT MEASUREMENTS FOR POLYETHYLENE AND COPPER AT SNOLAB

Neutrons are a challenging background for dark matter direct detection experiments such as the Super Cryogenic Dark Matter Search (SuperCDMS), and can come from contamination within common shielding materials such as polyethylene and copper. We present measurements of the alpha-activity accumulation on surfaces due to exposure to the elevated level of radon present deep underground at SNOLAB. Surface contamination from plate-out and implantation of radon daughters can give rise to neutron and gamma-ray backgrounds from (alpha,n) and Bremsstrahlung interactions. To help characterize these backgrounds, large-area samples were exposed underground for approximately three months in the planned SuperCDMS SNOLAB experiment location while simultaneously monitoring several environmental factors. Predictions of the radon-daughter plate-out rate are compared to the resulting surface activities, obtained from high-sensitivity measurements of alpha emissivity using the XIA UltraLo-1800 spectrometer at SMU. A predictive model is discussed for these materials placed in similar environmental conditions.

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Keping Xie (#56) Tie-Jiun Hou; Bo-Ting Wang
Advisor: Pavel Nadolsky
Physics, Dedman College

A BRIDGE BETWEEN THEORY AND EXPERIMENT FOR LHC

As the integrated luminosity increasing, the LHC accumulates a large amount of data, which reduce the statistical uncertainties at a high precision level. In order to match the highly precise data, we theorists have to improve our calculations to get the same precision level. The main theory uncertainties comes from 3 resources, Monte-Carlo (MC) uncertainties, PDF uncertainties and renormalization/factorization scale uncertainties. The MC uncertainties can be reduced by increasing MC sampling, while scale uncertainties is reduced with increasing perturbation orders. Therefore, the PDF uncertainties gradually becomes the main constraint. At the same time, when the perturbation order increasing, the computation time increasing drastically. Our jobs is to come up with some strategies to invoke the latest high-order theoretical calculations and the most precise experimental data to constraint the PDFs well in a reasonable time scale, in order to build a bridge to enable the theorists and experimentalists to talk at LHC.

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Li Zhou (#57)
Advisor: Robert Kehoe
Physics, Dedman College

COUPLINGS OF THE HIGGS BOSON TO W BOSONS AND TOP QUARKS

The Higgs boson has a mix of couplings with bosons and fermions in its production and decay processions. To study the bosonic and fermionic (Yukawa) couplings of the Higgs boson will help us to understand the Higgs mechanism, and understand how bosons and fermions acquire masses. The ATLAS analyses of H?WW channel at center-of-mass energy of 7 and 8 TeV in Run 1, and at 13 TeV in Run 2 are introduced. A likelihood has been built upon the $t\bar{t}$ kinematic reconstruction to discriminate the $t\bar{t}$ background in H?WW analysis. Results of the measurements of Higgs couplings to bosons and fermions in Run 1 and Run 2 are presented.

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Mathematics

Claudia Castro-Castro (#58) Benno Rumpf; Yannan Shen
Advisor: Alejandro Aceves
Mathematics, Dedman College

NONLINEARITY, PT SYMMETRY, TWIST, AND DISORDER IN DISCRETE NONLINEAR SCHRÖDINGER EQUATION

The study of optical fiber arrays has drawn a great deal of attention in the field of nonlinear physics during the past few years since they provide spatially inhomogeneous structures for guiding light signals. We analyze the management and control of light transfer in nonlinear multi-core fibers. We utilize

mathematical modeling and numerical simulations to specifically show how nonlinearity, coupling, geometric twist, and balanced gain/loss relate to existence and stability of nonlinear optical modes modeled by the Discrete Nonlinear Schrödinger Equation (DNLS). In addition, we explore the effects of the inherent variability on the fiber core diameter (disorder) by building a statistical understanding of the formation of low or high amplitude (localized/breather) states, and the long-time asymptotics of DNLS with low-amplitude initial conditions.

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Jiahui Chen (#59) Johannes Tausch
Advisor: Weihua Geng
Mathematics, Dedman College

COMPARISON OF FAST MULTIPLE METHOD AND TREECODE ALGORITHM FOR SCREENED COULOMB POTENTIAL

Both fast multiple method and treecode algorithm are presented for calculating electrostatic potentials in a large N-body system. For fast multiple method, it is known as cluster to cluster interaction algorithm, while treecode algorithm is a particle to cluster interaction algorithm. We use two different recurrence formulas with respect to two methods for solving higher order derivatives of the Green's function due to different algorithm mechanism. We present cpu runtime, memory usage and accuracy to show the performance of these methods. Further, we will develop a fast multiple method accelerated solver for solving electrostatic potential partial differential equation.

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Brian Citty (#60)
Advisor: Thomas Hagstrom
Mathematics, Dedman College

EFFECT OF OUTSIDE UNCERTAINTY TO THE WAVE EQUATION IN A BOUNDED DOMAIN

Here we consider the classical wave equation in an unbounded domain. In a bounded domain, the wave speed is known, but outside of the bounded domain the wave speed is unknown. What effect does this uncertainty have on functionals of the solution? How does one model the uncertainty in physical situations to begin with? These issues are explored in this paper.

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Nicole Deyerl (#61)
Advisor: Johannes Tausch
Mathematics, Dedman College

PARABOLIC GALERKIN BOUNDARY ELEMENT METHOD WITH MOVING SURFACES

The successful implementation of the Galerkin Boundary Element Method hinges on the accurate and effective quadrature of the influence coefficients. Integrals for parabolic boundary integral operators must be performed in space and time where integral have singularities when source and evaluation times

coincide. A set of transformations is derived that render the singular cases into smooth integrals that can be treated with standard tensor product Gauss quadrature rules. These transformations are particularly useful for problems with moving geometries where the time integration cannot be performed analytically, and are implemented numerically in the two dimensional case.

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Fritz Juhnke (#62) Thomas Hagstrom
Advisor: Thomas Hagstrom
Mathematics, Dedman College

DISCONTINUOUS GALERKIN DIFFERENCE DISCRETIZATION OF THE WAVE EQUATION

High-order finite difference (FD) methods for evolving simulated waves in time typically permit larger time steps than discontinuous Galerkin (DG) methods of equal order and degrees of freedom. This gap in efficiency widens as the order increases. If, however, one uses finite-difference-style basis functions within a Galerkin formulation, one can enjoy the stability benefits of a built-in discrete energy and upwinding without sacrificing the efficiency of large time steps. We call this new approach the discontinuous Galerkin difference (DGD) method.

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Yang Liu (#63)
Advisor: Sheng Xu
Mathematics, Dedman College

THE PARALLELIZAITON OF THE IMMERSED INTERFACE METHOD FOR FLOW AROUND NON-SMOOTH BOUNDARIES

In the immersed interface method (IIM), singular forces are used to represent the effect of objects immersed in a fluid, and jump conditions induced by the singular forces are incorporated into numerical schemes to simulate the flow. Previously, we have extended the method for non-smooth objects by computing necessary jump conditions using line segment representation of 2D objects. Here we present the parallel strategy for the development of the high-performance program for distributed-memory parallel computing with MPI. Our tests on cavity flow, circular Couette flow and flow past a cylinder indicate that our parallel program is stable and valid, achieves second-order accuracy, and shows good improvements on computational time.

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Jean Sexton (#64) Daniel Reynolds
Advisor: Daniel Reynolds
Mathematics, Dedman College

HIGH-ORDER RELAXED MULTIRATE INFINITESIMAL STEP METHODS FOR MULTIPHYSICS APPLICATIONS

In this work, we consider numerical methods for integrating multirate ordinary differential equations. We are interested in the development of new multirate methods with good stability properties and improved efficiency. We discuss the development of multirate methods, particularly focusing on those that are based on Runge-Kutta theory. We introduce the theory of Generalized Additive Runge-Kutta methods proposed by Sandu and Guenther. We also introduce the theory of Recursive Flux Splitting Multirate Methods with Sub-cycling described by Schlegel, as well as the Multirate Infinitesimal Step methods developed by Savceno, Wensch, Knoth, and Galant which this work is based on. We will leverage these theories to develop new families of methods which have similar or higher order, and similar stability properties compared to current methods and which address some of the deficiencies of those methods.

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Thomas Sheffield (#65)
Advisor: Benno Rumpf
Mathematics, Dedman College

ENSEMBLE DYNAMICS IN WAVE TURBULENCE IN ONE AND TWO DIMENSIONS

We investigate correlations in wave turbulence by monitoring the dynamics of ensembles of trajectories. The system under investigation is a simplified model for surface gravity waves in one and two dimensions with a square-root dispersion and a nonlinear four-wave interaction term. We study decaying turbulence where we detect Kolmogorov-Zakharov spectra. We numerically compute ensembles of trajectories that emanate from sets of random phase initial conditions in order to compute ensemble-averages of emerging correlations. Our results confirm the predictions of wave turbulence theory on the shape, the scaling behavior and the time evolution of fourth-order correlations.

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Jennifer Swenson (#66)
Advisor: Scott Norris
Mathematics, Dedman College

SWELLING AS A STABILIZING MECHANISM IN IRRADIATED THIN FILMS

Irradiation of semiconductor surfaces often leads to the spontaneous formation of rippled structures at certain irradiation angles. However, at high enough energies, these structures are observed to vanish for all angles, despite the absence of any identified, universally-stabilizing physical mechanisms in operation. Here, we examine the effect on pattern formation of radiation-induced swelling, which has been excluded from prior treatments of stress in irradiated films. After developing a suitable continuum model, we perform a linear stability analysis to determine its effect on stability. Under appropriate simplifying assumptions, we

find swelling indeed to be stabilizing at wavenumbers typical of experimental observations. Therefore, this mechanism may account for the vanishing ripples observed at high energies.

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Ting Yan (#67) Amnon J. Meir
Advisor: Daniel Reynolds
Mathematics, Dedman College

REACTION-DIFFUSION MODEL OF DRUG CONCENTRATION IN A LYMPH NODE

It is recognized that there exist reservoirs of HIV located outside the bloodstream, and that these reservoirs hinder the efficacy of antiretroviral medication regimens in combating the virus. The prevailing theories regarding these reservoirs point to the lymphatic system. In this work, we model the concentration of antiretroviral therapy (ART) drugs entering and passing through a lymph node. This model consists of a system of reaction-diffusion partial differential equations (PDEs), where the diffusion coefficients vary between species (HIV, ART drugs, T-cells, B-cells) and include discontinuous jumps to capture differing properties of internal lymph node structures. For this work, we are implementing realistic 3D geometric models of the lymph node, approximating solutions to the PDEs using continuous 3D finite element methods, and solving the resulting systems using scalable parallel solver algorithms. We approximate the lymph node geometry using an unstructured tetrahedral 3D mesh produced using the Gmsh package. We present results from our current work on solving a single diffusion equation with discontinuous coefficient using the FEniCS finite-element infrastructure, and with underlying parallel algebraic solvers from PETSc.

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Anyu Zhang (#68) Brandilyn Stigler
Advisor: Brandilyn Stigler
Mathematics, Dedman College

COUNTING DISCRETE MODELS OF GENE NETWORKS

Gene regulatory networks (GRNs) play an important role in regulating cellular processes. While experimental data are abundant, the structure of most GRNs is largely unknown. As many models can fit the same data set, identifying the most biologically relevant model becomes crucial for making predictions. Polynomial dynamical systems (PDSs) over finite fields have been used as discrete models of GRNs and can be partitioned into equivalence classes via Grobner bases (GBs), a multivariate nonlinear generalization of Gaussian elimination. We aim to characterize data sets that result in a single equivalence class with a canonical representative: the unique minimal PDS. Our future work will focus on generalizing the formulas to larger data sets. we aim to extend the formulas for sets up to 6 points for any number of states and any number of variables. This will require parallelizing existing scripts for computing all possible data sets and their corresponding GBs. Furthermore, we hope to characterize geometric features of the data which may provide an important connection to the structure of the underlying GRN.

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Earth Sciences

Kimberly DeGrandpre (#69) Jeremy Pesicek; Zhong Lu
Advisor: Zhong Lu
Earth Sciences, Dedman College

SURFACE DEFORMATION AND SOURCE MODEL AT SEMISOPOCHNOI VOLCANO FROM INSAR AND SEISMIC ANALYSIS DURING THE 2014 AND 2015 SEISMIC SWARMS

During the summer of 2014 and the early spring of 2015 two notable increases in seismic activity at Semisopochnoi volcano in the western Aleutian islands were recorded on AVO seismometers. These seismic swarms did not lead to an eruption. This study employs differential SAR techniques using TerraSAR-X images in conjunction with more accurately relocating the recorded seismic events through simultaneous inversion of event travel times and a three-dimensional velocity model using tomoDD. The interferograms created from the SAR images exhibit surprising coherence and an island wide spatial distribution of inflation that is then used in a Mogi model in order to define the three-dimensional location and volume change required for a source at Semisopochnoi to produce the observed surface deformation. The tomoDD relocations provide a more accurate and realistic three-dimensional velocity model as well as a tighter clustering of events for both swarms that clearly outline a linear seismic void within the larger group of shallow (<10 km) seismicity. These techniques are both complimentary and efficient forms of remotely monitoring volcanic activity that provide much deeper insights into the processes involved without having to risk hazardous or costly field work.

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Yusuf Eshqi Molan (#70) Jinwoo Kim
Advisor: Zhong Lu
Earth Sciences, Dedman College

PERMAFROST DEFORMATION MODELING USING INSAR

In this research, we integrated spaceborne optical and synthetic aperture radar (SAR) data to map and model the burnt area and detect wildfire-induced deformation over permafrost covered by boreal forests in Alaska interior. Permafrost stores massive amounts of carbon. In addition, permafrost is structurally important, and its melting can cause landslides and ground subsidence. The active layer, the top layer of ground over permafrost is subject to annual thawing and freezing and subsequent subsidence and uplift, respectively. Wildfire and subsequent loss of thermal insulation can change the status of active layer and underlying permafrost. Remote sensing technologies provide the unique opportunity to monitor and assess the degradation of permafrost. Our model revealed up to 25 cm permafrost melting in the study area.

