2014 UTEP Interdisciplinary Research (IDR) Symposium: Rewarding and Recognizing Interdisciplinary Research

Abstracts - 4/23/14

* = Graduate Student Poster

1. Life Charting: A Research Approach to Explore Aspirational Capital of Latinas in Computer Science and Engineering

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Engineering and computer science disciplines have been historically underrepresented in gender despite other professions reaching parity. As a sex-segregated discipline, only 18 percent of engineering degrees are awarded to females with two percent awarded to Latinas. The research team brings diverse perspectives, as informed by their respective fields, to the investigation of Latinas in computer science and engineering to identify how agency and identity affect their resilience and persistence in pursuing their careers. One of the research methods utilized in this investigation is life charting — a cultural tool from the field of anthropology that uses systematic reflection on life experiences to co-construct knowledge in determining how various relationships and individuals impact one another. Our preliminary findings suggest that although the life chart instrument is useful as a method to gather and organize data for research it is more useful as a method for Latinas to reflect on their trajectory, identify key events in their life stories, and in identifying examples of resiliency and success. The life chart as a tool also serves to re-affirm the research participants' appreciation for contributions to their aspirational capital along their career path. Challenges associated with this interdisciplinary team include manuscript authorship, group analysis of qualitative data, and assumption of others' perspectives; the most successful aspect has been the generation of manuscripts for publication.

*2. A versatile PDMS/paper hybrid microfluidic platform for rapid and sensitive infectious diseases diagnosis

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Bacterial meningitis is a serious health concern worldwide. Given that meningitis can be fatal and many meningitis cases happened in high-poverty areas, a simple, low-cost, highly-sensitive method is in great need for immediate and early diagnosis of meningitis. Herein, we report a versatile and cost-effective polydimethylsiloxane (PDMS)/paper hybrid microfluidic device integrated with loop mediated isothermal amplification (LAMP) for the rapid instrument-free detection of the main meningitis-causing bacteria, *Neisseria meningitidis* (*N. meningitidis*). This hybrid system offers versatile functions, by providing not only on-site qualitative diagnostic analysis (i.e. a yes or no answer), but also

confirmatory testing and quantitative analysis in clinical laboratory settings. The limit of detection of *N. meningitidis* is about 3 copies per LAMP zone within 45 minutes. In addition, we have achieved two-step pathogen detection without laborious sample preparation process and without the use of centrifuges. This low-cost hybrid microfluidic system provides a simple and highly sensitive approach for fast instrument-free diagnosis of *N. meningitidis* in resource-limited settings. This versatile PDMS/paper microfluidic platform has great potential for the point of care (POC) diagnosis of a wide range of infectious diseases, especially for developing nations.

*3. DETECTION OF ENDOCRINE DISRUPTING CHEMICALS IN MUNICIPAL WASTEWATER TREATMENT UNIT PROCESSES IN EL PASO, TX.

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The presence of endocrine disruptors (EDCs) (such as Bisphenol-A (BPA), 17β-Estradiol (E2), 17α-Ethinylestradiol (EE2), Nonylphenols (NPs), as well herbicides and pesticides) in wastewater influents poses a potential adverse health effect to humans and the environment. This research aims to improve the sustainability of wastewater treatment systems for removing EDCs and agricultural compounds. The objectives of this study are to (1) evaluate the removal of EDCs, herbicides, and pesticides in two municipal, tertiary wastewater treatment plants (WWTPs); (2) develop a model that represents the removal efficiency and estrogenic impact of the WWTPs in a pilot plant scale to enhance their EDC removal efficiency, and (3) create an assessment of the WWTPs environmental sustainability. This study is part of an interdisciplinary collaborative project titled "Study of Removal of Contaminants of Emerging Concerns in Municipal Wastewater", which received Level II funding through the IDR Enhancement Program, a program made possible through the Office of Research and Sponsored Projects and the Office of the Provost. To achieve these objectives, this study integrates chemical and biological analytical techniques as well as engineering sustainability tools into different phases. First, the removal of EDCs and agricultural compounds will be analyzed for a period of three months by monitoring the compound concentrations (by means of GCMS and yeast bioassay for mass concentration and estrogenic activity, respectively) at strategic points in the wastewater treatment process. Second, a pilot plant study will be performed to improve the WWTPs performance with advanced oxidation processes (AOPs) such as ultraviolet (UV) light and hydrogen peroxide. Third, an evaluation of the sustainability of conventional and advanced WWTP processes will be performed using carbon and water footprints. Initial results of this collaboration have shown wastewater treatment processes with great efficiency for removal of EDCs. Results demonstrated most significant removal of EDCs such as BPA and estrogens during biological wastewater treatment unit processes. NPs, herbicides and pesticides were detected downstream of these treatment units.

