Indiana University Bloomington is a founding member of V4I. Building on the collaborative successes of PTI, V4I will translate the deep scientific knowledge of research leaders into innovative industry solutions in aerospace, automotive, energy, and life sciences, reducing cost, scope and time of physical product and process testing.

Pharmacologic Ascorbic Acid Enhanced Chemosensitivity of Non-Small Cell Lung Cancer Cells to Paclitaxel and Doxorubicin

Saleha B Vuyyuri[1], Amanda Pursell[2] and Keith R. Davis[1]

[1]Biology Division, Biotechnology Program, [2]Owensboro Cancer Research Program, Owensboro, KY

Chemotherapeutic drugs in combination with other anti-cancer agents are commonly used for treatment of advanced cancers where radiation therapy and surgery alone are not sufficient to eliminate the cancer cells. Treatment of non-small cell lung cancer (NSCLC) includes combination treatments of carboplatin and paclitaxel. Pharmacological doses of ascorbic acid (AA) have significant selective antitumor activity in many cancer types, and causes reduced ATP levels and increased ROS with minimal toxic effects in normal cells. In this study, we compare the effects of AA and combinations of AA with the chemotherapeutic drugs, paclitaxel and doxorubicin, on the viability of NSCLC cell lines and an immortalized lung epithelial cell line. The combined treatment of AA (25 μM to 500 μM) and paclitaxel (0.2 to 2 μM) or doxorubicin (2 μM to 10 μM) caused a synergistic induction of cell death in NSCLC cell lines. No significant loss of viability was observed in the immortalized lung epithelial cell line. We found that AA in combination with paclitaxel or doxorubicin significantly increased DNA fragmentation and caspase 3-7 activity suggesting an apoptosis- mediated cell death mechanism. Our data signifies that pharmacological doses of AA combined with relatively low doses of chemotherapeutic drugs induce synergistic cell death in NSCLC with minimal toxicity to normal cells. Our results demonstrate the effectiveness of pharmacological doses of AA alone as an adjuvant therapy and further supports the idea that AA combined with chemotherapeutic drugs may represent an improved lower toxicity therapy for the treatment of NSCLC.

Engineering Population Collapse

Mike Wade, Distinguished Professor, Department of Biology

Naturally occurring selfish genes spread through populations and can carry with them other genes deleterious to viability. New genetic engineering technologies allow us to create artificial selfish genes to reduce the population size of pest and disease vectoring insects. They provide a potential alternative to pesticides.

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IUB Innovation Conference Poster Abstracts

Thursday, April 6, 2017
9:00 am – 6:00 pm
Indiana Memorial Union, Frangipani Room
Biddle Hotel and Conference Center
900 E. Seventh Street
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Poster Abstracts

Epitope Mapping using Covalent Labelling and Mass Spectrometry
Akshada Abhyankar, Robert Vaughan, Director of Graduate studies Biotechnology

Known for their high target specificity and minimal side effects, monoclonal antibody (mAb) based therapeutics are among the fastest growing segments of the pharmaceutical industry. Global sales are expected to surpass $150 billion in 2017. To engineer these therapeutic proteins, pharmaceutical companies combine high-throughput screening with advanced analytical techniques to select the best candidate proteins to further develop. Due to the high costs associated with drug development, the number of mAbs that are chosen for development has to remain low. Due to the important role the antigen binding site (epitope) plays in drug function, mAbs are typically categorized into groups through a process called 'binning' that categorizes them based on whether their binding sites overlap. This is currently done in a pairwise, competition immunoassay to determine whether antibodies block the same epitopes on their target antigen. This process is time consuming, and changes in protein conformation upon binding could skew results.

To address this issue, we have adapted a covalent labelling / mass spectrometry based assay widely used to study protein structure to rapidly map antibody-antigen binding sites. As a proof-of-concept, we have used Remicade (Infliximab) to map its epitope on TNF-α. Several different parameters were explored such as protein concentration, amount of covalent label to use, enzyme used for proteolytic processing, enzymatic deglycosylation, and specific binding conditions. This system represents several challenges one would typically be met with performing this type of assay on an unknown system. Given these method improvements, we are continuing to apply this assay to other systems including those with unknown binding sites. This method has gained significant interest by pharmaceutical companies, as comparable methods are either low resolution, time consuming, or require large sample volumes.

