

Undergraduate Research Symposium May 16, 2014 Mary Gates Hall

Online Proceedings

SESSION 1U

CHEMISTRY OF MATERIALS AND BIOMOLECULES

Session Moderator: Matthew Bush, Department of Chemistry
175 JHN

12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Supercharging of Native-Like Proteins and Protein Complexes: Effects of m-Nitrobenzyl Alcohol versus Sulfolane

Christiane (Chrissy) Stachl, Senior, Chemistry, Neurobiology Initiative for Maximizing Student Development Scholar, UW Honors Program

Mentor: Matthew Bush, Department of Chemistry

Mentor: Samuel Allen, Chemistry

Ion mobility mass spectrometry is a powerful technique for analyzing proteins and protein complexes in the gas phase. Ions are generated using nanoelectrospray ionization from aqueous, buffered solutions containing the protein or protein complex of interest. The resulting ions are native-like; their structures have low, narrow charge-state distributions and resemble those in the condensed-phase. There is an interest in probing different charge states of protein and protein complexes. High charge-state distributions of proteins and protein complexes, for example, can be seen after addition of 'supercharging' reagents, e.g., sulfolane or m-nitrobenzyl alcohol, to the electrospray buffer. Several mechanisms have been proposed to explain the mechanism of supercharging. Here, we used ion mobility mass spectrometry to probe the charge-state distributions and collision cross sections of a large set of native-like protein and protein complex ions, with masses ranging from 6–468 kDa, generated from solutions containing 1% m-nitrobenzyl alcohol. We determined the extent of supercharging by calculating the percent increase in highest charge state observed between supercharged and non-supercharged cations. We observed a large range of percent increases in highest charge state but in general, there is evidence that small proteins (<100 kDa) exhibited a greater increase than larger proteins in these experiments. Upon comparison of these results to those for ions generated from sulfolane-containing solutions, we found that the maximum

extent of supercharging observed with m-nitrobenzyl alcohol was less than that observed when sulfolane was used. The most supercharged cations generated with m-nitrobenzyl alcohol had up to a 96% increase in collision cross section compared to ions generated without supercharging agents, but the differences in collision cross sections with and without supercharging were less than 2% for large protein complexes (> 100 kDa). These results suggest that ions supercharged using m-nitrobenzyl alcohol may retain their structures better than those supercharged using sulfolane.

POSTER SESSION 2

Commons East, Easel 47

1:00 PM to 2:30 PM

Carbon Nanotube Paper as a Novel Pressure Sensor

Curtis Robert Thompson, Senior, Mechanical Engr: Nanoscience & Molecular

Caleb Ogier, Senior, Mechanical Engr: Nanoscience & Molecular

NASA Space Grant Scholar

Garrett Kelly Allawatt, Senior, Mechanical Engr: Nanoscience & Molecular

Mentor: Jae-Hyun Chung, Mechanical Engineering

Methods and devices used for pressure measurement are extremely varied and typically do not offer the ability to operate accurately when subjected to pressure values outside of the standard operating range. Typical methods and devices used for pressure measurement at low levels of stress, such as those exerted by biological cells, are prohibitively expensive with quite complex manufacturing processes. This research focused on characterizing a device constructed of carbon nanotubes, paper, and polydimethylsiloxane (PDMS), for use as a pressure sensing smart skin with exceptional sensitivity. The geometry and quantum mechanical properties of carbon nanotubes make them highly sensitive to strain. The effects of various factors such as temperature, tension, and environmental air pressure on the electrical resistance of the device were recorded over time to determine its response to its ambient surroundings. Thermal fluctuation, vacuum chamber, mechanical deflection, and control tests were carried out on the sensor to identify its gauge factor and tendency towards hysteresis. The effectiveness of spin- and dip-coating at forming a suitable PDMS layer was investigated. Tests with no PDMS on the sensor were also run. The sensors resistance is directly

affected by vacuum pressure and temperature. Increasing the thickness of the PDMS layer reduces the sensitivity to temperature. By characterizing the sensors behavior at various temperatures and pressures, a calibration algorithm is recommended in order to isolate the effect that strain has on the sensors resistance. This easily manufactured, nanostructured sensor for measuring pressure at very low values is an effective tool for research in many fields due to its scalability and ease of use.

