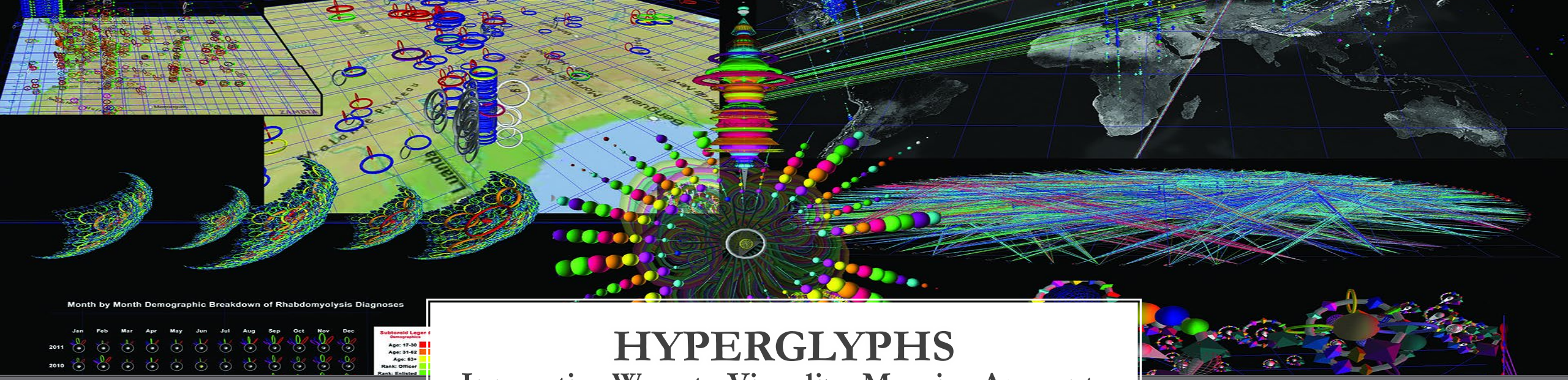


HYPERGLYPHS

Innovative Ways to Visualize Massive Amounts of Unconventional, Unstructured Data

Jeff Sale

Learning Design Technologist

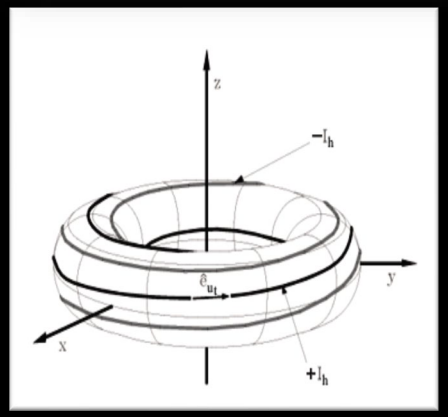
San Diego Supercomputer Center, UC San Diego

Innovation Lab, Mesa College, November 14, 2018

About Me

Born in Canada (Naturalized last year. Woohoo, I voted!!)

A.S., Physics, Mesa Community College



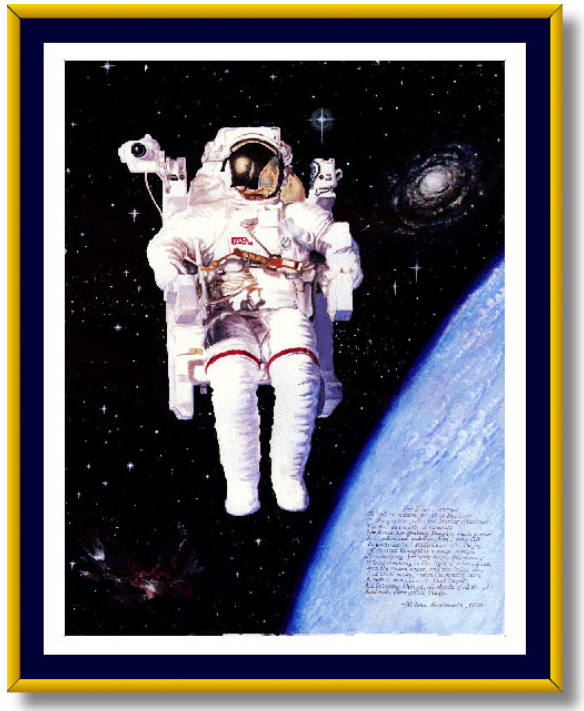
B.S., Applied Physics
Emphasis: Condensed Matter ("Solid State Physics")
San Diego State University

M.A. Degree
Learning Design and Technology
MOOCs

Motivation…

THE JOHN MUIR TRAIL

Art



Computational Painting

His art goes up against the wall

By Peter Rowe
Staff Writer

Portrait of a work of art as a young phenomenon

It stands two stories tall on the wall of a boxy, relentlessly pink apartment building on the east side of Interstate 5. It is a man's head of classical proportions, rendered in three shades of blue, staring intently off to his left, toward Old Town.

It is based on one of Michelangelo's greatest creations, his marble sculpture of David.

It is all yours, San Diego.

"If I had to dedicate it," said the artist, Jeff Sale, "I would dedicate it to San Diego in general. All my experiences in San Diego have been very valuable."

Sale, who describes himself as a "budding artist," is a physics student at San Diego Mesa College, an employee of San Diego Blueprint, an amateur hockey player and something of a philosopher. A Renaissance man — as was his idol, Michelangelo.

"Michelangelo is my hero," said Sale, 27. "He was just such an incredibly great guy when it came to art."

Sale has been dabbling with pencil and paint for years, even before his family moved, after stops in Toronto and Chicago, to San Diego in 1970. But he had never attempted anything on this scale before.

"I just wanted to see if I could do it," he said. "I wanted to say to everybody who saw it, 'This can be done.'"

Selecting his canvas was easy. Sale inhabits one of four apartments in that stunning pink building. "That wall is just so damn ugly. It was just asking to be done."

Selecting a subject, however, was tougher. A woman friend suggested a nude male. His roommate and brother, Rob Sale, and several Baptist neighbors preferred Michelangelo's "Christ on the Cross."

See ART on Page C-2

The San Diego Union/Carol Woods

Jeff Sale stands in front, top and left photos, of his creation: a rendition of Michelangelo's David on the side of his apartment building near Old Town.

Inside Today

- Chile uses troops to crush protests in capital — Page A-2.
- President delays decision on budget savings required to chop deficits in half by 1988 without raising taxes — Page A-6.

120 Pages, 6 Parts

The Arts/Movies ..... C-5 to 8
Billy Graham A-22
Classified Ads ..... D-12 to 24
Comics C-10
Crossword Puzzle D-15
Currents ..... C-1 to 4
The Economy ..... D-1 to 8
Editorials B-10, 11
Goren on Bridge A-22
Horoscope A-22
Mike Grant C-1
Obituaries B-4
Sports ..... E-1 to 12
Tom Blair B-1
TV/Radio C-9

Huge painting highlights apartment building wall — Page C-1.

Fair

Fair today with a temperature range of 47 to 69 degrees along the coast; 37 to 69 degrees inland. Page C-11.

Continued from C-1

Sale's taste led him to reject the first, his religious convictions the second. He believes in God, but is not a Christian. "I was not ready to make that sort of commitment," he said.

David — young man with a sling, psalmist and king — spoke to him more directly, as one of Michelangelo's triumphs and as a product of the Renaissance.

So, for 20 hours, Sale sketched from a photograph of the sculpture. Then he bought a few cheap brushes, two gallons of paint — light "Ice Blue" and dark "Night Blue," mixing them provided the medium tones — borrowed a ladder and set to work.

The painting took a month, although some time was spent correcting early mistakes. "I started from the bottom and worked up," said Sale. "But the drips fell down. So I went to the top and worked down."

He finished in mid-September, but is not entirely satisfied.

"Flaws right and left," he commented. The left eye lacks proper dimension. Pink paint still shows through the right eyebrow.

So says the artist. But an architect, scads of photographers and several wandering art fanciers have dropped by the neighborhood to admire Sale's handiwork. Even his landlord, who had approved the project, likes it.

Sale modestly accepts praise. "I don't consider myself an artist," he said. "I copy things really well. For that reason I think that anyone could do this."

Besides, Sale argued, the artists of today's Renaissance do not necessarily wield paintbrush and palette.

"You can do now with physics what you could do back then with art," he said, "make a statement about man and his relationship with God."

The expanding universe, quarks, black holes, infinity captured within an atom — physics appeals to his spiritual side. "You just feel close to God learning about this," he said.

But there are times when the heaven of science can wait.

SDSC Education, Outreach, and Training

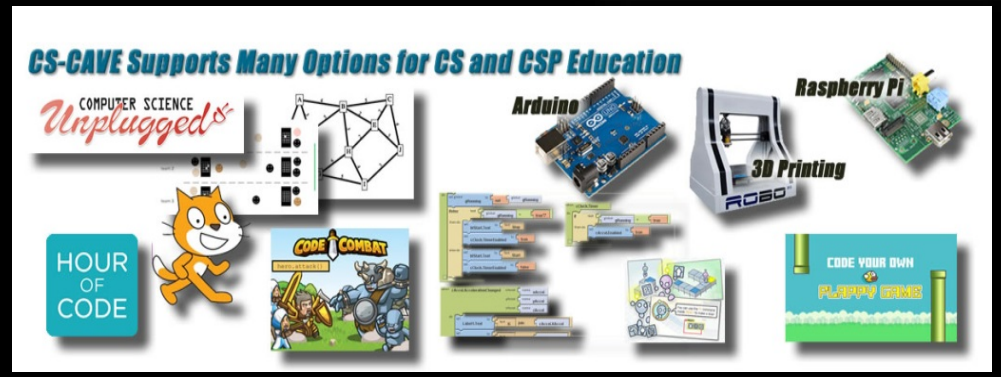
San Diego Supercomputer Center
TeacherTECH
Sharing Science Technology Tools with Teachers with Educational Science Series Seminars, Hands-On Technology Workshops & User Groups

StudentTECH

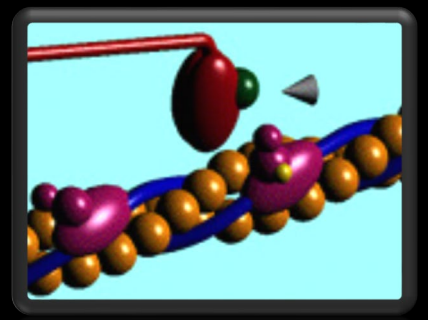
The Discover DATA Portal
SDSC A San Diego Supercomputer Center Education Portal

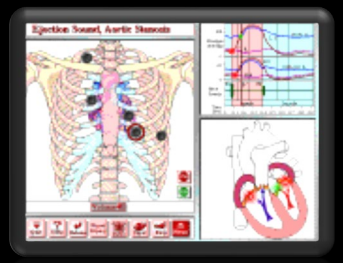
CS-CAVE
Creating a Village of CS Educators

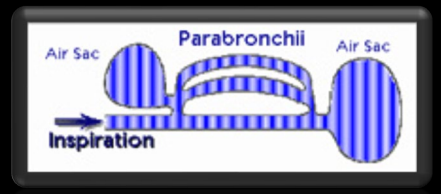
Alice
Learn to Program with Interactive 3D Graphics
a free gift to you from
Carnegie Mellon