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Tyler Fritz (#71) Crayton Yapp
Advisor: Crayton Yapp
Earth Sciences, Dedman College

MIOCENE WEATHERING AND THE STABLE CARBON ISOTOPE GEOCHEMISTRY OF GOETHITE IN CHANNEL IRON DEPOSITS OF WESTERN AUSTRALIA

Extensive Miocene chemical weathering of an iron-rich landscape produced goethite/hematite-rich pelletoids that were transported into meandering river channels to form the economically important channel-iron deposits (CID) of the Hamersley Province in Western Australia. Information on carbon cycles operating in this oxidative weathering environment was obtained through isothermal dehydration-decarbonation analyses of 13 goethite (FeOOH) samples from two cores drilled in the Robe Formation an iron ore mine at Mesa J. Goethite contains occluded CO2 present as a Fe(CO3)OH component in solid solution. The mole fraction (X) and d13C of Fe(CO3)OH are related, respectively, to the concentration and d13C of CO2 present in the crystallization environment. Values of X ranged from 0.0072 to 0.0401 and d13C from -20‰ to -24.2‰, which implies organic matter ?13C of about -25‰ to -30‰. The values of X represent very high concentrations (= 40,000 ppmV) of ancient soil CO2 and indicate high rates of oxidation — suggesting microbial mediation. In addition, Fe-reducing bacteria in these environments probably played an important role in promoting cycles of mineral dissolution and re-precipitation, which could have contributed to the accumulation of Fe(III)-oxides in the ore-grade concentrations found in the CID.

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SeongJu Jeong (#72)
Advisor: Brian Stump
Earth Sciences, Dedman College

STRESS DROP ESTIMATES FROM POSSIBLE INDUCED SEISMIC EVENTS IN THE FORT WORTH BASIN, TEXAS

Since gas and oil production began in the Fort Worth Basin, there have been five earthquake sequences (DFW Airport, Cleburne, Azle, Dallas/Irving and Venus) associated with the Barnett shale development. These earthquake sequences are suggested to be induced by disposal of recovered wastewater by previous studies. Previous studies suggest average stress drops of 10 bars and 43 bars for DFW and Cleburne earthquakes, respectively. The aim of this study is to calculate stress drops using absolute estimation based on Brune model in the other three sequences (Azle, Dallas/Irving and Venus). To do this, path correction including attenuation and geometrical spreading are applied prior to making the source estimates. A second time domain procedure is also used to estimate the stress drop and is found to estimates slightly higher stress drops than the frequency domain estimates. This study suggests that stress drop estimates are in agreement with global average intra-plate earthquakes including previous average stress drops estimated for the Fort Worth Basin. The stress drops suggest a breakdown in self-similarity with increasing moment magnitude. However, because of the limited magnitude range of the data analyzed this conclusion need further study.

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Kevin Kwong (#73) Zhong Lu; Jin Woo Kim
Advisor: Heather DeShon
Earth Sciences, Dedman College

IMPROVED TELESEISMIC LOCATIONS AND INSAR OBSERVATIONS OF THE 2016 PEDERNALES ECUADOR EARTHQUAKE SEQUENCE

The Pedernales Ecuador earthquake (Mw 7.8) on April 16, 2016 is the recent megathrust event between the boundary of the Nazca plate and the South American plate. Large scale ground deformation of this event can be imaged using SAR interferometry (InSAR) using the Sentinel-1A satellite. The InSAR image of the Mw 7.8 event reveals deformation distributed south of the mainshock epicenter with observed peak ground displacement at ~60 cm. Separate large aftershock InSAR images is examined in this study due to the fact that a Sentinel 1-A pass was acquired between the times of the two largest aftershocks (Mw 6.7 and Mw 6.9) on May 18, 2016. To verify the earthquake deformation from these InSAR images, we invert for ground surface displacement due to a uniform dislocation on a fault surface. Focal mechanism analysis and double-difference relocation of telseismic catalog data is done to provide constraints on the fault orientation and geometry along the megathrust. The new relative locations of the mainshock and the two largest aftershocks shifted eastward (towards the trench) relative to their initial USGS epicenters and closer to the IG-EPN in-country network locations. A major motivation of this study is to examine the feasibility of using geodetic observations and models from InSAR to validate or help constrain seismically determined absolute and relative earthquake locations.

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Mason MacPhail (#74)
Advisor: Brian Stump
Earth Sciences, Dedman College

QUANTIFICATION OF THE EFFECTS OF ASSUMED SOURCE DEPTH AND SHEAR WAVE STRUCTURE ON RESULTING MOMENT TENSORS FROM A SMALL, CONTAINED CHEMICAL EXPLOSION

Discrimination techniques differentiate energy sources within the earth such as nuclear explosions and earthquakes. In our study, the seismic moment tensor is recovered by linear inversion. The experiment focuses on observations in the 37-680 m range from small-scale contained chemical explosions that can be used as proxies for nuclear explosions. Gfs are constrained by a P-wave refraction survey at the site but the shear wave structure is less well constrained. The effect of variable shear wave structure and assumed source depth on the source characterization is explored. Our Gf analysis shows that surface wave energy is sensitive to source depth whereas body waves and surface wave energy are both dependent on shear wave velocity (Vs). The source inversions are able to replicate the observed data well. The resulting source models suggest that Vs, assumed source depth and free surface interaction play key roles in how the source is represented. In our 2-10 Hz bandwidth of interest, deeper sources and slower Vs models have more explosion–like representations and shallower depths and faster Vs have more CLVD-like representations. The free surface interaction highlights secondary source effects, demonstrated by the much greater Mzz component when compared to the isotropic component. These analyses will help to understand the phenomenology accompanying underground explosions.

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Louis Quinones (#75) Heather DeShon
Advisor: Heather DeShon
Earth Sciences, Dedman College

STRESS ORIENTATIONS IN THE FORT WORTH BASIN

Since October of 2008 the Dallas-Fort metroplex, located in the eastern part of the Fort Worth (Barnett Shale) Basin, has experienced over 30 magnitude 3.0+ and 1 magnitude 4.0 earthquake. SMU and collaborators operate seismic networks in the area to monitor earthquakes and explore causal links between seismicity and oil and gas operations in the basin. In order to induce an earthquake on a pre-existing fault, the fault must have stored elastic energy and be oriented within the modern stress field such that failure (slip) can take place. Earthquake focal mechanisms calculated from P-wave first motion and S to P-wave amplitude ratio data provide information on fault plane orientations and subsurface stress orientations. The focal mechanisms are consistent with failure within a normal faulting regime for NE-SW striking faults. The orientations of the maximum compressional, least compressional, and intermediate stress for each focal mechanism are inverted to solve for minimum and maximum stress values for subregions within the basin. Maximum regional horizontal stress in the basement rocks hosting earthquakes strikes ~30-40° in the NE direction, and is consistent with borehole breakout data from overlying units. The compatibility of the modern stress field with pre-existing fault orientations in the basin implies that small perturbations to stress can be enough to induce slip.

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Monique Scales (#76) Heather R. DeShon; M. Beatrice Magnani; Jacob I. Walter; Louis Quinones; Thomas L. Pratt
Advisor: Heather DeShon
Earth Sciences, Dedman College

A DECADE OF INDUCED SLIP ON THE CAUSITIVE FAULT OF THE MW4.0 2015 VENUS EARTHQUAKE, NORTH TEXAS

On 7 May 2015, an Mw4.0 earthquake occurred near Venus, Johnson County, Texas. In response, a local seismic network was deployed in May 2015 to capture additional earthquakes, identify and image the causative fault, and explore potential links between ongoing industry activity and seismicity. Double-difference derived hypocenter relocations of the local earthquake catalog indicate a fault striking ~230°N, dipping to the west, consistent with a nodal plane of the USGS Mw 4.0 regional moment tensor. Fault plane solutions calculated using a combination of P-wave first motions and S, P amplitude ratios also indicate primarily normal faulting with B-axes oriented parallel to maximum horizontal stress. Active source data allow us to identify the structure hosting the current seismicity and better map the fault across the region. Template matching at regional stations in place since 1992 indicates that earthquakes with similar waveforms, but below magnitude 2, extend back to 2008. We suggest it likely that these wastewater injection activities led to increases in subsurface pore fluid pressure that over time contributed to triggering this long-lived earthquake sequence. The Mw4.0 event represents the continuing evolution of slip on a pre-existing fault rather than a mainshock-aftershock sequence on a newly reactivated structure.

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Vanshan Wright (#77) Matt Hornbach; Wynne Castille
Advisor: Matt Hornbach
Earth Sciences, Dedman College

FAULT REACTIVATION AND GROUND SHAKING IN THE KINGSTON METROPOLITAN AREA

This study uses core and seismic data to identify previously unrecognized active fault systems in Kingston Jamaica, determine the faults' slip rates and forecast the probability for large magnitude earthquakes along the newly identified faults. Our analyses indicate that active faults clearly exist in offshore Kingston (i.e. Kingston Harbor). The faults are likely a blind extension of two major faults (the Long Mountain and Cavaliers fault) that receive slip from the EPGFZ or the South Coastal Fault Zone (SCFZ). Based on first-order analysis of core and seismic data, we estimate that the newly identified faults activated within the last ~5000-1500 ka. During this time, the faults accommodated strain via a complex mix of compression (structural folds) and extension (a pull-apart basin). The horizontal rate of motion along the hanging wall (0.42-1.4 mm/yr) is lower than the current horizontal rates of motion (5-15 mm/yr) within Kingston, thereby indicating that the rate of slip transfer between the Gonave-Caribbean Plate boundary has increased through time in Jamaica. Based on fault dimensions, we estimate that 2 segments of the fault system are not only active but individually capable of generating Mw 4.9-6.6 earthquakes. The analysis therefore highlights the clear evidence for significant seismic hazard in the region.

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Biological Sciences

Lauren Ammerman (#78) James McCormick; Jake Oien; John Wise; Pia Vogel
Advisor: John Wise
Biological Sciences, Dedman College

IN SILICO OPTIMIZATION AND DEVELOPMENT OF SMU-29, A NOVEL INHIBITOR OF P-GLYCOPROTEIN, TO REVERSE MULTIDRUG RESISTANCE

P-glycoprotein (P-gp) is an integral membrane efflux pump that is capable of transporting a broad range of substrates out of cells, including chemotherapeutics and other medicinal compounds. P-gp's efflux activity lowers the intracellular concentration of many drugs to sub-therapeutic levels; consequently, overexpression of P-gp has been implicated in the development of multidrug-resistant cancer. Multiple conformations of P-gp were used by our lab for in silico molecular docking assays to screen for potential inhibitors of P-gp activity. A hit compound, SMU-29, was identified by us in silico and confirmed in vitro as a successful inhibitor of P-gp activity, resulting in re-sensitization of cancer cells in culture to chemotherapeutics (Brewer et al. (2014), Molecular pharmacology 86, 716-726 and Follit et al. (2015), Pharmacol. Res. Perspect. 3, e00170). Using a novel computational medicinal chemistry program, we generated numerous SMU-29 variants and docked them to the P-gp nucleotide binding domains. This assay allows us to screen SMU-29 variants for increased inhibition potential and P-gp binding affinity, and select leads for future analysis in vitro. In future studies, this procedure can be used to generate variations of lead compounds and identify structures with similar or improved activity for the target protein of choice.

Description of Commercial Viability:

In future studies, this procedure can be used to generate variations of lead compounds and identify structures with similar or improved activity for the target protein of choice. Our novel program would greatly reduce the cost and efficiency of current drug-screening techniques by filtering compounds in silico prior to testing in vitro.

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Gang Chen (#79) Jett Ballou-Crawford; John Wise
Advisor: Pia Vogel
Biological Sciences, Dedman College

IMPROVING THE SENSITIVITY OF P-GLYCOPROTEIN TO DRUG-LIKE INHIBITORS IN ATPASE ASSAYS AND ESR STUDIES

Multidrug resistance (MDR) in cancers is frequently associated with transmembrane efflux proteins including P-glycoprotein (P-gp), multidrug resistance associated protein (MRP1), and breast cancer resistance protein (BCRP). Over-expression of these transporters in cancer cells increases efflux of therapeutic drugs rendering them ineffective. In order to re-sensitize multidrug resistant cancers to chemotherapy, we have found inhibitors of P-gp by in silico screening methods (Brewer et al, Mol. Pharmacol. 2014). To investigate the mechanism underlying the inhibition, we have employed biochemical assays and electron spin resonance spectroscopy (ESR), and have established nanodisc technologies that incorporate and stabilize P-gp in native-like phospholipid bilayer environments for our drug finding and mechanistic studies. In ATP hydrolysis assays using P-gp in micelles, we found that the concentration of detergents used to solubilize P-gp during purification had a significant impact on the sensitivity of P-gp to the putative inhibitors. We hypothesized that partitioning of the compounds into empty micelles may decrease the effective concentration of the potential inhibitors. Carefully decreasing the amount of detergents used during purification resulted in significantly increased sensitivity of P-gp to the inhibitors, while overall protein activity and stability were not affected.

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Maisa Correa de Oliveira (#80) Collette LaVigne; Henry Thornton; Brandon Tran; John Wise; Pia Vogel
Advisor: Pia Vogel
Biological Sciences, Dedman College

NEW STRATEGIES FOR THE EXPRESSION OF THE HUMAN P-GLYCOPROTEIN (MDR1) IN THE YEAST PICHIA PASTORIS

P-glycoprotein (P-gp) overexpression is often correlated with multidrug-resistance (MDR) of cancer. To search for P-gp inhibitors as co-therapeutics to combat MDR, we had previously used high-throughput in silico ligand docking studies to identify drug-like compounds and their effects on P-gp ATPase hydrolysis activity, followed by assays of MDR-reversal of a prostate cancer cell line. More recently, computationally identified compounds were shown to reverse MDR in cancer cells, but did not inhibit ATP hydrolysis by isolated P-gp. One reason may be that mouse P-gp rather than human P-gp was used in these tests. Although expression of human P-gp in Pichia pastoris was previously reported, we experienced very

modest levels of the human P-gp expression construct for P. pastoris available in our lab. A gene for human P-gp was designed with optimized codon usage for translation in P. pastoris. The synthesized DNA was cloned into a pUC57 cloning vector. When transformed into E. coli, DNA rearrangement was observed. To identify whether a specific section of the insert was the cause of this condition, the insert DNA was digested into 5 component pieces and each one was subcloned. One of the sections was found to be more susceptible to rearrangements. We report here our attempts at constructing a stable, codon-optimized, human P-gp gene for high yield protein production in P. pastoris.

