

VIZ VIGNETTE

From the Desk of *Dr. Vetricia L. Byrd, PhD*

Summer 2017

Undergraduate Summer Research in the Byrd Visualization Lab

This summer The Byrd Visualization Lab hosted three undergraduate scholars participating in Purdue University's Summer Research Opportunity Program (SROP). The SROP program encourages talented undergraduate students from social and economic backgrounds that are underrepresented in research careers to pursue graduate education, and to enhance their preparation for graduate study. Participants are selected on the basis of their interest in pursuing a doctoral degree, relevant college coursework and grades, letters of recommendation, and their ability to contribute to the goal of the program. The 8 week program involved intensive research experiences an introduction to data visualization tools and techniques. Each student was co-mentored by research faculty with research and data visualization needs. SROP Mentors included **Dr. Vetricia L. Byrd**, Assistant Professor of Computer Graphics Technology, Polytechnic Institute, **Dr. Mark Daniel Ward**, Associate Professor of Statistics, Associate Director of Actuarial Science, and Undergraduate Chair, **Dr. Douglas LaCount**, Associate Professor of Medicinal Chemistry and Molecular Pharmacology, and **Dr. Harm Hogenesch**, Associate Dean of Research and Professor of Immunopathology. The summer undergraduate scholars, were supported by The Polytechnic Institute (The Dean's Office and The Office of the Associate Dean for Research), Department of Computer Graphics Technology, Department of Statistics, College of Veterinary Medicine and The Department of Medicinal Chemistry and Molecular Pharmacology.



*The mission of the Byrd Visualization Laboratory is to advance the field of data visualization through learning, discovery and engagement, to be a leader in **Visualization Capacity Building** among future research scientists, to train students and postdoctoral fellows to be outstanding scientists and to serve as **"Agents of Insight"** who utilize visualization to enable scientific discovery, engage in multi-disciplinary, interdisciplinary collaborations and foster broader participation and inclusion in STEM.*



Figure 1. Dr. Vetricia Byrd, Elena Cadenas, Judith Reyes and Graciany Lebron after a group lunch at East End Grill in Lafayette.

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Figure 2. 2017 SROP Data Vis Cohort: Graciany Lebron, Elena Cadenas, and Judith Reyes

The Data Vis 2017 SROP Cohort

Graciany Lebron

Graciany Lebron is Computer Engineering major at the University of Puerto Rico Mayagüez Campus (UPRM). His research interests lie in the field of computer graphics with applications in game development, data visualization, and biology. At UPRM, he works with Dr. Nayda Santiago on an educational video game project called Nanito which is an outreach program aimed to motivate middle school students to pursue Science, Technology, Engineering and Math (STEM) fields. This summer Graciany worked with Dr. Vetria Byrd (CGT) and Dr. Mark Daniel Ward (Statistics) on a data visualization project exploring big data analytics applied to heterogeneous (different sources and/or format) Systemic Lupus Erythematosus (SLE) data. Graciany enjoys traveling with his family, playing video games, programming, and occasionally practicing the violin and the guitar during his spare time. Graciany's research experiences at UPRM and Purdue this summer has strengthened his interest in pursuing a PhD in computer graphics. He is undecided in which field in computer graphics at the moment. Details of Graciany's summer experience can be viewed at <http://web.ics.purdue.edu/~vbyrd/srop/GracianyLebron.html>

Elena Cadenas

Elena Cadenas is an undergraduate student at the Pennsylvania State University Schreyer Honors College. She is a Bunton-Waller Fellow, Women in Math Scholar, and is in the Phi Eta Sigma National Honor Society and the National Society for Leadership and Success. She is a Scholars Helping Scholars mentor and Schreyer Orientation mentor for the Honors College as well as an ambassador of the Scholar Advancement Team. Currently, she is a Math major with a Biology minor on the pre-medicine track. She aspires to get an MD/PhD and to be a pediatrician. She has traveled, with Global Medical Brigades, to explore her passion for medicine. In her free time she likes to make art, go antique shopping, play sports, and spend time with her friends and family, and travel. Due to her interest in health, she conducts research at Penn State on the Combinatorial Threshold-Linear Networks of neural networks. Last summer she shadowed Dr. Maria Pace at INOVA Hospital in the Radiology department. This summer Elena participated in the SROP program at Purdue University where she worked with Dr. Vetria Byrd (CGT) and Dr. Harm HogenEsch (Veterinary Medicine) researching and creating visualiza-

tions about the genetics of the immune response of inbred *Mus musculus* to the Diphtheria, Tetanus, and acellular Pertussis vaccine. Details of Elena's summer experience are available at