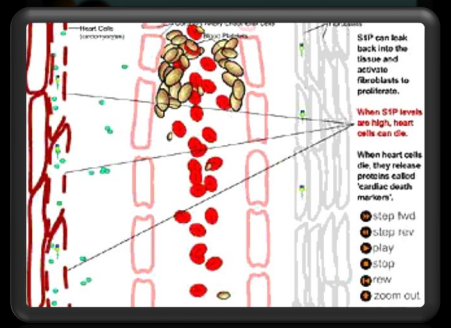


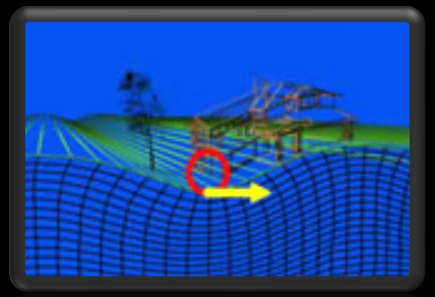
Models and Simulations for Learning

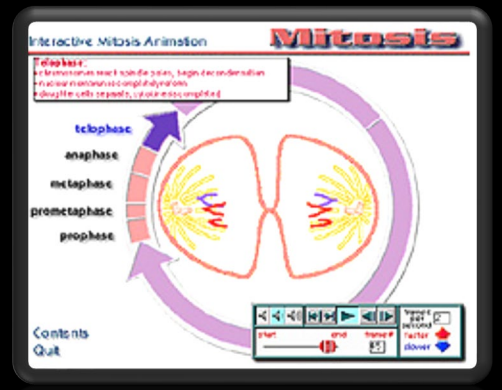


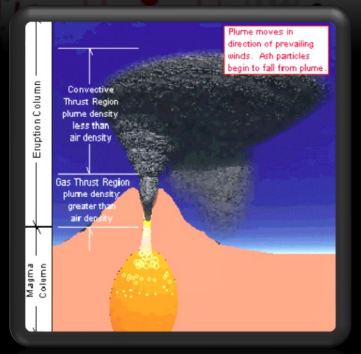


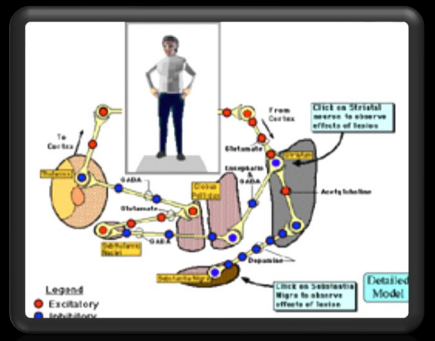


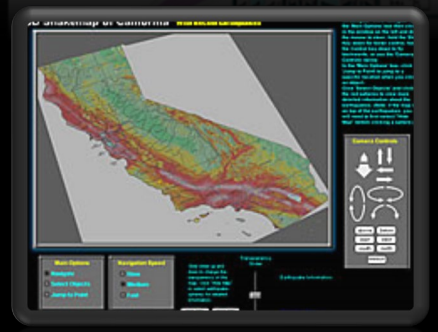










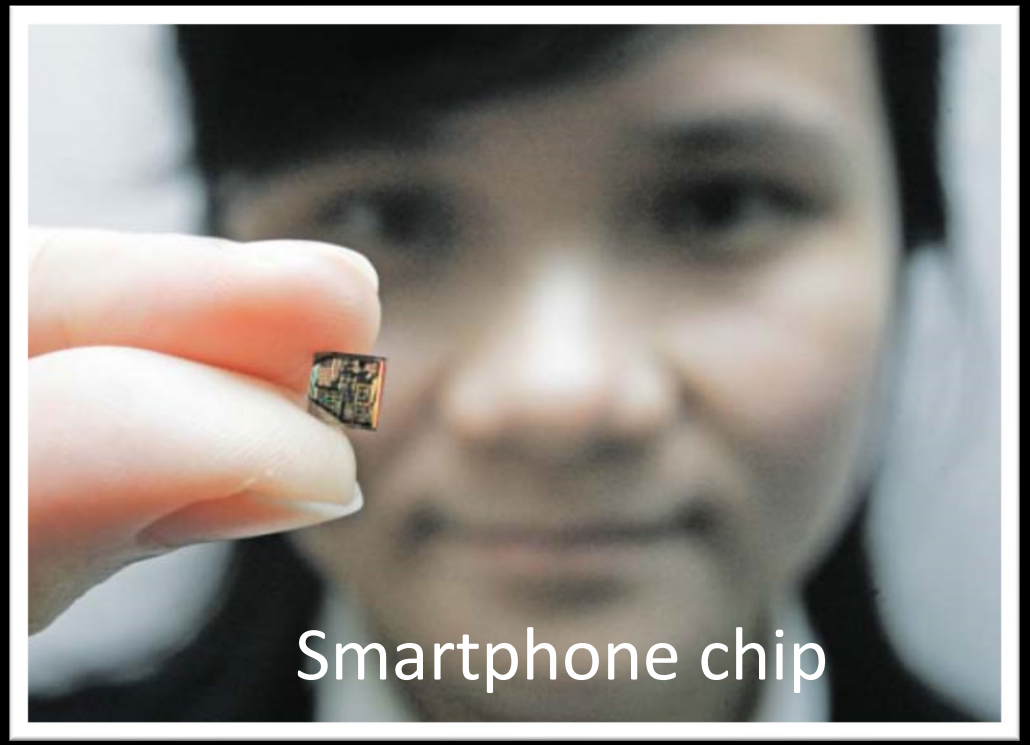


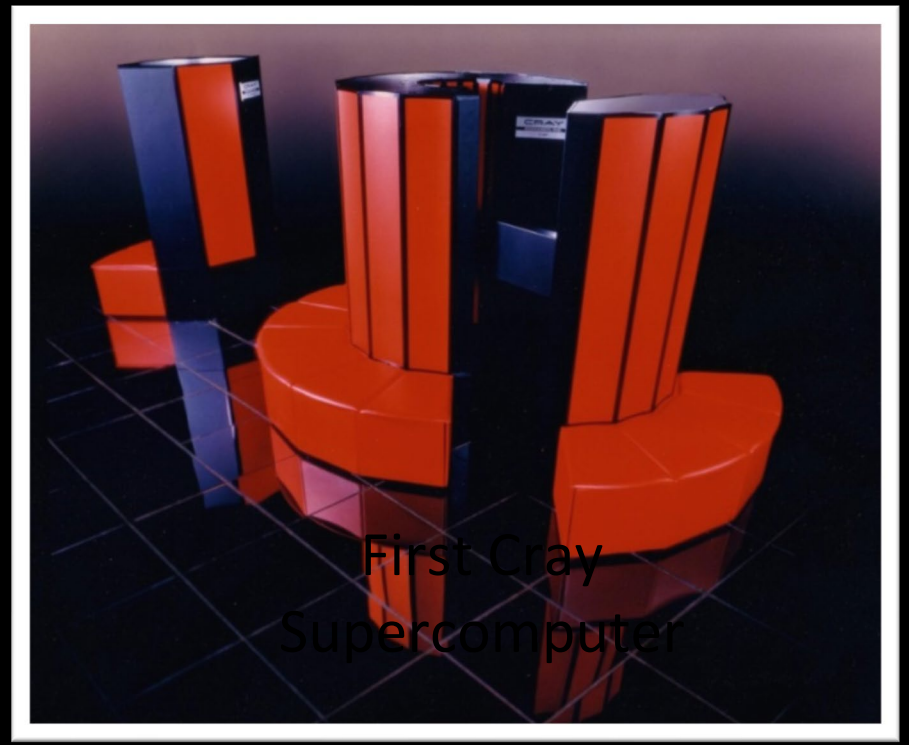
About Supercomputing

IN THE BEGINNING

Electric Counting Machine, 1951

TODAY



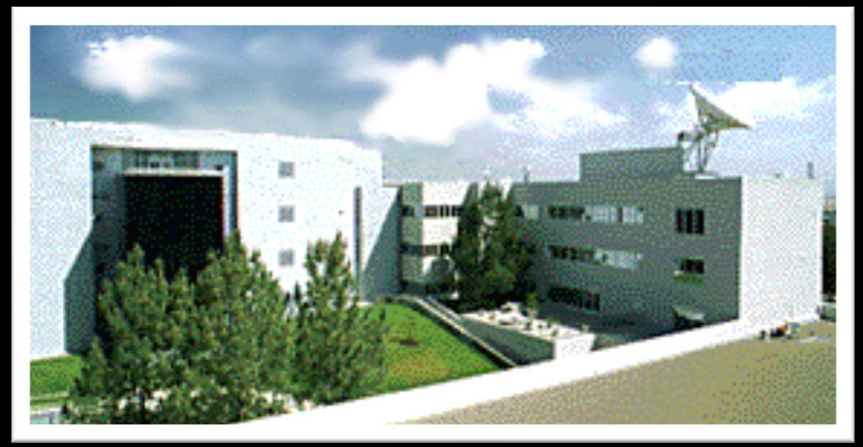


Smartphones are faster than the first Cray Supercomputer!!

SDSC : ENABLING SCIENTIFIC DISCOVERY SINCE 1985

SDSC Then –

- Founded in 1985
- Staff of 70
- One of first 5 supercomputer centers in the world



SDSC Now –

- More than 250 researchers
- More than $30,000,000 in research funding each year
- One of the largest academic data centers in the world

DR. MIKE NORMAN, SDSC DIRECTOR

Director since 2010

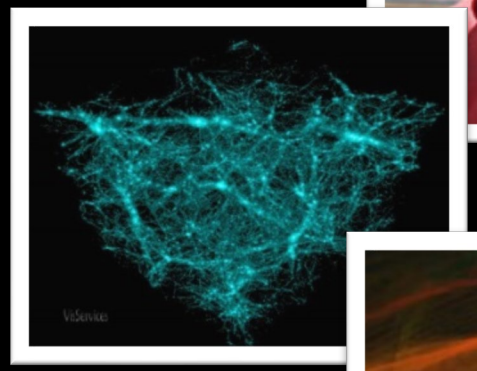
UC San Diego Distinguished Professor of Physics

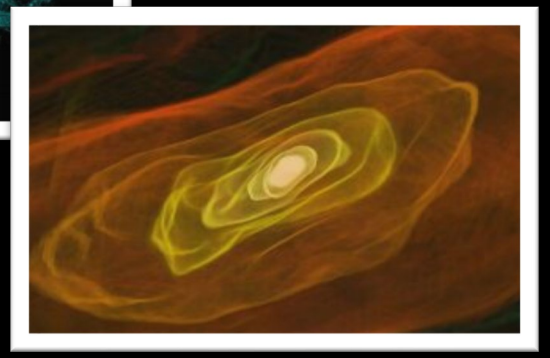
Astrophysicist

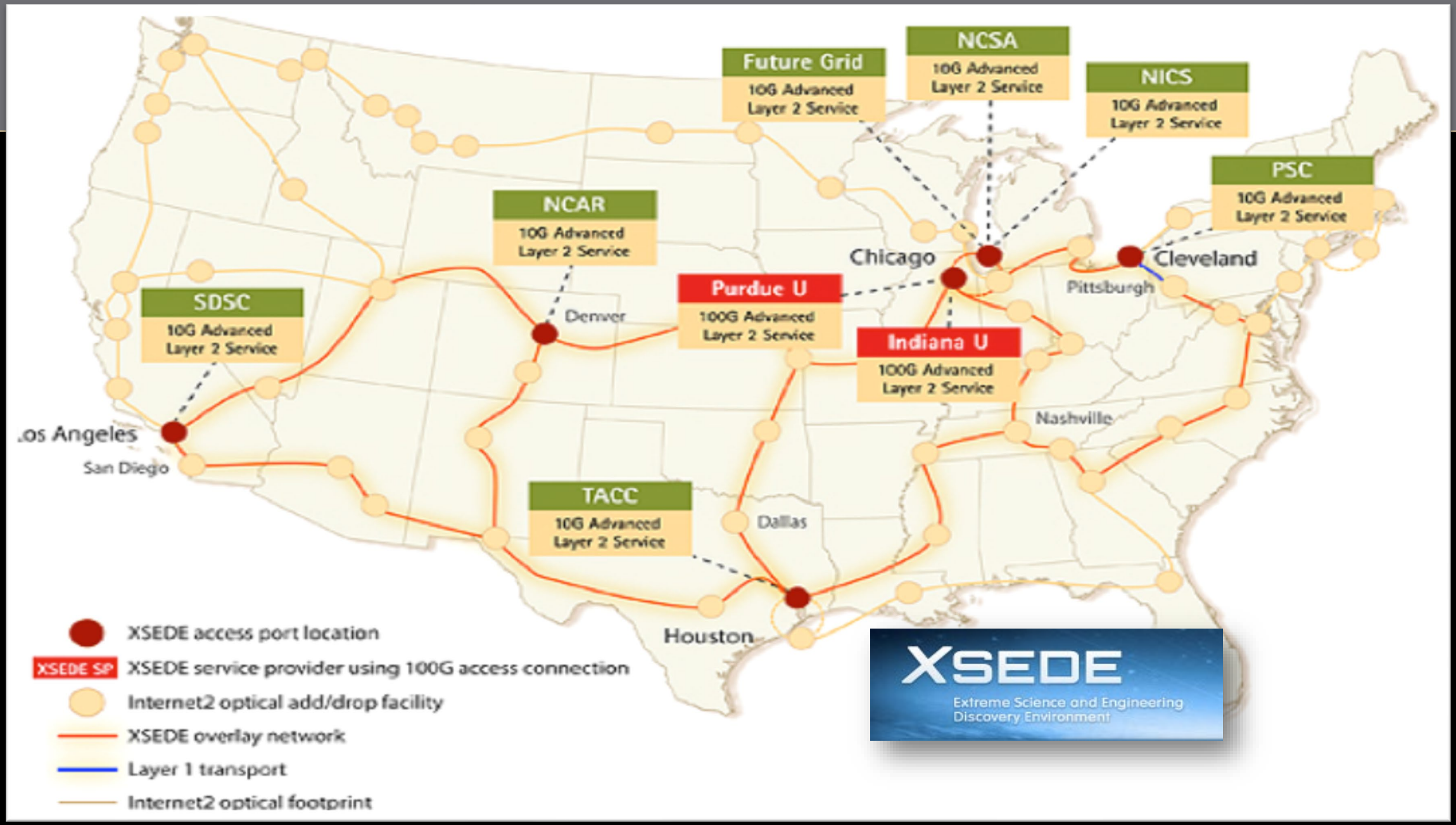
Early Universe Simulations

Alexander von Humboldt Research Prize

IEEE Sidney Fernbach Award






NCSA
10G Advanced Layer 2 Service
Future Grid
10G Advanced Layer 2 Service
NICS
10G Advanced Layer 2 Service
PSC
10G Advanced Layer 2 Service
NCAR
10G Advanced Layer 2 Service
SDSC
10G Advanced Layer 2 Service
Purdue U
100G Advanced Layer 2 Service
Indiana U
100G Advanced Layer 2 Service
TACC
10G Advanced Layer 2 Service
Chicago
Cleveland
Pittsburgh
Denver
Nashville
Dallas
Houston
San Diego
XSEDE access port location
XSEDE SP
XSEDE service provider using 100G access connection
Internet2 optical add/drop facility
XSEDE overlay network
Layer 1 transport
Internet2 optical footprint
XSEDE
Extreme Science and Engineering Discovery Environment

SDSC'S "GREEN" DATA CENTER

UCSD's first LEED Gold Certified building

Recycled material

Building orientation,

Sun shades,

Window glazing,

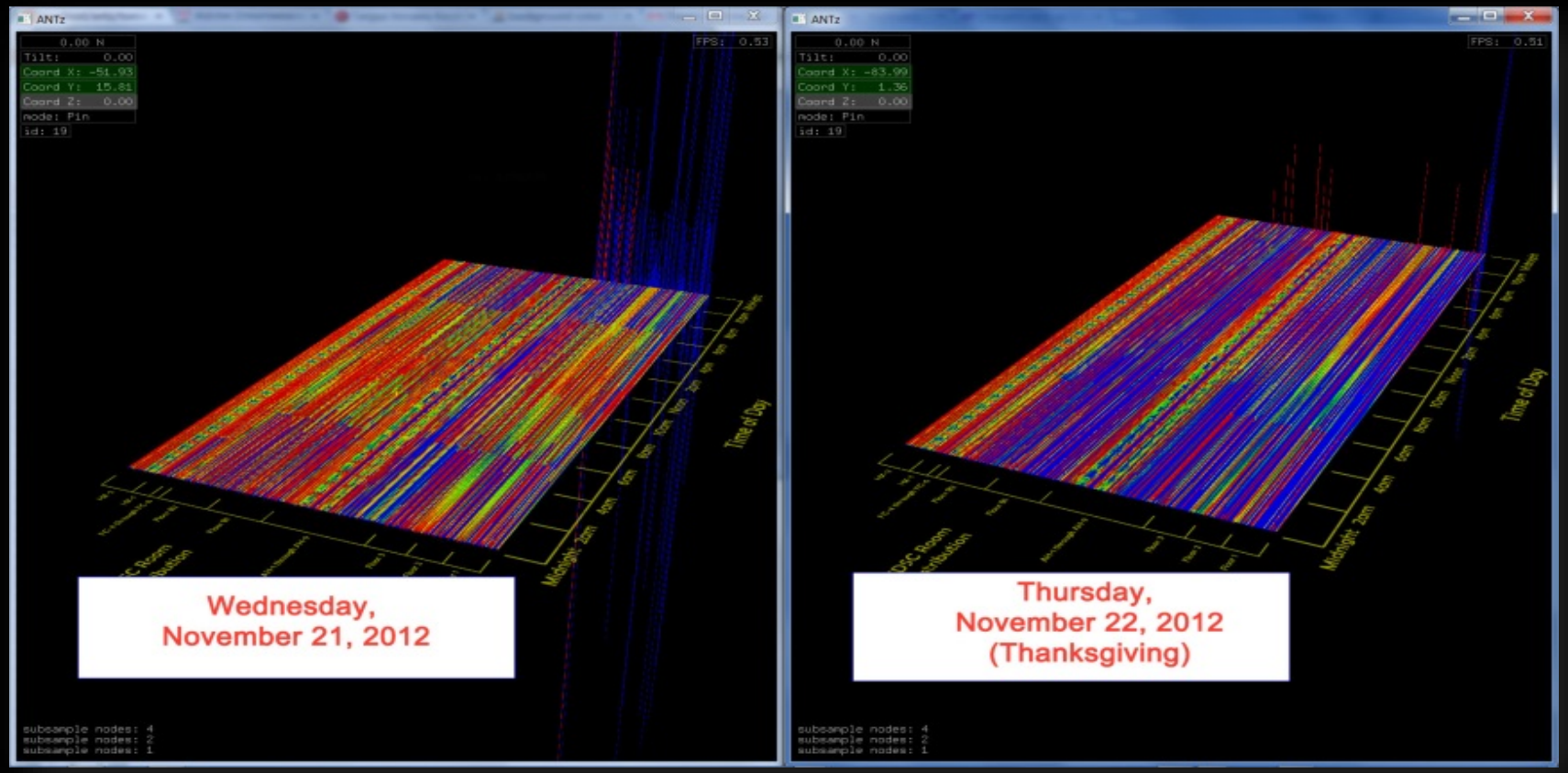
Concrete interiors,

Solar reflecting roof to dissipate heat

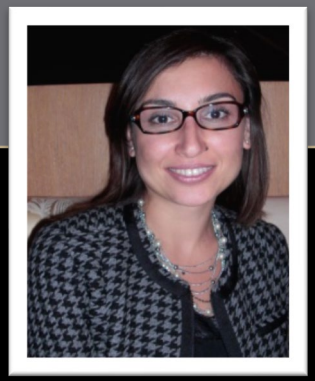
Solar panels

SDSC'S "GREEN" DATA CENTER

80,000 sensors measure energy use, heating, air conditioning, computer power consumption



SDSC STRENGTH: DATA



High-speed high-capacity “Flash data” memory supercomputers

SDSC Gordon is Fastest on Big Data Top 100 List

COMET soon to exceed Gordon in IOPS

World-Class Data Scientists

Ilkay Altintas, Amarnath Gupta, Chaitan Baru

SDSC ‘Data Oasis’ wins HPCWire Editor’s Choice Award

TWO DATA CENTERS

Original Data Center

New State-of-the-Art Data Center

Total – 35,000 ft²

STATE-OF-THE-ART DATA CENTER

2,000 square meter facility,

Climate-controlled,

Secure biometric access,

1-10+ Gb copper/fibre networking

SDSC DATA OASIS

6000 Spinning Hard Discs

9 Petabyte capacity

64 Object Storage Servers

dual-core Westmere processors, 36 high-speed SAS drives, and two dual-port 10GbE network cards

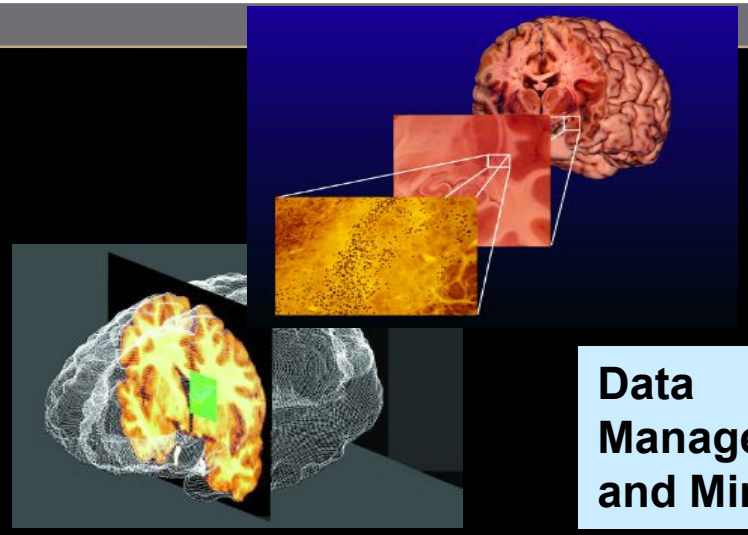
More than 450 active 10GbE connections

Up to 100 Gb/s sustained transfer rates

Easily expanded scalable storage

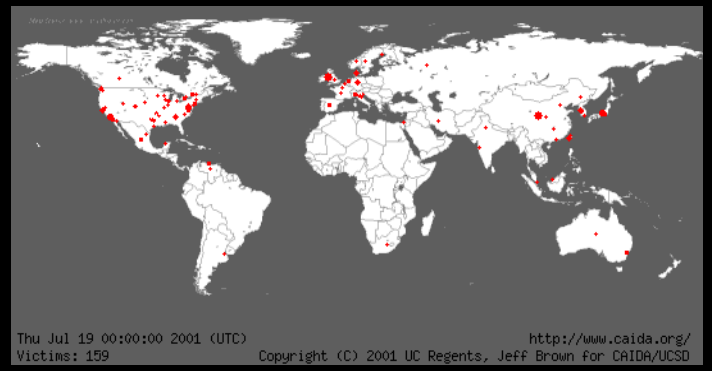
DATA COME FROM EVERY FIELD . . .