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Noah Earland[UG] (#81)
Advisor: William Orr
Biological Sciences, Dedman College

INVESTIGATING PEROXIREDOXIN IMPACT ON THE INTERSECT OF CONSTITUTIVE AMP PRODUCTION AND AGING IN DROSOPHILA

The sum of reducing and oxidizing reactions comprise the cell's redox state, as measured by antioxidants like glutathione. Peroxiredoxins (Prx) are a peroxidase family of enzymes which convert hydrogen peroxide generated inside the cell into water, and can also the IMD pathway transcription factor Relish (NF-?ß homologue), leading to an increase in antimicrobial peptide (AMP) production. This increase in AMP expression is associated with late stage aging and death in drosophila, along with a pro-oxidizing shift in redox state. The transgenic flies I produced, have reduced expression of the ER localized Prx4, and reduced expression of two mitochondria localized Prx3 and Prx5. In these mutant flies, I assessed their lifespans and their AMP level using RT PCR. It's been previously shown reducing Prx3 and Prx5 expression causes an increase in AMPs. When I decreased Prx4 in addition to decreasing Prx3/Prx5, it caused a decrease in expression of key AMPs. However, the lower AMP expression correlate with any significant increase in lifespan. Thus, a redox signal seems to be generated in the mitochondria from the lack of Prx3/Prx5, which normally reduce the oxidative stress generated in the organelle. This redox signal, which may react with thiol groups in the catalytic domains of enzymes, then transfers to the ER, possibly via mitochondrial-ER membrane fusion, before being transferred through a Prx4 mediated process to the transcription factor Relish, which drives AMP expression.

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Elnaz Ghotbi Ravandi (#82)
Advisor: Richard Jones
Biological Sciences, Dedman College

THE RECOGNITION OF TARGET GENE TRANSCRIPTIONAL STATE BY POLYCOMB GROUP PROTEINS

Polycomb Group proteins are conserved epigenetic transcriptional regulators that maintain the transcriptional repression of silenced genes by altering chromatin structure. Most studies on PcG proteins have been focused on the maintenance phase of PcG silencing, thus the molecular mechanisms by which PcG proteins initially recognize a repressed gene and the establishment of PcG-mediated repression remain unknown. Our lab previously used Drosophila genetic tools to produce bcd osk tsl Drosophila embryos, in

which gt, a PcG-target gene, is uniformly repressed by PcG proteins. Time course ChIP experiments on bcd osk tsl embryos in different embryonic stages showed the weak presence of PcG proteins at gt in earlier stages prior to their stable binding in later embryonic stages. On the other hand, we generated a genetic system in which gt is ubiquitously expressed by producing embryos that lack the gt repressor Hb and ubiquitously express a maternal gt activator, Cad. In order to determine whether binding by particular transcription factors or the transcriptional state of a target gene identifies PcG target loci as initially repressed, we will examine whether PcG silencing complexes assemble at a transcriptionally inert gt transgene in a background in which endogenous gt is transcriptionally active.

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Tetiana Hutchison (#83) Aditi Malu; Rachel Bergeson; Kendra Peck; Carolyn Harrod; Wesleigh Gwinn; Robert Harrod
Advisor: Robert Harrod
Biological Sciences, Dedman College

THE SUPPORTIVE ROLE OF THE HTLV-1 P30II PROTEIN IN VIRAL CARCINOGENESIS

The human T-cell leukemia virus type-1 (HTLV-1) transforms CD4+ T-cells and causes adult T-cell leukemia/lymphoma (ATLL), an aggressive hematological cancer for which there are no effective treatments. The highly conserved nucleotide sequence, pX, encodes several products which control viral replication and latency and deregulate host signaling pathways associated with aberrant lymphoproliferation and leukemic T-cell transformation. We have previously demonstrated the HTLV-1 latency-maintenance factor, p30II, cooperates with the c-Myc oncoprotein and induces oncogenic foci-formation through transcriptional interactions with c-Myc and the MYST-family acetyltransferase, TIP60. Interestingly, TIP60 is a cofactor for both c-Myc and p53, and the oncogenic expression of c-Myc induces a DNA-damage-like response which is dependent upon p53 and TIP60 functions. We have shown that p30II inhibits the c-Myc-induced K120-acetylation of p53 and prevents oncogene-induced cytotoxicity through the activation of p53-regulated pro-survival signals, including the TP53-induced glycolysis and apoptosis regulator (TIGAR). Our findings have further demonstrated that p30II inhibits mitochondrial damage and oxidative stress induced by oncoproteins. These results allude to a pivotal role for p30II during viral carcinogenesis.

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Collette LaVigne Marchesseault (#84) James McCormick; Pia Vogel; John Wise
Advisor: John Wise
Biological Sciences, Dedman College

CHARACTERIZATION OF MEDICALLY RELEVANT ABC TRANSPORTERS FOR TARGETED DRUG THERAPY

ABC transporters are integral membrane proteins and some function to export a wide variety of toxins from the cell. Overexpression of these proteins has been shown to play a role in multi-drug resistance. The broad substrate specificity exhibited by these proteins has made the search for possible inhibitors challenging. MsbA is a prokaryotic ABC transporter that is essential for growth in gram-negative bacteria, making it a possible antibiotic target. Breast Cancer Resistance Protein (BCRP) is a eukaryotic ABC transporter and has been implicated in multi-drug resistance to chemotherapy. In efforts similar to those

described in (Brewer et al. Mol Pharm. 2014) computational screens were performed to search for drug-like compounds that effectively inhibit MsbA and BCRP ATP hydrolysis without being themselves transported. Identified compounds were purchased and tested to determine efficacy. A His6-tagged MsbA was overexpressed and purified from E. coli and reconstituted into nanodiscs, where MsbA has been shown to have high catalytic activity. BCRP was cloned into the Pichia PINK system and purified. ATP hydrolysis rates of MsbA and BCRP were measured in the presence and absence of potential inhibitors using a coupled enzyme assay. Further experiments will aim to better characterize the proteins and optimize the compounds for potential use as novel antibiotics or anti-cancer drugs.

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Aditi Malu (#85) Tetiana Hutchison; Katie Smith; Katherine Nelson; Robert Harrod
Advisor: Robert Harrod
Biological Sciences, Dedman College

THE HTLV-1 LATENCY-MAINTENANCE FACTOR P30II INHIBITS TAX-INDUCED NF-KAPPA B-SIGNALING, GENOMIC INSTABILITY, AND CYTOTOXICITY

The human T-cell leukemia virus type-1 (HTLV-1) infects CD4+ T-cells and causes adult T-cell leukemia/lymphoma (ATLL), often-fatal lymphoproliferative disease. The activation of NF-?B by the viral transactivator Tax, is mediated through binding of Tax to the regulatory subunit of the I?B kinase (IKK), NEMO or IKK?. This interaction results in constitutive activation of IKK? and IKK?, degradation of I?B?, and activation of both canonical and non-canonical NF-?B pathways. Tax-induced hyper-activation of NF-?B triggers a defense mechanism that causes rapid cellular senescence. Tax also inhibits p53 functions through NF-?B-signaling. Stathmin is a microtubule-destabilizing factor and was recently shown to interact with p65-RelA complexes associated with aggressive disease phenotypes in pancreatic cancers. The stathmin gene is negatively regulated by p53/mSin3a/HDAC1 repressor complexes; and has been shown to play an oncogenic role in a range of invasive cancers. We therefore hypothesize p30II might suppress NF-?B-mediated cytotoxicity and Tax-induced genomic instability through the inhibition of Stathmin/p65-RelA interactions. Our results demonstrate that HTLV-1 p30II induces p53 and inhibits Stathmin expression associated with reduced p65-RelA levels. p30II inhibits Tax-dependent NF-?B transactivation and effectively blocks Tax-induced cellular senescence.

Description of Commercial Viability:

These findings suggest that p30II cooperates with the viral transactivator protein and may promote the survival of HTLV-1-infected leukemic T-cells by dampening Tax-induced NF-?B-signaling and inhibiting Tax-induced genomic instability. It is conceivable that anticancer chemotherapy compounds which activate p53 or inhibit NF-?B-mediated inflammation could have the unintended consequence of promoting the survival of ATLL tumor cells by suppressing Stathmin levels and inhibiting Tax-induced cytotoxicity.

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Amila Nanayakkara (#86) James McCormick; Courtney Follit; Collette LaVigne; Pia Vogel; John Wise
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EFFECTS OF IN SILICO IDENTIFIED INHIBITORS OF ABC TRANSPORTERS ON DRUG ACCUMULATION IN MULTIDRUG RESISTANT CANCER CELL CULTURE MODELS

P- glycoprotein (P-gp) and breast cancer resistance protein (BCRP) are two of the most studied drug transporters related to multidrug resistance (MDR) in cancers. No clinically approved drugs are currently available that inhibit these proteins. Using computational methods we have identified new compounds that inhibit P-gp (Brewer et al., 2014 and Follit et al., 2015). Here, we show that co-administration of identified P-gp inhibitors, SMU-29, 34 and 45, led to increased accumulation and retention of the chemotherapeutic agent, daunorubicin, in the P-gp over-expressing ovarian cancer cell line, A2780ADR. Treatment of P-gp over-expressing DU145TXR prostate tumor spheroids with daunorubicin in the presence of SMU-29 resulted in a significant reduction in spheroid cross sectional area. Inhibition of P-gp led to an increased accumulation and penetration of the P-gp substrate calcein in these spheroids. A prolonged incubation of spheroids with non-toxic P-gp inhibitor SMU-29, after an initial 3 hour co-administration of paclitaxel with SMU-29, led to reduced viability of MDR cancer cells. We have also assessed in silico identified BCRP inhibitors in vitro using in house established BCRP over-expressing cell line, MCF-7 M100 and identified several compounds causing accumulation of the BCRP substrate, Hoechst 33342 at nM concentrations.

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Lacin Yapindi (#87) Tetiana Hutchison; Aditi Malu; Megan Romeo; Robert Harrod
Advisor: Robert Harrod
Biological Sciences, Dedman College

HUNTING TIGAR: TARGETED SIRNA-INHIBITION OF TIGAR MAKES HELA CERVICAL ADENOCARCINOMA CELLS SENSITIVE TO CHEMOTHERAPY DRUGS THAT INDUCE OXIDATIVE DAMAGE

The deregulation of growth and proliferative pathways in cancer cells necessitates their increases in metabolism, glucose uptake, and energy production. This begs the question: How do tumor cells overcome the cytotoxicity normally associated with metabolic byproducts, such as reactive oxygen species (ROS), to cause neoplastic disease? Many human cancers contain elevated expression of the Tp53-induced glycolysis and apoptosis regulator (TIGAR) –a 2,6-bis-fructose phosphatase that scavenges ROS through the increased production of NADPH. Our lab has demonstrated that cancers caused by the human T-cell leukemia virus type-1 (HTLV-1) or high-risk human papillomaviruses (HPVs) exhibit high levels of TIGAR. We therefore hypothesized that inhibiting TIGAR could sensitize therapy-resistant cancer cells to chemotherapy drugs that induce oxidative damage. Using the HPV18-transformed HeLa cell-line, my research has shown that siRNA-tigar-knockdown of TIGAR induces mitochondrial depolarization and drastically sensitizes cervical cancer cells to chemotherapy drugs (cisplatin, etoposide, doxorubicin, and cyclophosphamide) which cause oxidative damage. Our future studies will explore the molecular mechanisms by which TIGAR-signaling protects cancer cells against oxidative stress with the long-term goal of developing a therapeutic strategy to inhibit TIGAR in vivo for clinical applications.

Description of Commercial Viability:

Our findings demonstrate that inhibiting TIGAR –a key antioxidant factor which protects cells against the cytotoxic effects of metabolism, makes therapy-resistant cancer cells susceptible to chemotherapy drugs that cause oxidative damage. Further, we have shown that targeted siRNA-inhibition of TIGAR increases the "killing" effectiveness of these drugs, even at sub-inhibitory concentrations. The implications of this are: 1) it may eventually become possible to administer these compounds at lower, better tolerated doses with reduced side-effects, and 2) inhibiting TIGAR sensitizes cervical adenocarcinoma cells to cyclophosphamide –which potentially could add a new drug to the arsenal to treat cervical cancer. The Harrod lab is developing proprietary technology to inhibit TIGAR as an adjuvant to anticancer chemotherapy against cervical, pancreatic, and ovarian cancers to be validated in vivo using the xenograft tumor model.

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Piao Ye (#88) Elnaz Ghotbi Ravandi; Judith Benes; Jumana Haj Abed
Advisor: Richard Jones
Biological Sciences, Dedman College

THE CONTRIBUTIONS OF MULTIPLE FACTORS IN PCG RECRUITMENT

Polycomb-group(PcG) proteins are conserved epigenetic transcriptional regulators that are capable of maintaining transcriptional repression through an indefinite number of cell cycles. giant(gt) is a gap gene in Drosophila and also a PcG target gene. Hunchback(Hb) is a repressor for gt. Previously we found that PcG takes over gt repression after Hb is degraded. We have generated a genetic system in which maternal hunchback Hb is expressed ubiquitously but no zygotic Hb expression is absent. Chromatin immunoprecipitation (ChIP) analysis of embryos at multiple developmental stages has been performed to determine the timing and locations of binding by transcription factors, PcG proteins, and deposition of histone modifications. In order to determine the roles played by individual proteins or protein complexes in establishment of PcG silencing, individual proteins will be knocked down using combinations of a maternal Gal4 driver and UAS- shRNA-expressing transgenes. Current work includes generating fly cage for embryo collections following ChIP experiments. Results from these ChIP experiments will show whether PcG proteins has changed missing certain protein.

