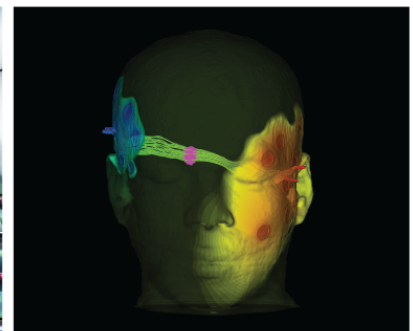
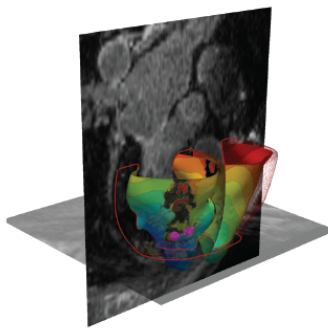
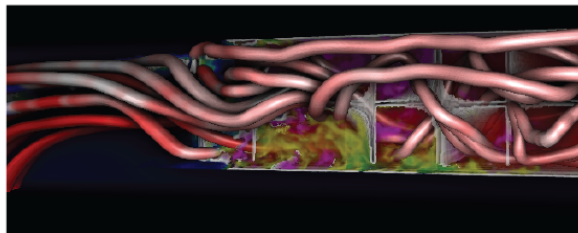
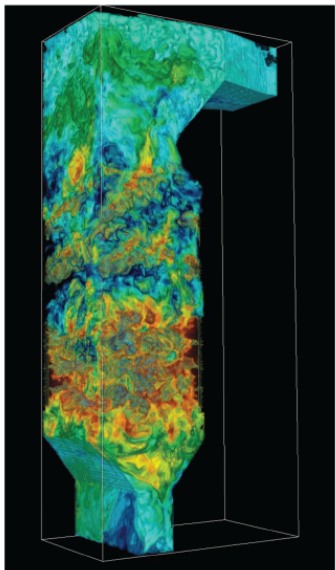
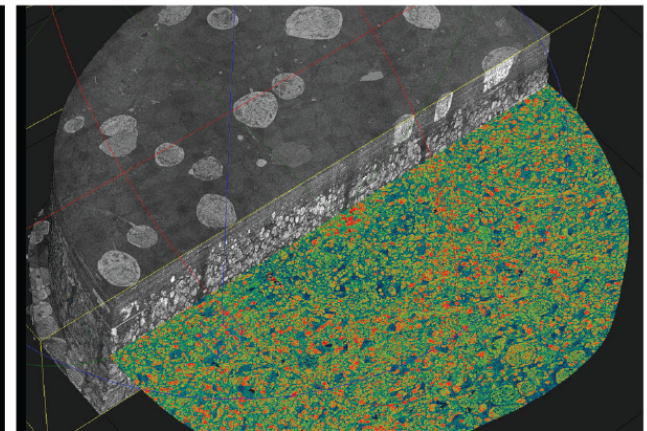
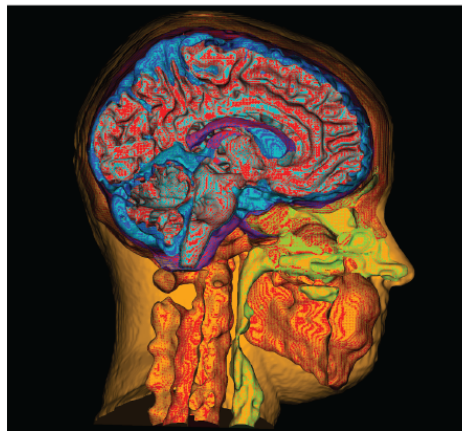
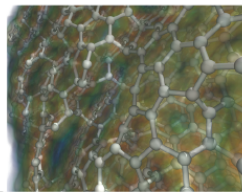
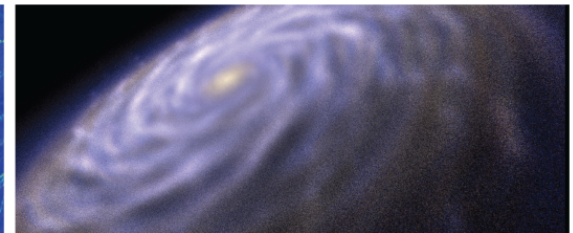
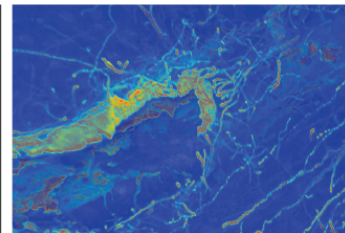
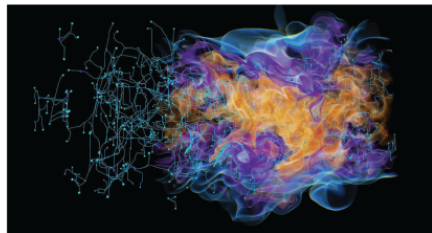
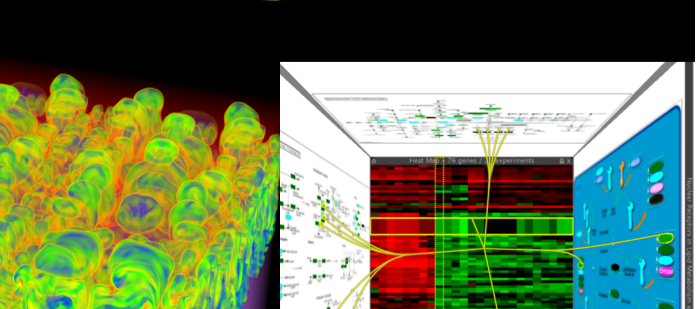
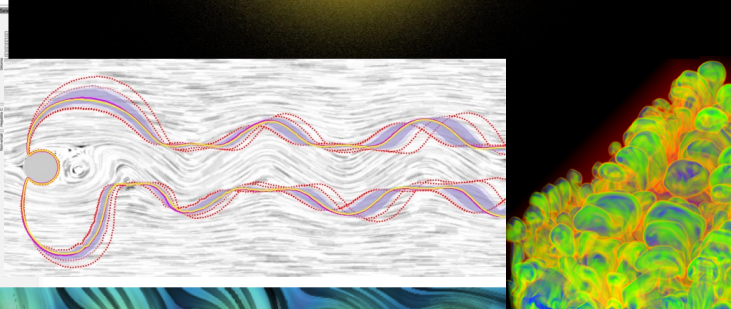
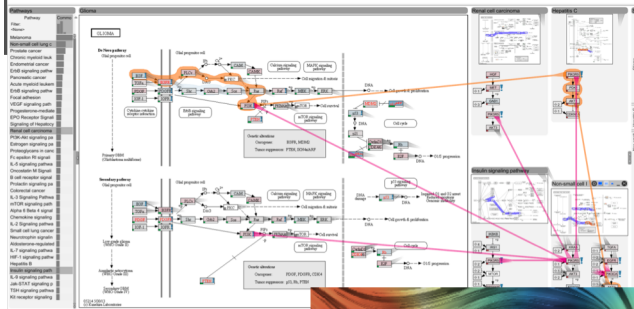
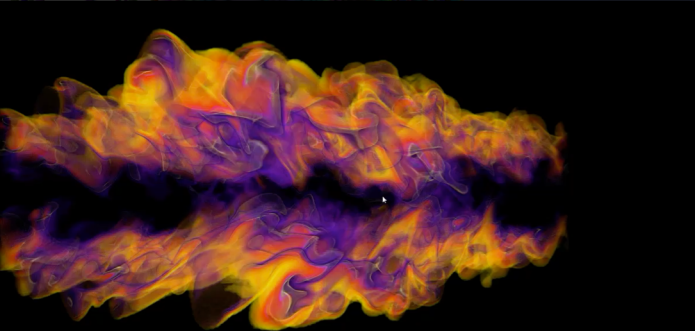
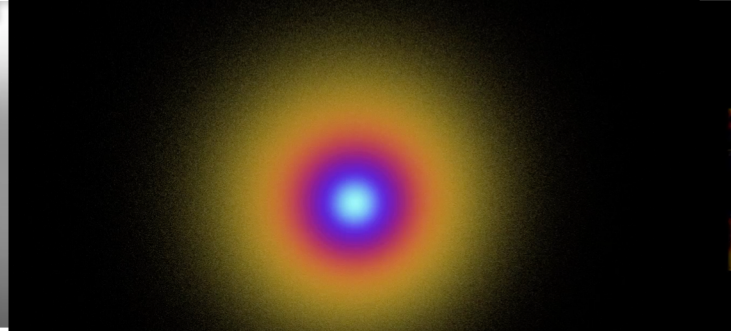
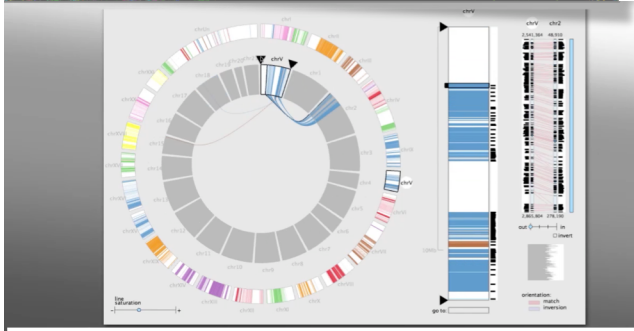
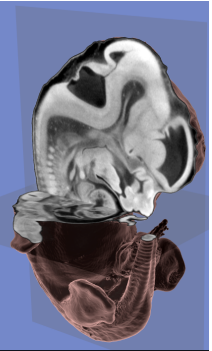
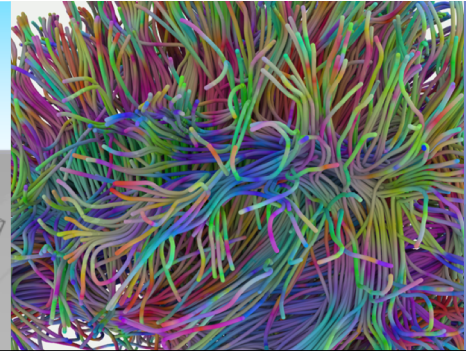
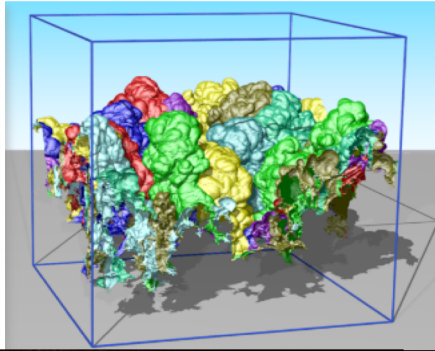
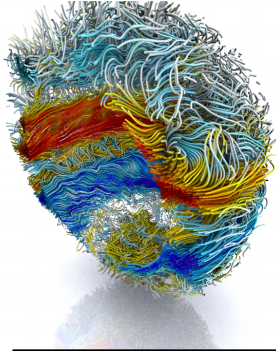
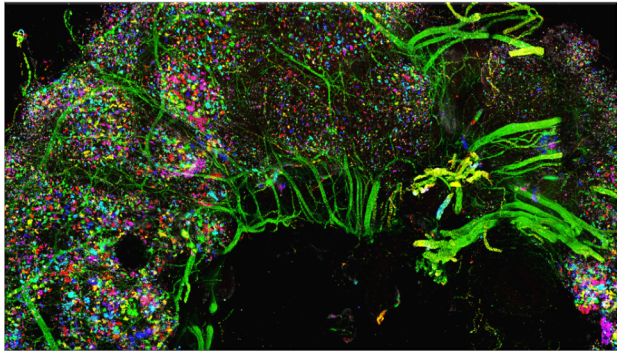


SCI Institute History

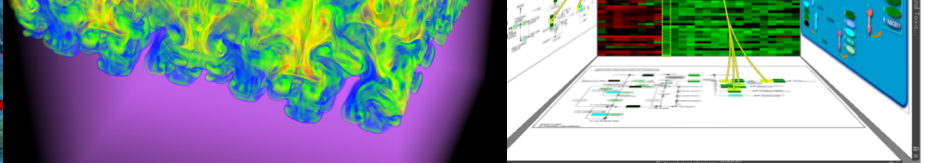
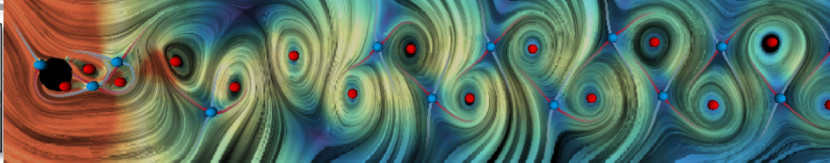




Scientific Computing and Imaging (SCI) Institute



SCI
INSTITUTE



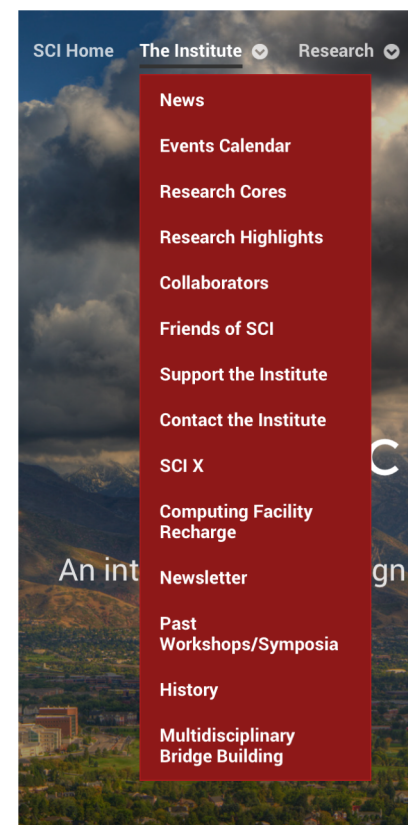
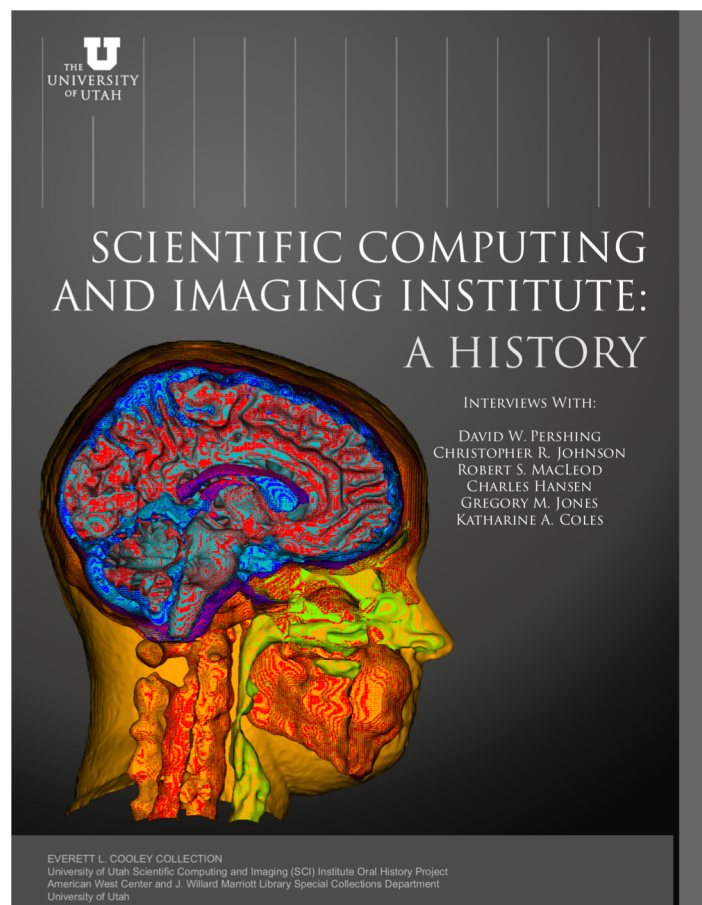
SCI Institute Mission Statement

Our **vision** is to see applied computing bring transformation across disciplines in a way that benefits the U and through it, society at large.