Astronomy



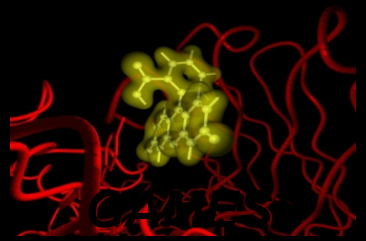
Data Management and Mining

Geosciences

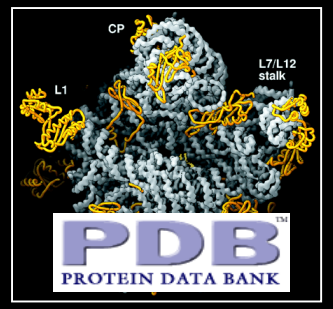


Modeling and Simulation

Physics



Life Sciences



THE INTERNET OF THINGS
WiFi

Google
2 MILLION Searches
Spotify
14 New Songs Added
DOMAINS
70 New Registered
15 THOUSAND Tracks downloaded from iTunes
WordPress
347 New Blog Posts
WEBSITES
571 New Created
Walmart
Transactions 17 THOUSAND
tumblr.
New Tumblr Photos 20 THOUSAND
EMAIL
emails sent 204 MILLION
Instagram
photos every second 3,600
Pinterest
Active Users 11 THOUSAND
Linked in
Professional searches 11 THOUSAND
amazon.com
Amazon Sales $83,000
snapchat
Photos Shared 104 THOUSAND
twitter
278 Tweets THOUSAND
flickr
20 Photo Views MILLION
skype
1.4 MILLION Minutes Connecting with Each other
350GB of data
facebook
41 THOUSAND posts every second
1.8 MILLION likes
YouTube
72 HOURS of Video uploaded

Zettabyte

x 1024

Exabyte

x 1024

Petabyte

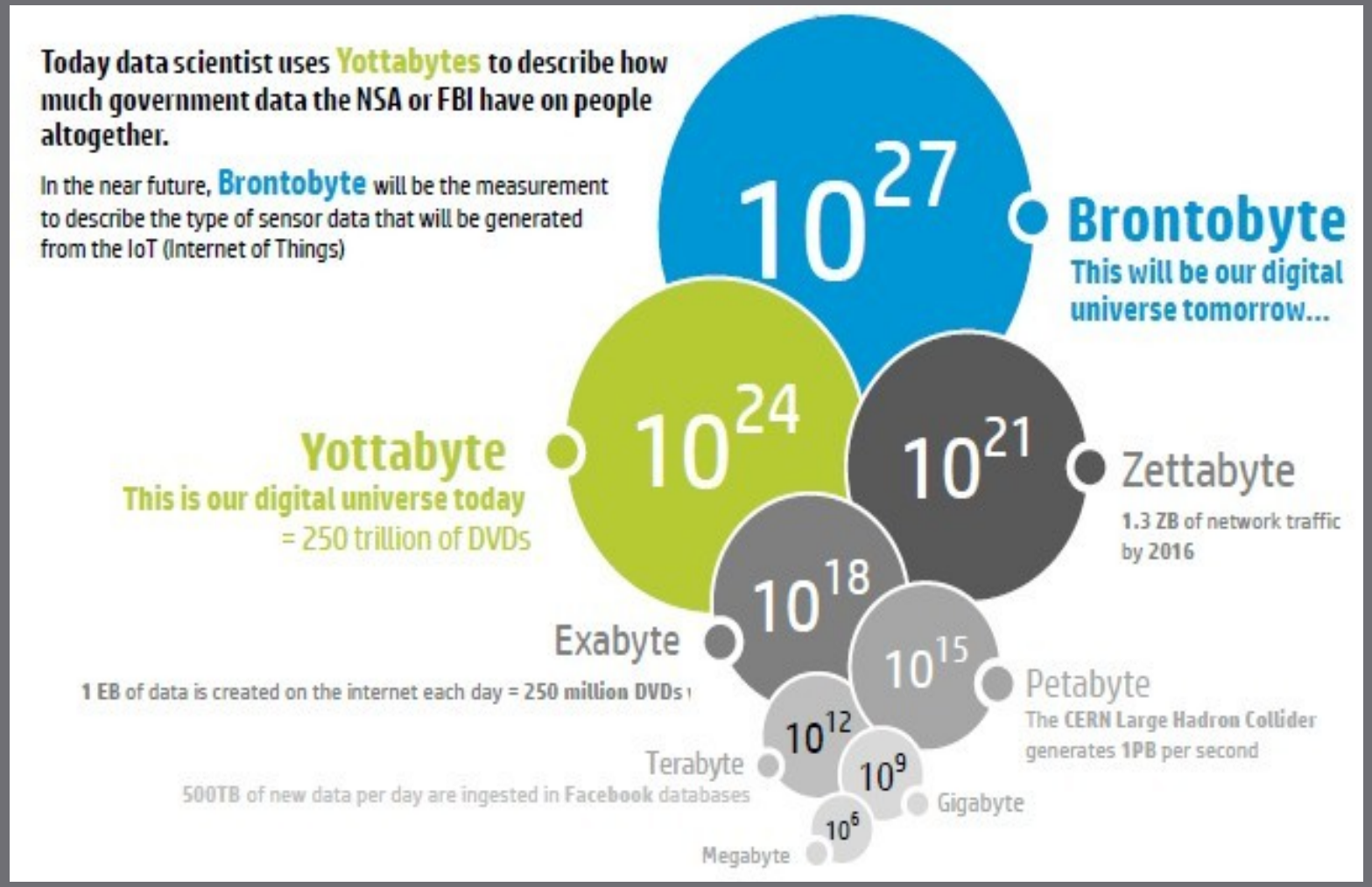
x 1024

Terabyte

x 1024

Gigabyte

Growing Internet of Things Data



IMPORTANT WORDS

Cyber-Infra-Structure (CI)

Cyber (from the Greek “cybernetic”, to steer)

Infra (within, foundation)

Advanced Computational Infrastructure

High-Performance Computing (HPC)

Big Iron, Big Data

Solid State Disk (SSD) or ‘Flash’ Memory

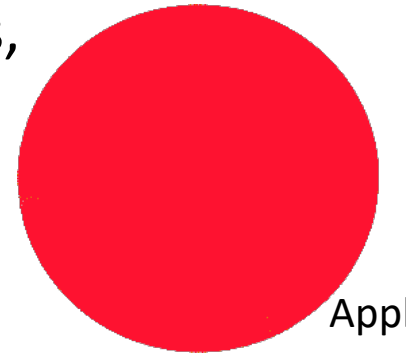
Computational Science & Engineering

WHAT IS COMPUTATIONAL SCIENCE?

SCIENCE + SIMULATION/MODELING + COMPUTER SCIENCE

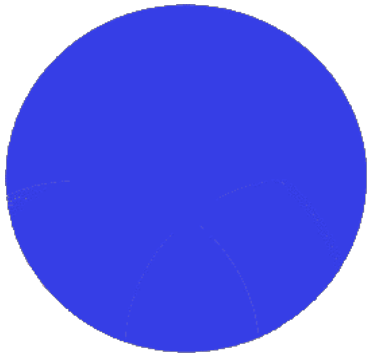
Science or HASS Discipline

Physics, Chemistry, Biology, Arts, Humanities, Social Science, etc.



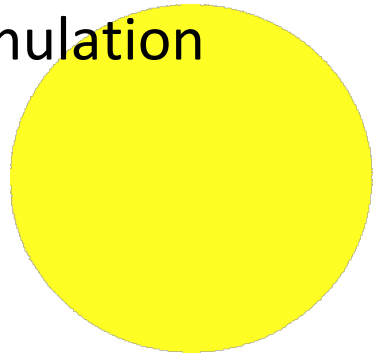
Computer Science

Hardware/Software



Applied Mathematics

Numerical Analysis, Modeling, Simulation

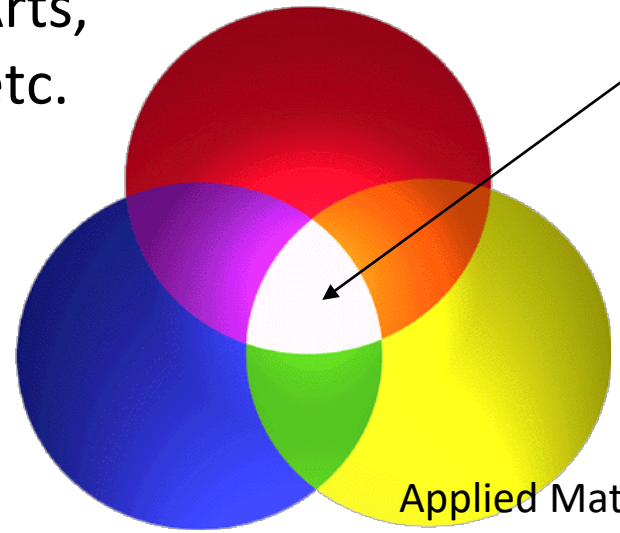


COMPUTATIONAL SCIENCE REQUIRES TEAMWORK AND COLLABORATION

Teamwork and Collaboration

Science or HASS Discipline

Physics, Chemistry, Biology, Arts, Humanities, Social Science, etc.



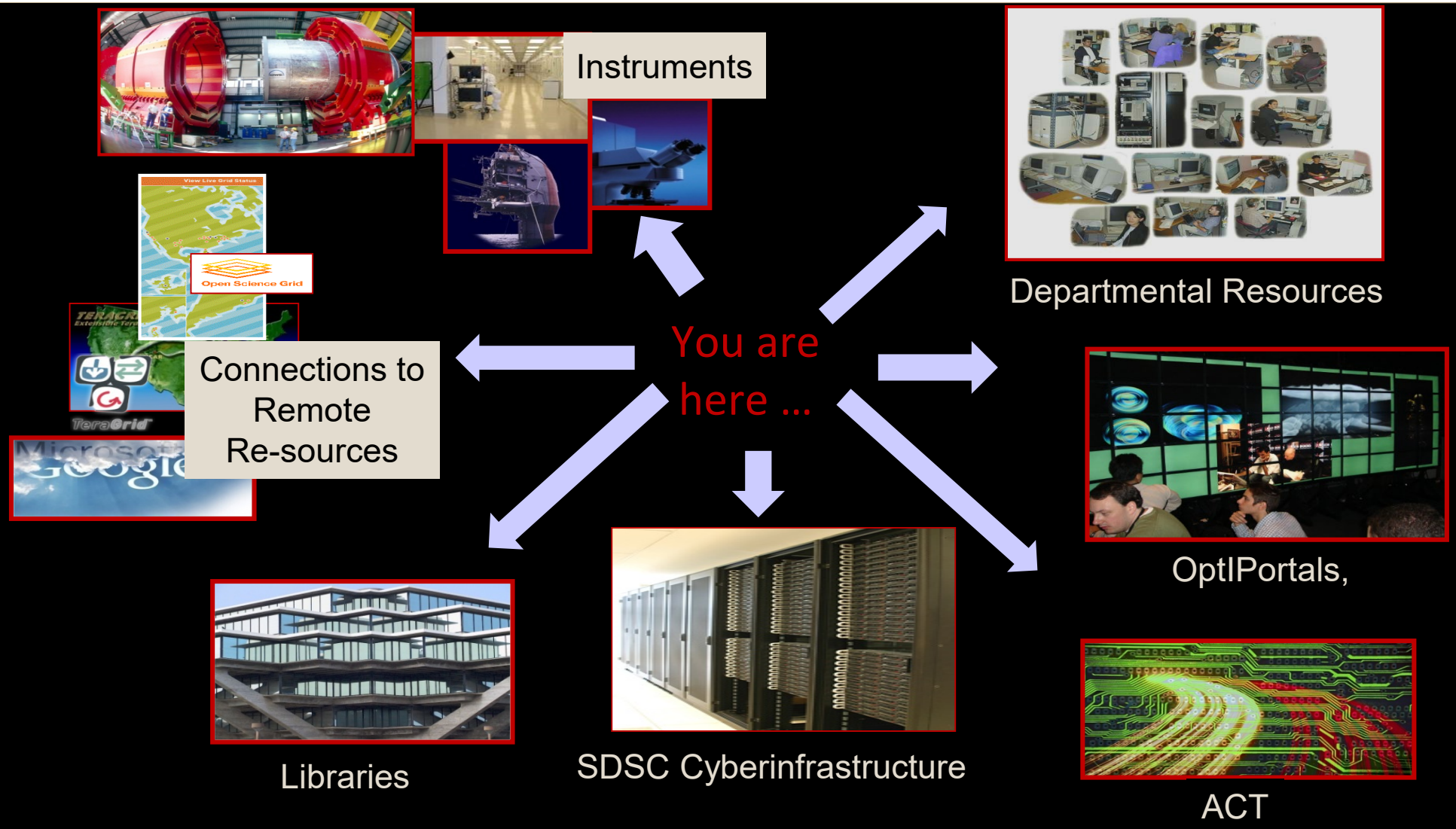
Computer Science

Hardware/Software

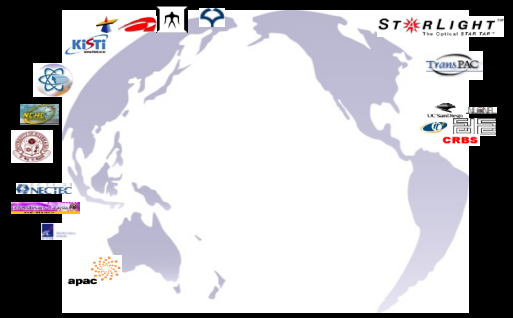
Applied Mathematics

Numerical Analysis, Modeling, Simulation

TODAY'S RESEARCH DEPENDS UPON SECURE, DEPENDABLE CONNECTIONS AMONG CYBERINFRASTRUCTURE TOOLS.

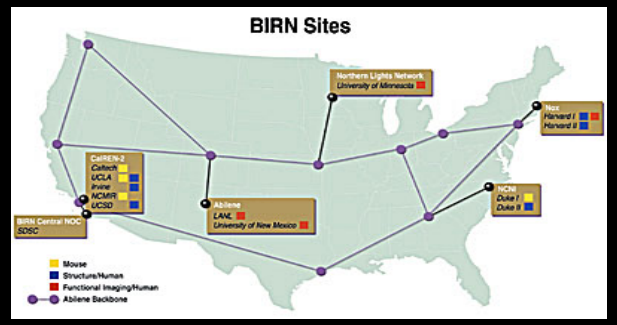


DATA ARE SHARED AMONG RESEARCHERS AROUND THE WORLD.

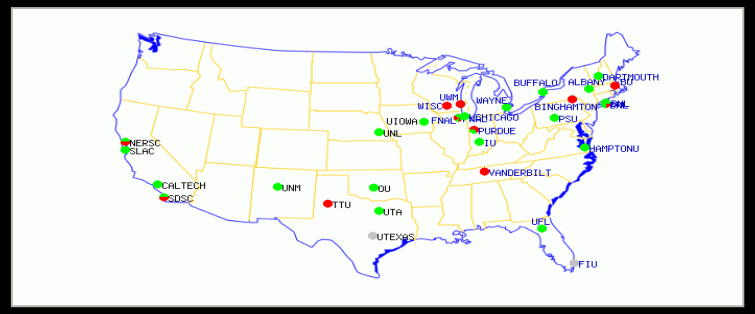


PRAGMA: *Pacific Rim Grid Middleware Consortium*

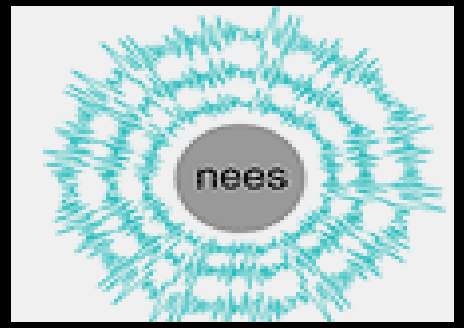
TeraGrid: *National Research Resource Grid*