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Fang Zhang (#89)
Advisor: Steve Vik
Biological Sciences, Dedman College

THE ASSEMBLY PATHWAY OF LMN SUBUNITS IN COMPLEX I

In all animals, the final stage of the oxidation of chemical compounds derived from food takes place in the mitochondrion. This occurs through a series of small steps, during which the energy that is released is carefully converted into the chemical energy currency known as ATP. These steps are catalyzed by enzymes that are embedded in the membranes of the mitochondria. A key enzyme in this pathway is called respiratory Complex I, one of the largest of all known enzymes. Since the 3-dimensional structure of Complex I has been determined, we know what the final product is. But the assembly pathway of the of 13 subunits of Complex I is unknown. In this project we will address the assembly pathway of the 13 subunits

of Complex I. We can predict likely pathways of association based on the observed contact sites that the subunits have with each other. The initial focus is to examine assembly of three subunits, L, M and N. Assembly is tested by expressing these genes, and using a gentle detergent, dodecyl maltoside, to extract complexes from cellular membranes. Results so far have indicated an assembly of M and N, but subunit L is absent, and possibly migrates as an oligomer. Expression of all subunits leads to a large complex that appears to be Complex I.

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Chemistry

Maha Aljowni (#90)
Advisor: Alexander Lippert
Chemistry, Dedman College

SYNTHESIS OF ANTI-CANCER DRUGS TO INHIBIT P-GP PUMPING ACTION

In recent years, many cancer chemotherapeutic agents have not shown much promise because they have failed to accumulate in cancer cells long enough to have any effect. This is due to the overexpression of a plasma membrane protein called P-glycoprotein (P-gp). Generally, the role of P-gp is to protect the cells from any toxins or foreign substances by pumping these toxins (including chemotherapeutic drugs) out of the cell. As part of my graduate research, biologists at SMU are using a computer-generated model to predict the structures of P-gp inhibitors that can be synthesized in order to stop or inhibit the action of P-gp. This model is proposed to help researchers stop P-gp pumping after docking with new drugs and to understand the mechanism of it. Furthermore, my current research is focused on a collaboration with the chemistry and biology departments for synthesizing multiple drug analogues that can inhibit the P-gp protein. These are being tested in cancer cell lines for efficacy and strength of inhibition so that future chemotherapeutic drugs can work effectively in cells.

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Zheng Dong (#91) Hongyu Zhou
Advisor: Peng Tao
Chemistry, Dedman College

COMBINING PROTEIN SEQUENCE, STRUCTURE AND DYNAMICS: A NOVEL APPROACH FOR FUNCTIONAL EVOLUTION ANALYSIS OF PAS DOMAIN

PAS domain is widely spread in archaea, prokaryote and Eukaryota, and plays important roles in various functions, such as voltage-sensitive ion channels, photoreceptors and circadian clocks. In this study, we aim to show the residue vibration distribution differences among various biological functions (nucleotide binding, photoreceptor activity and transferase activity) and construct functional evolutionary relationship among proteins in PAS domain by using the evolutionary analysis of sequence divergence and elastic network model (ENM). The result showed that each biological function corresponds to a special vibration distribution for protein residues and core residues (identified by sequence and structure conservation analysis) has a lower fluctuation than others protein residues. It also suggested a special connection in which

the protein sequences were related to various functions (from functionally conserved residues with low dynamical fluctuation to protein biological functions). This research is a new attempt to delineate functional evolution of proteins using the integrated information of sequence, structure and dynamics.

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Alan Humason (#92)
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Chemistry, Dedman College

DECIPHERING THE NATURE OF THE PANCAKE BONDING INTERACTION - ARE THESE THE LONGEST BONDS IN CHEMISTRY?

Free radical molecules are generally short-lived because of their tendency to self-dimerize into more stable covalently bonded species. In the 1950's, Mulliken proposed that novel chemistry could be observed by creating a sterically hindered free radical molecule, which could not dimerize, as steric repulsion between the species hinders dimerization. He named this proposed, but unobserved, interaction 'pancake bonding.'

Once synthesized, studies of magnetic properties and X-ray structures of these pancake bonded compounds found that the molecules exist as stacked dimers, at distances longer than normal covalent bonding distances, but shorter than the sum of their van der Waals radii. This led to speculations about the nature of the interaction.

In this work, we employ quantum chemistry to study the bond/dimer dissociation energies of five pancake bonded species. We use the analysis of vibrational modes to determine the local stretching force constants between the dimers, which give a reliable measure of the strength of the interaction between them. We use the critical points of the electron density distribution to characterize the interactions between the monomers. We demonstrate that pancake bonding is not a covalent bonding interaction, and that the so-called 'pancake bonds' are a result of dispersion interactions between two radicals.

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Shital Kale (#93)
Advisor: Brian Zoltowski
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STUDY OF BLUE-LIGHT PHOTORECEPTORS PROTEINS IN SOYBEAN AND BRASSICA RAPA

Plants utilize light not only for growth and development but to synchronize physiological process with daily environmental changes. Arabidopsis thaliana is a useful model for plant circadian rhythms and photoperiodic flowering. In Arabidopsis, LOV domain containing blue-light photoreceptors Zeitlupe (ZTL), Flavin-Kelch-Fbox-1 (FKF1) and LOV-Kelch-Protein-2 (LKP2) are involved in the regulation of the circadian clock and seasonal flowering. These plant photoreceptors contribute to agricultural productivity. Therefore, we extended these plant photoreceptor studies to Soybean and Brassica rapa, the world's major agricultural crops. Sequence alignments of photoreceptor ZTL/FKF1 of Arabidopsis similar to the Brassica rapa LKP2 families as well as Soybean ZTL/FKF1 family members. In order to understand biological functions of Soybean and Brassica rapa, it is vital to understand its photocycle and chemical activation. Accordingly, we

studied photochemical characterization to confirm the recovery rates of these LOV domain photoreceptors. We further investigated these proteins as bio-functionalized photocurrent generators on metal oxide electrode system at room temperature.

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Rajesh Kumar (#94)
Advisor: Nicolay Tsarevsky
Chemistry, Dedman College

UTILIZING 1-CHLORO-1,2-BENZIODOXOL-3(1H)-ONE IN THE PREPARATION OF BRANCHED POLYMERS

(Hyper)branched polymers have found many applications due to their unique structure and the presence of multiple functionalities (e.g., situated at the chain ends). The one-pot synthesis of highly branched polymers with numerous alkyl chloride-type chain ends was accomplished by the copolymerization of vinyl monomers and crosslinkers in the presence of 1-chloro-1, 2-benziodoxol-3(1H)-one (CBIO), which served both as an initiator and a transfer agent. CBIO is a heterocyclic hypervalent iodine (III) compound with a labile I-Cl bond, which can be easily cleaved homolytically upon heating or irradiation with visible or UV light. In addition, CBIO is likely able to react with propagating radicals by transferring a Cl atom. As a result of this transfer, gelation in systems containing crosslinker is significantly delayed and up to relatively high monomer conversions, soluble highly branched polymers are formed. The effects of co-monomer and CBIO concentrations, temperature, light source, and solvents on the outcome of the copolymerizations were systematically studied.

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Siying Lyu (#95)
Advisor: Elfi Kraka
Chemistry, Dedman College

THE ROLE OF H-BONDING IN RNA AND DNA

The strands of the DNA or RNA double helix are hold together by the hydrogen bonds of the base pairs whereas the strands themselves are influenced by the conformational flexibility of the (deoxy)ribose rings, which depends on their pseudolibration modes and the rotation of the side groups. The latter are also influenced by hydrogen bonding, which couples pseudolibration and side group rotations.

In this work, the strength of the H-bonds keeping the various base pairs together is determined and compared with that in the (deoxy)ribose rings. Based on the calculated local stretching force constants of the type O…H or N…H there is a clear preference of H-bonding in the base pairs compared to that in the (deoxy)ribose rings, which for the first time is quantified. H-bonding in the (deoxy)ribose rings is undergoing a large amplitude oscillation guided by the pseudolibrational motion of the five-membered ring.

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Patricia Nance[UG] (#96)
Advisor: Patty Wisian-Neilson
Chemistry, Dedman College

SYNTHESIS AND CHARACTERIZATION OF ANTIBACTERIAL POLYPHOSPHAZENE MATERIALS

Properties of the polyphosphazene, [RR'PN]n, can be selected for specific purposes by post polymerization modification of the side groups, R and R', which are attached to the polymeric backbone via phosphorus carbon bonds. Poly(methylphenylphosphazene) (PMPP) is among the most extensively studied of these alkyl/aryl polyphosphazenes, which are synthesized by condensation polymerization of N-silylphosphoranimines. PMPP is most easily modified by deprotonation of the methyl group followed by substitution of electrophiles. This ongoing work explores the use of this method to substitute antibacterial groups onto the polyphosphazene backbone so that they may be used for biomedical applications.

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Matthew Nguyen[UG] (#97)
Advisor: Nicolay Tsarevsky
Chemistry, Dedman College

UTILIZING CBR4 AS TRANSFER AGENT IN MINIEMULSIONS TO SYNTHESIZE DEGRADABLE BRANCHED POLYMER PARTICLES

Diethylene glycol methyl ether methacrylate (DEGMEMA) and bis(2-methacryloyloxyethyl) disulfide (5, 10 and 20 mol% relative to DEGMEMA) were copolymerized in the presence of transfer agent CBr4 (5-, 10-, 20- and 40-fold excess vs. initiator) to form highly branched polymers with alkyl bromide peripheral groups. The miniemulsion polymerization technique was employed to polymer particles consisting of branched degradable polymers, which can be used for drug delivery purposes. The disulfide bond in the crosslinked or highly branched polymer can be easily cleaved under reducing environment yielding linear polymer chains of DEGMMA. Nile red (hydrophobic dye) was incorporated in the particles as a model for the cancer drug, which releases as the disulfide bond breaks in the presence of reducing agent (triphenyl phosphine) and the release efficiency was studied using florescence spectroscopy. Peripheral alkyl bromide groups can be readily converted to azide groups, which could be employed in further “click”-type surface functionalization reactions, for instance with alkynyl-group containing folic acid.

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Vytor Oliveira (#98) Elfi Kraka
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Chemistry, Dedman College

EXPLORING THE NATURE AND STRENGTH OF CHALCOGEN BONDING FOR THE RATIONAL DESIGN OF NEW MATERIALS

Non-covalent interactions guide the self-assembly of macromolecules such as proteins, DNA/RNA, polymers, and are responsible for drug-receptor recognition, crystal packing, ion-transport, etc. Besides the well-known hydrogen bonds, chalcogens (O, S, Se, Te) are also able to form short, directional, non-

covalent interactions, called chalcogen-bonding. Since this interaction is less explored than hydrogen bonding and other non-covalent bonds, chalcogen compounds are interesting candidates for the development of materials with unique properties.

We studied 90 chalcogen-bonded complexes, calculated their local stretching force constant, and analyzed their electron density distributions. We found out that most chalcogen bonds involve the charge transfer of lone pair electron density of a hetero atom A to the antibonding orbital s*(Y-E) involving the chalcogen E and a suitable atom (group) Y. The strength of chalcogen bonding depends on the polarizability of E, polarizing power of Y, and electron donor ability of A. In a divalent chalcogen, the second ligand can enhance the strength of the bond by withdrawing charge from the lone pair of E and decreasing exchange-repulsion between E and A. There are possibilities to fine-tune a divalent chalcogen compared to a monovalent halogen or hydrogen. Based on this study, a receipt for creating new chalcogen-bonded building blocks is given.

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Shreya Patel[UG] (#99)
Advisor: Alexander Lippert
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RHODAMINE-DERIVED OPTICAL SWITCHES FOR THE GENERATION OF THREE-DIMENSIONAL DISPLAYS

Recently, photoswitchable fluorophores have been lauded for use in super resolution microscopy. However, other potential applications of these optical switches have yet to be discovered. We report the synthesis of a series of reversible fluorophores that are activated by ultraviolet light. Photoswitches capable of red fluorescence were synthesized from rhodamine derivatives by amide ring-forming substitution. In order to achieve red fluorescence, spirhodamine switches were activated by UV light and then made fluorescent by absorbance of visible green light. These switches are capable of being activated quickly and selectively by an innovative optical system, with hardly any effects of photobleaching over an extensive period of time. The optical switches have a high quantum yield and can be turned off almost instantaneously by novel mechanisms. The synthesis, spectroscopy, and innovative optical material applications of these photoswitches will be presented.

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Lucas Ryan (#100)
Advisor: Alexander Lippert
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A MOLECULAR COLOR PALETTE ACCESSED THROUGH DESIGN OF PHOTOCAGED CHEMILUMINESCENT MOLECULES

Chemiluminescent probes are popular targets in the detection of various cellular processes due to their inherently high signal-to-noise ratio. However, most of these probes suffer from inadequate signal when tested due to lack of bioaccumulation in the cell before the probes react. Photocaged molecules solve this problem by "caging" the reactive site of the probe, and can acquire increased signal due to increased probe

concentration. Here we describe the synthesis of several photocaged chemiluminescent molecules with tunable excitation and emission wavelengths to achieve a chemical "color palette" of probes.

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Kelly Schostag[UG] (#101)
Advisor: David Son
Chemistry, Dedman College

A NOVEL SYNTHESIS OF THIOLS UNDER MILD CONDITIONS

Thiols are incredibly useful compounds known for diverse applications in many fields. Thiols tend to be very important compounds in synthesis and stabilization applications as well as for protective coatings. For instance, thiols are used to stabilize gold nanoparticles which have shown promise in cancer cell imaging. Additionally, they are used in the formation of star polymers which have been proven to be useful tools in the medical field, and in the formation of plastics. Despite the utility of these compounds, a general and efficient synthesis of thiols and multi-thiols is unknown. This is in part due to the harsh conditions and multiple steps normally required to synthesize thiols; however, past research in the Son laboratory (unpublished) has found that certain thiols can be synthesized more easily by reacting a trithiocarbonate sodium salt with bromide in the presence of phase transfer catalyst. This project's aim has been to explore this process, increase its efficiency, and find whether this reaction can occur with other halides and other reaction conditions in order to find a process by which thiols can be made commercially available.