Our **mission** is to bring together excellence in multiple domains applied to multidisciplinary and interdisciplinary problems of societal importance. We accomplish this through collaborative research in simulation, imaging, visualization, and scientific and data computing that drives the development and distribution of advanced software tools.



The Marriott Library Cooley Collection

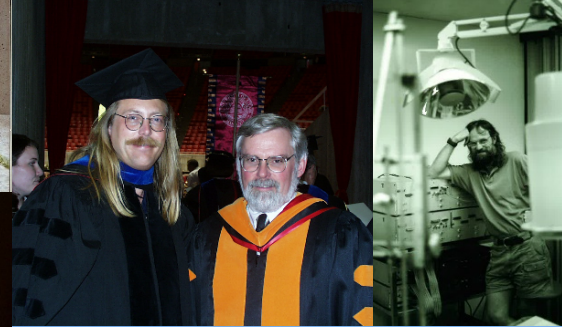
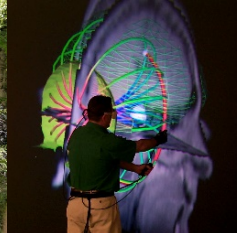


www.sci.utah.edu



http://www.sci.utah.edu/images/Research/SCI_History_Cooley.pdf

SCI UTAH



SCI INSTITUTE

Scientific Computing and Imaging (SCI) Institute Timeline

- 1990 - Chris Johnson and Rob MacLeod start working together at the CVRTI
- 1992 - Chris moves to the Department of Computer Science - 16 faculty at the time
- 1993 - Rob joins BE - 10 faculty at the time
- 1994 - Chris and Rob and 5 graduate students form the SCI Research Group (named by graduate student David Weinstein)
- 1996 - Center for Scientific Computing and Imaging formed - 15 people

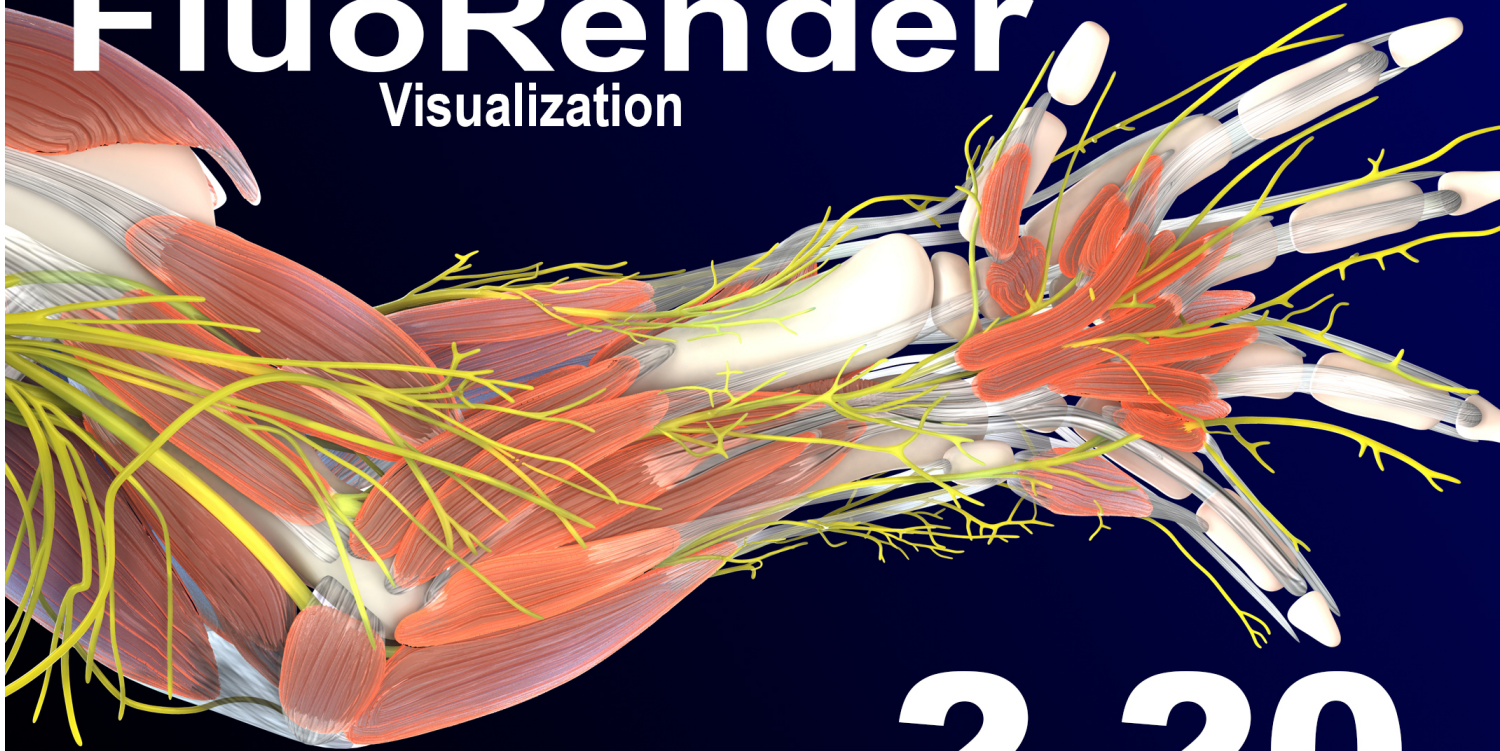


Scientific Computing and Imaging (SCI) Institute Timeline (cont.)

- 1997 - Chuck Hansen joins SCI from Los Alamos
- 1998 - DOE Visualization Center (Chuck Hansen and Chris)
- 1999 - NIH Center (Rob, Chuck, Chris)
- 2000 - SCI Institute formed - 32 people
- 2006 - SCI Institute growth - 100 people (11 faculty)
- 2010 - SCI Institute growth - 200 (17 faculty)
- 2018 - Mike Kirby becomes Interim Director
- 2020 - SCI Institute - 110 students, 18 faculty (3 open positions)

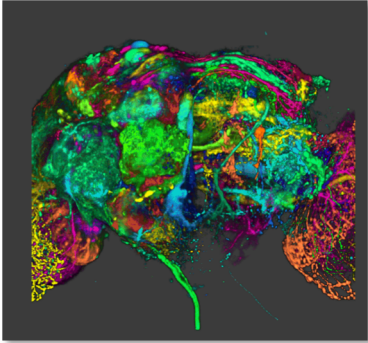


CIBC
FluoRender
Visualization

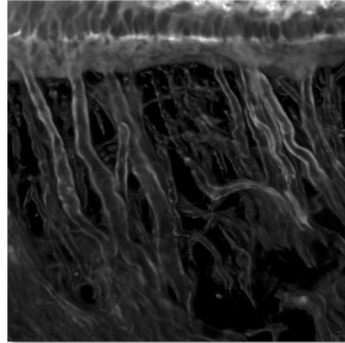


2.20

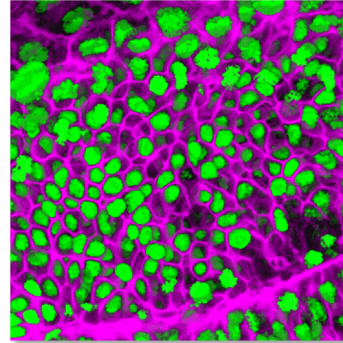
FluoRender - Chuck Hansen and Yong Wan



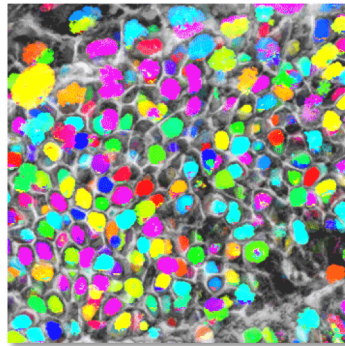
Multichannel
visualization



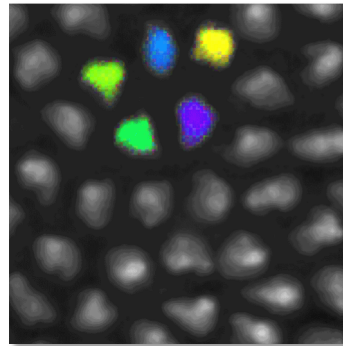
Interactive
segmentation



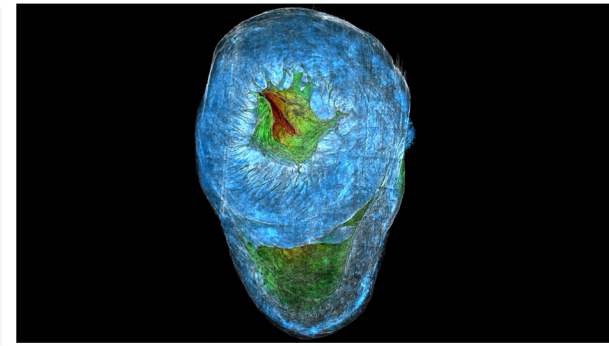
4D scan
visualization



Auto segmentation
on GPU

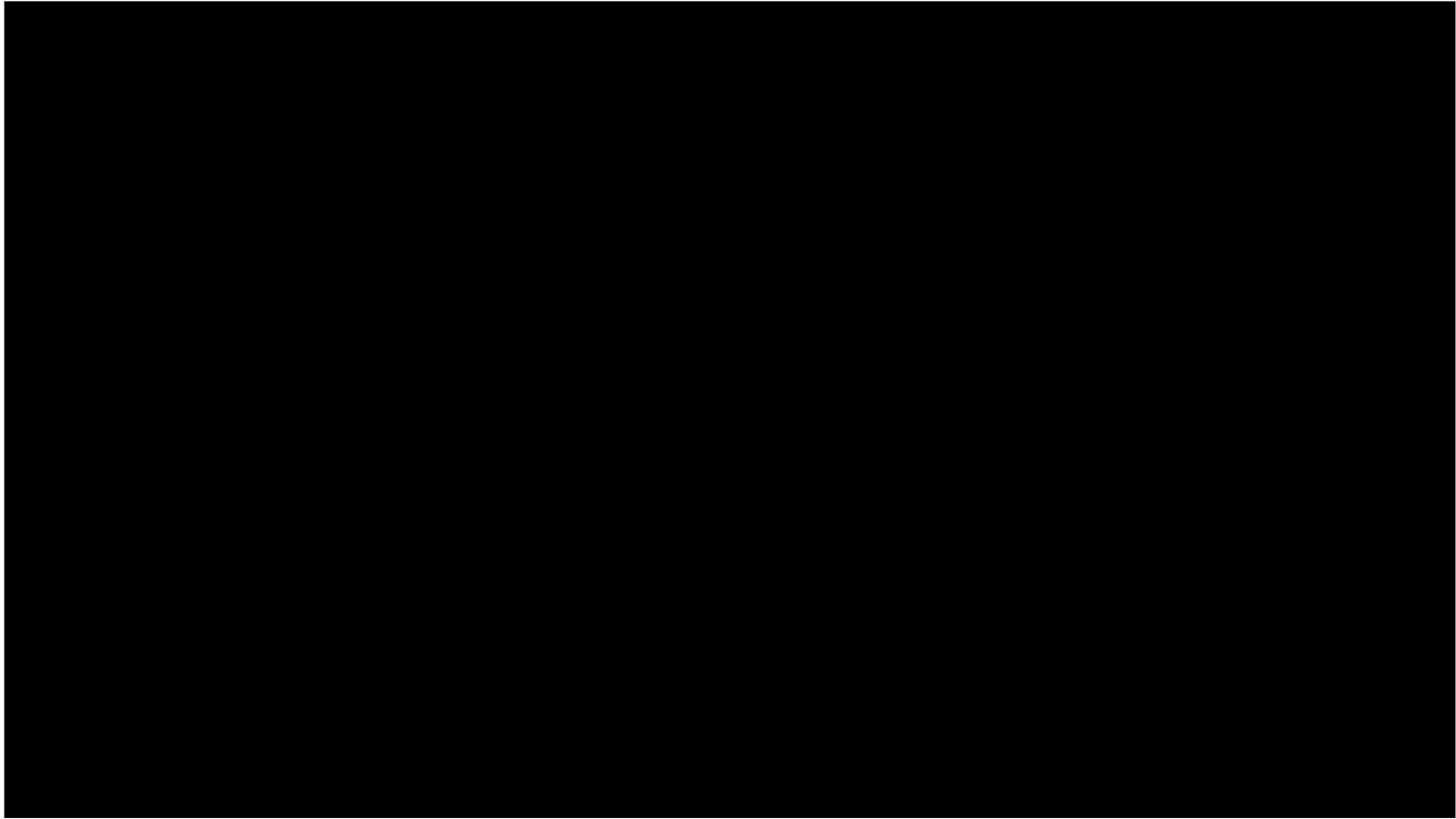


Tracking



Large-Scale Data

FluoRender



Utah Graphics History



1, 2. David Evans /Ivan Sutherland

- Founded CS Dept at the UofU in 1968
- Ivan Sutherland - Turing award
- Founded Evans & Sutherland Company

3. John Warnock

- Worked at Evans & Sutherland
- Founded Adobe
- Hidden Line Removal Algorithm
- Helped invent Postscript @ Adobe

4. Ed Catmull

- Worked at Lucas Film
- Co-Founded Pixar
- President of Disney Animation Studios
- Chair of CoE External Advisory Board