3-D Face Recognition Technology To Achieve A Low False-Negative Rate
Matthew Anderson, Thomas Sterling, School of Informatics and Computing, Center for Research in Extreme Scale Technologies

The vast majority of face recognition technologies available today have centered on machine learning approaches which provide a favorable trade-off between low computational requirements and moderate facial recognition accuracy.However, these approaches are easily fooled by simple tricks such as wearing a hat, changing hair color, or partially occluding the face with sunglasses. Yet for many industrial applications, the most important metric in face recognition is providing an extremely low false-negativerate that is currently out of reach for machine learning approaches. In order to achieve a false-negativerate that is orders of magnitude better than statistical methods, this work takes an entirely different approach to 3-D facial recognition by incorpo rating high performance custom photogrammetry software for high resolution 3-D point-cloud extraction and 3-D facial reconstruction using implicit surfaces. Both the point-cloud extraction and implicit surface generation algorithms are developed and implemented in the context of high performance computing on a supercomputer giving a time to solution on the order of seconds. This approach, while computational more expensive that statistical methods, provides facial recognition metrics that function even if the face is partially occluded by a hand or sunglasses or intentionally obscured through paint or makeup.

Bright SMiLEs: Turning Organic Nanoparticles Into Novel Dyes and Pigments
Christopher R. Benson, Bo Wegge Laursen, and Amar H. Flood, Department of Chemistry; Department of Chemistry, University of Copenhagen

Organic fluorescent dyes are increasingly essential to several areas of modern technology, including organic solar cells, light emitting diodes, and bright pigments. The value of moving to organic dyes over inorganic pigments comes from their high tunability (color and brilliance controllable through alterations in molecular

infrastructure as well as other collaborating computing resource providers. The SGRC provides consulting support for the use of SEAGrid as well as for the development of new science gateways for other communities.

Over the course of its lifetime, PTI has supported the creation of several start-up companies in Indiana including Bloominglabs (a Makerspace), Chalklabs (data analytics), Precise Path Robotics (autonomous robotic lawnmowers), and Wisdom Tools (educational games). In addition, PTI has maintained relationships with other companies doing business in Indiana including Cigital (PTI providing cybersecurity consulting and analysis), Cummins Inc. (PTI providing computational fluid dynamic simulations), and Naut Inc. (PTI providing scalability testing of algorithms). PTI will also be a founding member of the Virtual Verification, Validation, and Visualization Institute (V4I), a private-public partnership that will bring commercial and academic partners together to improve access to computational engineering tools and expertise. PTI would like to engage with the attendees of the Bloomington Innovation Conference and discuss potential partnerships to collaborate on cyberinfrastructure themes, regulatory compliance, and cloud computing.

V4I - Virtual Verification Validation & Visualization Institute
Randall Russell

V4I, the Virtual Verification Validation and Visualization institute, facilitates and enables the use of computation analytics to assure components and systems comply with specifications, fulfill requirements and satisfy stakeholder intended use. Established in Indiana as a consortium of industry and university contributors, V4I provides pre-competitive collaboration research, development, and realization opportunities through the execution of value added projects applying known and proven mathematic, scientific, and engineering principles through computational modeling and simulation.