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Li Shen (#102) Hongyu Zhou; Hao Xu; Feng Wang
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CATALYTIC MECHANISMS OF ß-LACTAMASES: CHEMICAL DRIVING FORCES BEHIND ANTIBIOTICS RESISTANCE?

ß-Lactamases are enzymes that hydrolyze ß-lactam antibiotics. They are the main cause of antimicrobial resistance, and continuously evolve adaptive mechanisms in a biological arms race with the development of antibiotics. Elucidating and predicting ß-lactamase evolution are crucial for the future development of antibiotics with low or even no resistance. ß-Lactamases cause antibiotics resistance by breaking the ß-lactam ring of antibiotics, rendering them ineffective. As the initial attempt to depict catalytic mechanism evolution of ß-lactamases, we carried out hybrid quantum mechanical and molecular mechanical (QM/MM) calculations within chain-of-states framework to obtain minimum energy pathways (MEP) to represent catalytic mechanisms of key ß-lactamases. These pathways from different ß-lactamases are superimposed and compared to shed lights on evolution of ß-lactamases catalytic mechanisms.

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Manasa Subbarao (#103) Weiwei An; Jian Cao; Luke Ryan; Audrey Reeves
Advisor: Alexander Lippert
Chemistry, Dedman College

DETERMINATION OF EFFICACY AND SELECTIVITY OF FLUORESCENT PROBES FOR RSON SPECIES IN A549 CANCER CELL LINE

Recent studies in human health and diseases have found an increase in reactive nitrogen, oxygen and sulfur species to be linked to inflammation in cases such as asthma and cancer. Many current techniques for prognosis and diagnosis of such diseases are invasive and complex. Our laboratory has synthesized fluorescent probes which selectively react with species such as NO, H2S and HNO. Based on the intensity of fluorescence, one can determine if the RSON species is elevated in the body tissue and, thus, if it is inflamed. Testing the probes in A549 lung epithelium cancer cells with exogenously introduced RSON species has shown promising results thus far. Our probes are novel or, in some cases, achieve more efficacy and selectivity than those that are currently available. They may also provide insight into the etiology, epidemiology and pathways involved in certain illnesses.

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Yunwen Tao (#104) Wenli Zou; Junteng Jia; Wei Li; Dieter Cremer
Advisor: Dieter Cremer
Chemistry, Dedman College

WHY DOES HOT WATER FREEZE FASTER THAN COLD WATER?

Water has many unusual physical and chemical properties, which are related to the network of hydrogen bonds in the liquid. One of the most peculiar properties leads to the observation that hot water freezes faster than cold water (Mpemba effect). Knowledge and use of the Mpemba effect goes back to Aristotle (350 AC), Francis Beacon (1561-1626), or Rene Descartes (1596-1650) who all describe the use of this effect. The Mpemba effect is the more interesting as it has been discussed controversely in the literature.

We investigated changes in the hydrogen bond network of liquid water using molecular dynamics simulations. We could identify 36 different hydrogen bonding situations of which 16 are relevant for the discussion. We determine the temperature dependence of H-bonding show that at higher temperature weaker H-bonds are broken whereas strong H-bonds dominantly remain. Our results provide a molecular explanation of Newton's law of cooling and the Mpemba effect.

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Avichal Vaish (#105)
Advisor: Nicolay Tsarevsky
Chemistry, Dedman College

PREPARATION OF SELF-HEALING & DYNAMIC GELS AND THEIR CONVERSION TO NON-DYNAMIC GELS USING HYPERVALENT IODINE COMPOUND

In modern organic chemistry, hypervalent iodine(III) compounds are frequently used as oxidizing agents but application of ?3-iodanes in polymer and material chemistry is still underexplored. In this work, we report on the preparation of dynamic and self-healing materials by employing ligand exchange reactions involving

hypervalent iodine(III) compounds of the type ArIL2 (Ar = Aryl, L = ligand, e.g., carboxylate or (pseudo)halide). These compounds can undergo ligand exchange reactions in presence of nucleophiles (Nu-) to form ArINu2. Diacetoxyiodo benzene (DAIB) was successfully employed as a crosslinker to prepare dynamic and self-healing gels derived from carboxylate-containing polymers. Furthermore, advantage was taken of the ability of DAIB to generate radicals upon UV light irradiation in order to convert the dynamic crosslinked structures to permanent (set) networks.

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Feng Wang (#106) Hongyu Zhou; Sung Joon Kim; Peng Tao
Advisor: Peng Tao
Chemistry, Dedman College

ATOMIC DETAILS OF BINDING MODES BETWEEN ANTIBIOTICS AND BACTERIA CELL WALL THROUGH MOLECULAR DYNAMICS SIMULATIONS

Vancomycin is an antibiotic used as the first line treatment for many infections like skin and bloodstream infections. It can inhibit the cell wall synthesis of Gram-positive bacteria through binding to the cell wall structure. It is proposed that the vancomycin binds to a peptide chain of cell wall, and prevents the completion of cell wall synthesis through crossing linking. Due to the limitation of experimental approach, the atomic details of binding mode of vancomycin and the target peptide chain of cell wall structure are yet to be obtained. To address this need, we carried out molecular dynamics (MD) simulation of the systems of vancomycin bound with S.aureus peptidoglycan unit. We also carried out similar MD simulations of variants of vancomycin, including desleucyl-vancomycin, LCTA-1421, F-oritavancin and desleucyl-F-oritavancin. Our simulations provided atomic details of vancomycin and related compounds binding with cell wall peptide. According to our simulations, desleucyl-vancomycin doesn't bind to bacterial cell wall tightly even under restraints based on solid nuclear magnetic resonance (NMR) experimental results. This agrees with the fact that desleucyl-vancomycin is a much less antibiotic than vancomycin. Similar observation was obtained for F-oritavancin and desleucyl-F-oritavancin system.

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Hao Xu (#107)
Advisor: Peng Tao
Chemistry, Dedman College

COMPUTATIONAL INVESTIGATION OF CELL NITROXYL (HNO) FLUORESCENT PROBE

Nitroxyl (HNO) is closely related to cell signaling molecule Nitric oxide (NO). It has been shown that HNO also has significant pharmacological effects in mammalian systems, including vasorelaxation, cardiac contractility, antinociception, and inhibition of enzymes such as aldehyde dehydrogenase. It is critical to develop chemical probe to directly detect presence and concentration of HNO in living cells to understand its functions in cell signaling and other biological processes. However, a sensitive, accurate, and multiple orthogonal chemical probe is yet to be developed to detect and image HNO in vivo. In an attempt to develop efficient fluorescent probes for HNO, two candidate molecules XF1 (nitroXyl Fluor 1) and XF2 were synthesized and investigated for their efficacy in HNO detection.

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Hongyu Zhou (#108) Peng Tao
Advisor: Peng Tao
Chemistry, Dedman College

DIRECT PATHWAY DYNAMICAL SAMPLING METHOD

Enhanced sampling methods are important to gain sufficient sampling around high-energy area on the potential energy surfaces of target sampling systems. Here, we developed an enhanced sampling method, named as direct pathway dynamical sampling (DPDS) method, as an attempt to overcome the above difficulties. In DPDS method, direct molecular dynamics simulations are carried out for the targeting reactions within chain-of-states framework. In the chain-of-states framework, a series of structures are generated and optimized to represent minimum energy pathway connecting a reactant and a product. The advantage of the chain-of-states framework is that no specific reaction coordinates are necessary to generate the reaction pathway, because such information is implicitly represented by the structures along the pathway. Benefitting from this advantage, the reaction coordinates are also implicitly defined in DPDS method. The chain of states setup in DPDS method also guarantees the sufficient sampling in high-energy space between reactant and product, such as transition states. Therefore, DPDS method is particularly effective in sampling the reaction pathway space. Three examples demonstrate the efficiency of DPDS method in sampling the high-energy area important for reactions on the potential energy surfaces.

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Statistical Science

Zhiyun Ge (#109) Daniel Heitjan; Sandi Pruitt
Advisor: Daniel Heitjan
Statistical Science, Dedman College

ESTIMATING LEAD-TIME BIAS

Surprisingly, the duration of survival from the time of a lung cancer diagnosis is longer for prior cancer survivors than for those with no prior cancer. A possible explanation is lead-time bias. That is, physicians perform more frequent and extensive diagnostic evaluations on cancer survivors, whose lung cancers they therefore detect earlier. A statistical model asserts that the survival time of a prior cancer survivor equals a lead time plus the 'natural' survival time. We aim to estimate the distribution of this lead-time bias using data from the NCI's SEER registry. Our model assumes a discrete semiparametric distribution for natural survival and a negative binomial distribution for lead time. Starting with the same natural survival in prior and no-prior groups, we then conduct a sensitivity analysis that allows natural survival to differ between arms according to a proportional odds model on the hazard function. The assumption of discreteness reflects the reality of the data and allows for parsimonious modeling. We estimate that for patients with stage I&II lung cancer, the lead time is highly skewed with a mean of 14.5 months if we assume no difference in natural survival.

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Yu Lan (#110) Daniel Heitjan
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Statistical Science, Dedman College

ADAPTIVE PREDICTION OF EVENT TIMES IN CLINICAL TRIALS

In event-based clinical trials it is common to conduct interim analyses at planned landmark event counts. Accurate prediction of the timing of these landmarks can support trial planning and the efficient allocation of resources. Available methods to create such predictions include parametric cure and non-cure models and a nonparametric approach involving Bayesian bootstrap simulation. The parametric methods work well when their underlying assumptions are met, and the nonparametric method gives calibrated but inefficient predictions across a wide range of models. In the early stages of a trial, when predictions have the highest marginal value, it is difficult to infer the form of the underlying model, including whether a cure fraction exists. We propose here an adaptive method that entertains predictions from a set of possible models while this uncertainty still exists, drawing predictions from the candidate model with the highest Bayesian posterior probability. To capture the uncertainty in model selection, we apply a simulation strategy using the Bayesian bootstrap. A Monte Carlo study demonstrates that the adaptive method produces prediction intervals that have good coverage and are slightly wider than non-adaptive intervals but narrower than nonparametric intervals. It leads to improved predictions with data from the International Chronic Granulomatous Disease Study.

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Xue Li (#111) Sherry Wang
Advisor: Sherry Wang
Statistical Science, Dedman College

A BAYESIAN LATENT VARIABLE APPROACH TO AGGREGATION OF PARTIAL AND TOP RANKED LISTS

Rank aggregation, a meta-analysis method, combines different individual rank lists into one single rank list which is ideally more reliable. It has a rich history in the field of information retrieval, with applications to text mining, webpage ranking, meta-search engine building, etc. However, methods developed in such contexts are often ill suited for genomic applications, in which gene lists generated from individual studies are inherently noisy, due to various sources of heterogeneity. Further, because of missing or zero-count data, a portion of genes are not analyzed in all component studies, leading to partially ranked lists; and for some lists, only top-ranked genes are reported. In this study, we develop Bayesian latent variable approaches to rank aggregation that formally deals with top and partial preference lists. The performance of the proposed method is shown to be an improvement over many popular methods based on a simulation study.

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Ryan McShane (#112) Ian Harris
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Statistical Science, Dedman College

A MODEL OF INCONSISTENCY: NON-TRANSITIVE RANKING IN SPORTS

If The University of Texas (UT) beats The Ohio State University (OSU) and OSU beats Texas Agricultural and Mechanical (A&M), does that mean that UT is better than A&M? Longhorn fans would certainly argue UT is better than A&M, but could dogmatic Aggie fans make a legitimate argument that their team is better? We explore the nature of non-transitive relationships with the method of paired comparisons framework popularized by Maurice G. Kendall and Babington Smith (1940). An algorithm is written and parallelized to extend the frequency distribution of circular triads to a larger number of teams, n, than has ever been published before. A graph theoretic approach is employed to leverage adjacency matrices. Their canonical forms are defined and counted combinatorically. These canonical forms are proposed as models permitting inconsistency.

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Robert Sickorez (#113)
Advisor: Ronald Butler
Statistical Science, Dedman College

NUMERICAL INVERSION OF MOMENT GENERATING FUNCTIONS

In applied probability computation, working with moment generating functions in the transform domain instead of density functions in the time domain allow us to obtain exact functional forms with relative ease. The drawback is the need to invert the resulting moment generating function to obtain the desired probability value. This is difficult when the functions are not rational, in which case we must use numerical methods to approximate the inversion integral along an infinite contour in the complex plane. Available methods integrate along the Bromwich contour, which runs parallel to the imaginary axis to the left of all singularities. Quadrature methods are slow to converge due to the periodicity of the complex exponential function, and so convergence acceleration methods have been introduced. We propose an inversion method that deforms the contour to follow the path of steepest descent. The effect is to dampen the oscillation in the integrand and as a result we dramatically improve the accuracy of numerical quadrature. We demonstrate that we cannot always exactly follow the path of steepest descent because the deformed contour may not be valid. However, by approximately following the path of steepest descent, making adjustments when required to avoid zeros and singularities, we can achieve probability estimates with higher precision than with the existing methods.

Description of Commercial Viability:

The methods we are developing will be useful in a variety of fields. For example, solutions to differential equations are often obtained by applying the Laplace transform and so transform inversion is required to obtain a solution in the original domain. The moment generating function and the Laplace transform are simply reflections of each other across the imaginary axis. Thus, our method will be effective in inverting Laplace transforms as well. We intend to incorporate our procedures into software that will assist researchers working in other fields who have a need to invert such transforms.