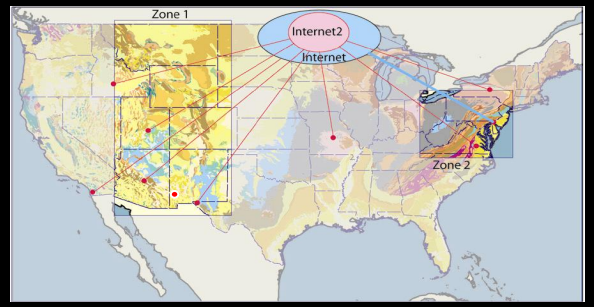
BIRN: *Biomedical Informatics Grid*



Open Science Grid: *Physics-driven Grid infrastructure*

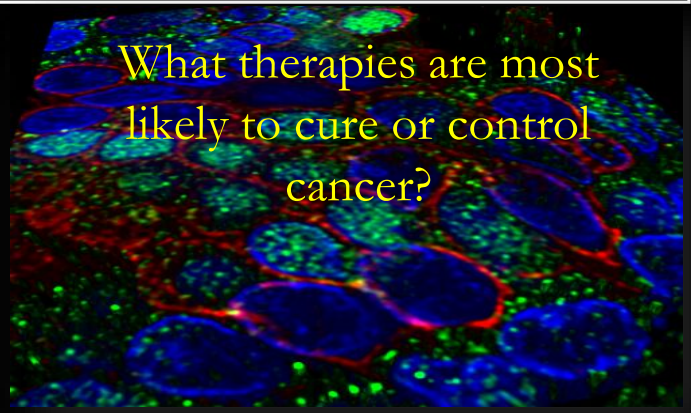


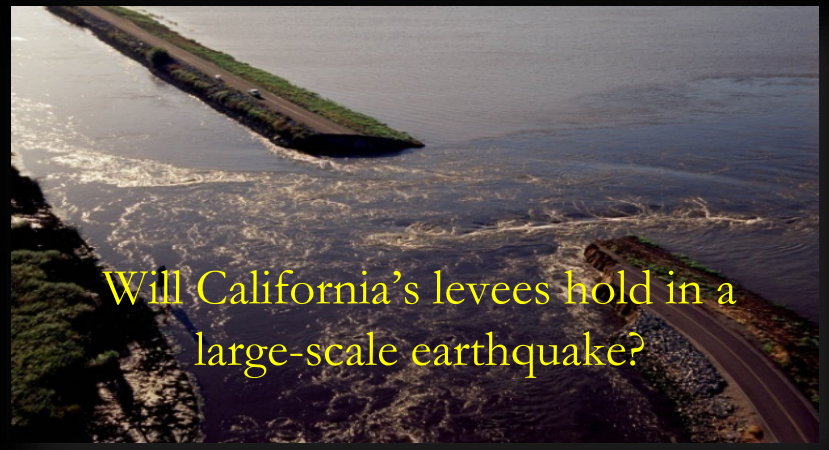
NEES: *Earthquake Engineering Grid*



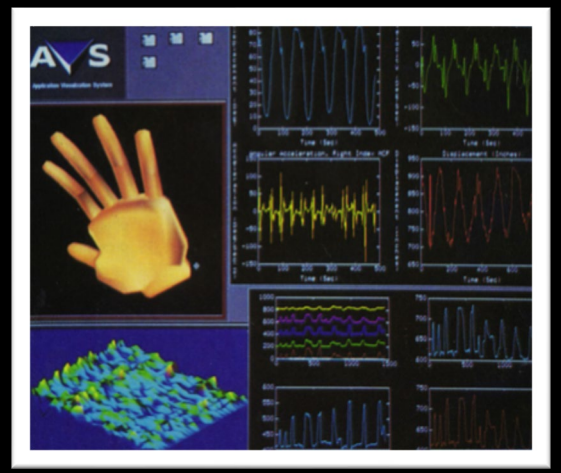
GEON: *Geosciences Grid*

WHY DO WE USE COMPUTATIONAL TOOLS? 21ST CENTURY PROBLEMS REQUIRE 21ST CENTURY SOLUTIONS





A Long Time Ago: Virtual Reality in Medicine



Loma Linda University School of Medicine, Dept. of Neurology

Dr. Doug Will, Dean, SoM, Dept. Chair, Neurology

Augmented Communication
Environmental Control
Quantitative Assessment

Used the VPL 'Data Glove' to study:

- Parkinson's Disease,
- Lou Gehrig's Disease (ALS),
- Huntington's Disease

The Neurology Research Team (NRT)

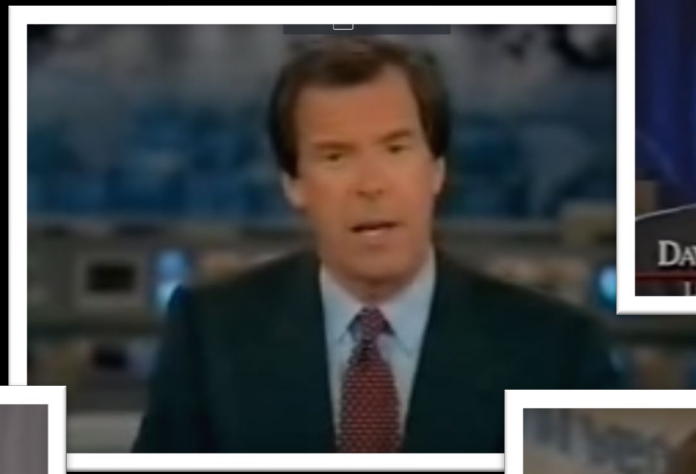
The 'NRT' Lab, "As opposed to INERT!"

Dr. Doug Will, Chair, Neurology,
Dean, LLU School of Medicine

Dave Warner	**Patrick Keller**
Steve Price	**Bill Rojas**
Jeff Sale	**Markus Schmidt**
Dave Gilsdorf	**Rik Rusovic**
Jodi Reed*	**Steve Birch**
My better half	**Alan Barnum-Scrivener**

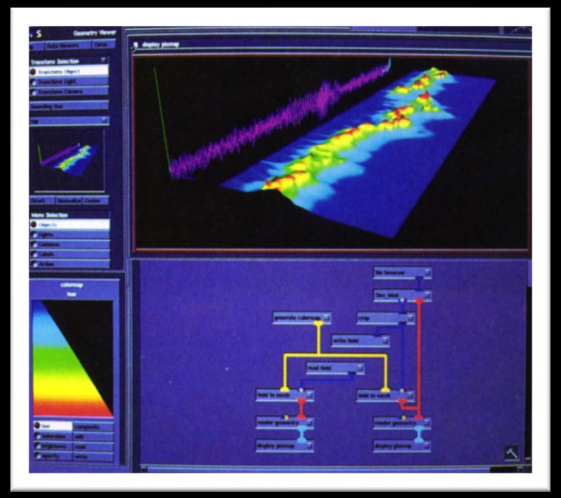
VR in the Clinic

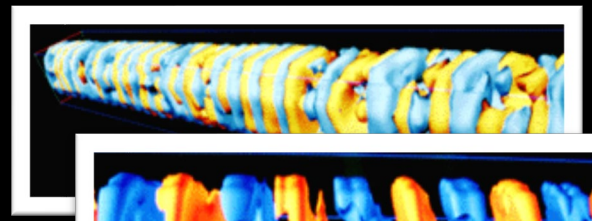
Augmented communication
Environmental Control
Quantitative Assessment

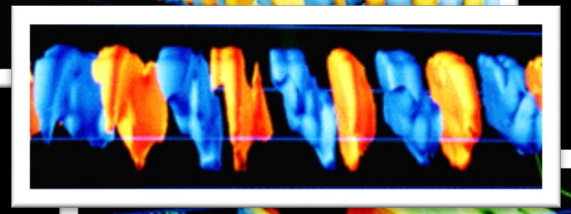


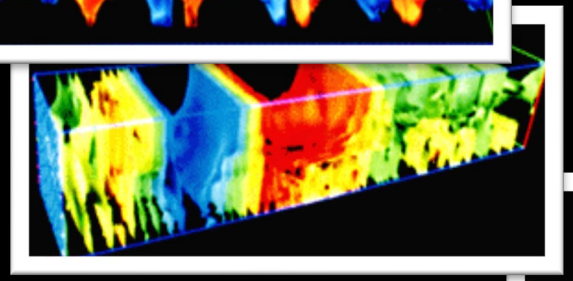
Data Visualization

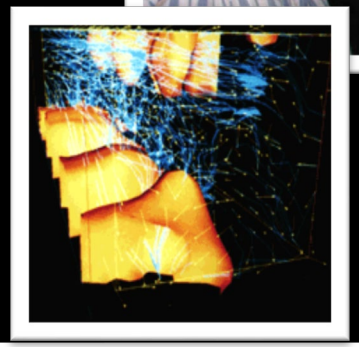
Compressed Dimensional Arrays
EEG, ECG Spatiotemporal Isosurfaces

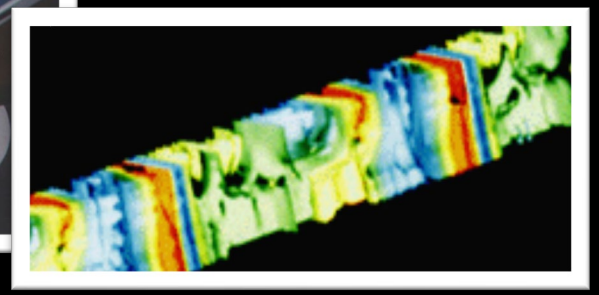


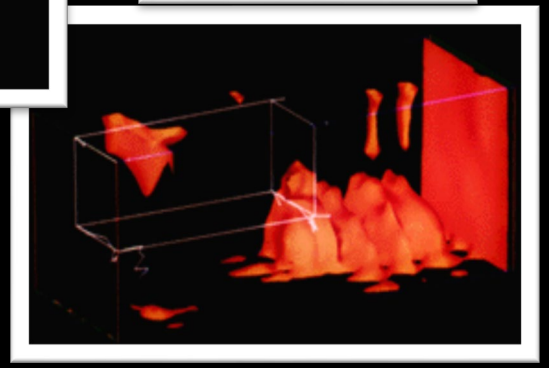












James Clark Visits the NRT Lab

SGI Hires Craig Upson, Developer of AVS
Wants to recreate AVS for SGI Platform with Clinical emphasis

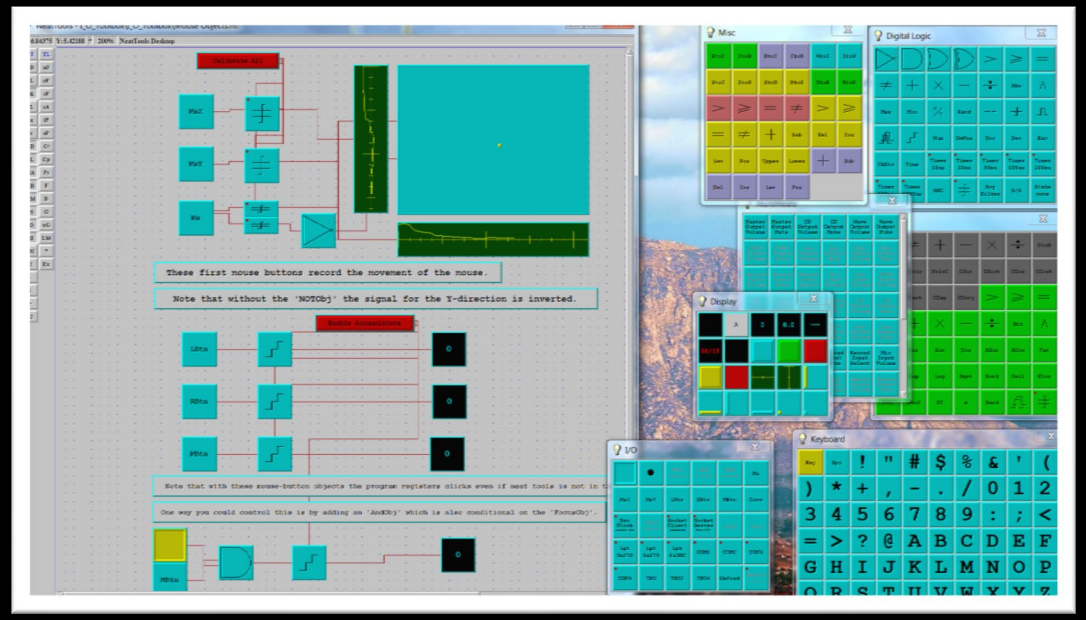
Dave's Cyberarium at Syracuse

Nason Fellowship

Syracuse University, under Dr. Geoffrey Fox

- Yuh-Jye Chang, Ph.D.
  - NeatTools Developer

Dr. Ed Lipson, Chair, Physics



Dave's Center for Really Neat Research

VR in the Clinic
Medical Education Technology
Interventional Informatics
Perceptual Cybernetics

The Institute for Interventional Informatics
PULSAR PROJECT
Improving quality of life in
Education, Recreation, Communication, and Health Care

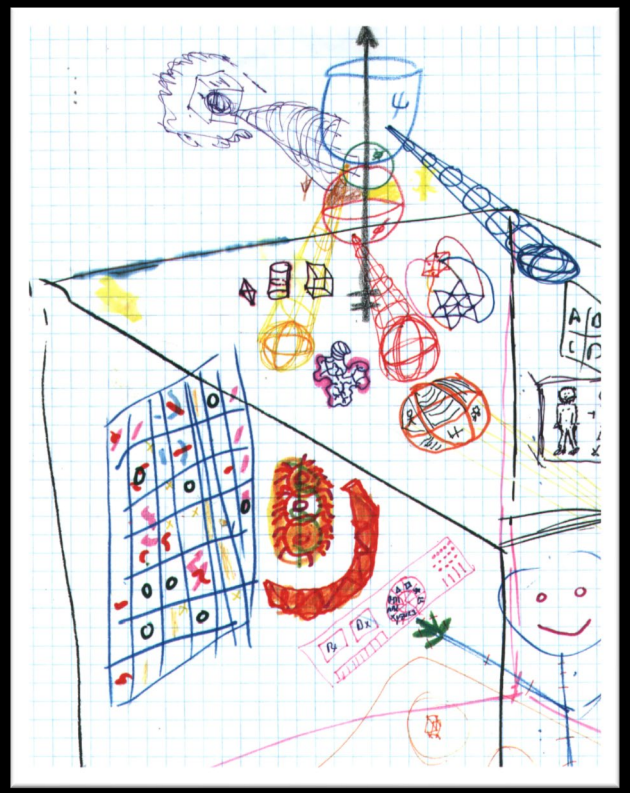
Dave Warner, the Visionary

M.D., Ph.D, Loma Linda University, "To Make Man Whole"

- Nason Fellow, Syracuse University (Advisor, Dr. Geoffrey Fox)
- Civilian-Military Communications
  - Bridging the Gaps

Perceptual Cybernetics

"Mind-in-the-Loop"



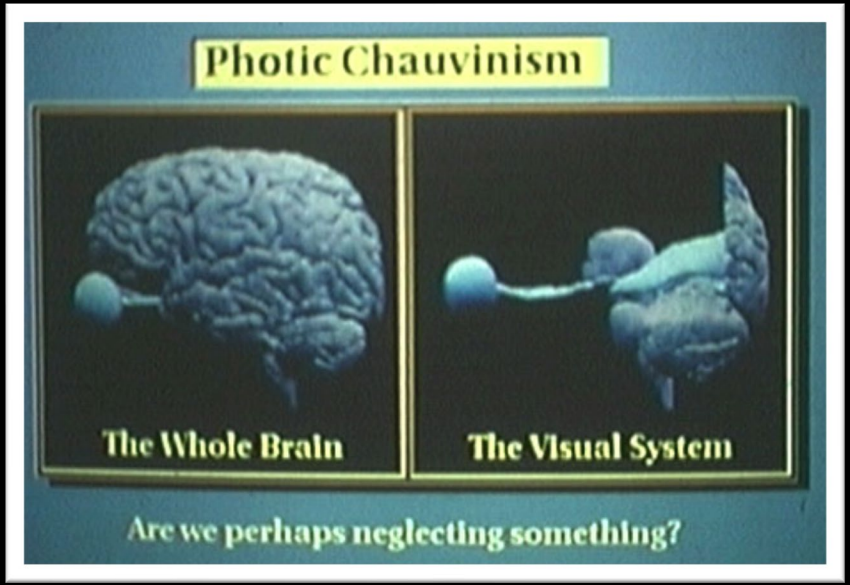
Perceptual Cybernetics

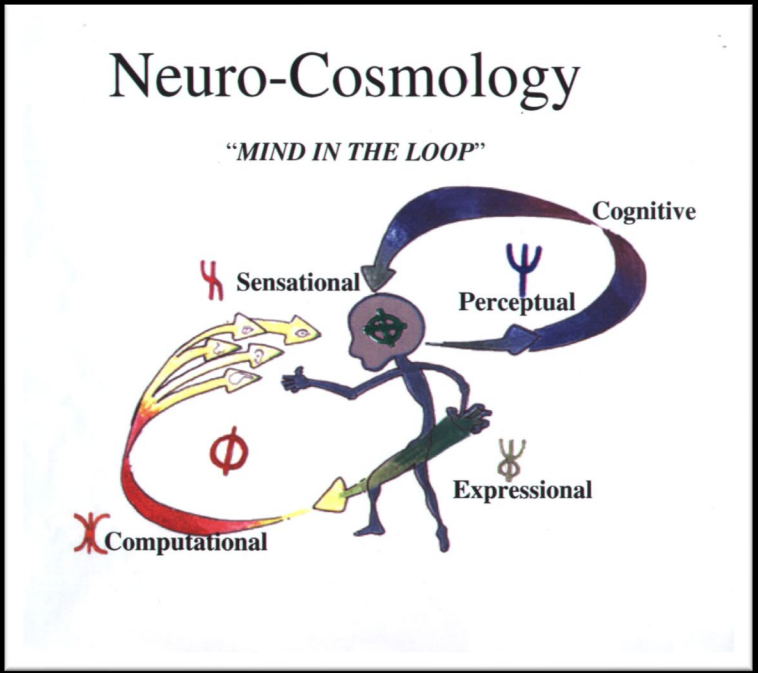
Mark Pesce* Gives Credit to PC in Landmark Paper

- PSI
- PHX
- PHI

http://hyperreal.org/~mpesce/interview.html
http://hyperreal.org/~mpesce/fa.html

"Mind in the Loop"