5. Jim Clark

- Founded SGI, Netscape, Healthcon
- Work in Geometry Pipelines

6. Alan Kay

- Personal Computer
- Turing Award Winner
- Object Oriented Languages

7. Nolan Bushnell

- Invented Pong
- Founded Atari

8. Jim Kajiya

- Rendering Equation
- VP Research at Microsoft

9. Tom Stockham

- Known for work in Signal Processing
- Helped to invent the CD Player

10. Jim Blinn

- Invented Blinn-Phong Shading Model

11. Henri Gouraud

- Invented Gouraud Shading Model

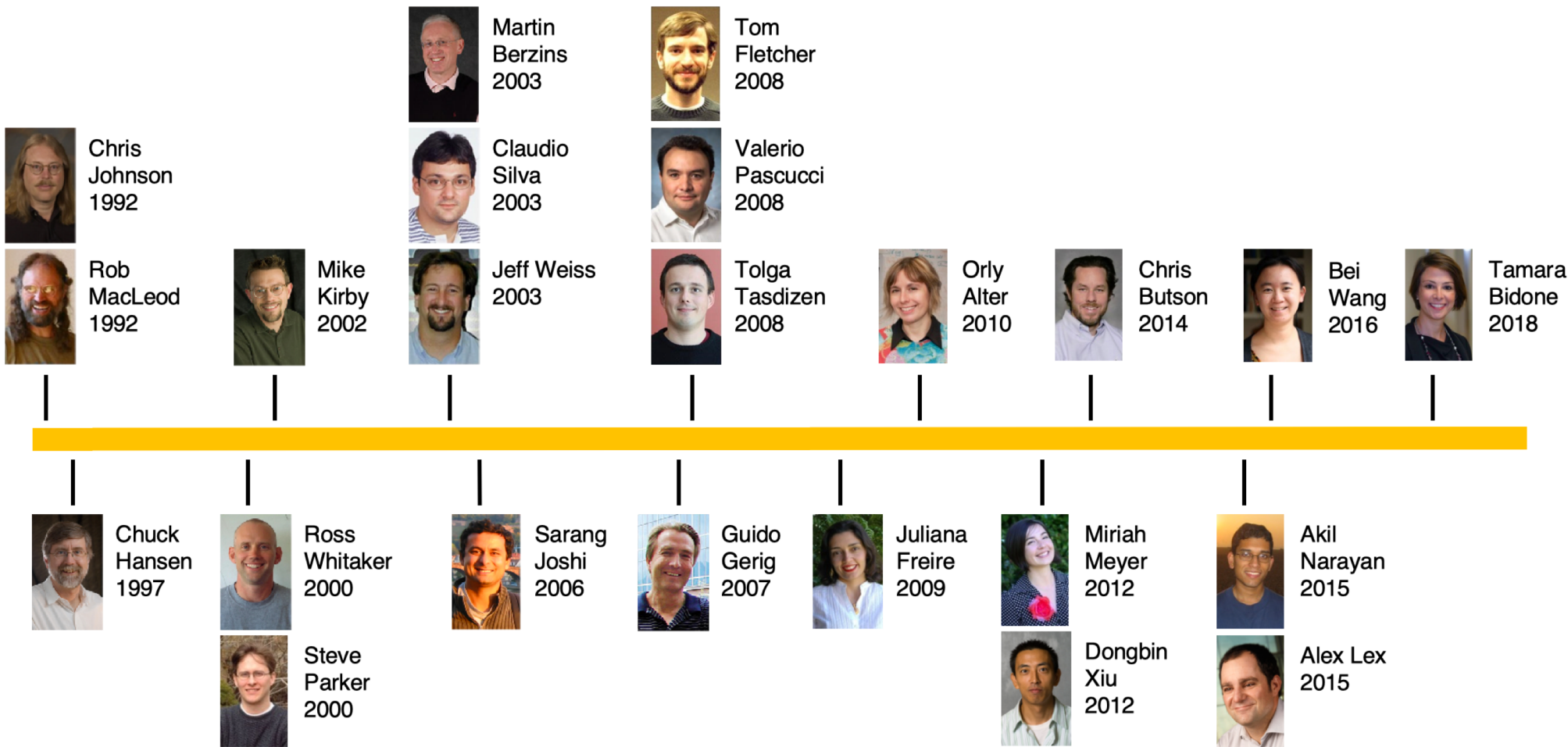
12. Bui Tuong Phong

- Invented Phong Reflection and Shading Models

13. Allen Ashton

- Word Perfect
- My CFO Founder



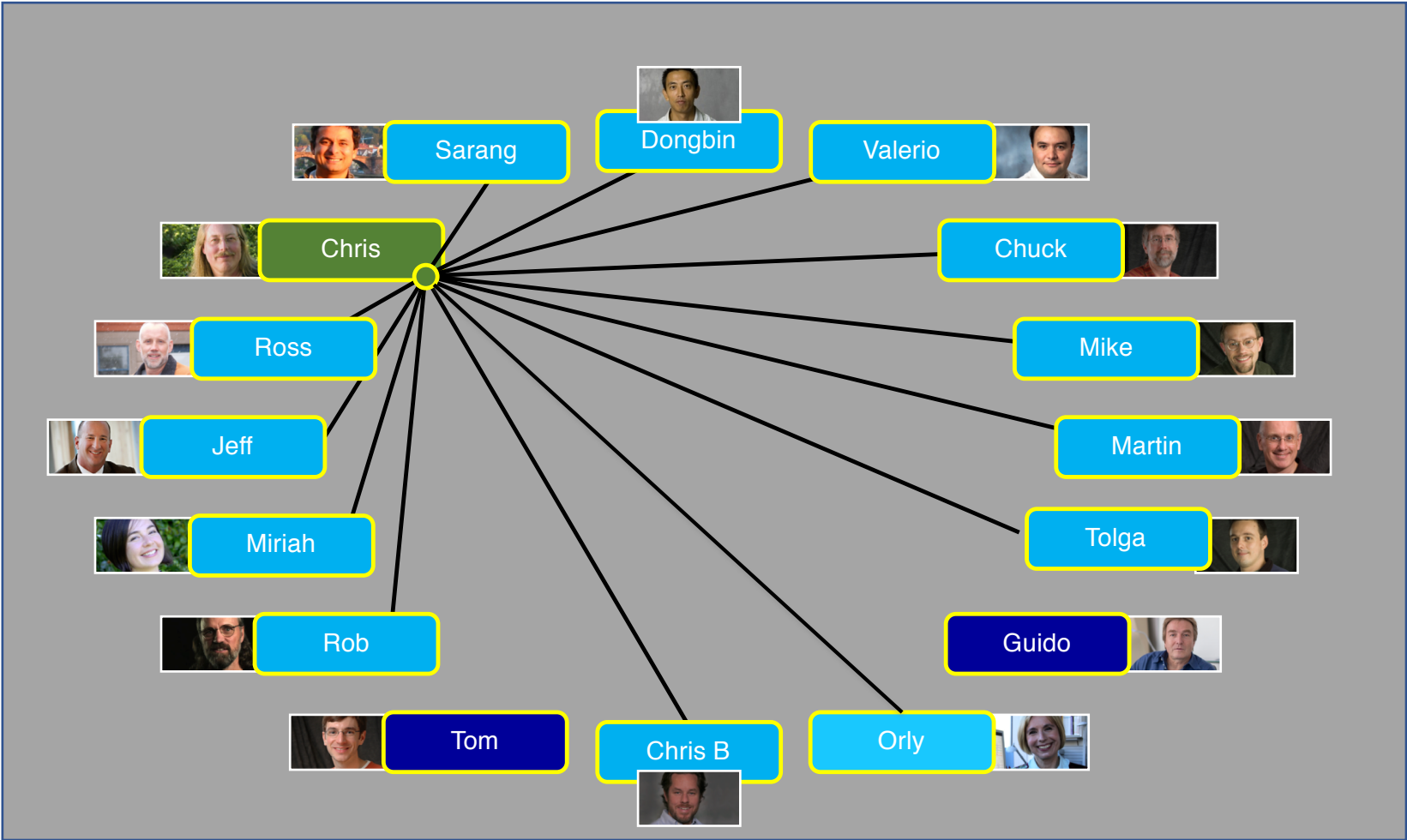


SCI Institute - Utah Collaborations

Architecture HCI School of Computing Pharmaceutical Chemistry
Mechanical Engineering Chemical Engineering UCAIR Mathematics
Moran Eye Center Materials Science UPDB TCO CHPC
CVRTI Neurology Pathology / ARUP
Neurosurgery Geography ICSE
Biomedical Informatics Cardiology
Genetics Physics Psychology
Nephrology Chemistry
Biology Brain Institute Nuclear Engineering EGI
Bioengineering PCMC Cardiology Radiation Oncology CTSA
English Epidemiology Radiology Physiology Geology Orthopedics



Internal SCI Institute Collaboration



National Research Centers

NIH Center for Bioelectric Field Modeling, Simulation, and Visualization

NIH Center for Integrative Biomedical Computing

DOE ASCI Center for the Simulation of Accidental Fires and Explosions

DOE Advanced Visualization Center DOE SciDAC Common Component Architecture

NIH National Alliance of Medical Image Computing

DOE Center for Exascale Simulation of Combustion in Turbulence

NCI Physical Sciences in Oncology Network NIH Center for Biomedical Computing

DOE SciDAC Scientific Data Analysis and Visualization

DOE SciDAC Visualization and Analysis Center NVIDIA Center of Excellence

Utah Center for Computational Earth Sciences

DOE PSAAP II

CDC Center for Decision Support for Infectious Disease Epidemiology

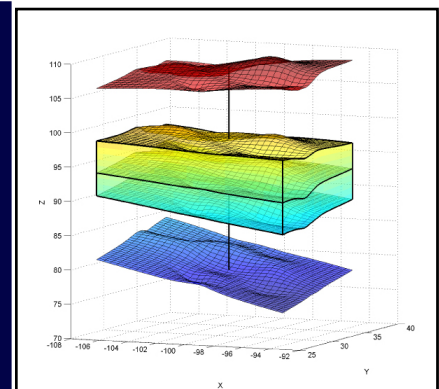
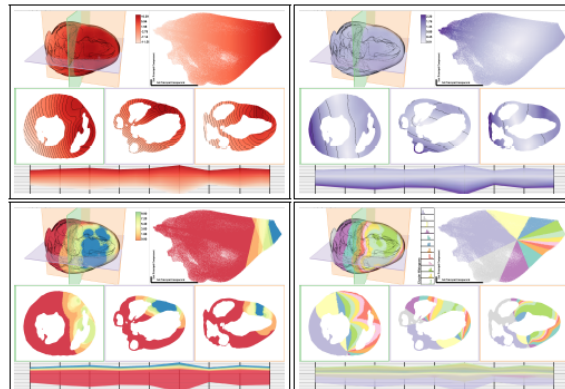
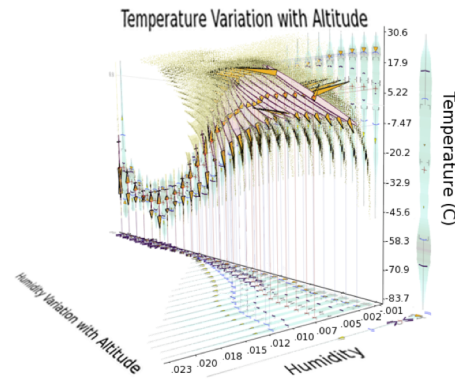
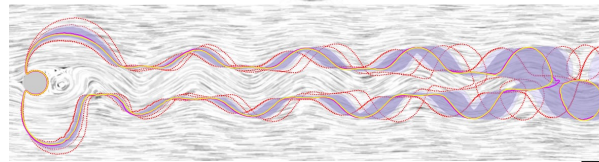
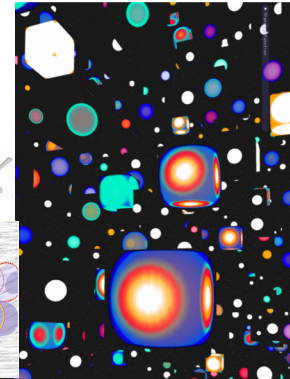
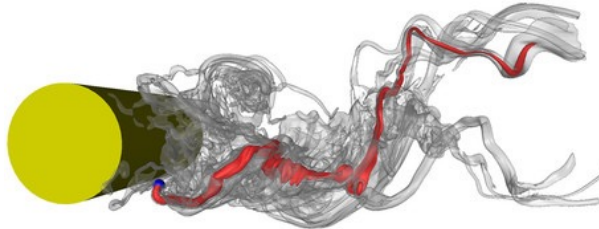
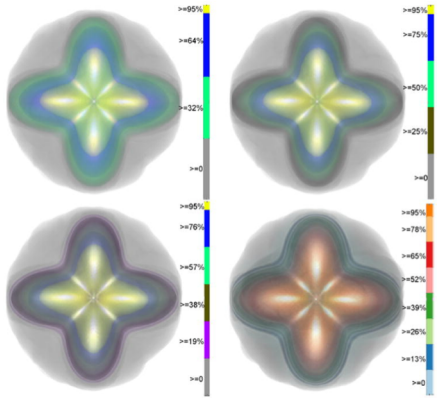
KAUST Institute for Applied Mathematics and Computational Science

DOD (ARL) Center for Computationally Designed Efficient Materials



Uncertainty Visualization

When is the last time you've seen an error bar on an isosurface?



G.P. Bonneau, H.C. Hege, C.R. Johnson, M.M. Oliveira, K. Potter, P. Rheingans, T. Schultz. "Overview and State-of-the-Art of Uncertainty Visualization," In *Scientific Visualization: Uncertainty, Multifield, Biomedical, and Scalable Visualization*, Edited by M. Chen and H. Hagen and C.D. Hansen and C.R. Johnson and A. Kauffman, Springer-Verlag, pp. 3-27. 2014.

M.G. Genton, C.R. Johnson, K. Potter, G. Stenchikov, Y. Sun. "Surface boxplots," In *Stat Journal*, Vol. 3, No. 1, pp. 1-11. 2014.

K. Potter, P. Rosen, C.R. Johnson. "From Quantification to Visualization: A Taxonomy of Uncertainty Visualization Approaches," In *Uncertainty Quantification in Scientific Computing*, IFIP Series, Vol. 377, Springer, pp. 226-249. 2012.

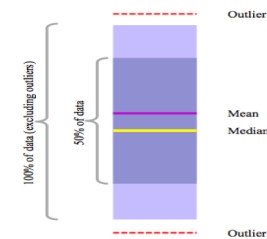
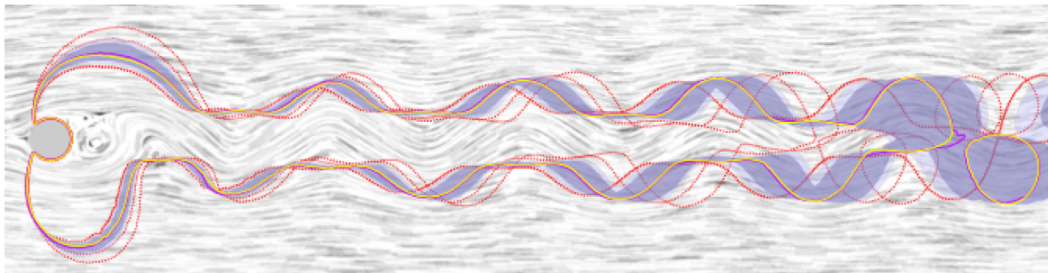
K. Potter, A. Wilson, P.-T. Bremer, D. Williams, C. Doutriaux, V. Pascucci, C.R. Johnson. "Ensemble-Vis: A Framework for the Statistical Visualization of Ensemble Data," In *Proceedings of the 2009 IEEE International Conference on Data Mining Workshops*, pp. 233-240. 2009.