4. Breath carbon stable isotope ratios identify changes in energy balance and substrate utilization in humans

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Rapid detection of shifts in substrate utilization and energy balance would provide a compelling biofeedback tool for individuals attempting weight loss. Our interdisciplinary team conceived of an approach using traditionally geochemistry methodology. The approach required an understanding and integration of stable isotope chemistry, plant biology, human physiology, and human behavior. We tested whether the natural abundance of exhaled carbon stable isotope ratios (breath $\delta^{13}C$) reflects shifts between negative and positive energy balance. Volunteers (n = 5) consumed a 40% energy-restricted diet for 6 days followed by 50% excess on day 7. Breath was sampled immediately before and 1h and 2h after breakfast, lunch and dinner. Exhaled breath $\delta^{13}C$ values were measured by cavity ring-down spectroscopy. Pre-breakfast breath values on days 2–6 were compared with day 1, and postprandial day 7 time points were compared with pre-breakfast day 7. Energy restriction diminished pre-breakfast breath $\delta^{13}C$ by day 3 ($P<0.05$). On day 7, increased energy intake was first detected immediately before dinner (-23.8 ± 0.6 vs -21.9 ± 0.7‰, $P = 0.002$ (means ± s.d.)), and breath $\delta^{13}C$ remained elevated at least 2h post dinner. In conclusion, when shifting between negative and positive energy balance, breath $\delta^{13}C$ showed anticipated isotopic changes. Although additional research is needed to determine specificity and repeatability, this method may provide a biomarker for marked increases in caloric intake which could be used to influence human behavior and improve compliance to an energy-restricted diet for the purposes of weight loss.

Lessons for successful IDR: The most challenging aspect of IDR is bridging the gap between fields with regards to communication, both within the team and when presenting the results to others in various fields of research. This requires teams to have a great deal of trust, patience, and perseverance, as well as strong communication skills.

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5. Music-themed Activities Support Contextualization of Mathematics Education

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This research team responded to the Round 3 call issued jointly by UTEP's Office of Research and Sponsored Projects (ORSP) and the Office of the Provost for the Interdisciplinary Research (IDR) Enhancement Program with Level 2 funding. Our proposal contributed towards achieving UTEP's strategic research priority of 21st-century education for a 21st-century demographic by advancing our understanding of how mathematics can be taught in meaningful contexts that both teachers and students find engaging. Our team is driven by a desire to understand the impacts from contextualizing K-12 mathematics education within arts-themed activities that encourage student creativity. During the funding period of January - December 2013, we used our IDR team's resources to study the use of music-themed activities as a context for providing K-8 students with mathematics education where the real-world problem solving power of mathematics was demonstrated and explored.