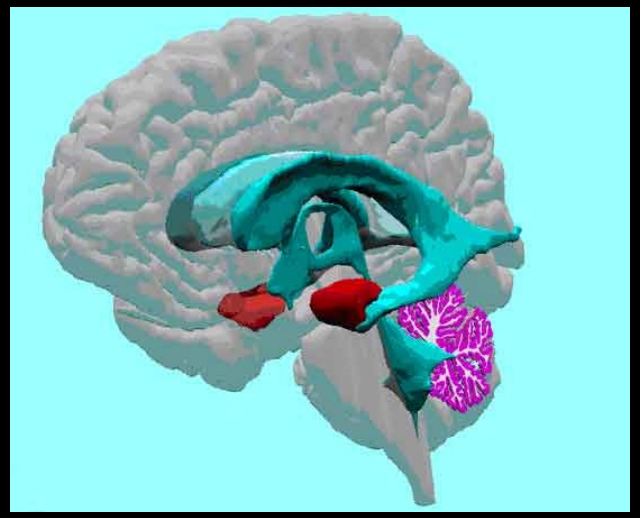


*Developer of Virtual Reality Markup Language (VRML)

Medical Education Technology

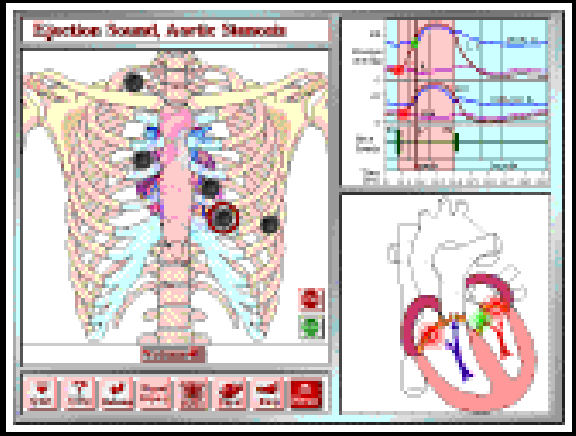
VR for Anatomy Instruction

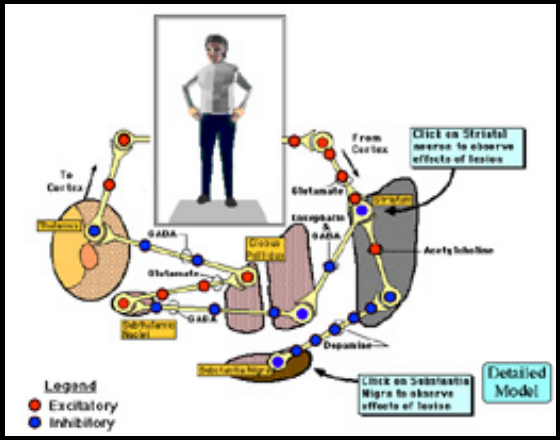
- The Visible Human
- The Digital Anatomist (University of Washington)

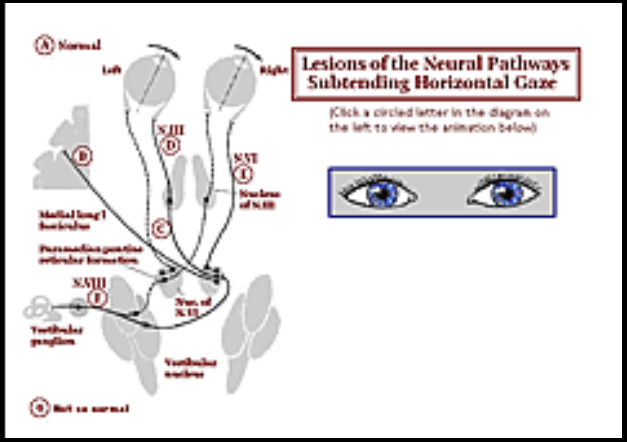


Interactive Courseware

- Heart Auscultation
- Neuropathology of Movement Disorders
- Neuropathology of Gaze Disorders







Humanitarian Communications Operations

ANTz: The Next "Kick-Ass" Viz

Robert Steele, Highest Ranking Civilian in the CIA

"…some of the most brilliant data visualization I have ever seen!"

"…it literally blew my mind!"

"… so good it could potentially change how we govern and manage everything…"

PUBLIC INTELLIGENCE BLOG

The truth at any cost lowers all other costs

Home About Blog Books Español Francais Links OSEE Reviews Trump #UNRIG Who

2013/12/17

Robert Steele: Kick-Ass Next Level in Big Data Visualization & Exploitation

Advanced Cyber/IO

I've been getting cranky as I have been reading and hearing all the hype over big data — data sets created by 1950's mindsets on top of 1970's technology and largely irrelevant to 21st Century solutions. I've also been looking at a few "solutions" packages — SILOBREAKER is still my favorite and Palantir is a complete disappointment. Cheering me up, considerably, are the below two sites.

Robert David STEELE Vivas

The first, ANTz is some of the most brilliant data visualization I have ever seen. I spent two hours with it this morning and it literally blew my mind. This stuff is so good it could potentially change how we govern and manage everything, within a decade. Visit them at http://www.edworlds.com/antz/toroids/.

Click on Image to Enlarge

The second, SynglyphX, is a new company that will in my view transform the information industry within the decade.

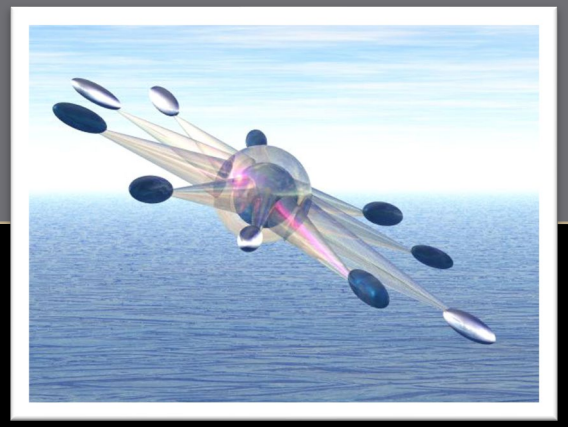
Fukushima Radiation, May 2011-Sept. 2012

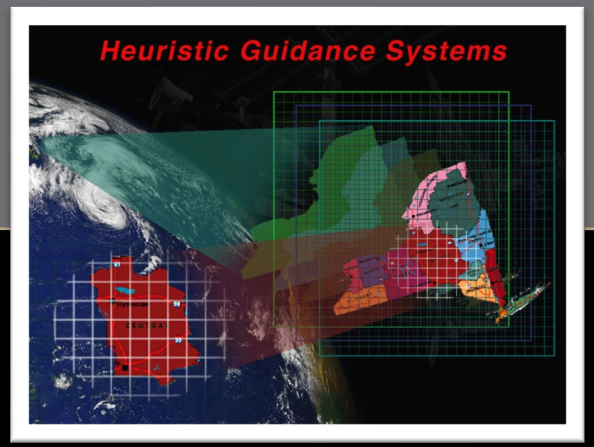
Legend

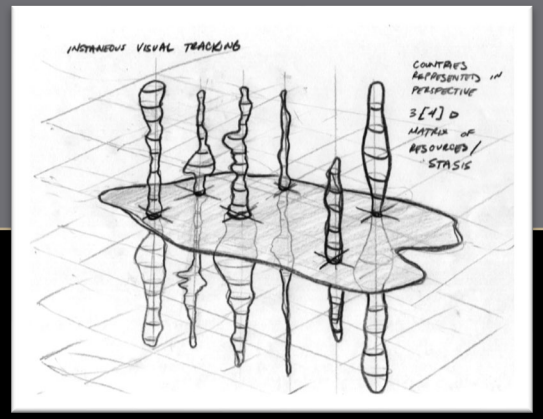
Time

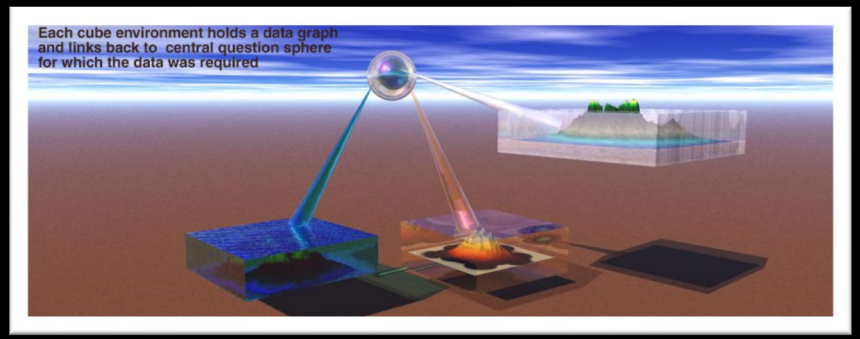
Click on Image to Enlarge

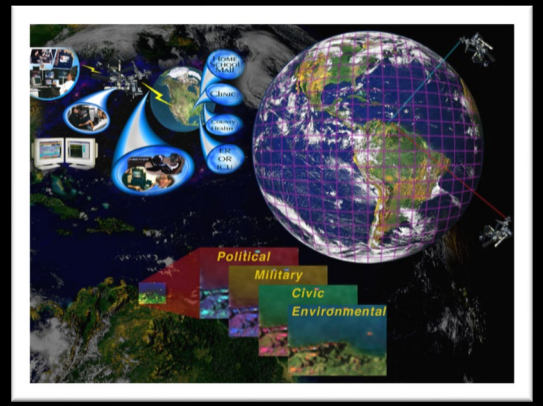
They are bringing the ANTz technologies (open source, by the way) to market, and

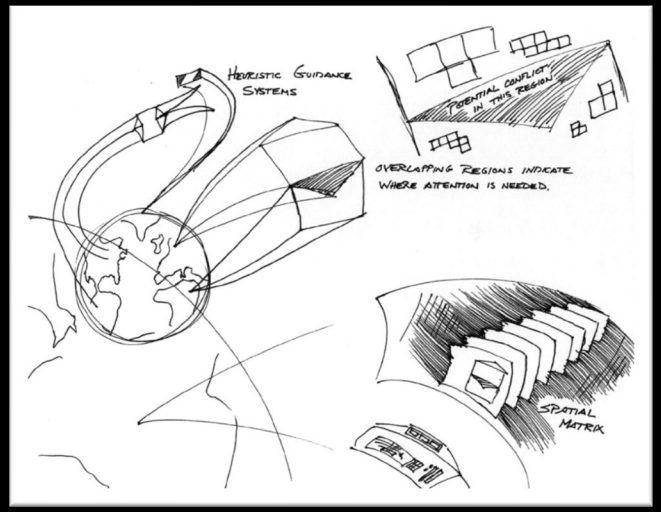


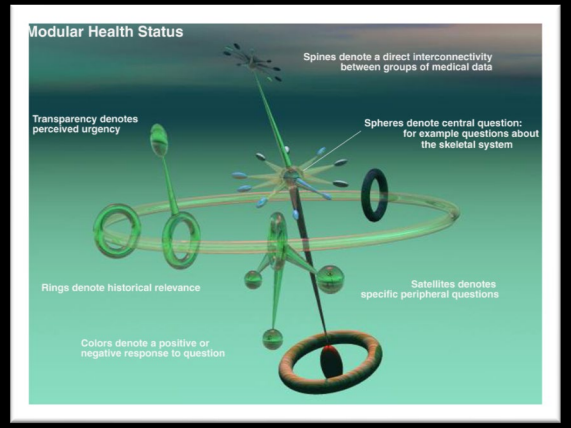

Heuristic Guidance Systems

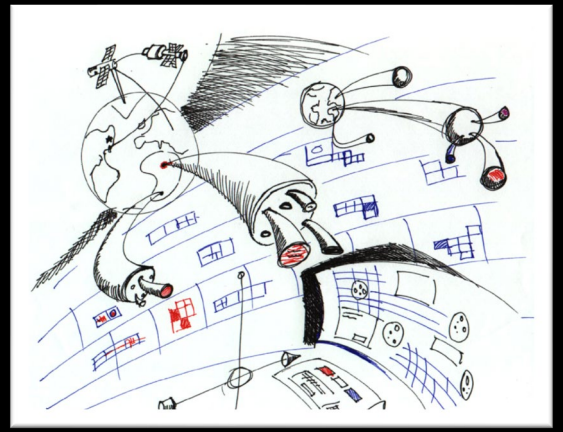

INSTANEOUS VISUAL TRACKING
CONTRAST REPRESENTED IN PERSPECTIVE
3[4] D MATRIX OF RESOURCES / STASIS


Each cube environment holds a data graph and links back to central question sphere for which the data was required


Political
Military
Civic
Environmental


HEURISTIC GUIDANCE SYSTEMS
POTENTIAL CONFLICTS IN THIS REGION
OVERLAPPING REGIONS INDICATE WHERE ATTENTION IS NEEDED.
SPATIAL MATRIX


Modular Health Status
Spines denote a direct interconnectivity between groups of medical data
Transparency denotes perceived urgency
Spheres denote central question: for example questions about the skeletal system
Rings denote historical relevance
Satellites denotes specific peripheral questions
Colors denote a positive or negative response to question