C.R. Johnson, A.R. Sanderson. "A Next Step: Visualizing Errors and Uncertainty," In *IEEE Computer Graphics and Applications*, Vol. 23, No. 5, pp. 6-10. September/October, 2003.

Contour Box Plots - Mike Kirby and Ross Whitaker

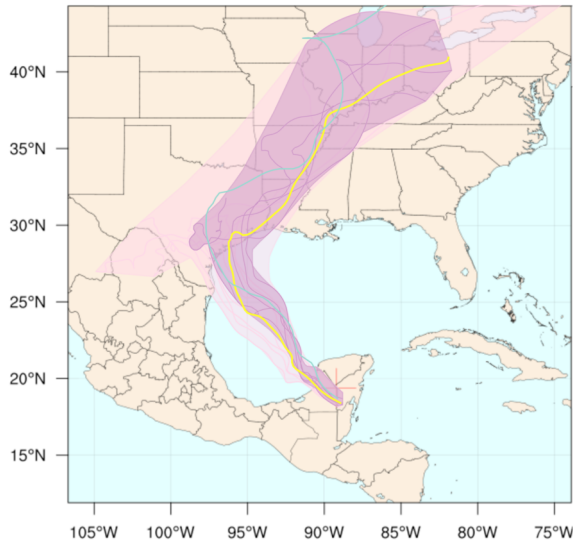


$$S \in \text{sB}(S_1, \dots, S_j) \iff \bigcap_{k=1}^j S_k \subset S \subset \bigcup_{k=1}^j S_k.$$



Whitaker, Mirzargar, Kirby, *IEEE Transactions on Visualization and Computer Graphics*, Vol. 19, No. 12, pp. 2713-2722, 2013.

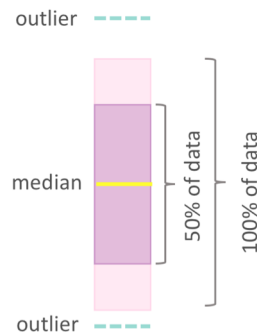
Ensemble Curved Boxplot



This plot is an experimental boxplot visualization

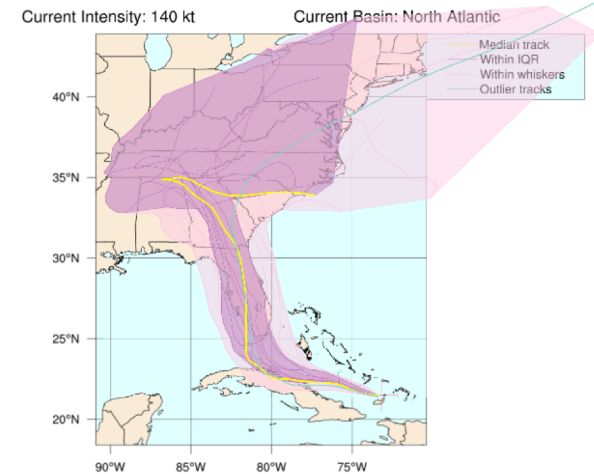
By using this plot, the user agrees to the UCAR Terms of Use which can be accessed at: <http://www2.ucar.edu/terms-of-use>

Plot generated at 0613 UTC 23 August 2017



MAJOR HURRICANE IRMA (AL11)

GFS ensemble curve boxplot initialized at 0600 UTC, 08 September 2017



This plot is an experimental boxplot visualization

By using this plot, the user agrees to the UCAR Terms of Use which can be accessed at: <http://www2.ucar.edu/terms-of-use>

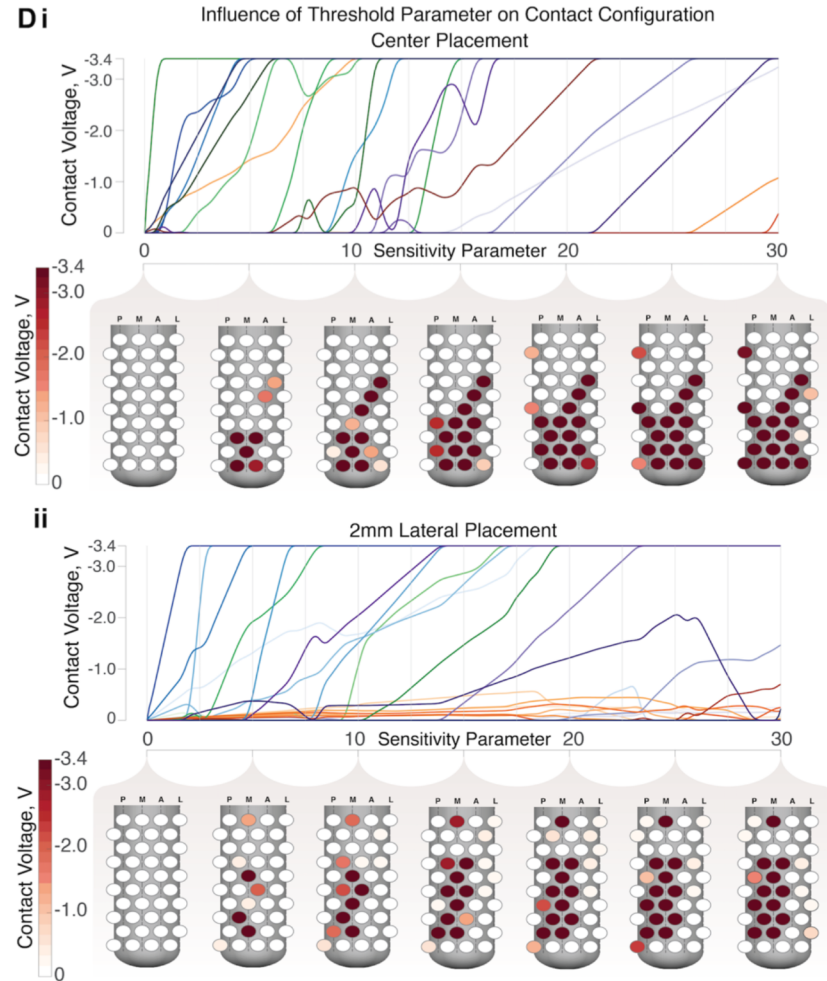
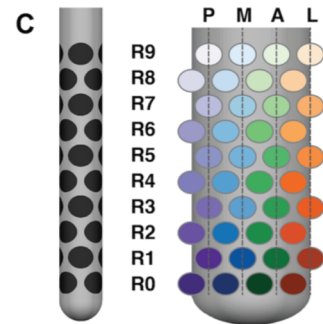
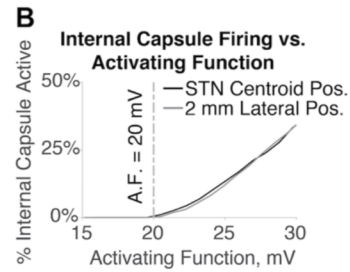
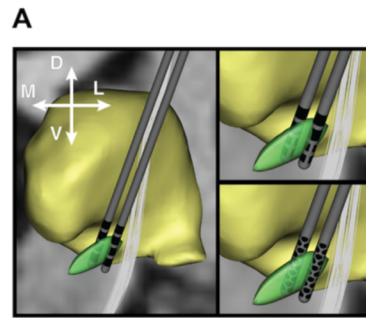
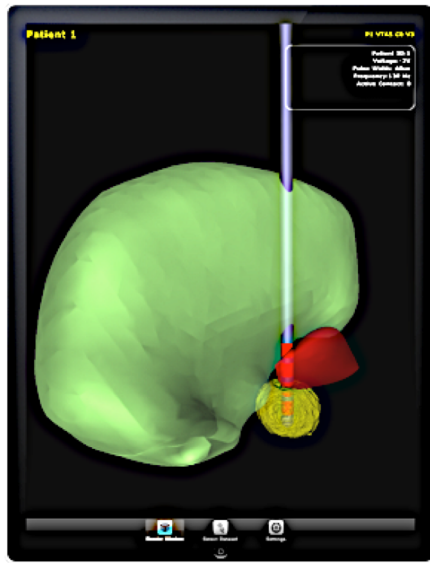
Plot generated at 1522 UTC 08 September 2017



M. Mirzargar, R. Whitaker, R. M. Kirby. "Curve Boxplot: Generalization of Boxplot for Ensembles of Curves,"
IEEE Transactions on Visualization and Computer Graphics, Vol. 20, No. 12, IEEE, pp. 2654-63. December, 2014.



Chris Butson

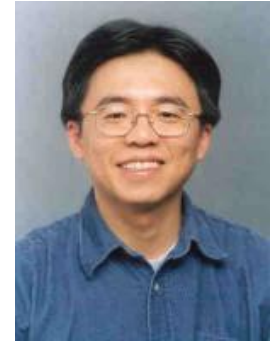


Anderson D, Osting B, Vorwerk J, Dorval AD, Butson CR, Journal of Neural Engineering, Dec 2017



Han-Wei Shen

- Ph.D. Student, Graduated in 1998
- Researcher at NASA Ames
- Professor of Computer Science at The Ohio State University
- Ruth and Joel Spira Award for Excellence in Teaching, 2014
- CSE Outstanding Teaching Award, 2002, 2009
- NSF CAREER Award, 2004
- DOE Early Career Award, 2003
- Graduated 25 PhD Students



Tolga Tasdizen



Automated text report generation from radiological images with machine learning

- Why? Radiologists spend most of their time generating reports (average 10 min/exam). Machine learning can help.
- Applications of machine learning to medical image analysis has generally been limited to learning from labeled data, i.e. normal vs. disease, for research.
- State-of-the-art deep learning models are data hungry. Radiology: Labeled data is rare. Text reports are plenty.
- Research direction: Automatic image captioning and visual question answering combines vision and language models.
 - NIH recently released 100K chest radiographs with text mined disease labels.
- Utah project
 - Radiology (Joyce Schroeder) + Computer Vision (Tolga Tasdizen) + Natural Language Processing (Vivek Srikumar)
 - Seed support from SCI and the Department of Radiology
 - First project: IRB approved for all chest radiographs taken at the U. of U. hospital and associated text reports over the last 5 years (~300K scans)
 - In process of de-identification (Clement Vachet)
 - Computational infrastructure: NVIDIA DGX (RIF + SCI + SoC funding)



Clinical information

69-year-old female with a history of smoking, asthma and bronchitis now with productive cough intermittently for several months.

Findings

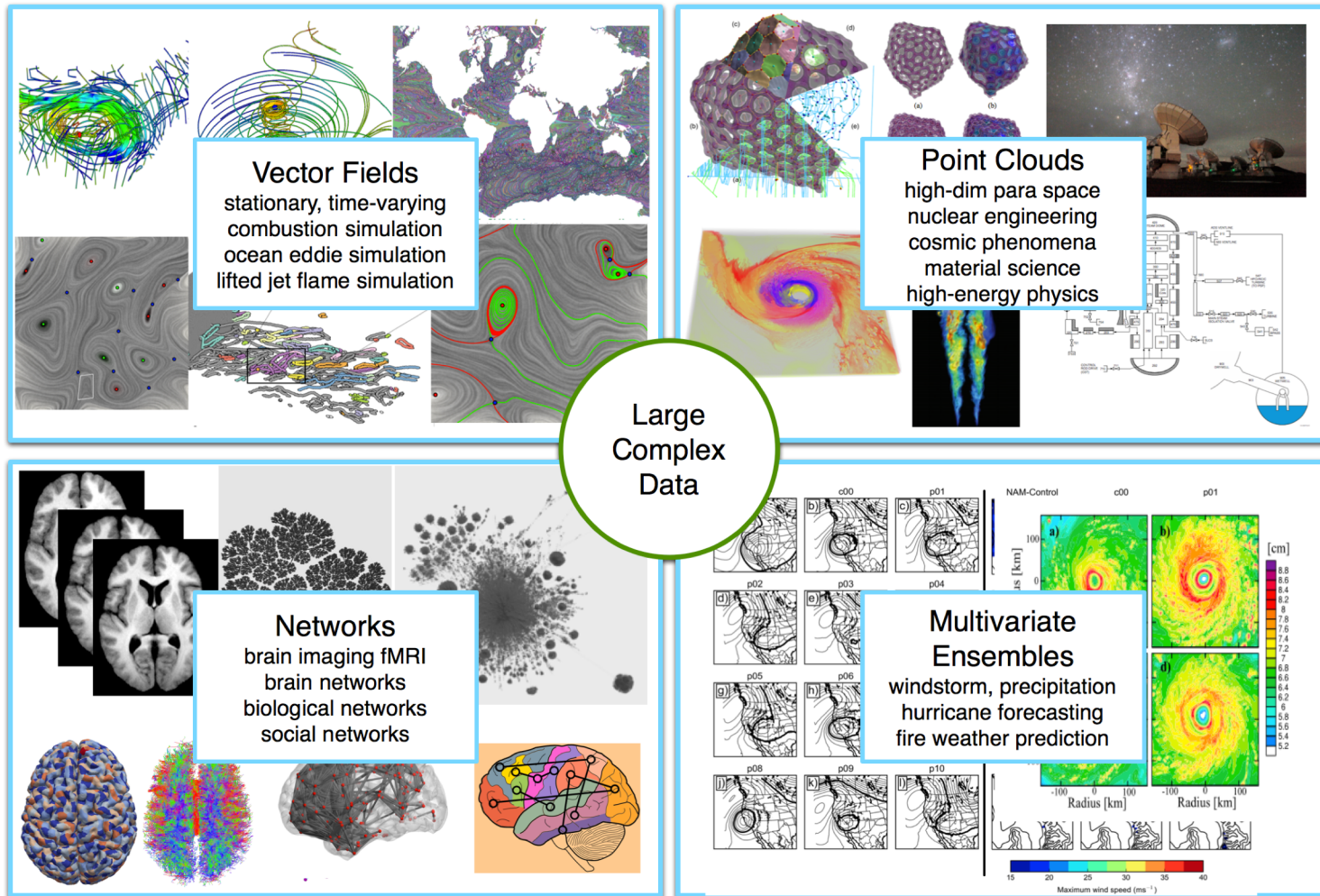
The visualized thyroid gland is unremarkable. The lungs are hyperinflated....

Impression

Tracheomegaly and bilateral bronchiectasis.
No adenopathy or effusion. ...