<http://web.ics.purdue.edu/~vbyrd/srop/ElenaCadenas.html>

Judith Reyes

Judith Reyes is a rising junior at the University of Puerto Rico- Rio Piedras (UPRRP), majoring in cellular and molecular biology. She has been part of the RISE program during this past year and will be part of the MARC program during the following two years. Both programs are funded by the NIH and their objective is to provide research training to future scientists. Judith has been part of Miguel Acevedo's Lab for a year and a half, studying the dynamics of lizard malaria in Puerto Rican Anoles. She has been also working on her independent research project identifying the vector for this malaria transmission. During last summer, Judith was part of the POWER summer program at Duke O'Brien Center for Kidney Research studying the use of mobile health to improve the outcomes of Diabetic Kidney Disease patients with Dr. Clarissa Diamantidis. Besides her interest in research, she also is enthusiastic about teaching. Consequently, she dedicates part of her time to being a tutor for the genetics class at her home institution. She also volunteered for more than a year in *Oceanica*, an educational exhibition that serve as a preamble to the *Ecoexploratorio: Science Museum of Puerto Rico*. In the future, Judith would like to pursue a PhD in Infectious Diseases with a focus in Genetics. This summer Judith worked with Dr. Vetria Byrd (CGT) and Dr. Douglas LaCount (Medicinal Chemistry and Molecular Pharmacology) researching and creating visualizations about Zika (ZIKV), Ebola (EBOV) and Marburg (MARV) viruses. Details of Judith's summer research experience are available at

<http://web.ics.purdue.edu/~vbyrd/srop/JudithReyes.html>



Exploring Theoretical Foundations of the Underpinnings of Big Data Analytics for Visualizing Heterogeneous Systemic Lupus Erythematosus (SLE) Data.

Graciany Lebron Rodriguez¹, Dr. Vetrica Byrd², Dr. Mark Daniel Ward³,
¹Department of Computer and Electrical Engineering, University of Puerto Rico Mayagüez Campus, Mayagüez, PR 00682, ²Department of Computer Graphics and Technology, Purdue University, West Lafayette, IN 47907
³Department of Statistics, Purdue University, West Lafayette, IN 47907.

The Lupus Foundation of America estimates that 1.5 million Americans, and at least five million people worldwide, have a form of lupus [1]. Systemic lupus erythematosus (SLE) is a heterogeneous systemic autoimmune disease [2]. Many of its clinical symptoms mimic that of other diseases, generating structured and unstructured data from a variety of sources in a variety of different formats. Currently, exploring how best to integrate such data is a primary research topic [3]. To date, published literature on the reporting of results on lupus has not included the use of visual analytics and data visualization type approaches. In this work, the theoretical foundations of the underpinnings of big data analytics for visualizing heterogeneous lupus data is explored. A systematic literature review on SLE was performed to acquire preliminary lupus data. An initial design for a framework was developed using Semantic User Interface and D3.js (Data Driven Documents), an open source, visualization tool written in JavaScript for manipulating data based documents. Associated genes related to the susceptible SLE genes for each ethnicity were acquired from published literature in numeric and text formats. It is expected that a variety of formats will be integrated into the initial framework. Therefore, careful considerations should be taken when integrating other data types and formats. The resulting type of visualization affects the parsing (structuring) stage of the visualization process which in turn impacts algorithms applied on the backend. This was the first step towards the development of a flexible, but robust framework that will allow for the integration and visualization of heterogeneous data. This summer research was supported by NSF Grant No. 1246818.

Determining and visualizing protein-protein interactions of emerging viruses.

Judith M. Reyes Ballista¹, Veronica Heintz², Douglas LaCount², Vetrica Byrd³
¹Department of Biology, University of Puerto Rico-Rio Piedras Campus, San Juan, PR 00931, ²Department of Medicinal Chemistry and Molecular Pharmacology, Purdue University, West Lafayette, IN 47907, USA, ³Department of Computer Graphics Technology, Purdue University, West Lafayette, IN USA

Emerging diseases such as Zika virus (ZIKV), Ebola virus (EBOV) and Marburg virus (MARV) can seriously affect the health of a population, causing illnesses and deaths by controlling the host cell for their own replication. Consequently, there is a need to study virus-host cell protein-protein interactions (PPIs) to understand which cellular pathways the virus could be using as targets, and which functions the virus is affecting. It can also provide us enough information to make comparisons between viruses and their mechanisms of action. In this study, the PPIs of ZIKV NS5 were investigated using a yeast two-hybrid assay. ZIKV infection of pregnant women is associated with an increased risk of microcephaly in their babies. We hypothesized that the viral protein would interact with centrosomal proteins due to the fact that these proteins have been previously associated with the genetic causes of microcephaly. In addition, an analysis of PPIs was conducted by creating visualizations to compare the interface between the viral and human proteins of EBOV and MARV. The use of data visualization provides insight for a better understanding of how these viruses behave and lead us to new discoveries. After doing a literature review and determining a list of visualization methods that were previously used, Cytoscape was chosen as the main software for visualizing the protein interaction networks for the full length viral proteins, as well as two individual fragments. These visualizations let us compare both viruses to identify differences in their mechanisms and interaction strengths. This research provides an overview to the study of PPIs that could contribute to the development of vaccines or treatments for these diseases in the future.