SynGlyphX, A Spinoff Start-Up

https://www.synglyphx.com/

Brief History of Glyphs

Petroglyphs

Brief History of Glyphs

Heiroglyphs

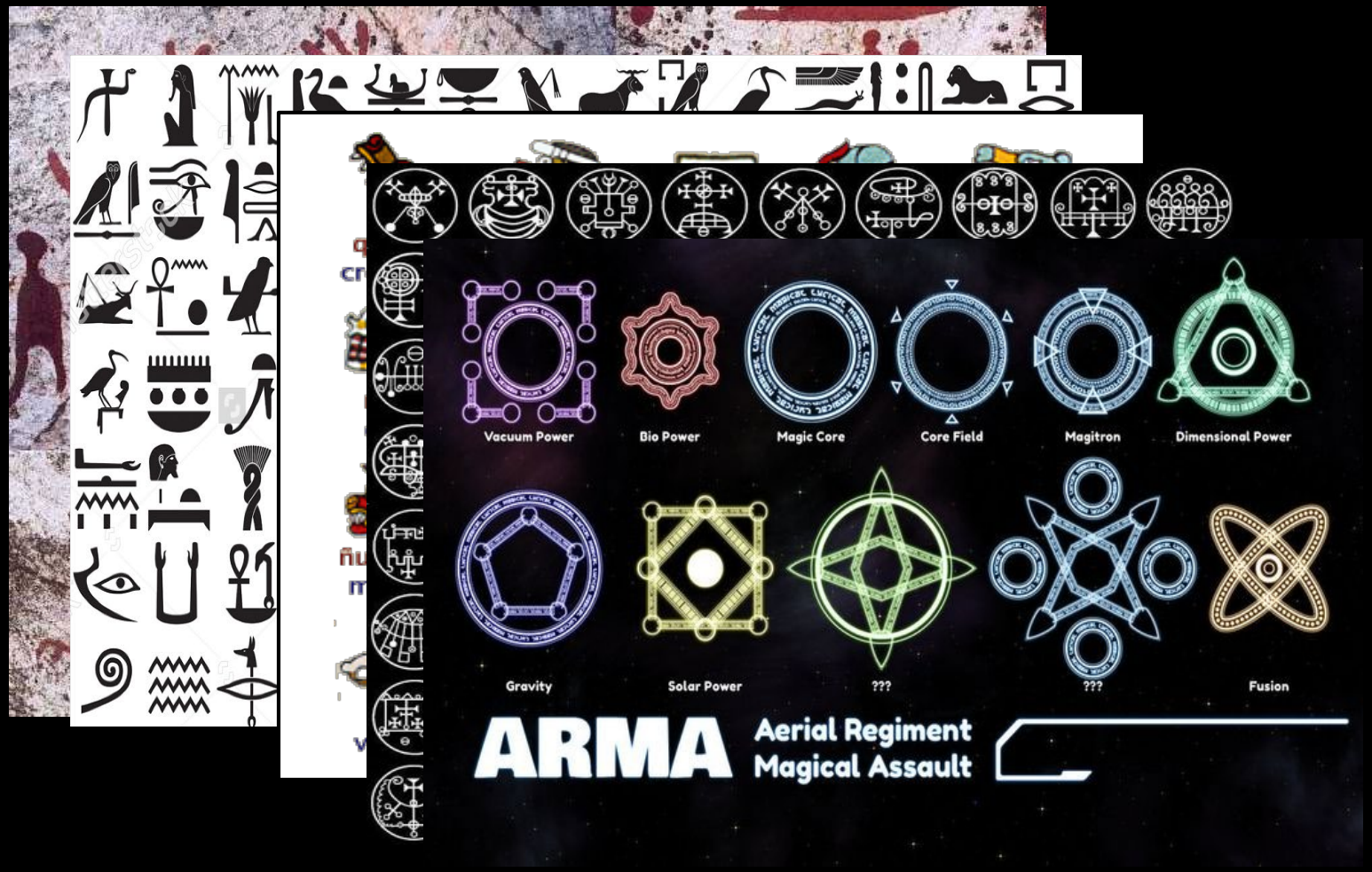
Brief History of Glyphs

Mayan Glyphs

Brief History of Glyphs

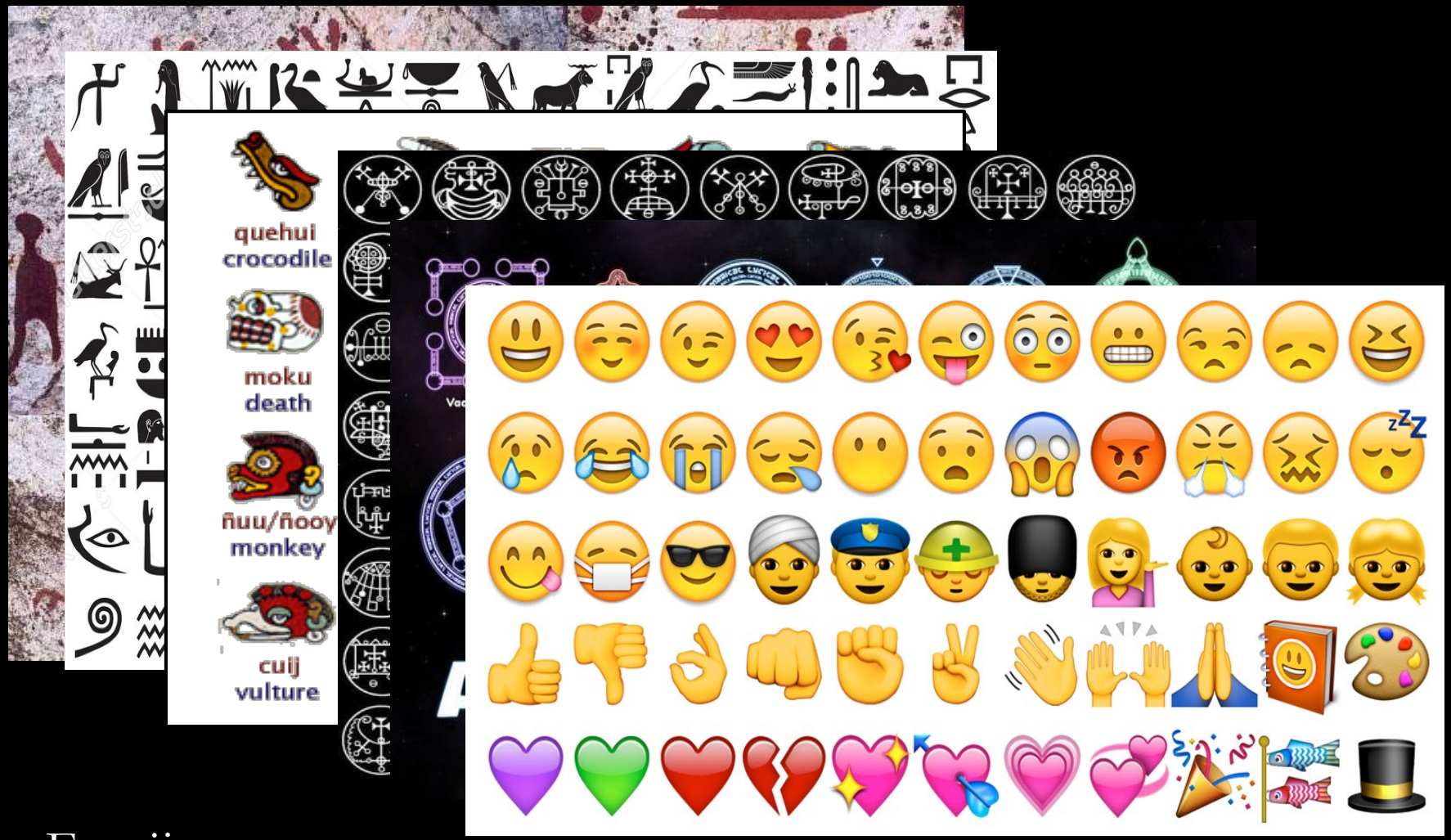
Mystical (Enochian) Glyphs

Brief History of Glyphs



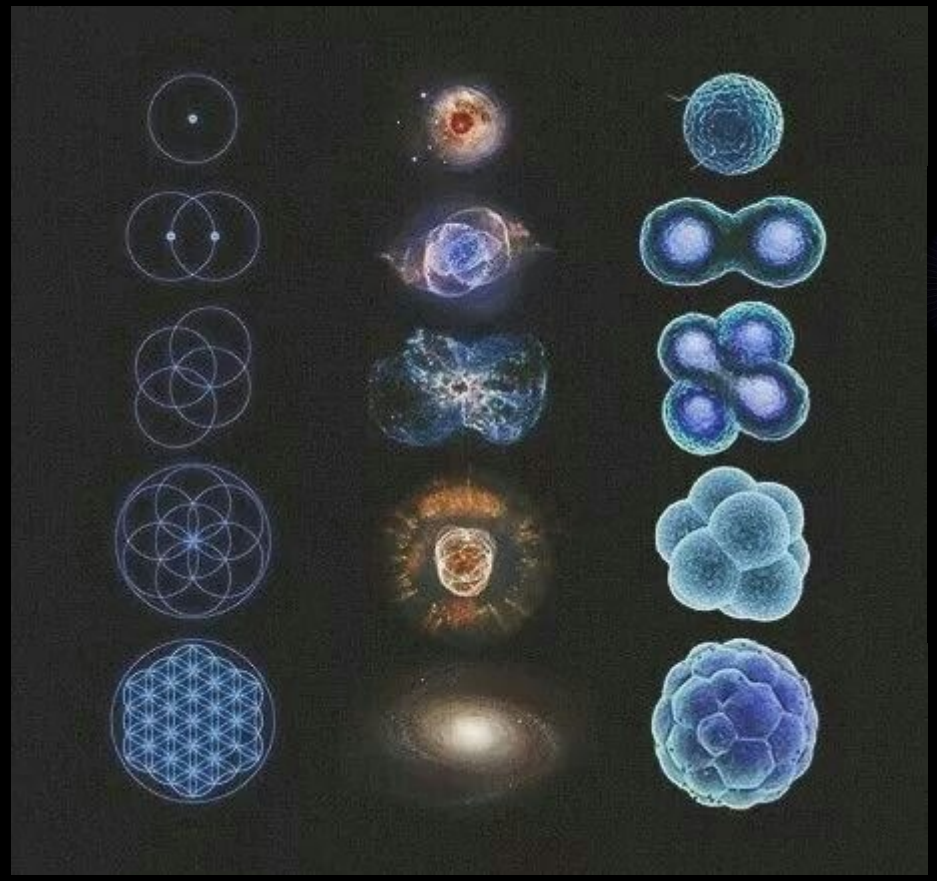
Video Game “Power” Glyphs

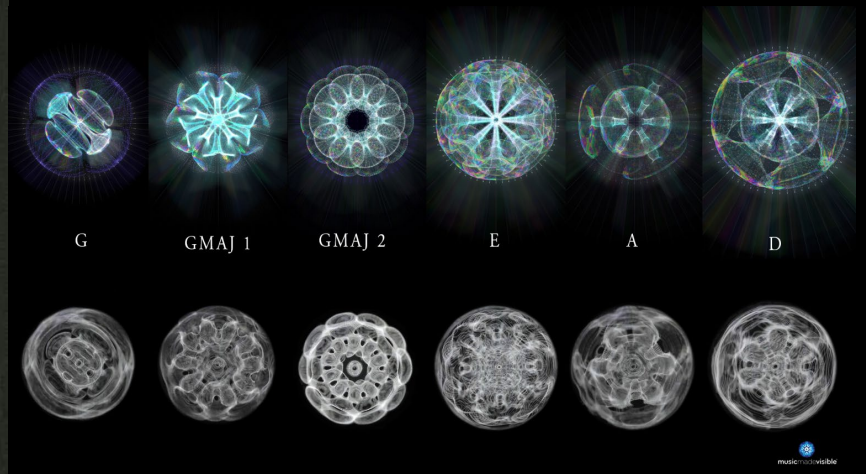
Brief History of Glyphs



Emojis

Nature Emulates Math





What is a Glyph?

From Wikipedia:

"In typography, a **glyph** /ˈɡlɪf/ is an elemental symbol within an agreed set of symbols, intended to represent a readable character for the purposes of writing. "

(No reference to glyphs in visualization)

From a Google search, "What is a glyph?":

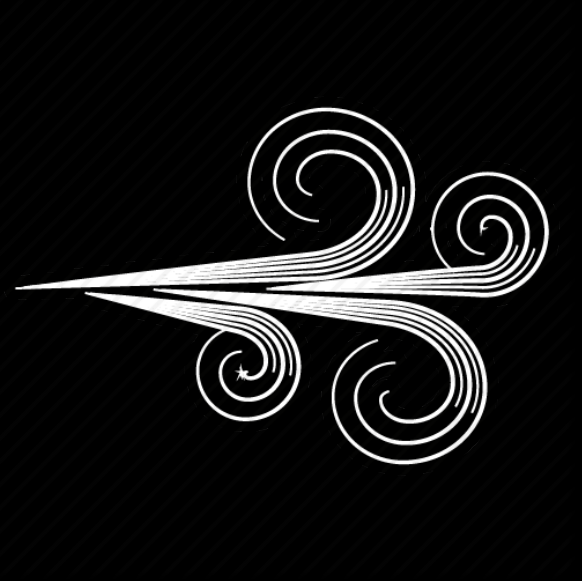
1. a hieroglyphic character or symbol; a pictograph.
"flanges painted with esoteric glyphs"
2.
ARCHITECTURE
an ornamental carved groove or channel, as on a Greek frieze.

Use of the term "glyph" over time

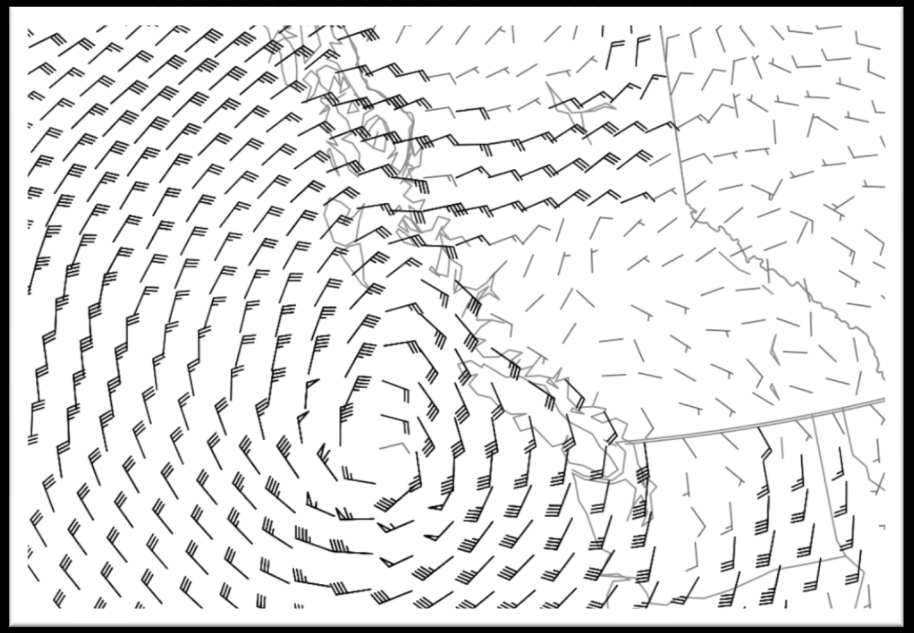
A Glyph is related to...

Grapheme: In linguistics, a **grapheme** is the smallest unit of a writing system of any given language.[1]
Morpheme: In linguistics, a **morpheme** is the smallest grammatical unit in a language.