Current research plans include several grant proposals that are already funded including an NSF CREST Broadening Participation Research (BPR) grant titled "*Increasing STEM Participation and Success Rates of Latino Youth Using Culturally Relevant Immersive Technologies*" funded at $297,550 from September 2013 to August 2016. All of these projects involve interdisciplinary collaborations that contextualize mathematics education

within authentically meaningful settings students find engaging because they involve their real-life interests. Articles resulting so far from this research have been published in: *The Interdisciplinary Journal of Teaching and Learning*, *Journal of Mathematics Education, European Journal of Science and Mathematics Education,* and *Journal for Learning through the Arts.* Our results have also been featured in a February 2013 *UTEPnews.com* article by Daniel Perez titled "Researchers Trumpet Music-Math Camp to Promote Technology" and excerpts of Dr. Lesser's teaching of local middle school students appeared on the February 1, 2013 KFOX-TV evening news.

6. Developing a methodological framework for estimating water productivity indicators in water scarce regions

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Water productivity is an area of growing interest in assessing the impact of human economic activities on water resources, especially in arid regions. Water productivity indicators can assist water users in evaluating sectoral water use efficiency, identifying sources of pressure on water resources, and in supporting water allocation rationale under scarcity conditions. This case study for the water-scarce Upper Rio Grande River Basin develops a methodological framework for relating sectoral water use to the human economic activities that impact the region's water resources. Water uses are linked to the corresponding economic activities at the county level through the application of Geographic Information Systems and input-output analysis– an approach that uses economic transactions to quantify the complex but mutual relations between various water using sectors. The case study is part of a larger interdisciplinary approach that aims to develop an environmental-economic accounting framework for water use in the basin, supported through IDR Enhancement Program Level II funding, a program made possible through the Office of Research and Sponsored Projects and the Office of the Provost. Preliminary results indicate that Irrigation is among the largest water consuming sectors, although it contributes very little to regional economic output. High economic value but low water use intensity economic sectors include Manufacturing, Mining and Steam Electric Power. One of the major challenges in conducting this interdisciplinary research arises from the need to successfully couple economic and water use data that is compiled at different spatial and temporal scales. In addition, the seemingly absolute nature of groundwater rights under Texas water law presents a water accounting challenge. An important insight so far is that successful secondary data acquisition hinges on networks of contacts and data sources that already exist and just need to be tapped from among IDR team members.

*7. Imaging Tuberculosis Cytosolic Translocation with Two-Photon Fluorescence Resonance Energy Transfer Microscopy

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It is estimated that one-third of the world population is latently infected by *Mycobacterium tuberculosis* (Mtb). The transition from latency to active tuberculosis requires Mtb to penetrate subcellular phagosomal membrane and translocate to the cytosol of the host macrophage, termed as "cytosolic translocation". We use *Mycobacterium marinum* as a model organism together with advanced optical microscopic techniques to study the mechanisms of cytosolic translocation. By using two-photon fluorescence resonance energy

transfer (FRET) microscopy, we demonstrate the capability to monitor mycobacterial infection process. Mouse macrophages were loaded with CCF-4, a FRET-based fluorescent probe that allows us to discriminate phagosomal location from host cytosol by a change of the FRET signal. The mean intensity was quantified for each cell in the blue and green fluorescent channels. The ratio of blue/green is an indication of the presence of bacteria in the phagosome or cytosol. Higher ratios have been obtained for M. marinum after 48 and 96 hours of infection, indicating its ability to gain access to the cytosol of macrophages. The use of sensitive cytoplasmic FRET reporter CCF-4 combined with our two photon laser scanning fluorescence microscope provides quantitative analysis of phagosomal rupture and cytosolic entry of cellular pathogens. The initial idea of this project comes from another faculty who is familiar with the two PIs' work. This interdisciplinary project applies a frontier optical technique developed in Physics Department on an important infectious disease study. Direct and frequent communication among our team members from the physics and biology departments has been crucial to advance our project constructively. Sharing of results and ideas within the group has contributed to a better experimental design.