Mission Execution Model: Envisioned as a private-public collaboration focused on accelerating the fourth industrial evolution (Industry 4.0) impacting the Manufacturing USA -- National Network of Manufacturing Innovation Institutes (NNMII), V4I drives the computational application of mathematic first principles, mechanistic, stochastic and probability models to objectively simulate product and process through the lifecycle, from stakeholder needs identification to design verification to product / process validation to implementation and operation to retirement and disposal. Key NNMII collaborators include Digital Manufacturing and Design Innovation Institute (DMDII), the National Additive Manufacturing Institute (America Makes). In addition, more than forty industry, university, professional society, and government agency members and contributors collaborate on common solutions which provide economic solutions that enable new possibilities in research, scholarly endeavors, and creative activity at Indiana University and beyond. RT also conducts education and technology translation activities to improve the quality of life of people in Indiana, the nation, and the world. growth opportunities through entrepreneurial networks of suppliers and fabricators as they seek solutions to market and customer challenges. These challenges include Digital Engineering, Digital Manufacturing, Digital Twin, and Digital Thread initiatives driving the Industry 4.0 evolution. The immediate establishment of V4I in Indiana as the epicenter for this consortium will itself evolve as a key collaboration partner across the Manufacturing USA network as a full partner in the NNMI landscape with national reach, and global impact.

Community Impact Model: V4I intends to lead a growth economic impact to the regional, national, and global community through the development and employment of a Science, Technology, Engineering, and Mathematics workforce focused on innovation of products and process which consistently meet stakeholder needs in a continuous improvement framework for greater safety, reliability, and usability. These individuals will be core contributors to established industry and the driving force of the re-birth of USA innovation in the entrepreneurial growth engine providing sustainable and renewable opportunities to local communities, regional centers of technical excellence, and rebuilding the national competitive advantage.

Financial Model: Industry, University, Government Agency, Professional Society and Entrepreneurial memberships fund V4I lean operations. Projects primarily funded from industry member consensus, government agency priorities will leverage university research deep expertise, High Performance Computing centers, professional and standards societies, and the vast entrepreneurial network.

Development of an Inclusive and Dynamic Rural Economic Model for Sub-Saharan Countries: Study Case of Cameroon.

Thierry Belinga*,Jun ZHOU*, Wuhan University of Technology, School of Economics

This research paper examines the Inclusive and Dynamic Rural Economic Model (IDREM) developed using dynamic systems and simulated via AnyLogic 7 University version 7.3.6. The IDREM is an innovative dynamic tool that aims to systematically transform the rural areas of Sub-Saharan countries through the development of economic clusters including Agricultural Production (farming and livestock), Agro-processing, tourism activities, Agro-financial related services (Agricultural Bank products and Agricultural Insurance products), Telecommunication services, transportation, and the development of strategic infrastructure such as roads, markets or even green energy production plants. Using the case study of Cameroon, the study shows that implementing such a model will facilitate the country's transition from an upper middle income economy by the year 2025 ($ 4,126 < Gross National Income per capita < $ 12,736) to a high income economy (Gross National Income per capita > $ 12,736) (World Bank - countries income classification, 2016) within a period of 30 years (i.e. by 2045). Using the development action group multiplicator (DAGk) model, this solves some crucial issues related to rural residency such as: low literacy rate, high unemployment rate and rural exodus. These issues are mitigated using training programs and industrializing companies which function as the main engine of the model. Additionally, the reinforcing and balancing feedback loops in the model allows it inherently function as a decision-making tool that could be used by Governments to prevent and predict negative or positive impacts of some rural economic policies that are being considered. The main stocks to be studied in this paper are the employed population stock, the rural gross national income per capita, rural and urban exodus, and the infrastructure investment fund stocks generated by the model. The parameters used while designing the model are based on assumptions made by the author and justified by his investigations made in the rural field since the author's work experience includes working within a financial institution specializing in rural development (2013-2014) and frequent communication with rural traders (2013-2016). The full results of this paper are embedded in the doctoral thesis of the author. Due to the limited space allocated to publish this paper, we will be focused on the explanation and justification of the IDREM. This practical tool is highly recommended to international institutions actively involved in rural development such as the World Bank, FAO, and the African Development Bank.