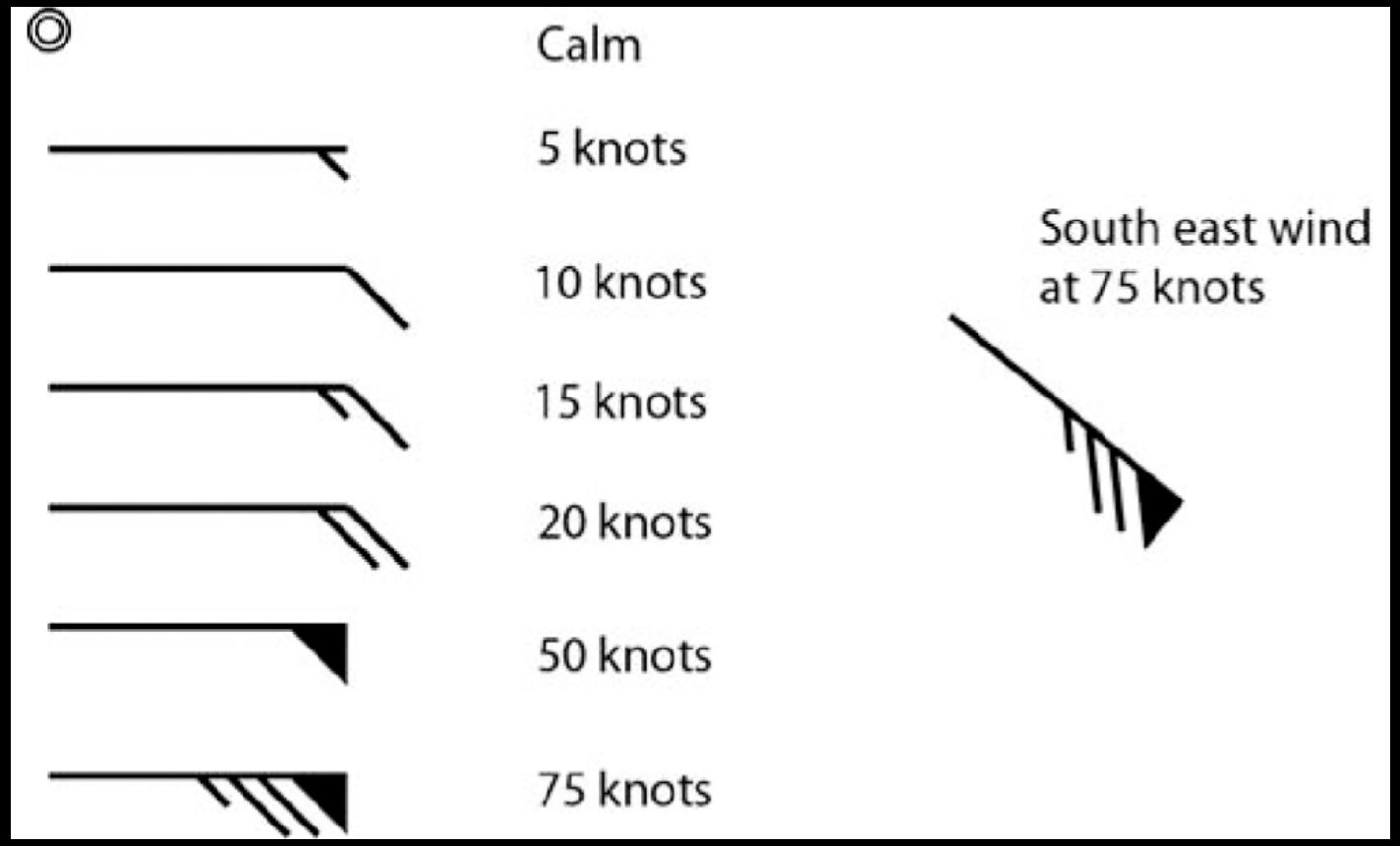
A Classic: The Wind Glyph



A Classic: The Wind 'Barb' Glyph



Wind **Speed** and **Direction**



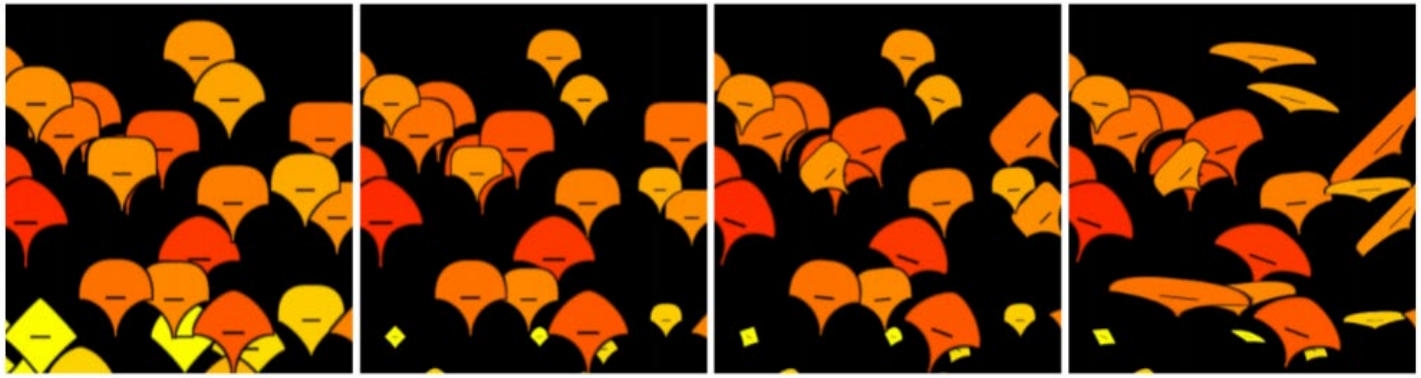
PREVIOUS WORK INSPIRING THIS WORK

Critical Design and Realization Aspects of Glyph-based 3D Data Visualization

Andreas E. Lie*
University of Bergen
Norway, www.ii.UiB.no/vis

Johannes Kehrer†
University of Bergen
Norway, www.ii.UiB.no/vis

Helwig Hauser‡
University of Bergen
Norway, www.ii.UiB.no/vis



(a) Two data attributes are represented as the upper / lower glyph shape

(b) Added data attribute to overall glyph size

(c) Glyph rotation has been assigned a data attribute as well

(d) A data attribute has been assigned to glyph aspect ratio

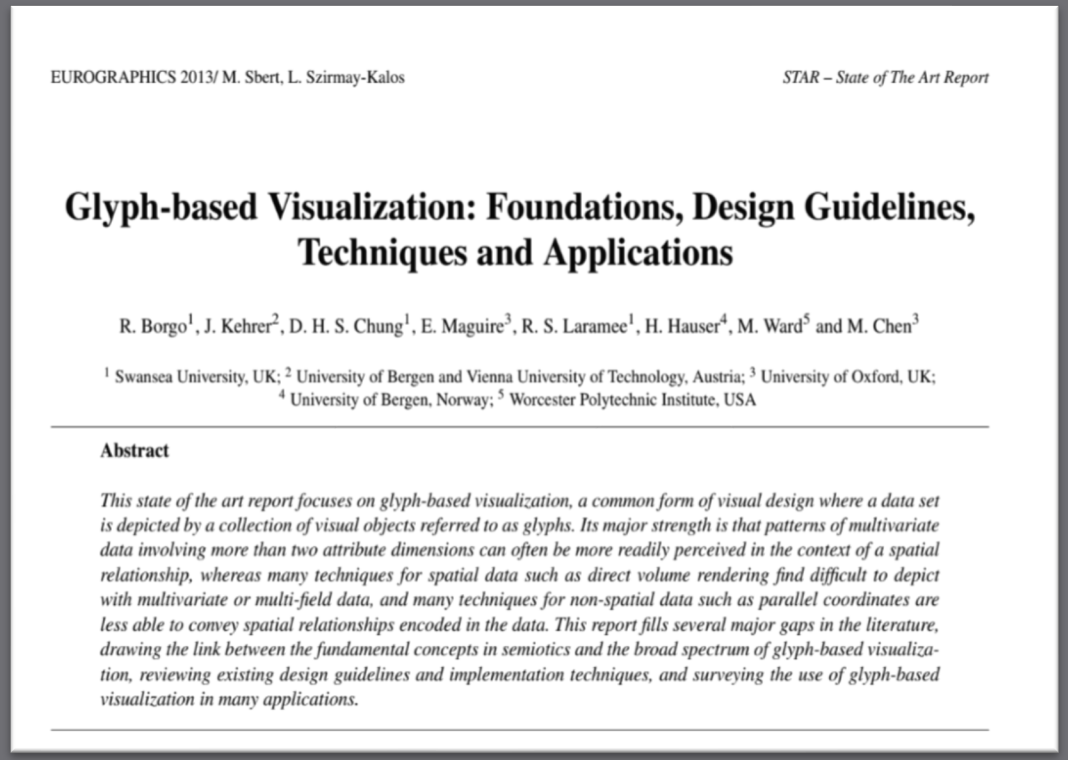
Figure 1: Adding more attributes to the glyph, while preserving the glyph's orthogonality.

Abstract

Glyphs are useful for the effective visualization of multi-variate data. They allow for easily relating multiple data attributes to each other in a coherent visualization approach. While the basic princi-

resulting datasets are 3D instead of 2D, time-dependent instead of single time step, only, and multi-variate with many values per space-time location, to name just three of more recent properties (which soon will be standard in many cases). This means that not only the large size of simulation datasets is challenging, but also its complexity. With this, it is getting more important and more

PREVIOUS WORK INSPIRING THIS WORK



EUROGRAPHICS 2013/ M. Sbert, L. Szirmay-Kalos — *STAR – State of The Art Report*

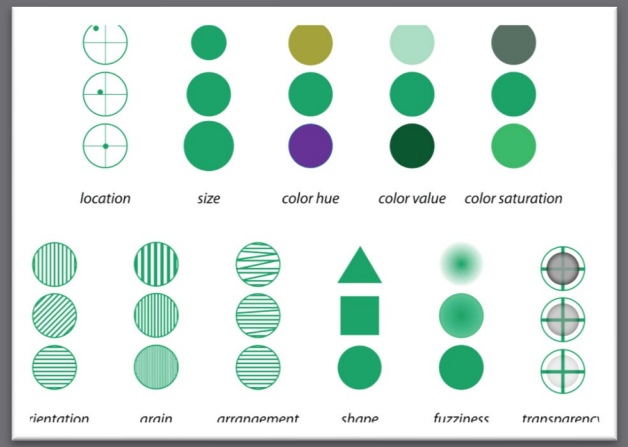
Glyph-based Visualization: Foundations, Design Guidelines, Techniques and Applications

R. Borgo[1], J. Kehrer[2], D. H. S. Chung[1], E. Maguire[3], R. S. Laramee[1], H. Hauser[4], M. Ward[5] and M. Chen[3]

[1] Swansea University, UK; [2] University of Bergen and Vienna University of Technology, Austria; [3] University of Oxford, UK; [4] University of Bergen, Norway; [5] Worcester Polytechnic Institute, USA

Abstract

This state of the art report focuses on glyph-based visualization, a common form of visual design where a data set is depicted by a collection of visual objects referred to as glyphs. Its major strength is that patterns of multivariate data involving more than two attribute dimensions can often be more readily perceived in the context of a spatial relationship, whereas many techniques for spatial data such as direct volume rendering find difficult to depict with multivariate or multi-field data, and many techniques for non-spatial data such as parallel coordinates are less able to convey spatial relationships encoded in the data. This report fills several major gaps in the literature, drawing the link between the fundamental concepts in semiotics and the broad spectrum of glyph-based visualization, reviewing existing design guidelines and implementation techniques, and surveying the use of glyph-based visualization in many applications.



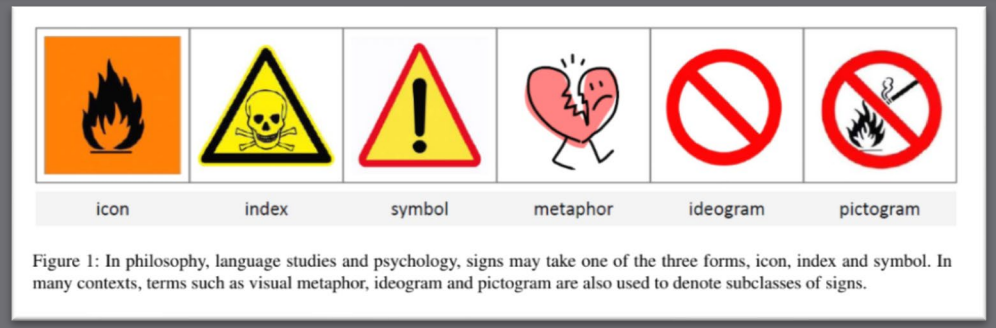


Figure 1: In philosophy, language studies and psychology, signs may take one of the three forms, icon, index and symbol. In many contexts, terms such as visual metaphor, ideogram and pictogram are also used to denote subclasses of signs.

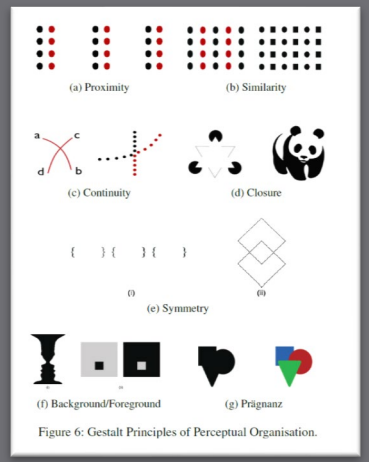


Figure 6: Gestalt Principles of Perceptual Organisation.

Visual 'Channels'

Geometric Channels	Optical Channels	Topological and Relational Channels	Semantic Channels
• size / length / width / depth / area / volume • orientation / slope • angle • shape • curvature • smoothness	• intensity / brightness • colour / hue / saturation • opacity / transparency • texture (partly geometric) • line styles (partly geometric) • focus / blur / fading • shading and lighting effects • shadow • depth (implicit / explicit cues) • implicit motion / motion blur • explicit motion / animation / flicker	• spatial location • connection • node / internal node / terminator • intersection / overlap • depth ordering / partial occlusion • closure / containment • distance / density	• number • text • symbol / ideogram • sign / icon / logo / glyph / pictogram • isotype

Table 1: Visual Channels [CF12].

Glyph Design Criteria

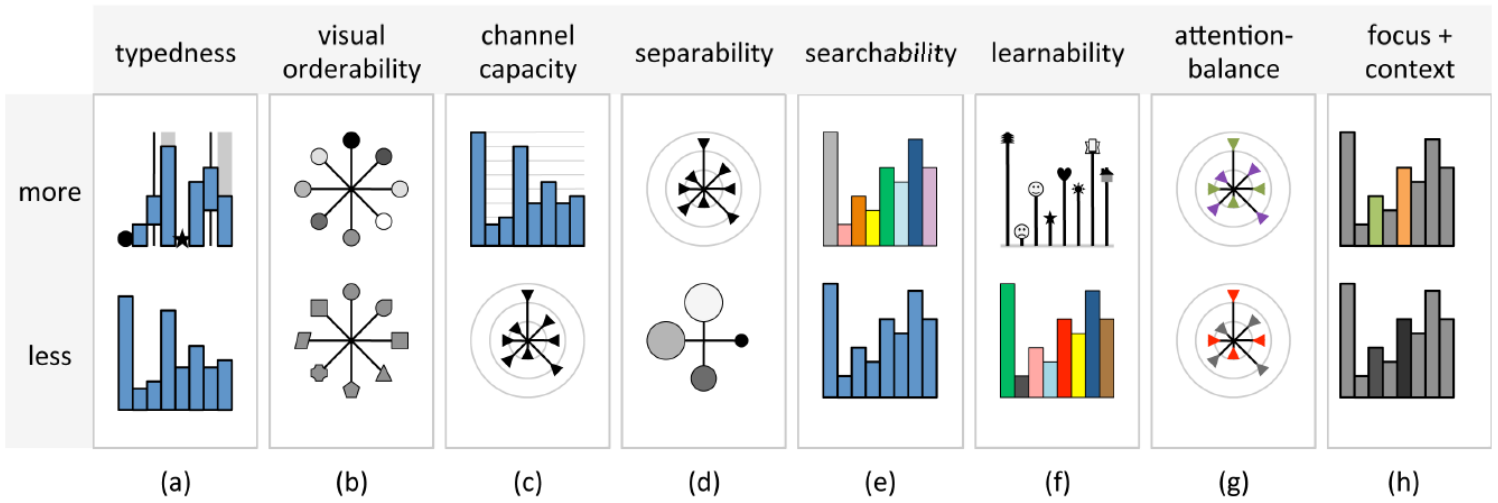
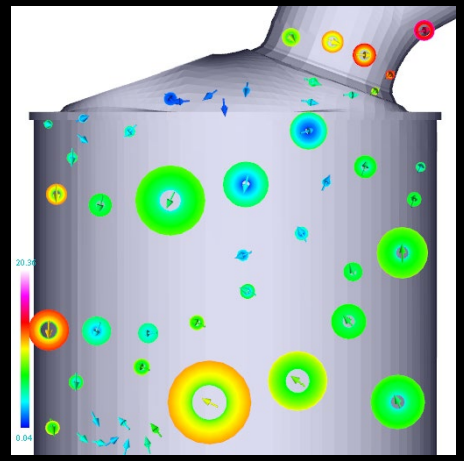
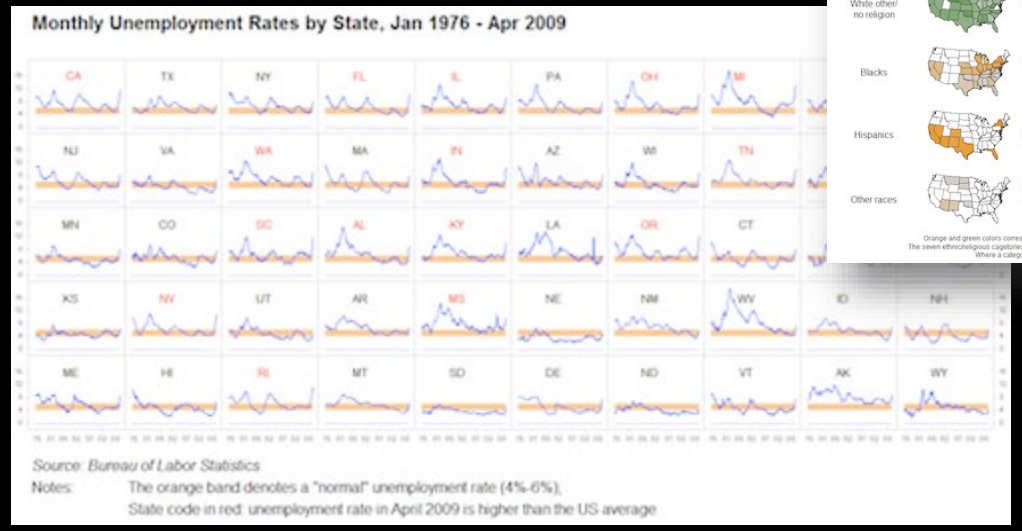


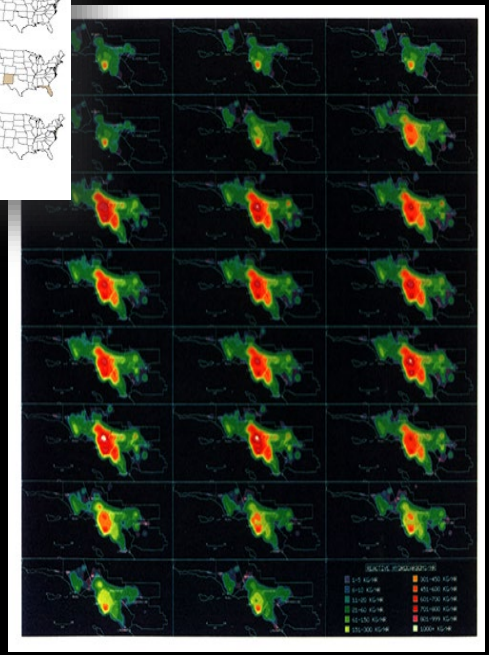
Figure 7: Glyph design criteria [CLP*13].



