Title

Four Views on Visualization in Science and Education

Description

Scientific visualization is by its very nature driven by the needs of collaborators in the sciences who have data sets and the need to understand and to clearly and concisely describe them. The best collaborations drive research in both the domain science and visualization, with buy-in from both teams.

This venue provides an opportunity for the visualization community to hear from and interact with four practicing scientists and educators who use visualization in their work and who are looking for visualization help with future projects. Each is involved in successful collaborations with visualization researchers and brings a unique perspective on what visualization means to them. Each of them will give examples of how visualization has been helpful to them in the past and a description of the kind of data sets and questions they deal with in their field. Together, this provides a cross-sectional view of what it looks like to be part of such collaborations from the viewpoint of the domain scientist.

Organizer

Russell M. Taylor II, Research Professor of Computer Science, Physics & Astronomy, and Applied Sciences at the University of North Carolina at Chapel Hill.

Participants

Steffen Bass

Bio: Steffen Bass is a Professor of Theoretical Nuclear Physics at Duke University. His main area of research is strong interaction theory, in particular the study of highly excited many-body systems governed by the laws of Quantum-Chromo-Dynamics (QCD). His research involves the application of transport theory, statistical mechanics, heavy-ion phenomenology, as well as the fundamental laws of QCD. He is the co-director of the Modeling And Data Analysis Initiative, which is a 4-institute project to develop statistical and visualization tools for the exploration of ensemble simulations in a variety of scientific disciplines.

Abstract: The modeling of highly energetic nuclear collisions is a computationally highly challenging task, involving a relativistic system of thousands of microscopic particles evolving out of equilibrium, governed by interactions which have to be calculated in the context of quantum field theory. Visualization has the potential to play an important role for the comprehension of the complex interactions and many-body effects present in these models, in particular since the simulated phenomena cannot be directly observed, and involve tensor interactions between color-charge carrying particles and fields in a high-dimensional parameter space. To have a hope of understanding the response of the simulations to changes in the parameters and find the best possible set of parameters to match the simulation to experimental data, all tools available in state-of-the-art computer and statistical science have to be brought to bear, pushing the boundaries of high-performance computing, statistics, and visualization. Within the MADAI project, we have made heavy use of visualization to understand these ultra-relativistic heavy-ion collisions. In my presentation, I will be showing visualizations produced by our team using ParaView and custom plug-ins and discuss what insights were gained. I'll then talk about where we're headed in the future and how you might help us get there.

Kerry Bloom

Bio: Kerry Bloom uses quantitative light microscopy to understand the structural basis of chromosome segregation. This research represents the forefront in our challenge to deduce structures of large macromolecular complexes in living cells and in real time. Kerry collaborates heavily with artists, physicists, applied mathematicians, and computer scientists, directing multifaceted approaches in his laboratory including molecular biology, genetics, fluorescence microscopy, computational modeling and biophysics, incorporating single molecule tracking and polymer physics. He has used visualizations produced by artists, by geometric calculations, and by physically-based simulations to gain further understanding of subcellular structures.

Abstract: The intersection of physics, computational, molecular and cell biology reflects major changes in our approach to basic cell biological questions in the post-genome era. New strategies to beat the resolution limit in live cells, examine dynamic processes with speed and accuracy, and perform these genome-wide, challenges cell biologists to use quantitative approaches developed by physicists and mathematicians. In our own work we apply principles of polymer physics to understand how chromatin architecture (such as DNA wrapping around nucleosomes, looping and catenation) contributes to faithful chromosome segregation. We have found that simple drawings and toy models are among the more effective means of communication. Starting with a white board to help visualize molecular concepts, we progress through artistic renditions, computer simulation and finally molecular dynamics. This progression has contributed to a successful endeavor that may profoundly influence understanding basic mechanisms for chromosome segregation. We are looking to further these approaches to deepen our understanding of the fundamental molecule of life, DNA. In particular, the physics is telling us that DNA in the cell (in the form of chromatin) can fluctuate between viscous and elastic states. We are looking for imaginative ways to represent these physical states, as well as others to gain a pictorial representation of the inner working of the cell.

David Feng

Bio: David Feng performs data analysis and visualization for the Allen Institute for Brain Science. After completing a PhD in multivariate data visualization from UNC-Chapel Hill in 2010, he moved to Seattle to support the fast-growing efforts of the Allen Institute to map and understand the human brain.

Abstract: I will discuss the topic of supporting the Neuroscience community through data visualization. The Allen Institute for Brain Science was built to develop large, free resources to fuel discovery in neuroscience. We produce industrial-scale data sets and that are too large and resource intensive for most laboratories to make alone. Visualization is critical not just for internal development and analysis of the data set, but also for engaging the neuroscience community. I will give an overview of some of the Institute's major data sets and how we use visualization to make big data approachable. I'll also talk about ongoing analysis projects with data sets that we would like help visualizing.

Gail Jones

Bio: Dr. Gail Jones has a PhD in Science Education from NC State University and currently serves as Professor of Science Education teaching preservice and inservice teachers and conducting research on size and scale as well as nanotechnology and nanoscale science education. Dr. Jones has over 150 scholarly publications in leading journals such as *American Education Research Journal*, *Science Education*, and the *International Journal of Science Education*. Her research has been recognized for excellence by the National Association for Research in Science Teaching, the NC Association of Research in Education, and the Association of Supervision and Curriculum Development. Dr. Jones is an author of *Nanoscale Science* that focuses on teaching nanoscale science for precollege education. She has also published a book on teaching science at large and small scales (*Extreme Science*) and this book received the Association of Educational Publishers Finalist Award for Science Curriculum. Dr. Jones' research group is currently researching size and scale, as well as the use of haptic technology to teach concepts of nanoscale phenomena.

Abstract: Visualization is a critical component of science education and is often approached in science education research as an integral part of concept development. The addition of haptics to visual representations has recently been explored as a way to strengthen conceptual development. This presentation explores the efficacy of haptics and visualization for learning about viruses, cells, balance beams, and particle motion. Results of research that compares visual only to visual plus haptics will be shared. Science education research on difficult areas to visualize such as size and scale will also be discussed.