8. UT A-PRIME TIME PROGRAM: AN INTERDISCIPLINARY INITIATIVE FOR MEDICAL EDUCATION

The University of Texas Accelerated - Professional, Relevant, Integrated Medical Education (A-PRIME) Transformation in Medical Education (TIME)

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The A-PRIME TIME program strengthens and shortens the path to the M.D. degree for high-achieving students, and aligns the pre-medical and medical curricula to provide a more continuous educational experience. The goal of the program is to develop and implement a new model of physician education that will prepare healthcare providers to serve Texas in the 21st century, and reduce the time to complete an M.D. from the traditional 8 years to as few as 6 years. In order to achieve its goals, A-PRIME TIME requires an effective interdisciplinary and inter-institutional platform, where the sciences and the humanities cross-fertilize to increase and integrate relevant content and facilitate student success as they work to achieve a more comprehensive level of training in less time.

A-PRIME TIME involves the UTEP, UT-Brownsville, and UT-Pan American campuses, in collaboration with UTMS-Houston and UTMB in Galveston. Currently, approximately 70 undergraduate students are enrolled in the program, which is in its inaugural year. Together, all institutions have been collaborating for nearly 4 years, with the support of the UT System, to establish critical program needs and components before engaging students in the academic pathway. The partner schools have developed three core interdisciplinary strands for the program: a) within the basic sciences; b) between the basic sciences and the humanities; and c) within the humanities. Examples of these include the examination and longitudinal study of patients (real or simulated) with selected medical conditions, increased availability of content that includes social, cultural and historical aspects of disease and healthcare, and the incorporation of ethics, logic, communication, and professional development into the curriculum. At each institution, multiple faculty members and administrators are engaged in curriculum development and implementation, admissions, and assessment. In addition, a number of participating team members are working on process publications to document our work within the field of medical education. As a result, the program serves as an excellent example of interdisciplinary collaboration in curriculum and research development.

9. I3: A Cyberinfrastructure and Communication-Based Model to Support a Synergistic Environment for Integrating and Institutionalizing Proven

Practices

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The vision of the I3 project is to transform UTEP into a university in which faculty are committed to sharing resources, collaboration is supported through recognition and rewards, effective STEM initiatives are extended across the university, discussion among diverse faculty members and administrators stimulates new ways of student preparation and advancement in STEM areas, and proactive strategies are employed to identify effective avenues for sustainability. The project focuses on: 1) capturing faculty, professional staff, and center profiles; 2) connecting faculty through communities of practice; 3) integrating research news stories from UTEP's Office of University Communications to enhance profiles; and 4) establishing a Provost-led STEM Council to focus efforts on broadening participation in STEM areas.

Collecting and publishing research expertise at a university and keeping it current is crucial for building collaborations and promoting expertise. The challenge this project faces is in the integration of information about education and research efforts that can be maintained at multiple Websites, databases, local computers, and specialized systems such as Digital Measures and Digital Commons. The project addresses data integration through the use of Semantic Web technologies to harvest, expose, and disseminate UTEP's expertise, knowledge, and resources. The data management and integration efforts are ongoing.

The I3 project team launched the Expertise Connector in April 2014 and formed communities in areas such as mentoring, peer education, advising, gender in STEM, and undergraduate research; co-sponsoring several connection building events and co-organizing an annual IDR Symposium to provide opportunities for faculty to share effective practices; and performed I^3 surveys and interviews to capture the positive changes at the university.

10. Blending Research Cultures to Address Heavy Drinking on the Border: Bridging Two World Views to Expand Research Horizons