IU Cyberinfrastructure, Security, and Science Gateways

Marlon Pierce, Von Welch, David Hancock, Suresh Marru, Winona Snapp-Childs, and Craig Stewart, Pervasive Technology Institute

The Indiana University Pervasive Technology Institute (PTI) is a collaboration between the IU Office of the Vice President for Information Technology, the IU Maurer School of Law, the IU School of Informatics and Computing, the College of Arts and Sciences, and the Kelley School of Business. One of PTI's key goals is to cultivate creativity and innovation by developing advanced cyberinfrastructure to impact the economic health and quality of life in Indiana, creating new jobs and nurturing new businesses. In addition, many activities are aimed at supporting the development of a 21 st century workforce within the state of Indiana. The PTI is composed of service centers, which provide access to and support for scholarly and research infrastructure, and research centers, which provide access to cross-cutting consulting and collaboration services. Research Technologies (RT) is PTI's primary service center. RT develops, delivers, and supports advanced technology

PTI research centers include the Center for Applied Cybersecurity Research (CACR) and Science Gateways Research Center (SGRC). CACR develops and deploys cybersecurity through the National Science Foundation (NSF) Cybersecurity Center of Excellence (trustedci.org). The Center of Excellence engages with a number of NSF projects to help address cybersecurity challenges and disseminate best practices. SGRC integrates cyberinfrastructure resources into science gateways to provide ease of access to complex hardware, software and infrastructures to end user scientists to manage their computations in a transparent manner. The Science and Engineering Applications Science Gateway (SEAGrid.org), for example, simplifies and expands access to computational chemistry, engineering and other scientific applications that are deployed on IU's computing structure) and superior materials properties (cheap, processable, and flexible). Unfortunately, the optical

optical properties of these organic dyes are unpredictable when prepared as solid state formulations for end users, making the development of functional materials extremely difficult. Using new materials developed in our laboratories, we have found a general method for preparing unique materials called single-molecule lattices (SMiLEs) whose solid-state optical properties retain the properties of their dissolved dyes. "Quantum dot"-sized materials prepared from the SMILEs are expected to be bright and highly emissive, and feature high processability with low material cost. We expect these optical materials will open up new opportunities in the technology of solar cells, OLED lighting and displays, as well as contrast reagents for biomedical imaging.

A tablet-based tool for accurate measurement of hand proprioception after stroke

Hannah Block, Assistant Professor, Department of Kinesiology

Position sense, or proprioception, plays an important role in motor control, motor learning, and functional activities of daily living. Proprioceptive deficits following stroke have been linked to motor control impairment and recovery, although the nature of this relationship is unclear. Our understanding is in part limited by the fact that current methods of measuring proprioception in the clinical setting are subjective, imprecise, and unreliable. We recently developed a portable tablet-based apparatus to measure static proprioception in the hand using an adaptive staircase procedure. In healthy individuals, the tool demonstrated better construct validity and inter-rater and test-retest reliability compared to two common clinical tests: passive motion direction discrimination (PMDD) and position matching (Hoseini et al., PLoS One, 2015). Here we evaluate the effectiveness of the tablet-based tool in chronic stroke survivors. We quantified proprioception at the metacarpophalangeal joint of the index finger of each hand using the tablet, PMDD, and the proprioception subsection of the Fugl-Meyer (FM). Both the tablet and PMDD reflected clear differences between the affected and unaffected hand, which the FM assessment failed to reflect. The tablet test has several advantages over PMDD, including sensitivity, range, standardizability, training required, and time to complete the test. These findings suggest that the tablet test has better clinical utility than the PMDD or FM assessments.

Places & Space

Katy Borner, Victor H. Yngve Distinguished Professor of Information Science, Department of Intelligent Systems Engineering and the Department of Information and Library Science, School of Informatics and Computing

Mapping Science is meant to inspire cross-disciplinary discussion on how to best track and communicate human activity and scientific progress on a global scale. Maps have an amazing power to help us understand, navigate, and manage both physical places and abstract knowledge spaces. The maps in the Places & Spaces exhibit range from groundbreaking historic maps, including a 19th century figurative map showing Europe's cotton imports, to visualizations on the cutting edge of the most current trends and dynamics, like a map of the US national mood based on tweets.