SESSION 2K

MODERN TECHNOLOGY / ECONOMIC MODELING

Session Moderator: Marc Dupuis, Computing and Software Systems
284 MGH

3:30 PM to 5:00 PM

* Note: Titles in order of presentation.

Using Modern Web Programming with Active Learning in CS1

Joonwoo Choi, Senior, Information Technology (Tacoma)
Joo Park, Fifth Year, Computer Science and Systems
Mentor: Sam Chung, Information Technology & Systems, UW Tacoma

The purpose of this paper is to propose a new curriculum of a college-level introductory computer science course called CS1 using modern web programming with active learning methods. The current CS1 courses have several limits - 1) distributed computing is not employed, 2) software architecture is not taught in advance, and 3) active learning methods are not usually used. To develop CS1based active learning using modern web technology, we chose a server side web programming that supports Client/Server (C/S) Computing and Model-View-Controller (MVC) architecture - Microsoft ASP.NET MVC4. Also, three active learning methods such as Just-in Time-Teaching (JiT), Peer Instruction (PI), and Flipped Classroom (FC) are used to encourage student learning in class. For JiT, we develop a reading assignment for the next class, which consists of one or two multiple choice quizzes and an essay question. CS1 students are required to submit their assignment before the next class. The instructor checks what the students could not understand and explain the topics in the class. For PI, a concept question, in which the most important concept that the students must understand in the class, is provided. The students in the class discuss the given concept test and explain each other to find a correct answer. After peers help each other, the instructor explains the concept test to the students. For FC, a programming lab, which is very similar to a programming assignment that will be done out of class, is conducted. This CS1 curricu-

lum with modern web programming allows a CS1 instructor to teach students modern web applications using C/S computing and MVC architecture, instead of console applications using monotonic computing and non-architecture. Also, the CS1 curriculum based active learning allows the CS1 students to be more engaged and interested in learning.

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MODERN TECHNOLOGY / ECONOMIC MODELING

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A Comparison of Server-Side Web Technologies based upon Knowledge, Skills, and Abilities

Rahul Deshpande, Sophomore, Computer Engineering & Systems, UW Tacoma
John (Himchan) Han, Junior, Information Technology (Tacoma)
Mentor: Sam Chung, Information Technology & Systems, UW Tacoma

The purpose of our research is to propose guidelines for web developers in choosing the appropriate server-side technology for web application development, based on KSAs (Knowledge, Skills and Abilities). Server-side technologies have evolved over the years. However, there are no clear guidelines for web programmers to distinguish between them, especially in the following areas : Architecture, Cloud Computing and Unit Testing. Knowledge of architecture helps easily design maintainable software systems. Cloud Computing allows to deploy the developed applications easily. Unit Testing is essential in testing units of code that has been written using server-side languages. Hence, these areas form a crucial basis for suggesting guidelines for comparison between server-side technologies. We study three knowledge areas of server-side technologies significant to web-application development : architecture, cloud computing and testing. Then, we compare the three server-side technologies on a specific framework on the basis of the skills required in the stated knowledge areas, and the abilities to demonstrate those skills: ASP.NET MVC, JavaServer Pages on Spring, and Python on Django. The results of our research make straightforward the similarities and differences between the server-side technologies discussed. Our conclusions will help web developers make the right decision when choosing a server-side technology for making web-applications.

POSTER SESSION 3

MGH 241, Easel 137

2:30 PM to 4:00 PM

Architecture Modeling of a Mobile D2D System Underlying in LTE-A Cellular Network

*Joo Park, Fifth Year, Computer Science and Systems
Heegun Yang, Senior, Information Technology (Tacoma)
Richard Lee, Senior, Computer Science and Systems,
Computer Engineering & Systems, UW Tacoma
Mentor: Sam Chung, Information Technology & Systems,
UW Tacoma*