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The relationship between acculturative stress and heavy drinking on the US-Mexico border is complex and remains ambiguous, particularly among males. The Interdisciplinary Health Behavior Change Consortium is funded by the Patient Centered Outcomes Research Institute to evaluate the efficacy of a culturally adapted brief motivational intervention among heavy drinking males admitted to a community based hospital for an alcohol related injury. While beyond the scope of the parent study, the concept of allostatic load has the potential to serve as a meaningful predictor of subsequent changes in drinking and response to a culturally adapted brief motivational intervention among heavy drinking males on the US-Mexico Border. This necessitates an interdisciplinary perspective on the relationship of acculturative stress and heavy drinking among men on the U.S.-Mexico border. For this ancillary project, an interdisciplinary collaboration between health behavior and biomedical researchers was established to assess allostatic load, a set of biological indicators of cumulative stress induced by physiological adaptation to stressors such as social inequality. Specifically, we will add measures of allostatic load including neuroendocrine, immune, metabolic, cardiovascular and respiratory and anthropometric indicators to prospective data of heavy drinking and alcohol problems collected during the parent study. In this way, funding of the parent study will catalyze translational research by

insuring the collection of blood samples from a clinical population of heavy drinking men on the US-Mexico Border and prospective assessment of important health outcomes.

One of the major challenges to conducting this interdisciplinary research is the logistics of acquiring, transporting and analyzing blood samples. Ultimately, this interdisciplinary collaboration will enhance patient oriented research using biomedical methodologies to further broaden the impact of the clinical research and provide a platform for innovation and future funding.

*11.Evaluation of CTLA-4 blockage with sequential metronomic chemotherapy for the treatment of preclinical breast cancer

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The targeting of the CTLA-4 protein with the antibody ipilimumab has been a success in terms of producing an increase in the survival of patients with unresectable melanoma, and clinical trials are ongoing to evaluate this strategy in other tumor types. Our aim in this study was to evaluate the combination of CTLA-4 blocking with metronomic chemotherapy regimens. To that end, we subcutaneously implanted murine EMT-6 breast tumor cells into syngeneic Balb/c mice (n=6-8/group) and evaluated therapies on the established tumors. Anti-CTLA-4 therapy was administered on its own or combined with metronomic regimens. These included; a) Bolus (150mg/kg, i.p.) cyclophosphamide (CTX) followed by metronomic CTX (20mg/kg/day, p.o.), b) metronomic CTX, and c) sequential gemcitabine therapy (160mg/kg every 3 days, i.p.). We observed that control (saline) treated tumors, or tumors treated with Bolus CTX plus metronomic CTX, grew rapidly. Anti-CTLA-4 monotherapy produced an initial tumor regression followed by tumor relapses, 2-3 weeks later. Surprisingly, the Bolus CTX plus metronomic CTX hindered the effective CTLA-4 therapy, failed to produce tumor regression, and resulted in rapidly growing tumors. The combination of anti-CTLA-4 plus metronomic CTX also produced tumor regression and resulted in a longer delay in the appearance of relapsing tumors ($p<0.05$ compared to anti-CTLA-4 alone). Collectively our data shows that Bolus plus metronomic CTX may compromise anti-CTLA-4 therapy. Furthermore, anti-CTLA-4 therapy may be effectively combined with metronomic CTX, or with a sequential gemcitabine therapy, in a preclinical model of breast cancer. We next plan to expand on these results through interdisciplinary collaborative work with colleagues in the Physics and Chemistry Departments (to help us model the rates of tumor growth, and to help us design new anti-cancer drugs, respectively), since progress in the development of these complex therapeutic strategies will require the expertise of scientists from different areas of research.

12. Cyber Security Vulnerability Analysis and Risk Management for Critical Operational Technology

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The continuous and safe operation of critical Operational Technology (OT) is a matter of National Security. Operational technology refers to the equipment required to support day-to-day mission and operation of critical infrastructures. The risk of critical OT equipment being compromised through a cyber attack has increased with the introduction of automated processes and advanced technological equipment into critical infrastructures. Traditionally, enterprises have used Information Technology (IT) security solutions to try to protect their critical infrastructure from cyber-attacks. The use of IT cyber security solutions in OT systems might interfere with the operations of the equipment, thus having a negative impact on human, economic, and mission factors for the infrastructure.