High resolution indoor positioning for educational research and beyond

Joshua Danish, Associate Professor, School of Education

In this poster we share our innovative approach to developing a high-resolution indoor positioning system. This approach was initially developed to support educational research and educational simulations for use in classrooms and informal learning spaces such as museums. Traditional positioning systems such as GPS are restricted to outdoor use, and other approaches to indoor positioning lack fine-grained positioning support. Our approach works in-doors, with resolution close to one inch, and also supports two-way communication with positioning badges.

BotOrNot: Social Bot Detection

Clayton Davis, Graduate Student, School of Informatics and Computer Science

While most online social media accounts are controlled by humans, these platforms also host automated agents called social bots or sybil accounts. Recent literature reported on cases of social bots imitating humans to manipulate discussions, alter the popularity of users, pollute content and spread misinformation, and even perform terrorist propaganda and recruitment actions. Here we present BotOrNot, a publicly-available service that leverages more than one thousand features to evaluate the extent to which a Twitter account exhibits

similarity to the known characteristics of social bots. Since its release in May 2014, BotOrNot serves millions of requests via our website and APIs.

A novel and rational approach to the development of an attenuated chikungunya virus vaccine
Nease, LM; Sokoloski, KJ; Hardy, RW, Department of Biology

Chikungunya virus (CHIKV) is a mosquito transmitted alphavirus that causes debilitating polyarthritis in humans. Endemic to east Africa and Southeast Asia in recent years CHIKV has appeared outside of endemic regions emerging in the Caribbean at the end of 2013. Since that time close to 2 million cases of disease have been reported in Caribbean nations and local transmission of CHIKV has been observed in the Southern United States of America. These data emphasize the continued threat posed by CHIKV to the health of the American public and Caribbean neighbors. The problem of CHIKV disease is exacerbated by the lack of low-cost, safe, and effective vaccines and anti-viral therapies. Hence, there is a critical need for research that may directly lead to the rational development of novel vaccine strategies.

Alphavirus's are positive sense, single stranded, RNA viruses encapsidated by a nucleocapsid core. Using a CLIP-Seq approach on cell lysates, we identified multiple specific sites of capsid protein interaction on cytoplasmic viral RNA. These sites did not display conservation at the level of nucleotide sequence or predicted secondary structure. Mutating any one of these binding sites resulted in a significant decrease in titer and viral growth kinetics, but no difference in RNA synthesis relative to wildtype. Interestingly, mutant viruses are not compromised in the production of particles, however the vast majority of particles produced are not infectious. Analogous mutants generated using a related alphavirus, Sindbis virus, were analyzed and found to have a defect in genome stability following entry into the host cell. Additionally, these mutants were significantly reduced in pathogenicity in mice. Thus, we have identified previously unrecognized determinants of pathogenesis that function very early in the process of virus infection, yield wild-type quantities of virus particles that are reduced in infectivity and pathogenicity.

An environmentally sustainable approach to protecting crops from disease
Matt Helm, Biology Department

Genetic-based disease resistance via resistance (*R)* genes is the most economical and environmentally sustainable approach to protecting crops from disease. Traditionally, conventional breeding strategies have been used to introduce desired *R* genes into crop germplasm collections to control plant diseases. Although effective, the deployment of single *R* genes into the field has proven to be a rather transient solution, as most pathogens evolve strains that overcome *R* gene-mediated response. There is thus an urgent need to generate novel disease resistance specificities, particular in developing nations, where access to control measures for plant disease are limited and often involve the application of environmentally damaging, and expensive, pesticides.

Our lab recently reported a novel system for expanding the recognition specificity of an *Arabidopsis* resistance protein, RPS5, by generating 'decoy' proteins that function as substrates for pathogen proteases. This strategy is based on our observation that modifying the protease cleavage site with *Arabidopsis* PBS1, which is a substrate of the AvrPphB protease from *P.syringae*, expands the recognition specificity of the *Arabidopsis* RPS5 immune response pathway, thereby conferring resistance to multiple pathogens. It is thus possible to generate new disease resistance to *Soybean Mosaic Virus* (SMV) based on the recognition of the viral protease by a PBS1 'decoy' protein.