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Mumu Wang (#114)
Advisor: Xinlei Wang
Statistical Science, Dedman College

USING RANKED SET SAMPLING WITH BINARY OUTCOMES IN CLUSTER RANDOMIZED DESIGNS

We study the use of ranked set sampling (RSS) with binary outcomes in cluster randomized designs, where a generalized linear mixed model (GLMM) is used to model the hierarchical data structure involved. Under the GLMM-based framework, we develop different estimators of the treatment effect, including the nonparametric estimator (NP), maximum likelihood estimator (MLE) and pseudo likelihood estimator (PL), and study their properties and performance via numeric evaluation and/or simulation. We also develop procedures to test the existence of the treatment effect based on the three RSS estimators, and examine the power and size of the RSS tests vs. simple random sampling (SRS) tests. Further, we illustrate the proposed RSS methods with two data examples, one for rare events and the other for non-rare events. Imperfect ranking is within our consideration throughout our study. Recommendations will be given on whether to use RSS over SRS with binary outcomes in CRDs, and if yes, when to use which RSS estimator among NP, MLE and PL.

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Xiaojie Zhu (#115) Wayne Woodward; Tony Ng
Advisor: Tony Ng
Statistical Science, Dedman College

IMPROVED TEST FOR THE MONOTONIC TREND IN TIME SERIES DATA

For testing the monotonic trend, Brillinger (1989) proposed a test statistic, which is a ratio of a linear combination of the time series values to an estimate of the standard error of the linear combination. However, when there is highly correlated residuals or short records, the procedure proposed by Brillinger (1989) tends to a problem that the observed significance level is higher than the nominal level. We found that the reason could be discrepancies between the empirical distribution of the test statistic and the theoretical asymptotic standard normal distribution. Hence, based on the Brillinger's method, we introduced bootstrap procedures to the test for monotonic trend, which shows improved significance level and comparable power. The proposed procedures are further applied to global mean temperature anomaly from 1880 to 2016, which shows a significant monotonic trend.

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Economics

Cullum Clark (#116)
Advisor: Klaus Desmet
Economics, Dedman College

ON THE UNINTENDED CONSEQUENCES OF STATE-SPONSORED ASSET MARKET BOOMS

I investigate the effect of variation in financial asset valuation levels on capital investment, private sector indebtedness, the relative size of the financial sector, and the evolution of wealth inequality across households, using two datasets: (1) panel data for 22 OECD member states from 1970 to 2015: and (2) U.S. data from 1960 to 2015. I conclude that relatively high asset prices are associated with high debt levels, a super-sized finance sector, and relatively high wealth inequality. While higher asset prices are also associated with higher investment, this effect attenuates when asset valuation levels are relatively high, and higher asset prices indeed become counter-productive at sufficiently high levels. My results argue for caution regarding the likely benefits and consequences of monetary and other policies designed to drive asset prices higher.

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Hao Li (#117) Daniel Millimet; Punarjit Roychowdhury
Advisor: Daniel Millimet
Economics, Dedman College

PARTIAL IDENTIFICATION OF ECONOMIC MOBILITY: WITH AN APPLICATION TO THE UNITED STATES

The global rise in inequality has brought renewed attention to the economic mobility of individuals and households. While many measures of economic mobility exist, reliance on transition matrices derived from survey data remains

pervasive due to simplicity and ease of interpretation. However, estimation of transition matrices is complicated by the well-acknowledged problem of measurement error in self-reported income. Existing methods of addressing measurement error are complex, rely on numerous strong assumptions, and often require data from more than two periods. In this paper, we investigate what can be learned about economic mobility as measured via transition matrices while formally accounting for measurement error in a reasonably transparent manner. To do so, we develop a nonparametric partial identification approach to bound the unconditional and conditional transition probabilities under various assumptions on the measurement error process. This approach is applied to Survey of Income and Program Participation (SIPP) from the United States. Our results show transition matrices of poverty status and the bounds of the transition probabilities in regard to measurement errors.

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Kuangli Xie (#118)
Advisor: Tim Salmon
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CAN FIRM COMPETITION EXPLAIN THE USE OF EXECUTIVE STOCK OPTIONS?

Stock options have long been used in executive incentive contracts and their ability to induce certain types of behavior from managers has been investigated in a large literature. What is absent from much of this literature is the competitive impacts of stock options which might justify the use of stock options. In a competitive environment, an firm owner granting a manager stock options instead of stocks will not only affect the behavior of that manager but also of the manager of the rival firm. The manager granted stock options would act more aggressively because of the protection from potential losses, and her rival manager would expect and react to this. We investigate this issue both theoretically and experimentally by examining how the payoff structure with loss exemption affects manager's investment decisions in a winner-take-all contest. Our theoretical results suggest that owners have little incentive to grant executive stock options if managers are risk neutral, since granting stock options decreases their rival manager's investment by a very small amount. According to the investment behavior observed in our lab experiments, granting stock options instead of stocks is a profitable deviation as it reduces the rival manager's investment significantly.

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Psychology

Rose Ashraf (#119) George W. Holden
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Psychology, Dedman College

MATERNAL DEPRESSION AS A MODERATOR OF HARSH VERBAL DISCIPLINE AND CONFLICT ABSENCE

Depressed mothers experience difficulty disciplining effectively. The relation between mothers' depressive symptoms and children's functioning is transactional: children with depressed mothers are more likely to have developmental deficits and mothers with difficult children are at higher risk for adjustment problems. It was predicted that mothers with high levels of depressive symptoms would not elicit conflict absence when using harsh verbal discipline (HVD) compared to mothers with low levels of depressive symptoms. Participants included 33 mothers. Mothers wore audio-recorders at home. HVD and conflict absence were coded. The Beck Depression Inventory (BDI) was used to yield a total score of depressive symptoms. There were 893 HVD incidents. A multilevel model with a binomial distribution and logit link function was utilized. There was a significant interaction between BDI and number of incidents predicting conflict absence. For mothers with low or average BDI scores, the probability of conflict absence decreased as frequency of HVD increased. For mothers with high BDI scores, the frequency of HVD did not significantly predict conflict absence. It is possible that mothers with high BDI are less likely to elicit conflict absence because their children have more difficult temperaments, are more emotionally reactive, or have higher levels of behavior problems overall.

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Grace Boyers (#120)
Advisor: Lorelei Simpson Rowe
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DEPRESSIVE SYMPTOMS AND RELATIONSHIP SATISFACTION IN BIPOLAR DISORDER

Depressive symptoms and relationship satisfaction (RS) are correlated (Beach et al., 1990), and current depressive symptoms may predict later levels of RS (Ulrich-Jakubowski et al., 1988). Depressive symptoms and RS also fluctuate non-linearly around an individual's own average (Whitton & Whisman, 2010). However, there is little examination of their covariance over more than 2-3 time periods. The current study tests the hypothesis that own and partner depressive symptoms will covary with RS in a weekly diary study. We also expected that weekly depressive symptoms would differentially impact weekly RS depending on average depressive symptoms. We tested hypotheses using a sample of individuals with bipolar disorder and their opposite-sex partners, a group that is particularly vulnerable to relationship distress. As expected, own average level of depressive symptoms was negatively associated with RS for patients; similarly, partners with spouses who were more depressed on average had lower RS. We found that having more depressive symptoms than usual is negatively associated with concurrent RS for patients and partners. Finally, we found a moderating effect of weekly fluctuations in depressive symptoms for patients with lower versus higher average depression: weekly fluctuations had a greater impact on RS for those whose overall depressive symptoms were less severe.

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Page Hurley[UG] (#121)
Advisor: Chrystyna Kouros
Psychology, Dedman College

EMOTION RECOGNITION ABILITIES AND PERCEPTIONS OF MATERNAL WARMTH

The present study examined emotion recognition ability as a predictor of children's perceptions of maternal acceptance and warmth. Participants were 74 mother-child dyads recruited from the community (M age=13.73 years, SD=2.45; 52.7% female; 44.6% White, 28.4% African American, 20.3% Latino/Hispanic, 7.6% reported another or multiple races). Children completed the maternal warmth subscale of the Children's Reports of Parental Behavior Inventory (Schaefer, 1965; a=.89), and mothers' completed the parent-report version (a=.80). Participants completed the Diagnostic Analysis of Nonverbal Behavior 2 (DANVA2; Nowicki & Mitchell, 1998), a computerized emotion recognition task. The Faces stimuli included 24 racially-diverse pictures of children's faces and the Voices stimuli were 24 audio-clips of a child's voice. After each stimuli, participants selected from one of four emotions: happy, angry, sad, or fearful. Errors on the faces and voices stimuli were averaged. The results showed that mothers' errors of misidentifying child negative emotions for happy predicted lower ratings of maternal warmth among children. For boys, their own errors in recognizing happy also predicted lower ratings of maternal warmth. Findings highlight the importance of understanding emotions for fostering healthy parent-child relationships.

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Juliet Kroll (#122) Ashton Steele; Amy Pinkhmam; Chongho Choi; David Kahn; Sheenal Patel; Justin Chen; E. Sherwood Brown; Thomas Ritz
Advisor: Thomas Ritz
Psychology, Dedman College

DISEASE DURATION ASSOCIATED WITH HIPPOCAMPAL NEURONAL INTEGRITY IN ASTHMA PATIENTS

Background: Asthma impacts an estimated 300 million individuals worldwide (GINA, 2016), with US prevalence rates increasing by nearly 15% over the past decade (CDC, 2011). Recent research indicates an increased likelihood of mild cognitive impairment in older individuals with asthma compared to older healthy individuals (Caldera-Alvaro et al., 2013). However, central nervous system (CNS) pathways associated with cognitive functioning in asthma patients are largely unknown. Methods: We therefore tested, in twenty individuals with asthma, associations among left hippocampal metabolites with Magnetic Resonance Spectroscopy (MRS) and disease duration. Participants underwent a 3T MRS scan with volumes of interest placed in the left hippocampus. Total N-acetylaspartate (NAA) concentration was calculated in reference to Creatine (Cr) and water. Results: Asthma duration was negatively correlated with NAA, a marker of neuronal integrity, controlling for age and gender. Discussion: These findings suggest that patients with longer disease duration have reductions in hippocampal neuronal integrity. As hippocampal neuronal integrity measured by NAA is associated with mild cognitive impairment in healthy and aging individuals, future research is warranted to examine asthma and treatment specific contributions to reduced NAA, which may influence cognitive function.

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Michael Ovalle (#123) Naomi V. Ekas; Chrystyna D. Kouros
Advisor: Chrystyna Kouros
Psychology, Dedman College

"TE DIJE": THE MODERATING ROLE OF ACCULTURATION ON HELICOPTER PARENTING AND DEPRESSIVE SYMPTOMS IN LATINO EMERGING ADULTS

Helicopter parenting during emerging adulthood has been shown to predict depression and anxiety in largely White samples. It is important to investigate how helicopter parenting may be related to negative outcomes in ethnic minorities. The current study investigated level of acculturation as a moderator of the relation between helicopter parenting and depressive symptoms in Latino emerging adults. Participants were 46 Latino college students who completed the Helicopter Parenting Scale, an acculturation scale, the Inventory of Depression and Anxiety Symptoms, the Beck Hopelessness Scale, and the Cognitive Style Questionnaire. Correlations showed that helicopter parenting was positively related to all three outcomes—depressive symptoms, hopelessness, and negative cognitive style. We ran three separate linear regression models that included the main effects of helicopter parenting and acculturation and their interaction. Level of acculturation significantly moderated the relation between helicopter parenting and concurrent depressive symptoms, $b = -0.56$, $SE = 0.28$, $p = 0.05$, hopelessness, $b = -0.19$, $SE = 0.09$, $p = .04$, and negative cognitive style, $b = -3.06$, $SE = 1.19$, $p = .01$. The findings underscore the importance of examining helicopter parenting and acculturation as important risk and protective factors related to negative mental health outcomes in Latino emerging adults.

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Caitlin Rancher (#124) Ernest N. Jouriles; David Rosenfield; Renee McDonald
Advisor: Ernest Jouriles
Psychology, Dedman College

PHYSICAL AND SEXUAL TEEN DATING VIOLENCE RE-VICTIMIZATION: THE ROLE OF TRAUMA SYMPTOMS

US national surveys consistently document that at least 10% of adolescents in romantic relationships experience physical and/or sexual teen dating violence (TDV) over the course of a year. Over 30% of those victimized also report re-victimization at a later time. Unfortunately, little is known about the factors contributing to TDV re-victimization. Research on adult intimate partner violence highlights psychiatric symptoms as a potential contributor to re-victimization. Specifically, experiencing victimization can result in trauma symptoms, such as re-experiencing the traumatic event, avoidance, and hyper-arousal. Such symptoms may, in turn, contribute to increasing the risk for re-victimization. This study uses longitudinal data to examine the extent to which trauma symptoms occur in response to TDV victimization, and predict future re-victimization. Participants were 104 (49% female) 14 to 17-year-olds. Results indicated that the re-experiencing symptom cluster mediated the relation between TDV victimization and re-victimization. Total trauma symptoms, avoidance and hyper-arousal symptom clusters were nonsignificant mediators. Our results suggest understanding how different trauma symptoms operate to increase adolescents' vulnerability to TDV is important, both for prevention programs and to increase understanding of the mechanisms contributing to TDV re-victimization.

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Catherine Rochefort (#125) Deanna Denman; Amy McQueen; Jasmin Tiro
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Psychology, Dedman College

IS ANTICIPATED REGRET A SEPARATE AND UNIQUE THEORETICAL CONSTRUCT FROM MOTIVATION IN THE CONTEXT OF HPV VACCINATION?

Anticipated regret (AR), a negative emotion stemming from the ability to reason counterfactually, predicts health behaviors, but no studies have shown that it is separate from motivation. AR is conceptually similar to introjected motivation (i.e., motivation to avoid guilt and shame). We hypothesized that AR about not vaccinating a child against HPV would more strongly predict introjected than autonomous motivation (i.e., motive that reflects personal values). We assessed AR, motivation, and vaccination intentions via telephone questionnaires from 223 parents of unvaccinated adolescents attending safety-net clinics. Using confirmatory factor analyses, a model including AR and autonomous, introjected, and external motivation provided a good fit to the data (TLI= .971, CFI= .983, RMSEA= .053, 90% CI: .013, .085). AR did not load onto introjected (.26) or autonomous motivation (.49). In a univariate regression, AR predicted intentions (ß= .243, $p < .001$). A multivariate model containing introjected motivation and AR showed both to be predictors of intentions, but when tested simultaneously with autonomous motivation, AR no longer predicted intentions. AR is a distinct construct from motivation. In addition, AR did not explain any variance in HPV vaccination intentions that is not shared with autonomous motivation. Implications for these findings will be discussed.