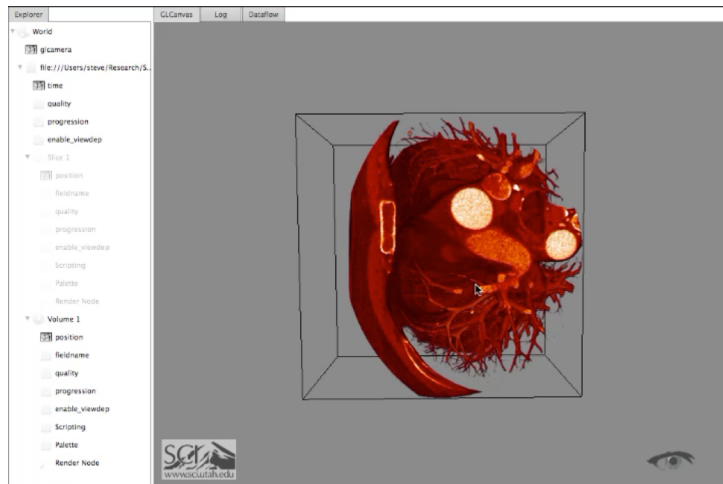
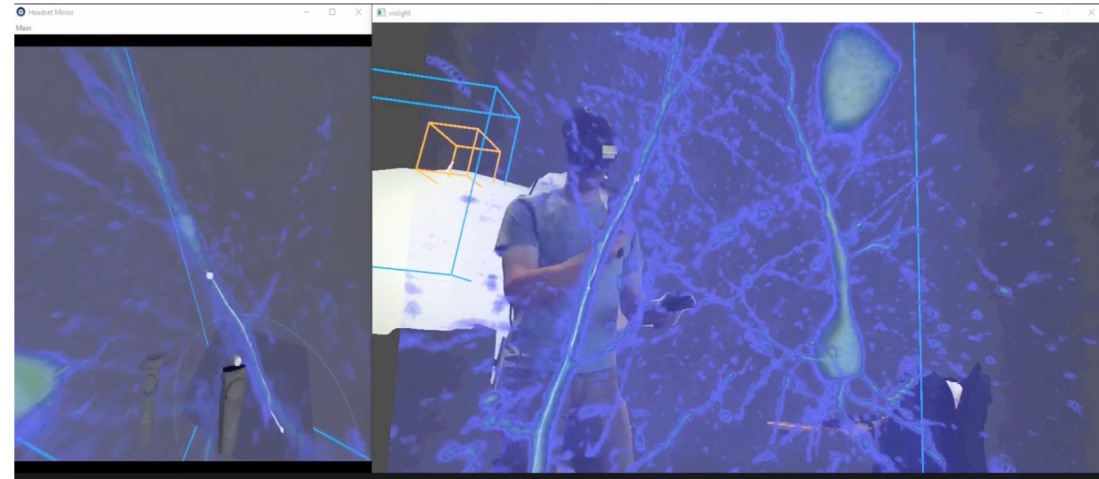
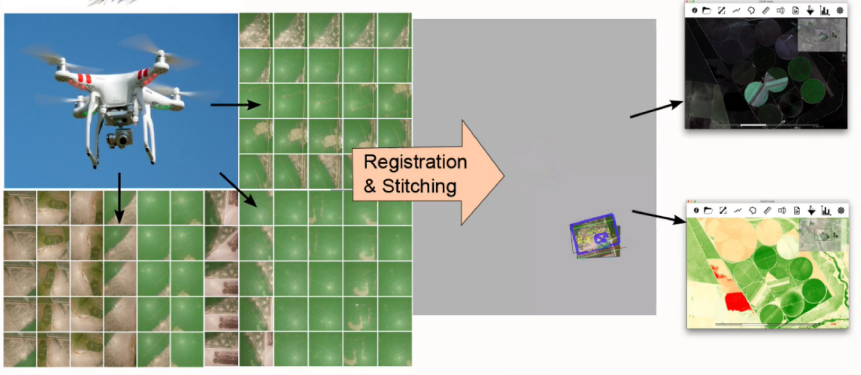


Topological Data Analysis and Visualization - Bei Wang



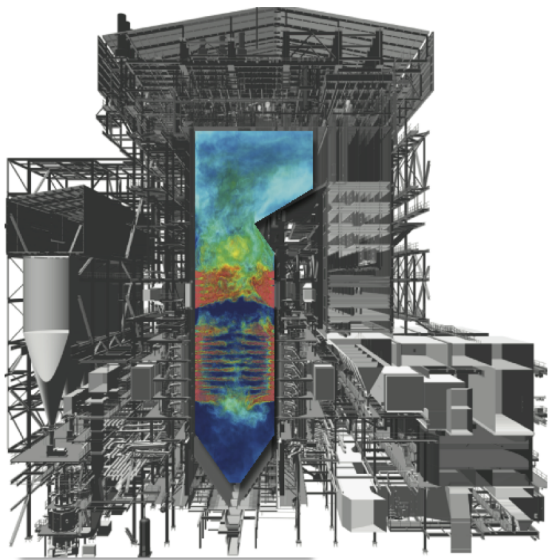
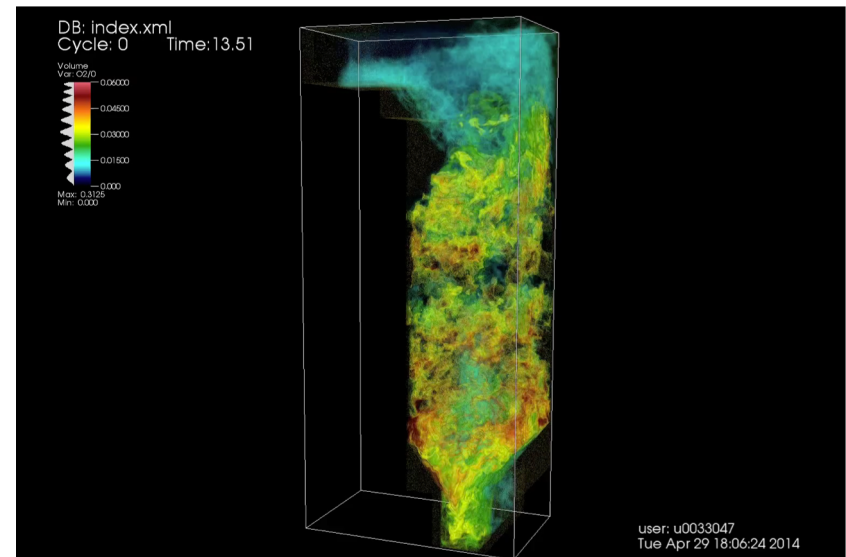
Valerio Pascucci

ViSOAR



Simulations of Clean(er) Coal Boilers - Martin Berzins

- Large scale turbulent combustion needs mm scale grids
 10^{14} mesh cells 10^{15} variables (1000x more than now)
- Structured, high order finite-volume discretization
- Mass, momentum, energy conservation
- LES closure, tabulated chemistry
- PDF mixing models
- DQMOM (many small linear solves)
- Uncertainty quantification



60m

- Low Mach number approx. (pressure Poisson solve up to 10^{12} variables. 1M patches 10 B variables)
- **Radiation** via Discrete Ordinates – many hypre solves Mira (cpus) or ray tracing Titan (gpus strong and weak scaling via AMR).
- FAST I/O needed PIDX for scalability

SCI Institute Faculty Area

Biomedical and Scientific Computing

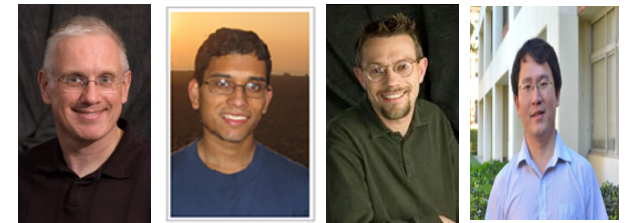


Image Analysis



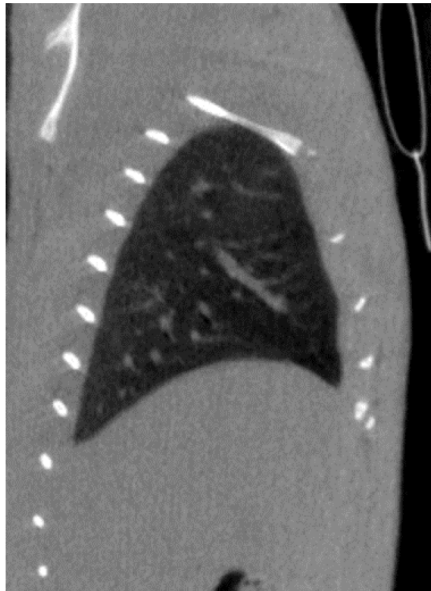
Visualization



Sarang Joshi



Diffeomorphic registration of lung CT images



- Goal: find diffeomorphic (bijective and smooth) transformations that accurately model:
 - Physics (conservation of mass^{1,2})
 - Physiology (local tissue compressibility)

- Rat imaged at 11 time points of breathing cycle using a ventilator
- CBCT reconstruction using FDK



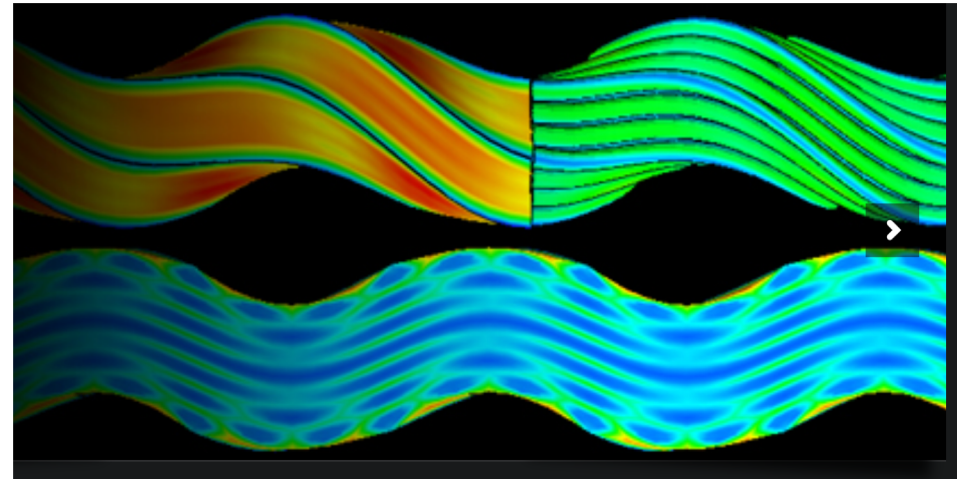
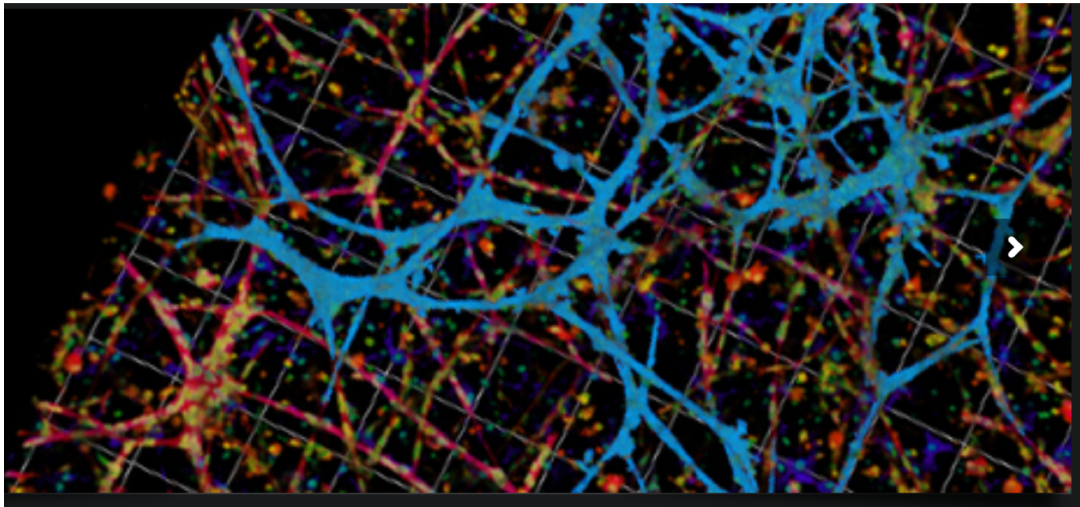
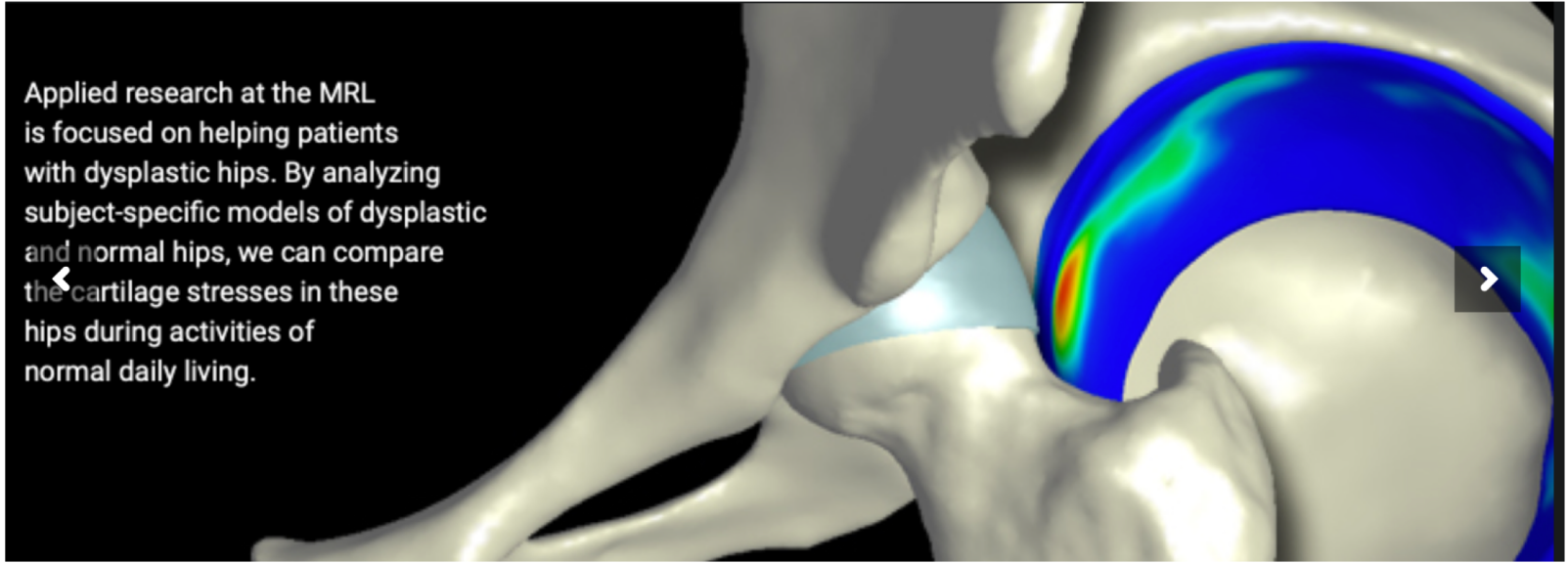
¹Yin, Hoffman and Lin. Mass preserving non-rigid registration of CT lung images using cubic B-spline. Medical Physics 36(9) 2009.