The Vulnerability Analysis and Risk Management (VARM) process is a non-intrusive, interdisciplinary solution, created to address the cyber security of critical OT. The VARM process helps cyber security professionals to identify critical assets in an infrastructure, to conduct cyber security vulnerability and threat analysis, and to mitigate cyber security risk.

The VARM is a byproduct of the collaboration between researchers from Computer Science, Systems Engineering, Electrical Engineering, and Business Administration. Systems engineering supported the creation and refinement of cyber security assessment processes, electrical engineering provided the technology analysis of the OT equipment, computer science provided the software development support, and business administration provided the commercialization aspect to the research.

Some of the defeated challenges and lessons learned associated with the interdisciplinary research conducted to develop the VARM process are related to: the creation of terminology common to the participating academic and industry researchers, the separation of concerns for the individual research fields, and the tradeoffs between commercialization, research & development.

This interdisciplinary work has led to two provisional patents and a utility patent being filed. In addition, a software toolbox to support the VARM process has been created for commercialization purposes.

*13. On the Optimization of the Inverse Problem for Bouguer Gravity Anomalies

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Inverse modeling of gravity data presents a very ill-posed mathematical problem, given that solutions are non-unique and small changes in parameters (position and density contrast of an anomalous body) can highly impact the resulting Earth's model. Although implementing 2- and 3-Dimensional gravitational inverse problems can determine the structural composition of the Earth, traditional inverse modeling approaches can be very unstable. Using different techniques, geophysicists and geologists obtain various models of the shallow substructure based on the density contrasts of anomalous bodies –with different densities with respect to a uniform region– or the boundaries between layers in a layered environment. Implementing an interior-point method constrained optimization technique (as developed in the mathematical numerical optimization community), we improve 2-D models of the Earth's structure through the use of known density constraints for transitional areas obtained from previous geological observations.

We apply the technique to synthetic data and gravitational datasets previously obtained from the Rio Grande Rift and the Cooper Flat Mine in Sierra County, NM. Specifically, we

improved the models by getting rid of unacceptable solutions (as assessed by geologists and geophysicists) given the reduction of the solution space.

This work results from collaborations between students and faculty from the Computational Science Program, the Computer Science Department, and the Geological Sciences Department. Some of the challenges faced on this research include the subjective nature and ambiguity of various geological techniques, which make it difficult to manipulate and analyze datasets automatically using computers. Weekly meetings and developing ontologies helped the group overcome these challenges.

*14. Derivation and analysis of preclinical models of human her-2 positive breast cancer

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Although a number of Her-2 targeting drugs are now available for the treatment of Her-2 positive breast cancers, resistance to these therapies rapidly emerges. Therefore, there is a need to study how Her-2 targeting strategies work in vivo, and the mechanisms by which tumors eventually become resistant to anti-Her-2 therapies. We report the in vivo selection of variants of the human Her-2 positive breast cancer cell lines BT474 and MDA-MB361. Both cell lines were initially implanted orthotopically into Severely Compromised Immunodeficient mice (SCID), and the resulting tumors were serially passaged into new hosts over a 4 year period. This selection process produced the BT474V3 and MDA361V3 variants, which grow rapidly in vivo and which retain their Her-2 over-expression, and which respond ($p<0.05$, relative to controls) to trastuzumab (20mg/kg i.p. every 3 days). Tumor variants were also derived from selected tumors that relapsed after 3 months of continuous trastuzumab monotherapy. MDA361V3 tumors showed a significant ($p<0.05$) response to the combination therapy of trastuzumab plus metronomic cyclophosphamide (20mg/kg/day, p.o.). Non-invasive monitoring of the Her-2 positive models in vivo was achieved by luciferase transfection of the tumor variants, or by transfection of chorionic gonadotropin (hCG) cDNA which allows for relative tumor growth to be evaluated via the resulting hCG levels in the mouse urine. Collectively, our data shows that we have derived models of Her-2 positive breast cancer that can be used to evaluate anti-Her-2 therapeutic strategies, and to study the emergence of resistance to anti-Her-2 based therapies.