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Andres Roque (#126) David Rosenfield; Jasper A. J. Smits; Naomi Simon; Michael W. Otto; Luana Marques; Mark H. Pollack; Stefan G. Hofmann; Alicia Meuret
Advisor: Alicia Meuret
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MODERATING EFFECTS OF DCS ON HOMEWORK COMPLIANCE IN SOCIAL ANXIETY DISORDER

Homework compliance (HC) has been investigated as a predictor of treatment outcome in anxiety disorders. In a study by Olatunji et al. (2015), those who received D-Cycloserine (DCS) and had higher HC were found to have significantly lower symptom ratings as compared to receiving placebo in a sample with obsessive-compulsive disorder. The aim of the present study is to further examine the effects of HC on symptom reduction in group CBT sessions in adults with Social Anxiety Disorder (SAD). We also investigated whether DCS would moderate the effect of homework on SAD symptom reduction. One hundred sixty-nine participants with SAD received 50 mg of DCS or placebo, administered prior to sessions 3-7, while participating in 12 exposure based group CBT sessions. Improvement in SAD was assessed at each session, post-treatment, and 1, 3, and 6 month follow-ups using the Liebowitz social anxiety scale (LSAS). We found that irrespective of treatment condition, greater between-session HC was related to significantly lower SAD severity at the next session ($b=-1.10$, $t(587)=-4.36$, $p<.001$) and at exposure sessions only ($b=-.72$, $t(371)=-2.29$, $p=.023$). DCS did not moderate the effect of HC on LSAS ($p=.90$). Greater HC in group CBT for SAD predicted greater reductions in SAD severity. These findings diverge from prior studies possibly due to DCS being administered before and not after sessions.

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Margarita Sala (#127) David Rosenfield; Austin S. Baldwin
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POST-EXERCISE AFFECTIVE RESPONSE: EXAMINING DIFFERENCES BETWEEN REGULAR AND INFREQUENT EXERCISERS

The purpose of this study was to determine the extent to which specific post-exercise affective states differ between regular and infrequent exercisers, thereby elucidating the "feeling better" phenomenon. Regular ($N = 32$; > 75 minutes per week of vigorous exercise) and infrequent exercisers ($N = 25$; < 30 minutes per week of vigorous exercise) completed a 10-minute bout of vigorous exercise on a treadmill and reported their affective states at various time points during and after the both. Consistent with previous findings, both regular ($p = .005$) and infrequent exercisers ($p < .001$) reported an improvement in core affective valence after the exercise bout (i.e., "feeling better"). However, infrequent exercisers reported a greater decrease in negative affect ($p = .01$) and a greater sense of relief ($p = .003$) immediately post-exercise than regular exercisers. In contrast, regular exercisers reported a greater increase in positive affect ($p = .02$) immediately post-exercise than infrequent exercisers. The systematic differences between regular and infrequent exercisers in post-exercise affect states indicates that "feeling better" after vigorous exercise is a different affective experience for regular and infrequent exercisers.

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Kelli Sargent (#128) Ernest Jouriles; David Rosenfield; Renee McDonald
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HIGH-SCHOOL STUDENTS' OPPORTUNITIES FOR HELPFUL BYSTANDER RESPONSES IN SITUATIONS POSING RISK FOR DATING VIOLENCE

Up to 40% of teens experience physical or sexual violence in dating relationships, and experiencing such violence predicts a variety of adjustment difficulties. Bystander programs seek to prevent dating violence by increasing adolescents' protective responses to take care of others, by interrupting situations posing risk of violence or intervening after violence has occurred. The current study examines age-related differences in opportunities for helpful bystander behavior, and how often teens actually intervene in these situations. Participants completed self-reports of bystander behavior at 2 assessments 3 months apart. As expected, there was variability in types of situations encountered and responses to situations. There was a main effect of age across assessments, with older students reporting more opportunities than younger students, $p = 0.02$. Age was not related to the proportion of bystander situations in which students intervened. Assessing bystander behaviors in the context of opportunity is informative for determining whether students choose not to intervene or simply do not encounter certain situations, and understanding why teens fail help. Results suggest that although adolescents may be increasingly exposed to situations posing risk for relationship violence as they age, processes that prevent helpful responses may remain consistent across adolescence.

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Rui Tang (#129) Lynette Silva
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THE IMPACT OF LANGUAGE AND EDUCATION ON NON-VERBAL NEUROPSYCHOLOGICAL MEASURES

Current study examines the role of language and education on commonly used non-verbal neuropsychological tests. 56 patients who come to the adult neuropsychology outpatient clinic with primary memory difficulties are examined in different domains of neuropsychological functions. Patients with any focal damage in the brain, including traumatic brain injury, tumor, or any other brain disorders are excluded. Patients who didn't pass the symptoms validity tests are also excluded. Patients reported an average age of 47.09 (SD= 15.48), average 11.73 (SD= 2.99) years of education. Variables of interest include Symbol Digit Modalities Test (Written and Oral), Trails Making B, Rey-Osterrieth Complex Figure Test (RCFT) and Brief Visuospatial Memory Test (BVMT). In multiple regression, sex and age are entered in step 1, years of education in step 2 and performance on WASI-Vocabulary in step 3 as predictors. Except for BVMT, WASI-vocabulary is a significant predictor of all four non-verbal tests when age, sex and education are controlled. These findings are consistent with the literature that verbal skills influence visuo-motor integration and non-verbal problem solving skills. It also suggests vocabulary might be a more sensitive indicator than years of education in predicting non-verbal neuropsychological performance.

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Natalie Tunnell (#130) David Rosenfield; Anke Seidel; Alicia E. Meuret
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PATHWAYS OF MULTIDEMINSIONAL CHANGE DURING IN-VIVO EXPOSURE IN PANIC DISORDER

The goal of this study was to examine the degree to which physiological responding during in-vivo exposure to feared situation mediated experiential responding. We investigated the extent to which prior coping skill training would moderate physiological and emotional responding. Thirty four individuals meeting DSM-IV diagnostic criteria for panic disorder and agoraphobia received 3 weekly in-vivo exposure sessions and a 4th session at 2-month follow-up, yielding 122 total sessions. Cardio-respiratory physiology, experiential symptoms and panic symptomatology were assessed throughout exposure sessions. Multidimensional, longitudinal moderated mediation analyses were employed to assess relatedness and direction of the psychophysiological fear indices. The treatment resulted in significant improvements in panic symptom severity, panic cognition, and functioning. Quadratic trends in cardiac responding mediated reductions in the experiential symptoms. Reductions in panic symptoms, however, were unrelated to changes in cardio-respiratory symptoms, cognitive symptoms, and anxiety during exposure. This mediation pattern was stable across sessions and independent of treatment condition. Results suggest physiological and experiential pathways of change to interact, thus supporting the important role of the physiological dimension in exposure-based treatments of panic disorder.

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Nicole Vu (#131) Ernest Jouriles; Renee McDonald
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EXPANDING THE DEFINITION OF CHILDREN'S EXPOSURE TO INTERPARENTAL VIOLENCE

Children's exposure to intimate partner violence (IPV) is typically conceptualized as exposure to acts of physical aggression. Yet, many governmental agencies conceptualize IPV to be broader. However, research examining the relative contributions of different types of IPV in predicting child externalizing problems and family processes associated with such problems is scarce. We evaluated the utility of broadening the conceptualization of children's exposure to IPV. We hypothesized that sexual coercion and psychological aggression will contribute uniquely in predicting children's externalizing problems and harsh parenting, after controlling for physical IPV. Participants were 517 children and their mothers from the community. Mothers completed measures of IPV and harsh parenting; mothers and children reported on children's externalizing problems. In cross-sectional analyses, psychological aggression and sexual coercion were positively associated with externalizing problems and harsh parenting. In prospective analyses, psychological aggression was positively associated with externalizing problems, but not harsh parenting. Our results suggest that researchers may gain a more comprehensive understanding of IPV and child adjustment by assessing not only children's exposure to physical aggression, but also sexual coercion and psychological aggression, in their measurement of IPV.

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Applied Physiology and Wellness

Dustin Allen (#132) Mu Huang; Elliot Frohman; Sushmita Purkayastha; Matthew Brothers; Scott Davis
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MULTIPLE SCLEROSIS ALTERS DYNAMIC CEREBRAL AUTOREGULATION DURING PASSIVE HEAT STRESS

The majority of individuals with multiple sclerosis (MS), a disease affecting the central nervous system, experience temporary worsening of their symptoms upon increases in core temperature (Tcore). This study tested the hypotheses that persons with MS: 1) have impaired dynamic cerebral autoregulation (dCA) during normothermia (NT), and 2) impairments would be further exacerbated during a whole-body heat stress (WBH). Seven subjects with MS and 7 sex, age, height, and weight matched healthy controls (CON) were outfitted in a water perfusion suit and exposed to NT (34 °C water perfused for 10 min) and WBH (48 °C water perfused until 0.8 °C increase in Tcore). Mean middle cerebral artery blood velocity (MCAv) and mean arterial pressure (MAP) were taken throughout each thermal condition. Transfer function analysis of beat-to-beat fluctuations in MAP and MCAv was used to quantify dCA during NT and WBH. Contrary to hypothesis one, LF phase ($p=0.29$) and LF gain ($p=0.52$) were similar during NT. However, a significant group x condition interaction ($p=0.01$) was observed for LF gain in response to WBH. Further analyses revealed differences in LF gain between groups following WBH (MS: 1.26 ± 0.47 vs CON: 0.79 ± 0.21 cm/s/mmHg, $p=0.03$). No differences were observed in LF phase during WBH ($p=0.66$). Taken together, dCA (an increase in LF gain) is impaired in MS during passive whole-body heating.

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Applied Physiology and Wellness, Simmons School of Education

IMPROVEMENT IN HEART RATE VARIABILITY DURING MILD COGNITIVE TASK FOLLOWING CONCUSSION

The study was designed to examine autonomic nervous system (ANS) modulation utilizing heart rate variability (HRV) at rest and during mild cognitive task in concussed and control athletes. 19 concussed and 19 controls were enrolled. Continuous heart rate was recorded at rest for 6 minutes and during a 3-minute mild cognitive task (2-Back). Average response time and the percentage of correct responses were obtained from the task. HRV was analyzed with power spectral analysis within the low and high frequency domains. Higher LF (61 ± 15 vs. 45 ± 12, $P=0.007$), lower HF (39 ± 15vs.54 ± 12, $P=0.008$) and higher LF/HF ratios (2.2 ± 2 vs.0.92 ± 0.4, $P= 0.005$) were observed in the concussed compared to controls at rest indicating exaggeration of the sympathetic modulation. Conversely, lower LF (44.5 ± 14, $P=0.003$), higher HF (55.4 ± 14, $P= 0.003$) and lower LF/HF ratio (0.92 ± 0.5, $P=0.003$) were observed during 2-Back as opposed to rest in the concussed group. Controls showed no difference in HRV between rest and 2-back. Despite similar response time for the cognitive task, the percentage of correct response was lower (79.9 ± 14.2 vs. 89.9 ± 4.6, $P=0.008$) in concussed compared to controls. Disturbances in ANS exist as early as 4 days following a concussion. Further studies are needed to determine if mild cognitive tasks improve cognitive function and may expedite the return-to-learn phase in student athletes.

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IMPAIRED CEREBRAL VASOREACTIVITY PERSISTS BEYOND SYMPTOM RESOLUTION FOLLOWING CONCUSSION IN COLLEGIATE ATHLETES

The purpose of this study was to examine cerebral vasorecativity (CVR) in collegiate athletes during acute (4±1 days) and sub-acute (21±1 days) phases following concussion and compare them with non-injured controls. 16 athletes with sports-related concussion and 16 controls were enrolled in the study. Symptoms and cognition were assessed. Continuous middle cerebral artery blood flow velocity (MCAV) was obtained with transcranial Doppler ultrasonography (TCD). End-tidal CO2 (PetCO2) were obtained through a nasal cannula. MCAV was evaluated in response to changes in PetCO2 for 2 minutes each during normal breathing (normocapnia), inspiring a gas mixture of 8% CO2, 21% O2 (hypercapnia) and, hyperventilating (hypocapnia). CVR was analyzed as the slope of the linear relationship between percent changes in MCAV per mmHg change in PetCo2. Concussed athletes exhibited higher symptom severity (26.3±0.5 vs. 5±7 P= 0.0007) and lower cognition (26.5±1.6 vs. 28.3±2.4 P=0.03) during acute phase compared to the controls. Symptoms and cognition were resolved during the sub-acute phase. However, CVR was lower in the acute phase compared to the controls (1.7±0.5U vs. 2.3±0.3U, P=0.0006) and continued to be blunted in the sub-acute phase (1.9±0.5U P=0.04). Despite improvements in clinical symptoms, physiological recovery measured as CVR was blunted in the sub-acute phase following concussion.

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TATTOOS ATTENUATE SWEATING RESPONSES DURING A PASSIVE WHOLE-BODY HEAT STRESS

Tattoos have recently increased in popularity among individuals aged 18-40. The tattooing process involves repeated needle insertions (50-3,000/min) to deposit ink at a depth of 3-5 mm into the dermal layer, potentially impairing thermoregulatory mechanisms. The aim of this study was to test the hypothesis that reflex increases in skin blood flow and sweat rate (SR) and are blunted in tattooed skin (TAT) compared to adjacent healthy skin (CON) during a passive whole-body heat stress (WBH). Four individuals (2M, 2F) with a large area of tattooed skin participated in the study. Skin blood flow and SR were continuously measured during baseline (34 °C water perfusing a tube-lined suit) and WBH (Tcore 1.0 °C via 48 °C water perfusing the suit). Results indicated that skin blood flow measurements are affected by the tattoo, not allowing for an accurate quantification of skin blood flow in TAT. Sweating responses throughout WBH (area under curve) were attenuated in TAT relative to CON (TAT: 19.06 13.20 vs CON: 24.34 15.61 mg/cm2, p=0.04). Attenuated reflex increases in SR in TAT could be due to ink within the dermal layer, damage to the sweat gland from repeated needle insertions, or some combination therein. Further research is warranted to assess whether these attenuated SR responses translate to increased risk of heat-related injury in those with increased tattoo area.