Fame and Fortune
Dr. Monika Herzig, Arts Administration, SPEA 433

The music business has unique challenges and product characteristics that can't be studied and learned in general business simulations and case studies. Such characteristics include the unpredictability of public responses, fashions, and other surrounding factors related to the artist, product, economy, culture, and society that influence the success of an artistic product/ career. In addition, the industry has experienced fundamental restructuring over this past decade due to new technologies such as file sharing and digital recording and transmission tools as well as new ways of communication due to social networking and subscription services,

among many others. As an active musician myself, I have certainly experienced the ups and downs of the music industry and the amount of work and investment that it takes to create a musical product and put it in the market place. For my students though, these concepts are more difficult to grasp as their experiences in the industry are mainly as consumers and participants in structured school programs so far. Our society is focused on a superstar artist image resulting in a "Winner Takes it All" economic model. For example, about 1% of touring artists receive close to 50% of all concert ticket revenue in the popular music market, and 80% going to the top 5% of touring artists1. This lottery-type environment of marketing an artistic product as well as the daily grind involved in being an artist may be easier to grasp with the help of an interactive tool rather than textbooks. Furthermore, chances for success will increase exponentially with the opportunity of testing a variety of real world decisions without real world consequences as often as desired, similar to flight simulators, in order to optimize goal-setting and decision-making.

In order to simulate this reality, I developed a game entitled "Fame and Fortune", where students in the classroom take on the roles of artists, record label executives, or consumers and engage in the process of selling a musical product and creating an artist career in three stages with the goal of witnessing the factors that influence financial as well as popular success. After initially introducing their product (in form of a song performed with a backing track), artists are approached by record label executives with cards outlining common contract details for major and independent label agreements. Artists agree to get 'signed' according to contract details presented or to pursue a career without a label. Consumers then engage in three stages of spending their allotted budgets initially on product, then concert tickets, then merchandise. After each purchase round there are random occurrences drawn via cards that influence income, roles, and future endeavors of all parties involved, such as highly visible engagements, social networking fads, loss of band members, etc. Artist/ Label pairs also need to calculate their respective income according to contract terms after each round and display their financial progress.

After extensive classroom testing, I would like to find partners for developing the game into a commercial product, ideally as an app where the simulation can be played beyond the classroom over extended time periods and expanded versions of the contracting options and consumer interaction and accounting process.

Graspable Math – Algebra Notation for a Digital World
David Landy, Erik Weitnauer, The Percepts and Concepts Laboratory, Psychological and Brain Sciences

Algebra underpins many disciplines in mathematics, engineering, and science. Yet our main tool to interact with algebra, algebraic notation, is too hard to master for three out of four high school students in the U.S. Based on our research in math cognition, we have developed an interactive, digital version of classic pencil and paper algebra notation: Graspable Math (GM). GM allows us to move algebraic work online by letting algebra learners use conceptually grounded gestures to work through derivations step-by-step in their browser. GM provides learners with direct feedback, while teachers, content providers, and researchers get access to rich interaction data.

The Antibiotic Resistance Crisis: Carbapenem Resistance in Central Indiana
Yunliang Zhang and Karen Bush

Carbapenem-resistant Enterobacteriaceae (CRE) represent one of the most urgent antibiotic resistance threats in the world. In this study a collection of well-characterized CRE isolates, collected in 2010-2015 from healthcare centers in central Indiana, were tested for their susceptibility to various antibiotics and for the presence of carbapenemases. The incidence of CRE isolates peaked at 3.0% in 2012, but has now leveled off around 1.5%. Transient production of metallo-□-lactamases was also observed. During the testing of antibiotic combinations with the □-lactamase inhibitor avibactam against a subset of 110 CRE isolates, an E. coli strain with decreased susceptibility to three avibactam combinations was identified. Unusual mutations were observed in the penicillin-binding protein, PBP3, from this isolate. With the exception of this strain, the avibactam combinations were highly effective against CRE isolates that produced serine carbapenemases.