²Gorbunova, Sparring, Lo, Loeve, Tiddens, Nielsen, Dirksen, and de Bruijne, Mass preserving image registration for lung CT, Med. Image Anal., 16(4) 2012.

Jeff Weiss



Applied research at the MRL is focused on helping patients with dysplastic hips. By analyzing subject-specific models of dysplastic and normal hips, we can compare the cartilage stresses in these hips during activities of normal daily living.



Steve Parker

- Ph.D. Student, Graduated in 1999
- SCI Institute and CS Faculty Member (2000-2007)
- SCIRun and Real-Time Ray Tracer Chief Architect
- Co-Founder of Ray Scale
- Director of HPC, NVIDIA (2008-Present)
- VP Professional Graphics, NVIDIA (2014-Present)



University Leadership

- Rob MacLeod – Associate Director CVRTI and SCI and CARMA* and Director of UG BE
- Martin Berzins – Director, ARL CDE3M*, Director of the SoC*, Director CES Program*
- Mike Kirby – Interim Director, SCI Institute, Executive Director of the Utah Informatics Initiative, Director, ARL CDE3M, Director, CES Program*, Chair, Scientific Computing Ph.D. Program*, Director of SoC Graduate Studies*, Associate Director, SoC
- Valerio Pascucci – Chair, Graphics and Visualization Computing Degree Program*, Director, CEDMAV
- Ross Whitaker – Director, SoC, Associate Director, SoC*
- Sarang Joshi - Associate Director of CORI
- Chuck Hansen – Associate Director, SCI Institute*, Chair, Graphics and Visualization Computing Degree Program*
- Chris Johnson – Director, SCI Institute*, Director, SoC*, Director, CES Program*, Director, ACCESS Program*, Director, Engineering Scholars Program*

* = Previous Position



National and International Leadership

DOE Advanced Scientific Computing Advisory Committee (ASCAC).

Board of Directors for the Computing in Cardiology Society

Flatiron Institute Advisory Board

Several Other National and International Advisory Boards

CRA Computing Community Consortium

CRA Board of Directors

CRA Awards Committee (Chair)

NSF HPC Committee

NSF Task Force on Software for Science and Engineering

NSF Task Force on Cyber Science and Engineering

CRA Education Committee

KAUST Advisory Committee

IEEE VGTC

DOE Advanced Scientific Computing Advisory Committee (ASCAC)
Subcommittees

IEEE Fernbach and Cray Award Committees

SIAM Computational Science Awards Committee



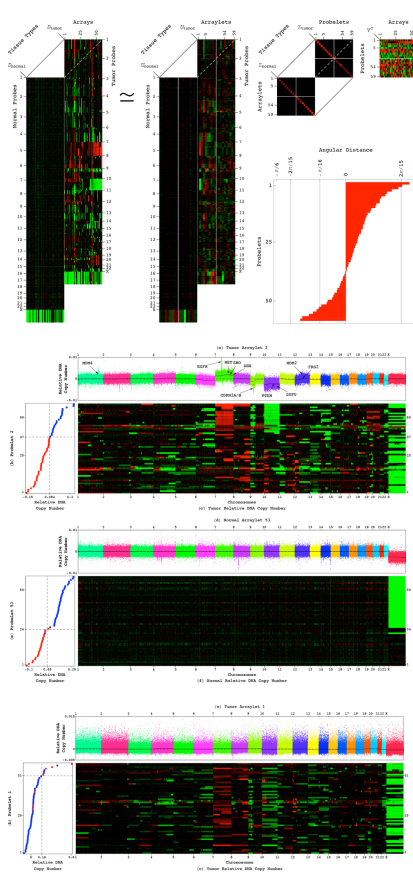
Orly Alter



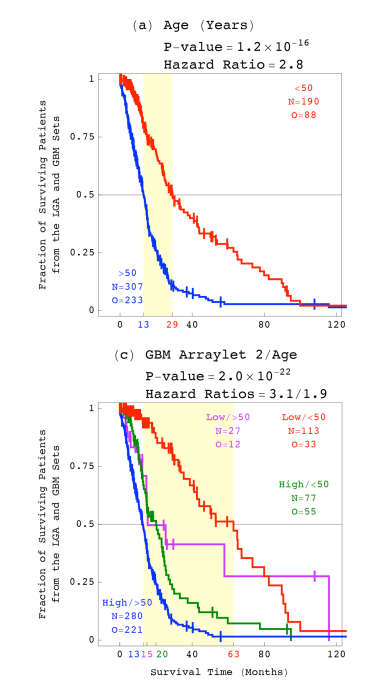
Platform-Independent Genome-Wide Pattern of DNA Copy-Number Alterations Predicting Astrocytoma Survival and Response to Treatment Revealed by the GSVD Formulated as a Comparative Spectral Decomposition

Aiello & Alter, *PLoS One* 11, e0164546 (2016); http://alterlab.org/astrocytoma_prognosis/

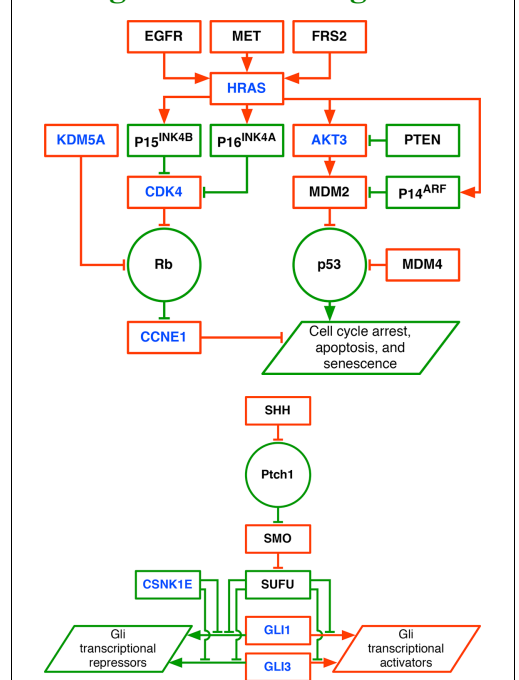
Physics-Inspired Mathematical Frameworks



Genomic Predictors of a Patient's Outcome



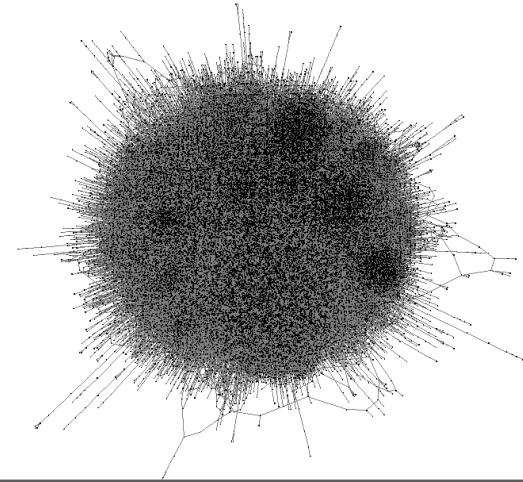
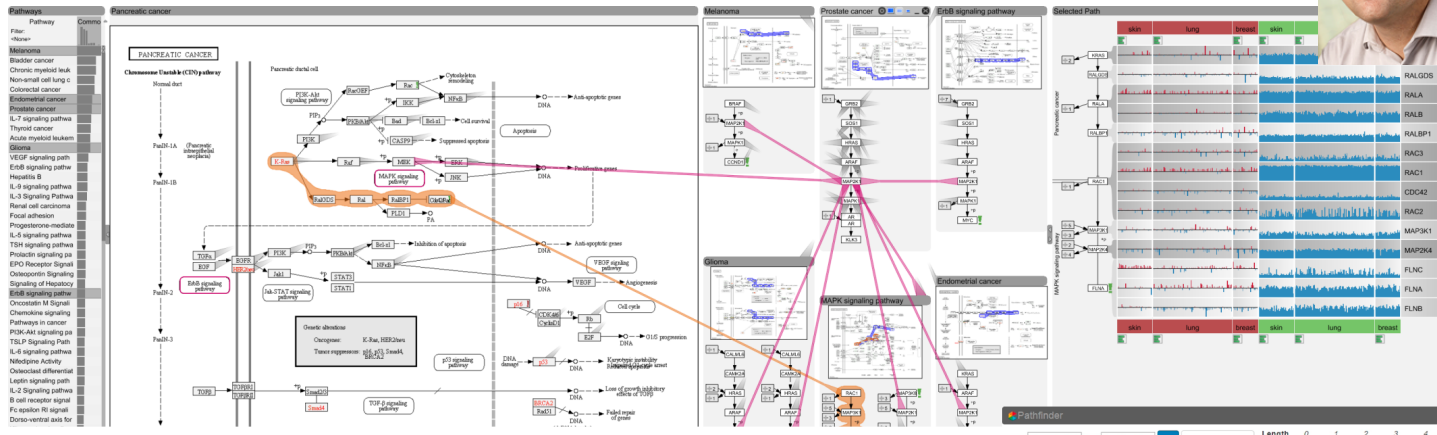
DNA Alterations in Personalized Diagnostics and Prognostics



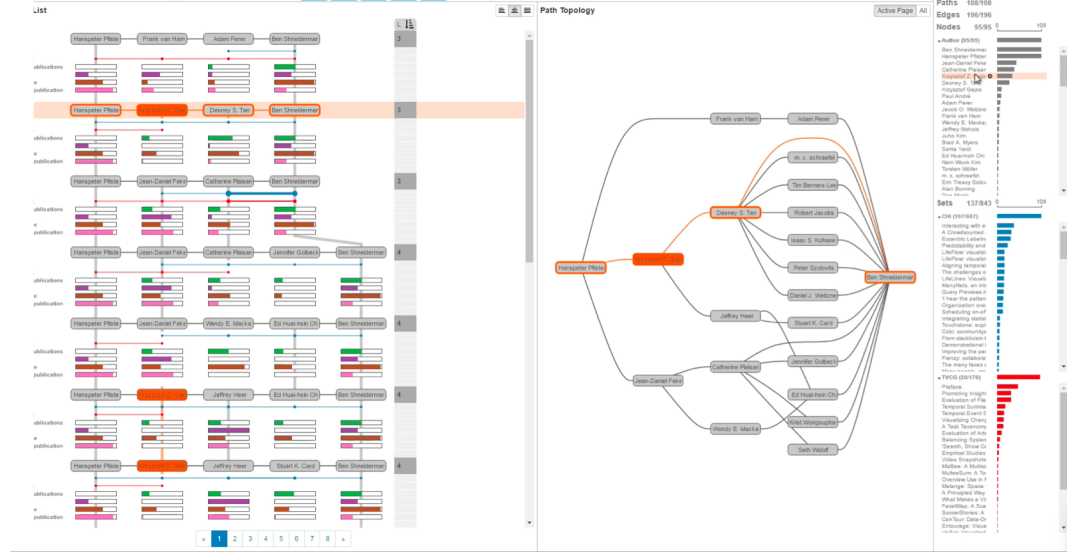
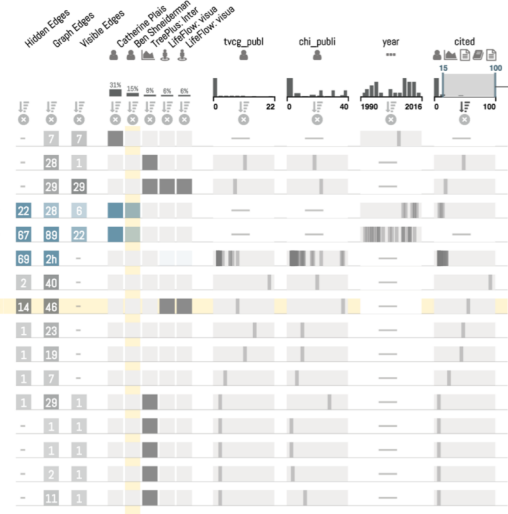
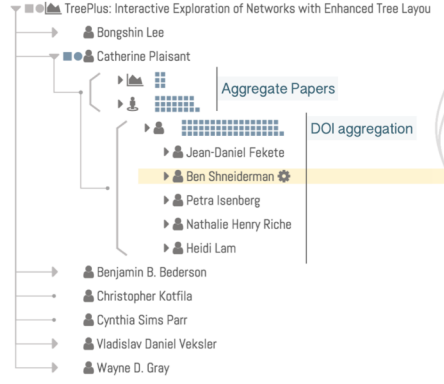
Recurring DNA CNAs were observed in astrocytoma tumors' genomes for decades, however, copy-number subtypes predictive of patients' outcomes were not identified before, despite the growing number of datasets recording different aspects of the disease, and due to a need for frameworks that can simultaneously find similarities and dissimilarities across the datasets.