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FOOT-GROUND FORCES DURING RUNNING: A LOADED APPROACH WITH SENSIBLE POSSIBILITIES

The action-reaction forces present between the foot and ground during locomotion determine the impact and peak loads experienced by the limbs as well as the motion of the body. We used load carriage as an experimental tool to evaluate the ability of an anatomically-based, two-mass model of the human body to predict vertical impact and peak forces during running from only four inputs: body weight (Wb), contact time (tc), aerial time, (ta), and lower-limb acceleration (a1). Simultaneous motion (from a 12-camera infrared motion capture system) and force data were acquired from seven subjects during steady-speed trials (3.0-6.0 m•s-1) on a custom, force-instrumented treadmill under three loading conditions: unloaded (1.0 Wb), 15% added weight (1.15 Wb) and 30% added weight (1.30 Wb). The two-mass model accurately predicted peak and impact forces from model-derived waveforms when compared to measured values. Wearable sensor acquisition of the model-needed inputs is fully feasible based on the ankle jerk and velocity data derived from optical position-time data. We conclude that the two-mass model offers a promising approach to quantifying running ground reaction forces using wearable technologies.

Description of Commercial Viability:

Ground reaction force curves during running, walking and other activities (i.e. jumping, hopping, etc.) can be analyzed to obtain a variety of important variables. These include: impact forces, peak forces, rate of force development, applied impulses, and foot-ground contact times. These parameters are important evaluation tools for footwear analysts, physical therapists, coaches, orthopedic surgeons, podiatrists, and trainers. Accordingly, our experimental demonstration of model efficacy for predicting the impact and peak force portions of vertical ground reaction force waveforms under loading conditions identifies obvious applications for a wider population of military combat specialists and first responders. Other potential uses extend to orthotics, prosthetics, and exoskeleton design. Implementation in an athletics performance facility or clinical site would involve a treadmill or runway and the wearable sensor affixed to the subject's ankle. The subject would run at the selected speed while his or her motion-based variables are captured and used in conjunction with software that incorporates the model's algorithms in order to generate ground reaction force waveforms. The waveforms would be used to analyze and potentially customize the needs of the subject for footwear, orthotics, and/or gait retraining to improve performance and/or minimize injury risk, etc.

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Education

Molly Ellis (#137)
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MEASURING CHANGES IN INSTITUTIONAL DIVERSITY

A foundation of American higher education is the variety of types of colleges and universities within the system. The diversity allows the system to meet the needs of many different types of students and to achieve many of the wide-ranging expectations placed upon the system. Researchers have found a declining level of institutional diversity over the past 40 years raising questions about the ability of American higher education to continue to live up to its historical role and mission. This paper examines changes in institutional diversity within the United States by building on the the foundational work of Robert Birnbaum and Christopher Morphew. Informed by institutional theory and using Integrated Postsecondary Data System (IPEDS), we apply four approaches for calculating institutional diversity and compare the results between 1989 and 2014. Findings demonstrate how institutional diversity has decreased during this timeframe. The study provides additional empirical evidence of how institutional diversity has declined in recent years and raises questions about the future of a foundational element of American higher education.

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CONNECTING THROUGH CONNECTIVITY: PARENT ENGAGEMENT THROUGH TECHNOLOGY AND 4G TABLETS

Although touted as a tool to mitigate inequities, technology often perpetuates educational disparities by socio-economic status (Kuhlemeier & Hemker, 2007; van Deursen & van Dijk, 2009). While there is a growing body of work around the persistence of gaps in the access to and use of technology in schools and homes, we know less about the potential of technology to shape home-school relationships. Drawing insight from Calabrese Barton, Drake, Perez, St. Loius, and George's (2004) work on the Ecologies of Parental Engagement (EPE), this study documents the planning and implementation of a 4G-tablet initiative at a South Central elementary school. The purpose of this study is twofold: 1) to examine how parents, teachers, and school leaders view parent engagement around technology; and 2) to consider the opportunities and barriers of using the 4G tablet to foster connections between schools and families. We captured diverse perspectives across the year, through 11 home visits, 8 parent focus groups, 7 teacher focus groups, 13 interviews with school leaders, 7 school-family event observations, and the analysis of more than 50 artifacts. Our findings suggest that the 4G tablet alters the engagement landscape in unique ways and highlights the opportunities and challenges of achieving equal opportunity through technology. Implications are discussed.

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Veronica Mellado De La Cruz (#139) Stephanie Al Otaiba; Paul Yovanoff
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MONITORING PROGRESS OF BILINGUAL STUDENTS' EARLY LITERACY SKILLS: EFFECTS OF PROBE LANGUAGE

Although policy legitimizes the use of early intervention for prevention and identification of reading difficulties, the field provides limited guidance regarding the best tools for struggling Spanish-speakers in this process. We contribute to the requisite knowledge-base by exploring performance on English and Spanish measures. Researchers explored relations between performance on English and Spanish literacy progress monitoring probes, whether probe language is significant when measuring progress across kindergarten, and which probe best anticipates end of kindergarten reading performance on an English norm-referenced instrument. A longitudinal design was used to measure Spanish-speakers' (N=99) literacy skills across kindergarten. All skills were measured in both English and Spanish. Stratified purposive sampling was used to oversample students at-risk for reading difficulties (n=89), for whom probes are most essential. Bivariate correlations between English and Spanish probes are provided. Probe language is tested as a moderator for measurement of early literacy skills growth via multivariate multilevel modeling. Finally, regression analysis is used to determine which probe (fall or winter) best predicts variance in criterion instrument scores at the end of kindergarten. Results are discussed in terms of implications for early intervention, as well as future research.

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Paul Polanco (#140) Meredith Richards
Advisor: Doris Baker
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ECONOMIC BENEFITS OF BILINGUALISM

Given the ongoing policy relevance of the merits of bilingual education, there is a critical need for rigorous empirical research on the impact of such bilingualism and bilingual education programs. In this study, we use longitudinal data from the National Center for Education Statistics (NCES) Education Longitudinal Study of 2002 (ELS) to provide evidence regarding the individual economic benefits of bilingualism. Specifically, we address the following questions: Does speaking a second language fluently present an economic benefit vis-à-vis similar students who are monolingual English speakers? For what groups are the economic effects greater?

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Anthony Sparks (#141) Alexandra Pavlakis
Advisor: Alexandra Pavlakis
Teaching & Learning, Simmons School of Education

INVESTIGATING COLLABORATION UNDER COLLECTIVE IMPACT

Collective impact organizations bring together different stakeholders in a community around a common goal. Stakeholders can include nonprofit organizations, schools, and community leaders who have a valued

interest in serving their community. Professional Learning Communities (PLCs), are commonly used in school settings but are less common amongst non-profits. This qualitative study asks, "How does collective impact shape practices of nonprofit organizations who focus is on improving academic achievement of the children they serve?". A case study methodology was adopted. Data collection consisted of interview, observation, and artifacts related to collaborative activities. Results from phase one of data collection suggest benefits and challenges to collaborating under a professional learning community model. Recommendations as well as next steps in the research are outlined.

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Sumei Wu (#142) Meei-Ling Liaw; Nancy Montgomery; Paige Ware
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VOICES OF INQUIRY IN INTERCULTURAL TELECOLLABORATIVE TEACHER PROFESSIONAL DEVELOPMENT

This presentation reports the findings from a qualitative study exploring how pre-service teachers in the United States and in Taiwan gained pedagogical expertise through their participation in a technology-mediated learning project during a 12-week semester. A total of 33 pre-service teachers were formed into 11 groups for intercultural learning which in language education focuses on the knowledge and skills needed to engage with individuals from different backgrounds (Byram,1998). Both groups communicated via various online interaction platforms (i.e. Zoom as a synchronous videoconferencing tool, Google Docs, Facebook) on topics related to teaching and learning in their local contexts and co-constructed a lesson plan unit. The telecommunication data (Google Docs, Facebook, and Zoom video recordings), pre- and post-surveys, and lesson plan units were collected and analyzed. The preliminary findings reveal that the voices of participants from diverse backgrounds caused tensions among group members, yet at the same time, mediated the establishment of shared domain knowledge and broadened their knowledge base. Based on the findings, the presenter will particularly demonstrate an intercultural partnership as a show case, provide suggestions for implementing successful international telecollaboration and preparing pre-service teachers to become interculturally sensitive educators.

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Anthropology

Michael Aiuvalasit (#143)
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COMMON GOODS IN UNCOMMON TIMES: WATER, DROUGHTS, AND THE SUSTAINABILITY OF ANCESTRAL PUEBLO COMMUNITIES IN THE JEMEZ MOUNTAINS, NEW MEXICO (AD 1100-1700)

The Jemez and Pajarito Plateaus of the Jemez Mountains, New Mexico share similar cultural, environmental, and climatic contexts, yet large Ancestral Pueblo communities of the Pajarito abandoned

mesa-tops for lowlands of the Rio Grande during the 16th century while occupations of the Jemez Plateau persisted until the 17th century. Droughts are hypothesized as a driver of depopulation of the Pajarito Plateau, but if so why wasn't the Jemez abandoned as well? I conducted interdisciplinary geoarchaeological investigations to evaluate if different strategies of water management impacted community-level resilience to climate change. In this presentation I present a paleohydrological model of hydrological sensitivities to prehistoric droughts, and a region-wide analysis of how droughts may have impacted water acquisition costs.

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Ian Jorgeson (#144)
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QUANTIFYING THE RELATIONSHIP BETWEEN GEOGRAPHY AND SOCIAL NETWORKS

Social Network Analysis (SNA) has become an important tool for archaeologists. However, unlike other social scientists who work with living populations, archaeologists do not have direct access to the social networks of ancient peoples. Instead, they rely on material culture to infer the presence, strength, and properties of social networks in the past. A standard approach is to compare assemblages of an artifact class among a group of sites, and quantify the similarity of those assemblages pairwise as a proxy for social networks. Pairs of sites with high similarity scores are inferred to be more strongly networked. For many artifact classes, the assumed link between assemblage similarity and strength of social network is well supported. However, this assumption is potentially problematic when assemblage similarity is based on geochemical sourcing of artifacts. In these cases, the distances between sites and the sources of the raw materials may do a better job of explaining patterns in assemblages among sites. This research develops a method for quantifying geographical similarity of sites to raw material sources using least cost path analysis within a GIS framework, establishing a baseline of expected assemblage similarity given local geography, which can then be compared to the results of SNA.

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English

Kathleen Hines (#145)
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English, Dedman College

ART, AGENCY, AND THE PROBLEMS OF DESIRE IN SIDNEY'S ASTROPHIL AND STELLA

I address poetry's artistic representations and their relationship to desire and agency in Sir Philip Sidney's "Astrophil and Stella." In his Defense of Poesy, Sidney argues that poetry's merit lies in its ability to "honor" God, the divine maker of poetry's "maker." He suggests that while poetry excels nature and clothes the poet with authority, it success depends on its aesthetic presentation of virtue. However, in "Astrophil and Stella," poetry and its artistic figurations have little to do with virtue or God.

Seeking "fit words to paint the blackest face of woe/ Studying inventions fine, her wits to entertain," Sidney's poet Astrophil believes that by recreating his body poetically, he will persuade Stella to "grant" her "body" to him (9.5-6). Metaphorically painting and repainting Stella and himself in poetry's imaginative space, Astrophil divorces the reality of Stella's staunch virtue from his own aestheticized desire for her. Though he "entertains,' Astrophil performs his unconsummated desire in an artistically produced edifice; he creates reflexive pictures of the desire he wishes to consummate with Stella by recasting her body as an object in sonnet and song. For Astrophil, poetry, and more broadly, art, exist to simultaneously illustrate and fulfill physical desire.

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SMU Guildhall

Bernard Kauffman (#146)
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Level Design, SMU Guildhall

DESIGNING CITIZEN SCIENCE GAMEPLAY

This thesis tasks players with analyzing vast sets of data within the context of a video game. Researchers analyzing possible cancer treating drugs are currently buying thirty drugs at a time from a database of thousands of possible candidates at a time. These drugs are so expensive that researchers can only afford thirty drugs at a time. Researchers have collected data across dozens of drug's properties, including molecular weight, boiling point, and a wide variety of other properties. This thesis uses k means clustering to find commonalities in these drugs, by identifying areas where drugs cluster around a certain property, so that researchers can buy drugs with similar properties in the future. As long as researchers can purchase drugs with a higher success rate than their current methods (picking at random), then this thesis is succesful.

This thesis is integrated within a pre-existing game called The 8 Cell, currently in development by Balanced Media Technologies in the Unreal Editor. Implementation consisted of using Unreal's default HUD blueprinting system as well as some custom C++ code for generating textures on the HUD.

Description of Commercial Viability:

This thesis provides a framework for a User Interface that allows players to analyze vast swaths of data. This data is not just limited to medical cases, it can be used to analyze anything from antibiotic resistances to the properties of successful selling cars. The algorithms in place provide a framework for allowing people to analyze large swaths of data that would normally take a complex neural network to solve.

Computer Science and Engineering Addendum

Gity Karami (#147) Jeff Tian
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MAINTAINING ACCURATE WEB USAGE MODELS USING

Markov operational profile (Markov OP) is a type of usage models for large applications involving state transitions such as web applications. Such usage models not only help us ensure and maximize product reliability, but can also be used to understand user behavior, and fine-tune system performance and usability. Web usage models can be constructed based on actual usage of the application by target users recorded in existing web logs. Such models constructed before maintenance and evolution may not reflect actual usage of the updated application accurately. On the other hand, Markov OP shares some common characteristics with activity diagrams or task models which describe the application in terms of user activities or tasks. We develop a method to update the initial Markov OP by analyzing its differences with the activity diagrams used in web application maintenance and evolution. We have applied our method in a web application to provide an initial validation of its applicability and effectiveness.