The purpose of this research is to propose architectural models and modeling guidelines of Device-to-Device (D2D) systems using LTE-A cellular network which has diverse and heterogeneous subsystems. Since a D2D system consists of four subsystems - Content, Platform, Network, and Terminal (CPNT), it is not easy for a D2D project participant to understand a legacy D2D system. For example, think of a mobile game app at a Google Store (Content) using Android operating system (Platform) on a Samsung mobile phone (Terminal) by using T-Mobile LTE-A cellular network and its billing system (Network). Stakeholders of each subsystem need to understand both their own and others views. For this purpose, we select a legacy D2D mobile system and apply a re-documentation methodology called 5W1H Re-Doc to the system. The architectural model of each subsystem is used to help communications among the D2D project participants - D2D system will be much easier and efficient to understand. In addition, the guidelines of architecture modeling will help the participants to share high level abstractions of the D2D system.

POSTER SESSION 3

MGH 241, Easel 136

2:30 PM to 4:00 PM

Architecture Re-Documentation Driven White-Box Penetration Testing for an Enterprise Application

*Yeonil Yoo, Senior, Computer Engineering & Systems, UW Tacoma, Computer Science and Systems
Mentor: Sam Chung, Information Technology & Systems,
UW Tacoma*

The purpose of this research is to propose an architecture re-documentation driven white-box penetration testing methodology for a mobile application. Security of the application is very critical issue especially when the application controls money and resources, and any security violation can result in significant money loss. To ensure security of the mobile application, testers must perform several kinds of penetration tests. We focus on white-box testing which is one of the penetration tests to discover a vulnerable point by exam-

ining internal process generating output with a given input. In order to perform the white-box testing, every tester has to have the same understanding of the application. Moreover, as the number of the testers increases, the total time to understand the source code also linearly increases. However, the total time spent to understand the source code could be significantly reduced with documentations of the application. In this case, several testers re-document the given application source code with the documents representing both dynamic and static views of the application, and other testers are easily able to understand how the application is constructed and working by observing the documents. We used UML, 5W1H Re-Doc, and a CASE tool to re-document an application, then applied the STRIDE threat classification defined by Microsoft to the documents to propose countermeasures. This approach has three benefits: Firstly, testers would get better understanding of the mobile application. Secondly, sharing the documents with other testers will help the testers understand the application faster which will lead to reduction of the time cost. Lastly, when the similar issue is re-visited in the future, the testers could save time to understand the application using the document.

POSTER SESSION 4

Balcony, Easel 102

4:00 PM to 6:00 PM

The HOPE Study: Utilization of ODK Tables to Streamline Data Collection

Saloni Parikh, Senior, Computer Science, Public Health-Global Health

UW Honors Program

Mentor: Sam Sudar

Mentor: Gaetano Borriello, Computer Science & Engineering

The HOPE Study is a randomized control trial conducted by investigators from the Kenya Research Program at the University of Washington Department of Global Health, Kenyatta National Hospital, and the Kenyan Ministry of Health. The clinical trial investigates the impact of home-based HIV testing and education for partners of pregnant mothers in Kisumu, Kenya. Couples are randomized to either home-based partner education and HIV testing (HOPE) as part of routine pregnancy services or to standard antenatal care (ANC). The intervention provides education and HIV testing to men in stable relationships with pregnant HIV-infected and HIV-uninfected women in order to improve overall health of women and infants, reduce risk for vertical and horizontal transmission, and increase identification of men living with HIV and link them to care. Couples will be followed up for uptake of HIV testing, facility delivery, exclusive breastfeeding and postpartum contraceptive use, as well as linkage to HIV care. Cost-effectiveness of HOPE will be eval-

uated in order to inform future scale up of the intervention in Western Kenya, a region with high HIV-1 incidence during the pregnant/postpartum period and high seroprevalence among men (~10%). A custom Open Data Kit (ODK) Tables application developed at the University of Washington Computer Science and Engineering Department serves as the entry-point for data collection, allowing users to collect client health information, send data to a server, and view aggregate data on their Android device. The HOPE Study Tables application allows the nurses and community health workers to screen patients for eligibility, follow up with the study participants and collect geo point data for home visits. The HOPE Study demonstrates the capabilities of ODK Tables as a data browser and manager, highlighting the importance of developing customizable data-driven applications for disconnected environments.