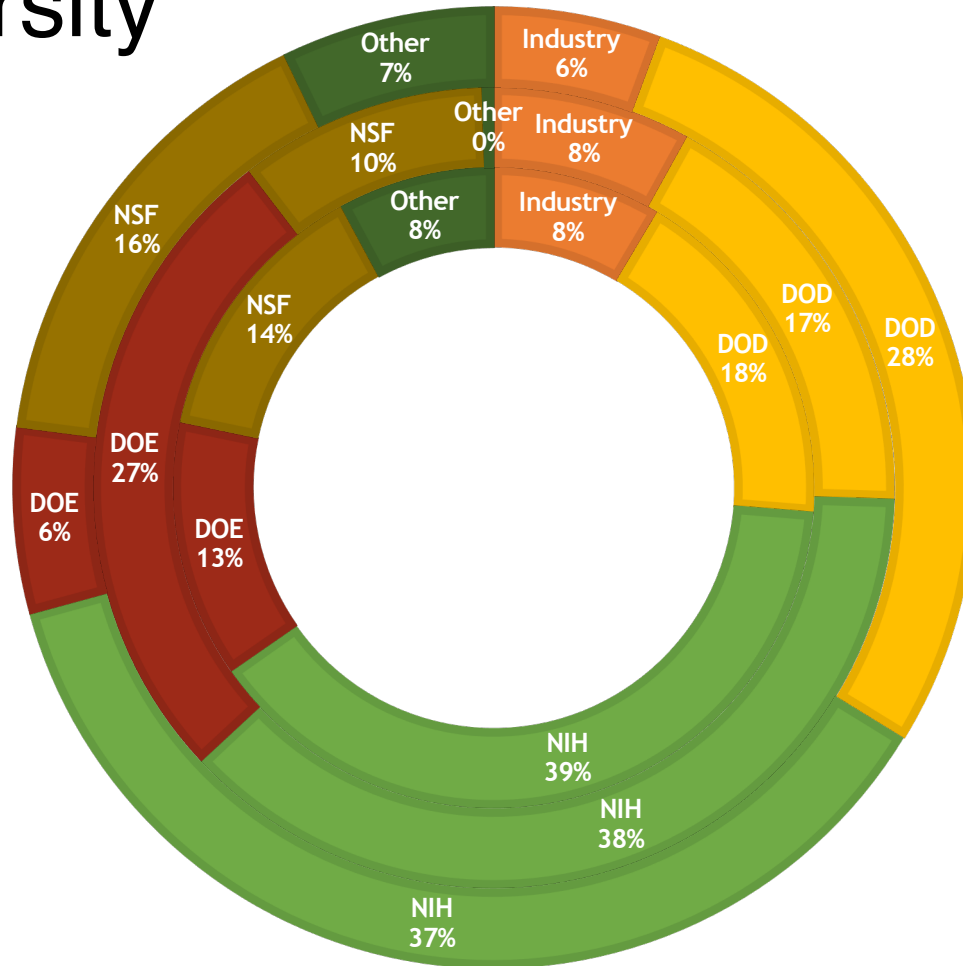
Large Networks - Alex Lex



Juniper
juniper.sci.utah.edu



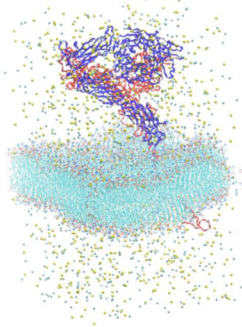
Funding Diversity



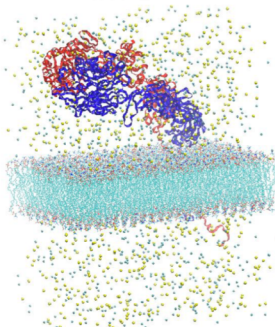
Tamara Bidone



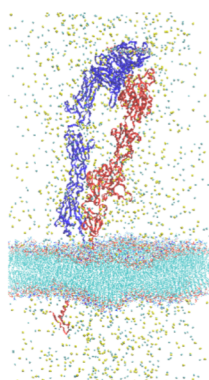
α -chain β -chain
BENT



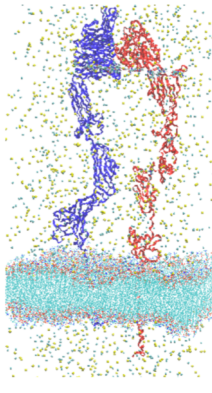
INT 1



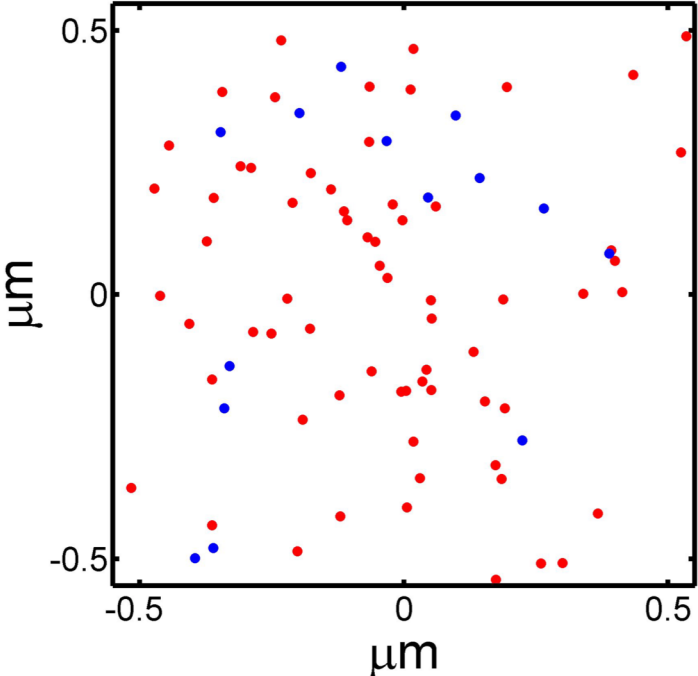
INT 2



OPEN



Molecular Model of Adhesion Proteins ACTIVATION

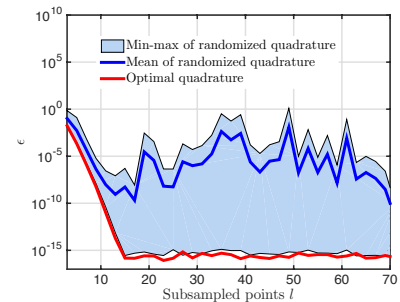
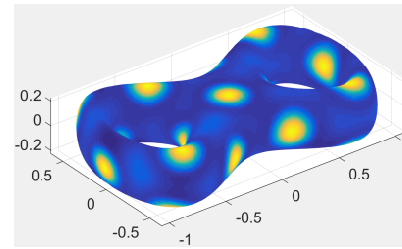
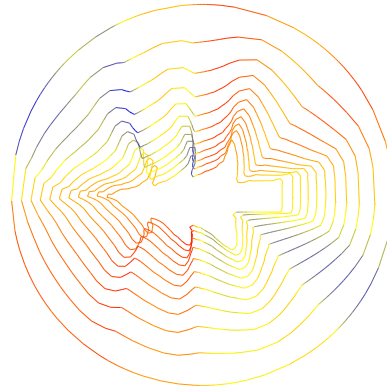


Micromechanical Model of Adhesions Mechanosensing

Akil Narayan



I am interested in *high dimensional approximation, model reduction, nonlocal models, uncertainty quantification, shape analysis.*



High-order methods: design of numerical schemes (stability, accuracy, etc.)

Inference/design on PDE quantities: optimization and inferential statistics

High-dimensional approximation: constructing functional surrogates

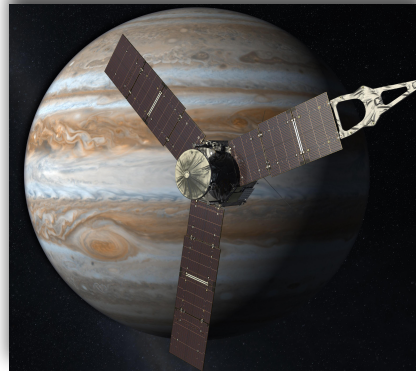
Model reduction: efficient compression numerical methods

Structure-preserving approximation: positivity, monotonicity

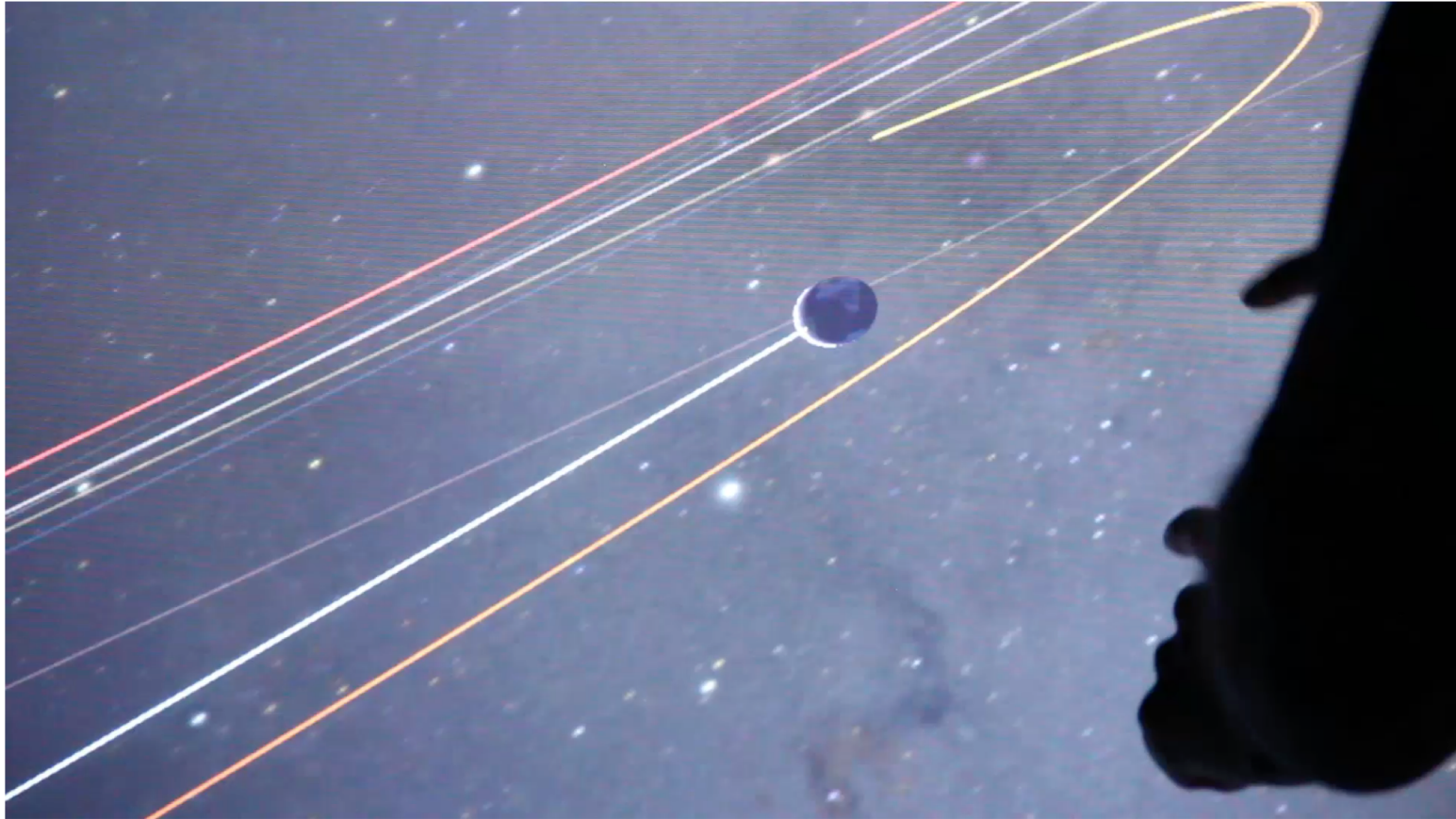
Riemannian shape analysis: statistical summaries, cliquing, metrization, ...