We next plan to continue our collaboration with the UTEP Physics Department, to use the hCG data to build mathematical models that can explain tumor growth rates in the presence and in the absence of therapeutic drugs that are used in the clinic for the treatment of a subset of breast cancer.

*15. The Hypothalamic Chemoarchitecture Project: High resolution mapping of neuronal populations involved in pre-autonomic, neuroendocrine, and feeding control

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Several neurochemical systems help control complex motivated behaviors and neuroendocrine and autonomic functions, but little is known about how these systems are spatially interrelated within the brain. In collaboration with our colleagues in Los Angeles (USC), we are conducting a large scale, wide field multi-fluorescence mapping project for the hypothalamus of the adult male rat, in which we are identifying nearly two-dozen chemical systems within the same brain at high resolution. Additionally, in collaboration with our Hungarian colleagues (Inst. Exp. Med.), we are confirming interactions among these chemical systems using electron microscopy. The interdisciplinary effort has allowed us to examine the full extent of the hypothalamus, since our teams of neuroscientists at USC and UTEP have examined separate potions of this vast structure and are combining the datasets. The work being done in Hungary has further allowed us to confirm the interactions of chemical systems in the hypothalamus at the synaptic level. Collectively, our team has identified many peptidergic neuronal populations in the hypothalamus of the adult rat, including those for acetylcholinesterase, Agouti-related peptide, calbindin, co-peptin, enkephalin, hypocretin/orexin, melanin concentrating hormone, alpha melanocyte stimulating hormone, neuronal nitric oxide synthase, neurotensin, parvalbumin and Substance P. Several of these peptides are also being visualized in relation to hypothalamic angioarchitecture. Our analyses are revealing novel interrelationships for these chemical systems that are being mapped within the Swanson rat brain atlas for the first time. This dataset should provide a greater understanding of how the hypothalamus coordinates autonomic, neuroendocrine and behavioral responses to changes in metabolic status and behavioral state. The success of this interdisciplinary effort rests in the seamless communication and interactions of our colleagues through in-person meetings at international conferences, and e-mail and live video conferencing. Data exchange is also promoted through virtual technologies.

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16. Earth, Life, and Semantic Web: Enabling the Integration of Environmental Data with Biodiversity Models

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Biodiversity scientists grapple with understanding potential climate and human impacts on the proliferation of different species. In these types of analyses there is much uncertainty involved - in what changes are likely to occur, how those changes interact with species, and how species interact with each other. A better characterization of uncertainty could be achieved by iterating over many combinations of data, models, and parameterizations, allowing for on-the-fly hypothesis testing and result comparison.

The Model Web, which supports complex and composite model generation, can support these biodiversity analysis scenarios. By leveraging the existing body of work surrounding metadata standards and service oriented architectures, more data and modeling services are being pushed to the Web - leading to the growth of dynamic networks of interacting models. Before this vision of generating complex composite models can be fully realized, the limitation of generating singular models must be tackled, where data can be automatically discovered, transformed, integrated, and finally served to a target modeling service.

We propose that *semantic bridges*, which semantically link source environmental data with biodiversity services, can facilitate the automation required for the integration of multidisciplinary scientific data with biodiversity models. A semantic bridge is a unified model for representing geo-referenced environmental data and biodiversity modeling services and therefore requires cross-domain knowledge from environmental scientists, Geographic Information System (GIS) experts, and biodiversity scientists. The culmination of knowledge provided by the different disciplines is formally encoded as bridges, which are in turn used to drive the automated discovery and transformation required for generating biodiversity models. We report on the structure of semantic bridges and their application to a specific biodiversity-modeling scenario supported by the NASA ACCESS funded project Earth, Life, and Semantic Web (ELSEWeb), which integrates data from the Earth Data Analysis Center (http://edac.unm.edu) with Lifemapper (http://lifemapper.org).