Visualizing the effect of differentially expressed genes in short and long longevity mouse strains exposed to Diphtheria, Tetanus and acellular Pertussis (DTaP) Vaccine.

Elena Cadenas¹, Yung-Yi Mosley², Harm HogenEsch², Vetrica Byrd³,
¹Department of Mathematics, Pennsylvania State University, State College, PA 16802 ²Department of Comparative Pathobiology, College of Veterinary Medicine, Purdue University, West Lafayette, IN 47907. ³Department of Computer Graphics Technology, Purdue University, West Lafayette, IN 47907.

The incidence of pertussis, otherwise known as whooping cough, has increased over the past twenty-five years despite appropriate childhood vaccination coverage. The age of clinical presentation has also increased among vaccinated patients suggesting that the current DTaP vaccine does not provide long-term protection. Recent studies with inbred mice indicate that host genetics affect the magnitude and longevity of the immune response to DTaP. Current experiments are aimed at identifying genes that are differentially expressed (DEGs) following DTaP vaccination. The selected strains of mice are LP/J (LPJ) (short longevity) and 129S1/SvImJ (129) and BALB/c (BC) (long longevity) to test the hypothesis that short and long longevity responders have differential gene expression. The data were visualized with volcano plots, heat maps, network clusters, Venn diagrams, and circos plots. Data visualization provides insight by representing a large amount of data into one figure. The visualizations of this data revealed that although the naïve mice of 129 and LPJ are most genetically similar, which was confirmed by the heat map, 129 and BC have longer antibody longevity after vaccination. The Venn diagrams and circos plots revealed 114 genes related to vaccination (DEGs expressed in all three strains) and 33 to antibody longevity (DEGs expressed in 129 and BC, but not LPJ). Significantly up and down regulated genes in each strain identified from volcano plots and network clusters demonstrate the functions of the genes affected by DTaP vaccination.



Figure 3. Dr. Camilo Vieira, PhD.

Postdoctoral Data Vis/UX Researcher Joined CGT

Camilo Vieira is a Postdoctoral Researcher in the Computer Graphics Technology Department at Purdue University, West Lafayette. He completed his undergraduate and his master's studies at Universidad Eafit, in Medellin Colombia. He holds a Bachelor's degree in systems engineering and a Master's degree in engineering. He completed his doctorate at Purdue University, where he worked on computing education, and learning analytics for engineering education. Dr. Vieira is working with Drs. Vetricia Byrd (Data Vis) and Paul Parsons (UX) on research on Designing Visual Analytics Tools for Dynamic Decision-Making under Uncertainty. Dr. Vieira will give a research talk "Data Visualization and Education Research," on October 13, 2017 at 4PM - 5PM as part of the Polytechnic Postdoc Seminar Series (Wang Hall 2501).

2017 IHPCSS: International High Performance Computing Summer School

This summer, June 26—July 1, 2017, Dr. Byrd was an invited lecturer for the annual International High Performance Computing Summer School (IHPCSS), sponsored by Partnership for Advanced Computing in Europe (PRACE), Extreme Science and Engineering Discovery Environment (XSEDE), The Advanced Institute for Computational Science and Compute Canada. The unique, highly competitive, expense-paid event brings together graduate students from many parts of the world to participate for one week in an exciting program coupled with dedicated mentoring and networking. This year the summer school was hosted at the University of Colorado at Boulder. During the summer school Dr. Byrd provides hands-on training in scientific visualization and mentor graduate students who participate in the program. The program receives over 300 applications and invites 80 students each year to participate in the program. Dr. Byrd has participated in the program for the last three years : Toronto, Canada (2015), Slovenia, Ljubljana (2016) and Boulder, Colorado (2017) as an invited instructor for scientific visualization training.



Figure 4. Dr. Vetricia L. Byrd (Purdue), and Mentees: Laura Bellentani (University of Modena and Reggio Emilia), Nuttliya Seekhao (University of Maryland) and Jingwei Li (University of Colorado at Boulder).

Byrd VisLab Sailing in Blue Waters

This year the Computer Graphics Technology Data Visualization Group participated in the online Blue Waters Visualization Seminar Series, sponsored by NSF. Blue Waters is one of the most powerful supercomputers in the world. Dr. Vetricia L. Byrd, from the Byrd Vis Lab, was selected to give two lectures as part of the Visualization Webinar series hosted by the Blue Waters group. More information about Blue Waters and Dr. Byrd's webinars (Introduction to Data Visualization and Introduction to SciVis featuring Paraview) are available at

<https://bluwaters.ncsa.illinois.edu/webinars/visualization>

Next Issue

The Fall 2017 Issue will feature

- Research Updates
- New Graduate Students in the Byrd Vis Lab
- Undergraduate Research in the Byrd Vis Lab
- Update on 2017 SROP Student Research