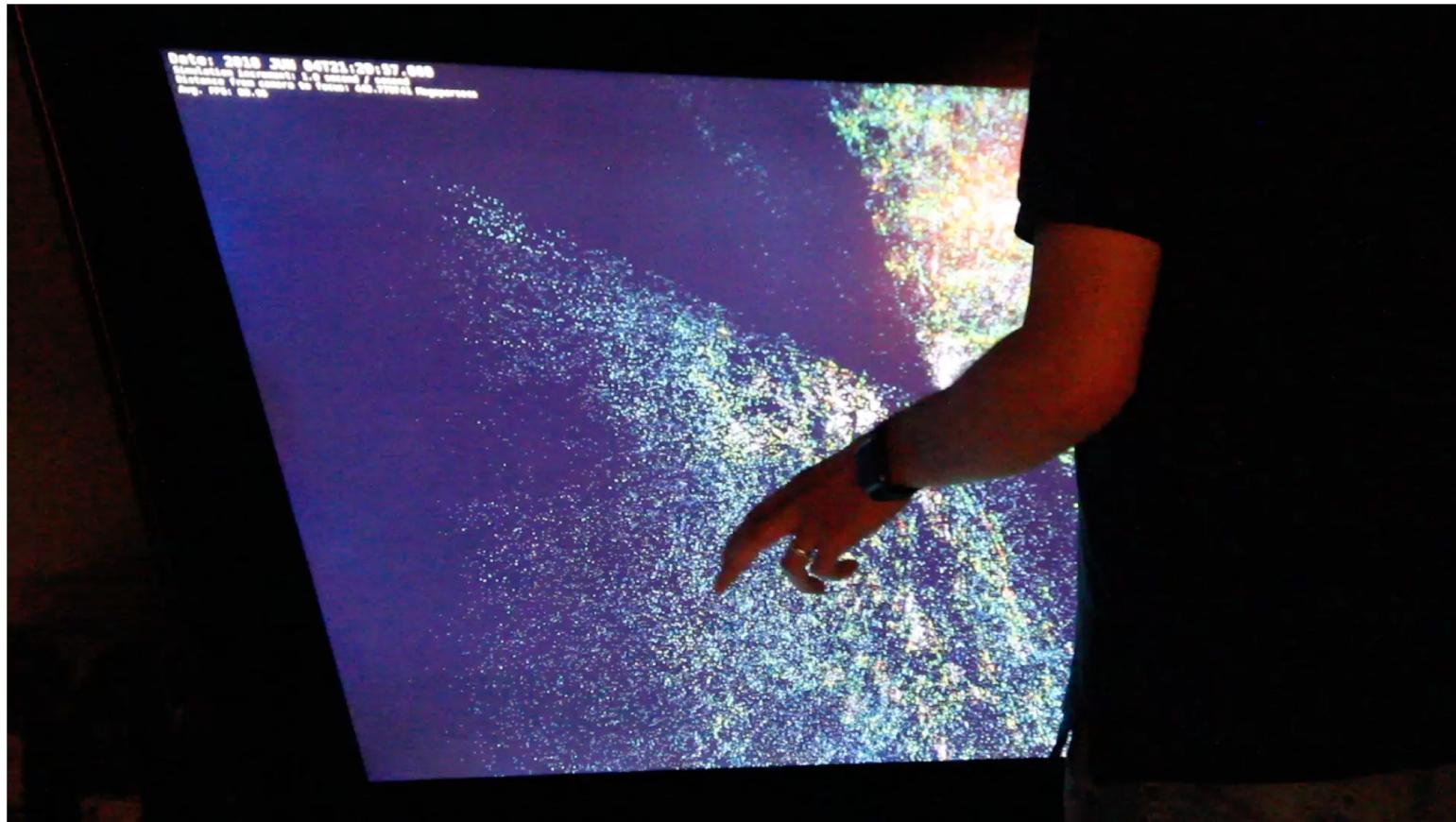


OpenSpace Team



<http://openspaceproject.com>



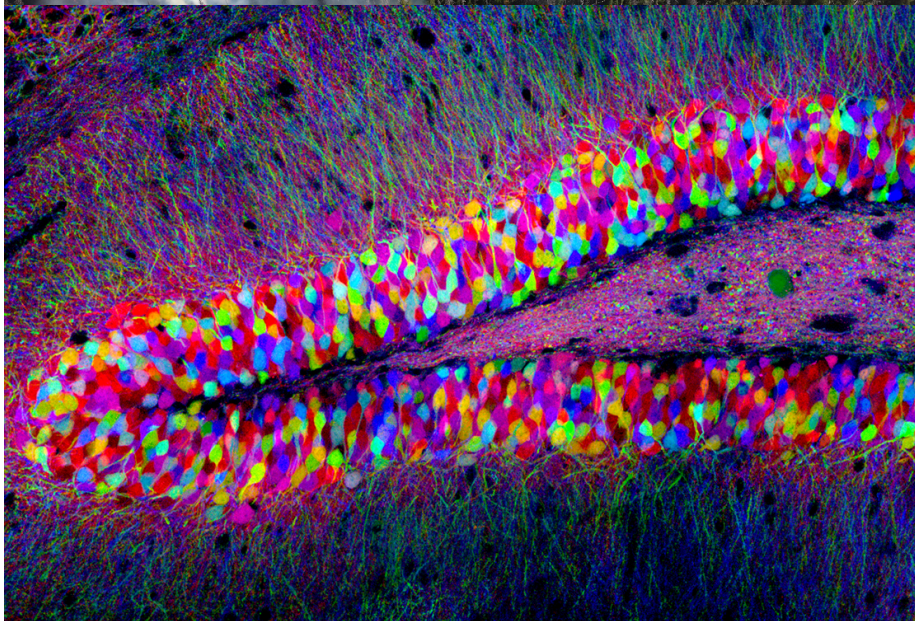


Miriah Meyer

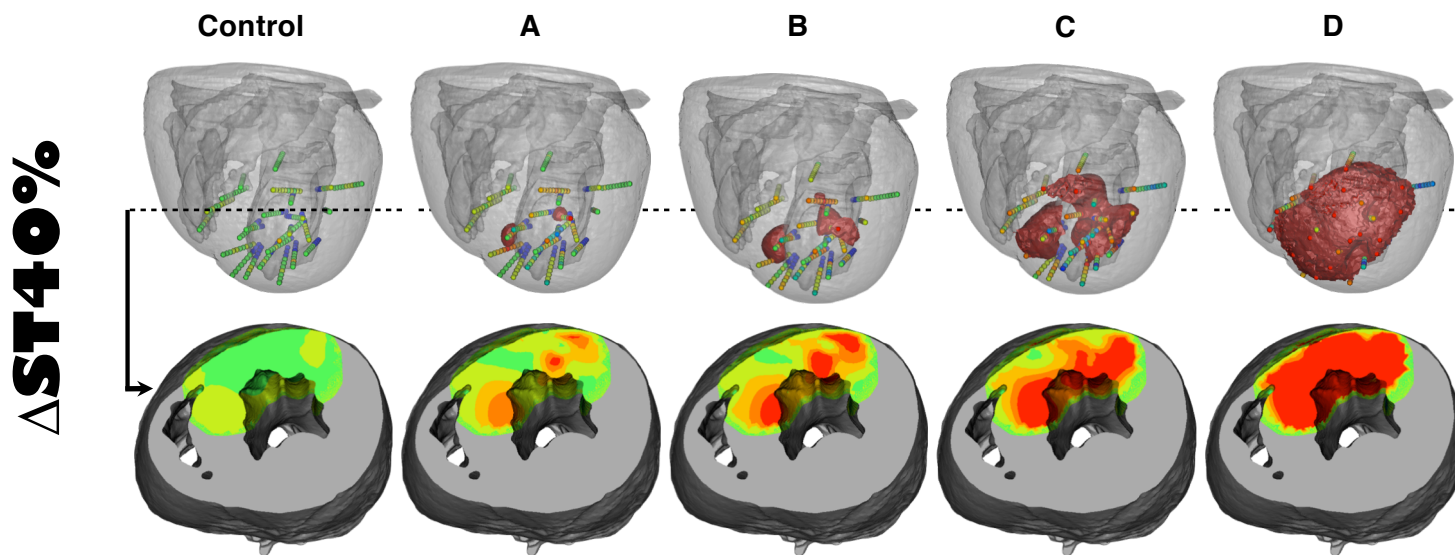
- Ph.D. Student, Graduated in 2008
- Research Fellow at Harvard and Broad Institute at MIT
- SCI Institute and SoC Faculty
- Distinguished Alumni Award, University of Utah, 2017
- Outstanding Teaching Award, School of Computing, University of Utah, 2015
- NSF CAREER Award, 2014
- Best Paper Award, ACM AVI Conference, 2014
- PopTech Science Fellow, 2013
- TED Fellow, 2013
- Microsoft Research Faculty Fellowship, 2012
- Fast Company Magazine's 100 Most Creative People in Business, 2012
- MIT Technology Review TR35: The Top 35 Innovators Under 35, 2011
- NSF/CRA Computing Innovation Fellowship, 2009
- AAAS Mass Media Fellowship, 2006



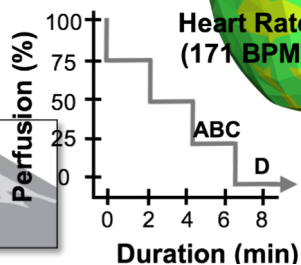
Miriah Meyer



Rob MacLeod



Study Protocol



5.3 4 2.7 1.3 0 -1.3 -2.7 -4 -5.3 ▲ mV

Acute Ischemia is More Complex
Aras et al., PhD Thesis; manuscript in preparation.



Research Awards and Recognition

- Over 49 Best Paper or Best Panel Awards
- IEEE Technical Achievement Award for Visualization
- 2 IEEE Visualization Career Award
- 5 Fellows: American Institute for Medical and Biological Engineers
- 3 Fellows: Institute for Electrical and Electronic Engineers
- Fellow: American Association for the Advancement of Science
- Fellow: Society of Industrial and Applied Mathematics
- Fellow: American Society of Mechanical Engineers
- Fellow: Department of Energy
- 6 NSF CAREER Awards + 1 NSF NYI and 1 NSF PFF
- 3 Distinguished Alumni Awards
- TR 35 Award
- Microsoft Faculty Fellow
- Charles Babbage Award
- Sidney Fernbach Award
- Rosenblatt Prize
- IBM Faculty Awards
- PopTech Science Fellow
- TED Fellow
- 2 HPC Wire People to Watch



CSRankings: Computer Science Rankings

csrankings.org

CSRankings is a metrics-based ranking of top computer science institutions around the world. **Click on a triangle** (▶) to expand areas or institutions. **Click on a name** to go to a faculty member's home page. **Click on a pie** (the 🍷 after a name or institution) to see their publication profile as a pie chart. **Click on a Google Scholar icon** (🔍) to see publications, and **click on the DBLP logo** (📄) to go to a DBLP entry. [Applying to grad school? Read this first.](#)

Rank institutions in by publications from to

All Areas [\[off | on\]](#)

AI [\[off | on\]](#)

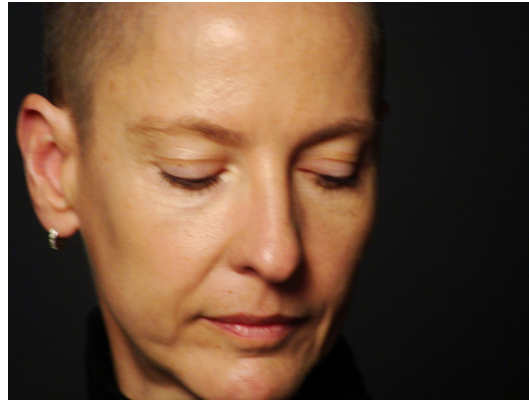
- ▶ Artificial intelligence
- ▶ Computer vision
- ▶ Machine learning & data mining
- ▶ Natural language processing
- ▶ The Web & information retrieval

Systems [\[off | on\]](#)

- ▶ Computer architecture
- ▶ Computer networks
- ▶ Computer security
- ▶ Databases
- ▶ Design automation
- ▶ Embedded & real-time systems
- ▶ High-performance computing
- ▶ Mobile computing
- ▶ Measurement & perf. analysis
- ▶ Operating systems

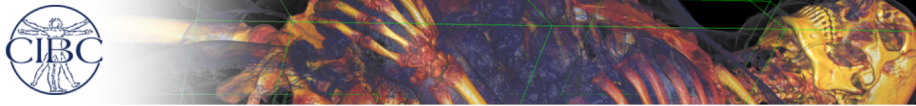
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|----|---|---------|
| 1 | ▶ University of Utah 🍷 | 14.8 |
| 2 | ▶ City University of London 🍷 | 14.2 |
| 3 | ▶ University of Maryland - College Park 🍷 | 11.9 |
| 4 | ▶ Georgia Institute of Technology 🍷 | 11.7 |
| 5 | ▶ University of Stuttgart 🍷 | 11.5 |
| 6 | ▶ TU Wien 🍷 | 10.3 |
| 7 | ▶ University of California - Davis 🍷 | 10.2 |
| 8 | ▶ Stony Brook University 🍷 | 9.8 |
| 9 | ▶ Graz University of Technology 🍷 | 9.7 |
| 10 | ▶ TU Eindhoven 🍷 | 9.6 |
| 11 | ▶ New York University 🍷 | 9.3 |
| 12 | ▶ University of Magdeburg 🍷 | 9.2 |
| 13 | ▶ Zhejiang University 🍷 | 8.5 |
| 14 | ▶ Harvard University 🍷 | 8.0 |

Katharine Coles - Distinguished Professor of English, Former Utah Poet Laureate, Guggenheim Fellow

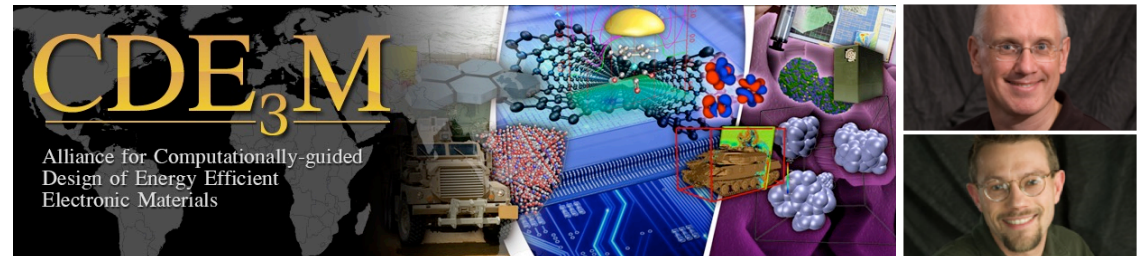
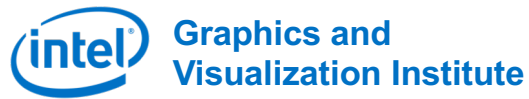


Acknowledgments

NIH/NIGMS Center for Integrative Biomedical Computing



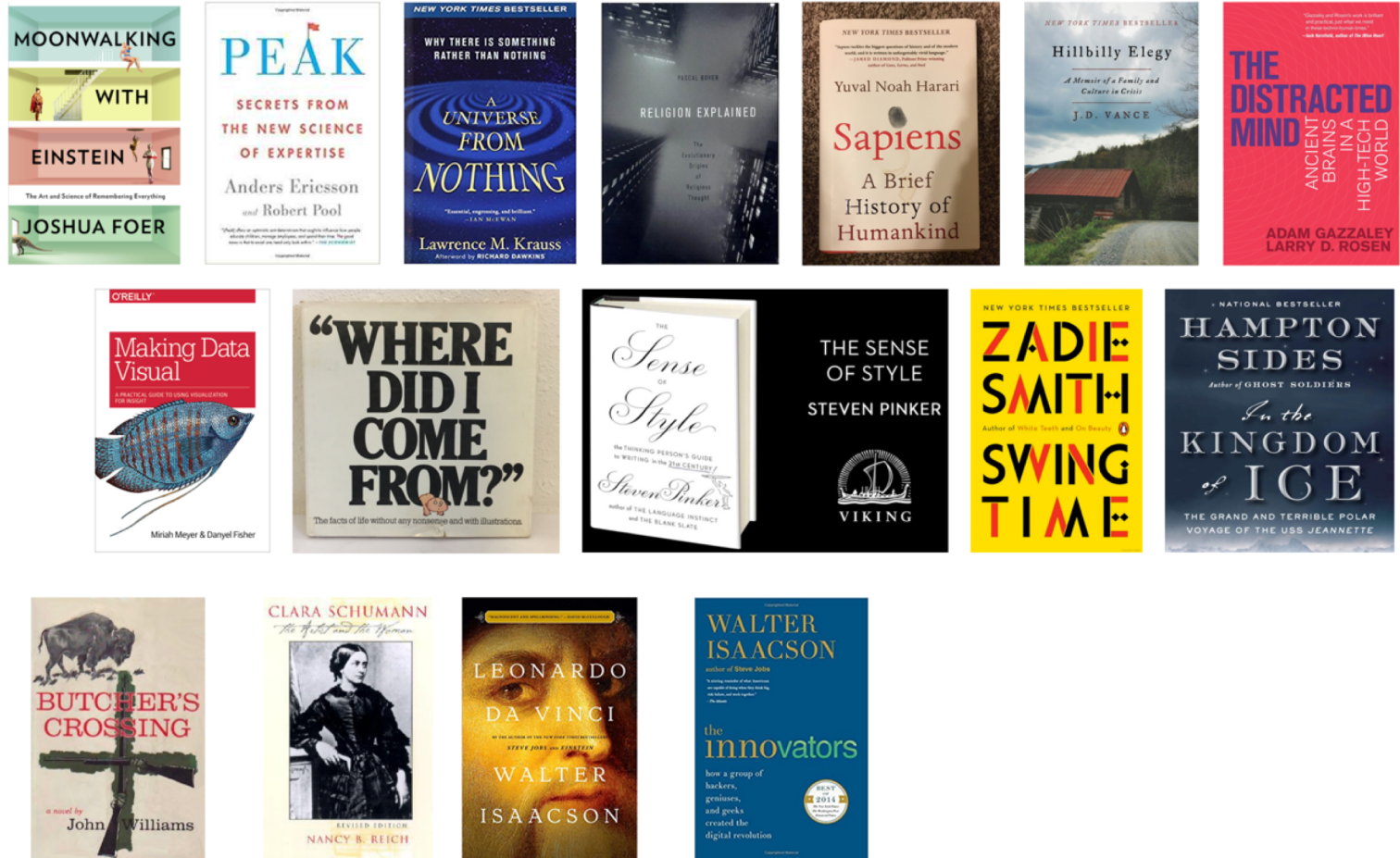
UNIVERSITY OF UTAH
CENTER FOR EXTREME DATA MANAGEMENT,
ANALYSIS, AND VISUALIZATION



Productivity Machines



SCI Institute Faculty Reading



www.sci.utah.edu



How Did I Get Here?

- 1985 - Assistant Professor of Physics - Westminster College
- 1989 - CVRTI - Research Assistant Professor of Medicine
- 1992 - Assistant Professor of Computer Science
- 1992 - Co-Director, Computational Engineering and Science Program
- 1993 - Director, University ACCESS Program
- 1994 - SCI Research Group Formed
- 1994 - Associate Chair of Computer Science
- 1996 - Director, Center for Scientific Computing and Imaging
- 1998 - Co-Director, DOE Center
- 1999 - Director, NIH Center
- 1999 - Director, Engineering Scholars Program
- 2000 - Director, SCI Institute
- 2003 - Director, School of Computing
- 2003 - Distinguished Professor of Computer Science