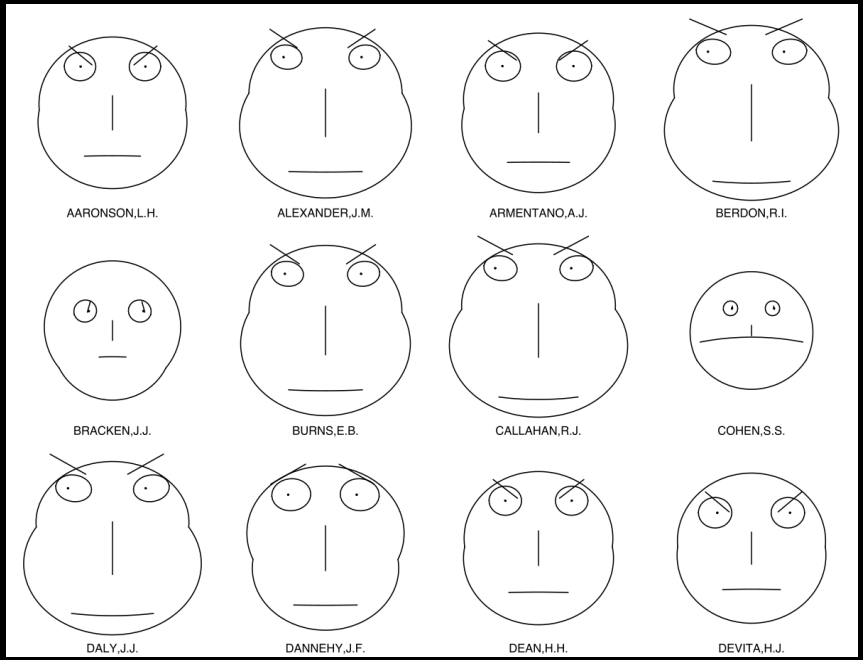
Principle of Small Multiples

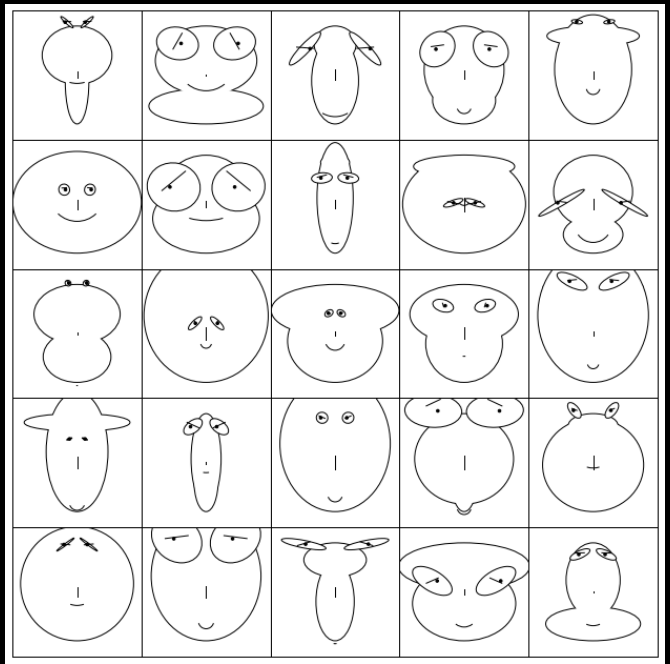
Edward Tufte, Viz Pioneer





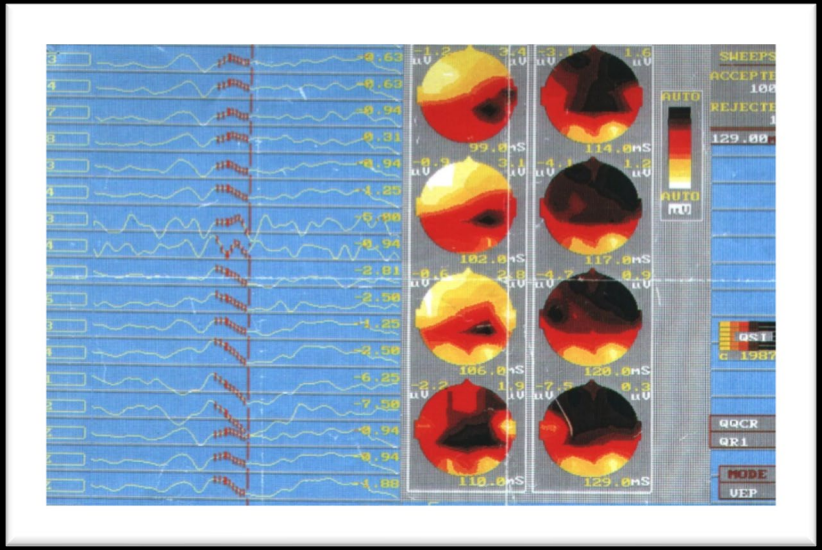
Chernoff Faces

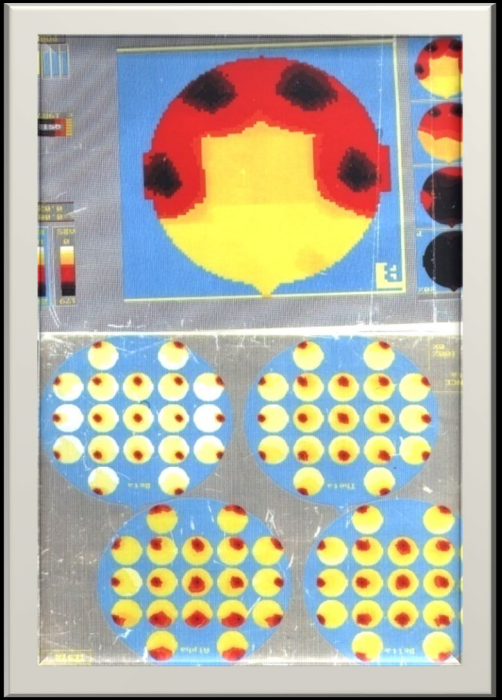




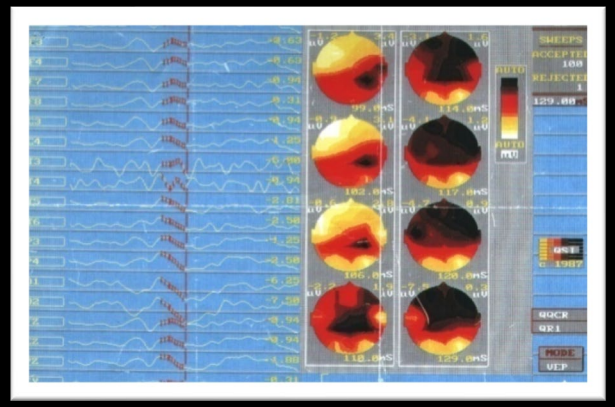
Spatiotemporal Isosurfaces

Visualization of a 2-dimensional dataset changing with time

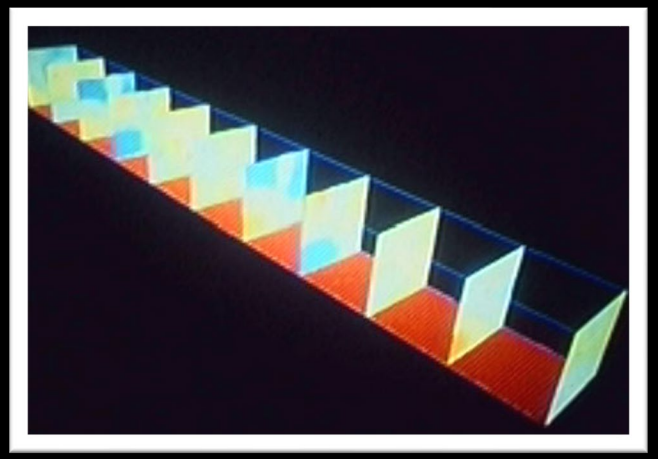


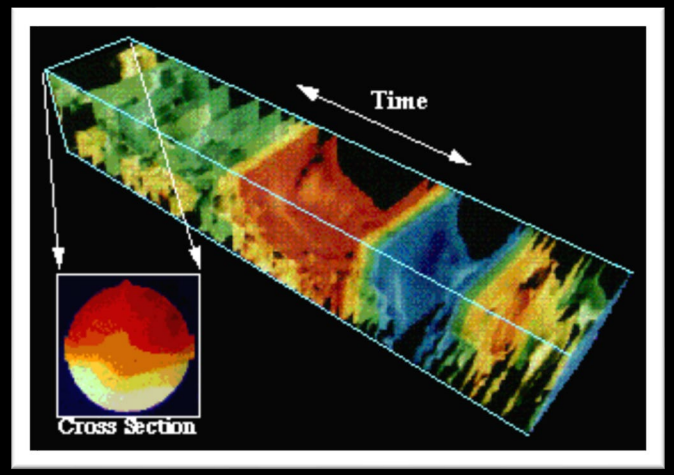


EEG Spatiotemporal Isosurfaces



Create a stack of 2D Dataset 'Slices' to form a 'Loaf of Break'
Use a visualization tool to create EEG 'Isopotential' Contour Surfaces



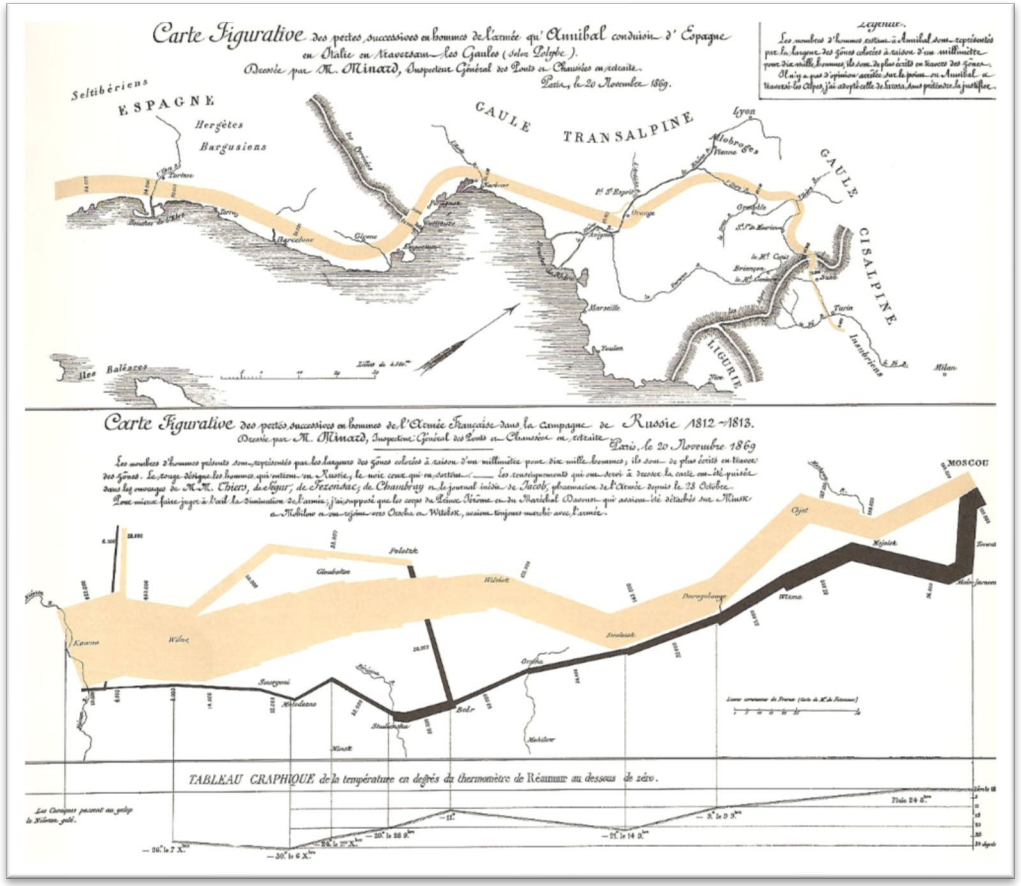


Narratives in Space and Time

- **Hannibal's campaign in Spain, Gaul, and northern Italy**

- **Napoleon's March on Moscow, 1812-13**

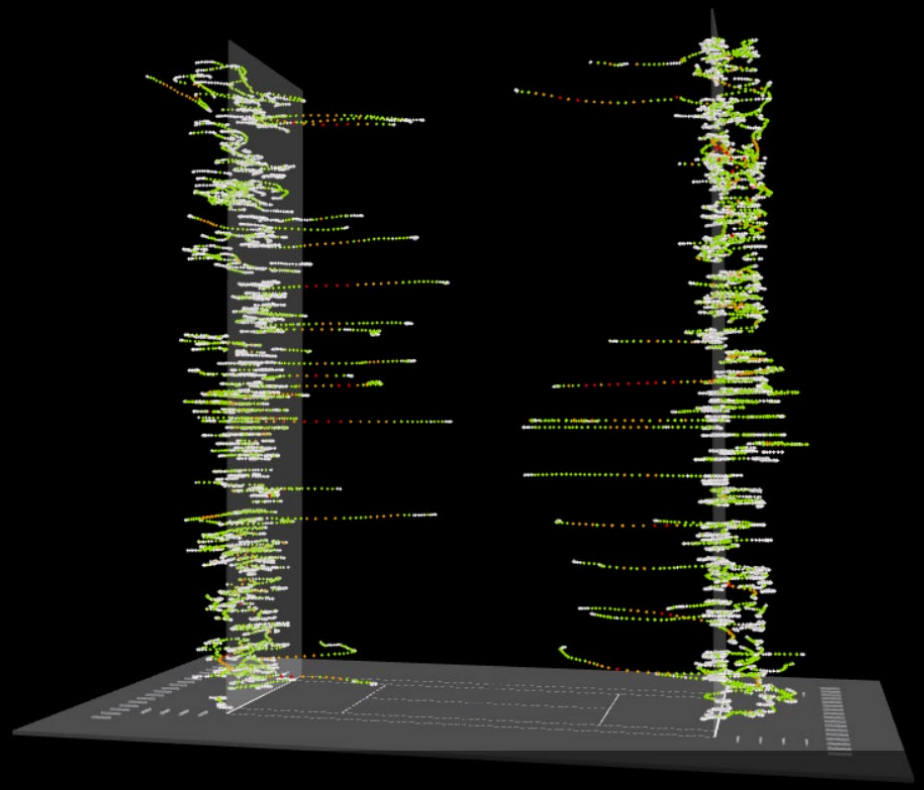
Charles Joseph Minard, Tableaux Graphiques et Cartes Figuratives de M. Minard, 1845-69.

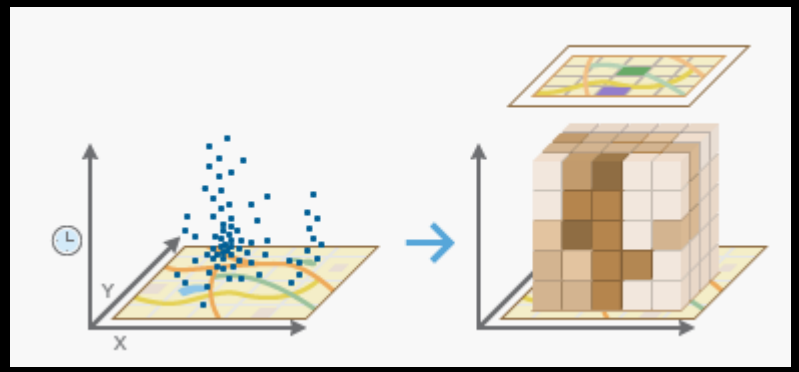


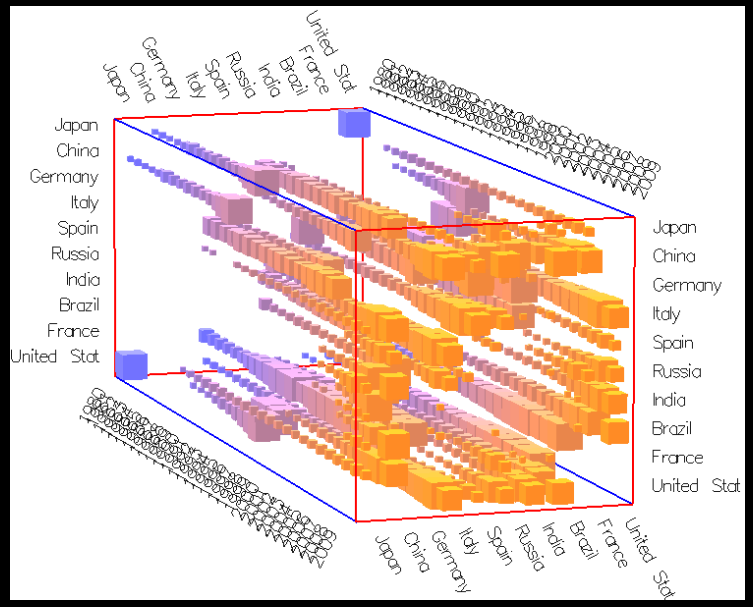
Edward Tufte, "The Visual Display of Quantitative Information", 1983, Graphics Press

Space-Time Cubes

Now an ArcGIS Official Viz Option





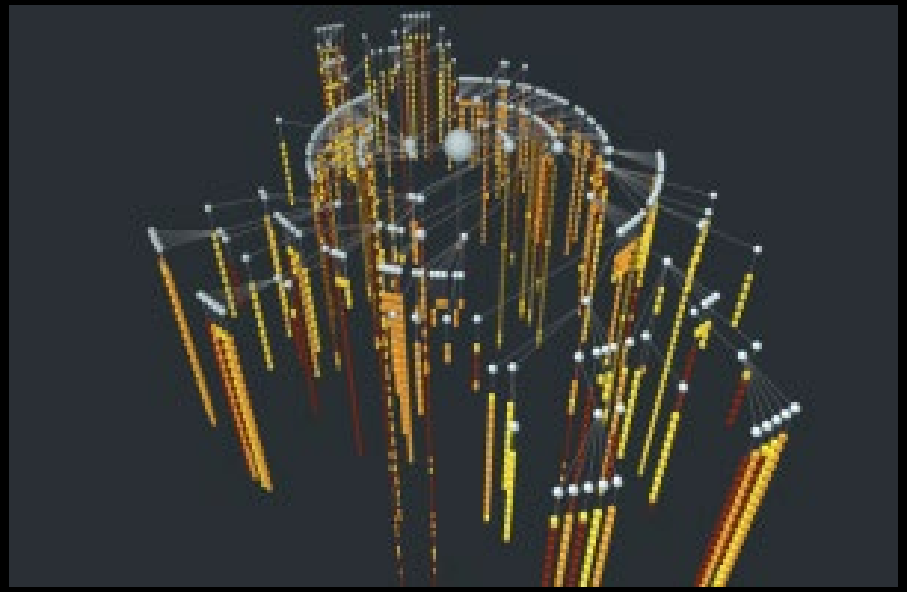


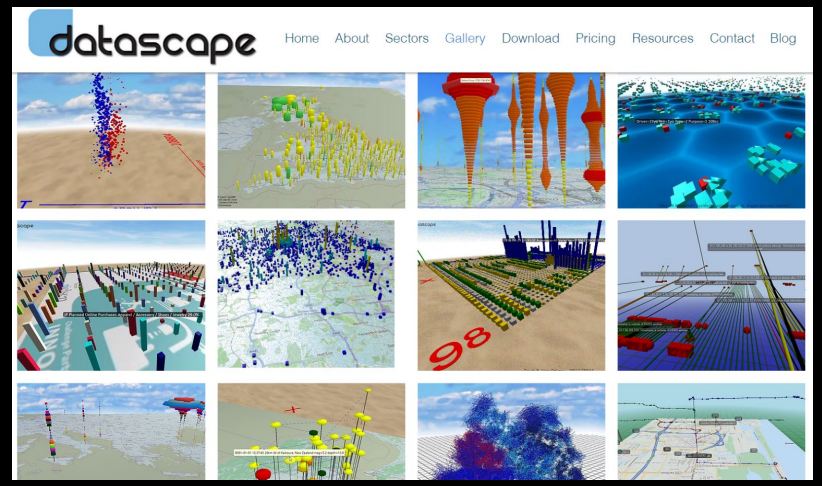
http://www.aviz.fr/~bbach/spacetimecubes/index.php

Apps Which Support Spatiotemporal Viz

Geotime

Datascape





Visualize the Forest AND the Trees

Learn the Conventions for Interpretation

The "Forest":

Spatial topological distribution of data (not necessarily Cartesian)

The "Tree":

Complex Self-contained Structure of Data or Information

Rules are made to be broken

The "Hyperglyph":

Blurring the boundaries between forest and tree

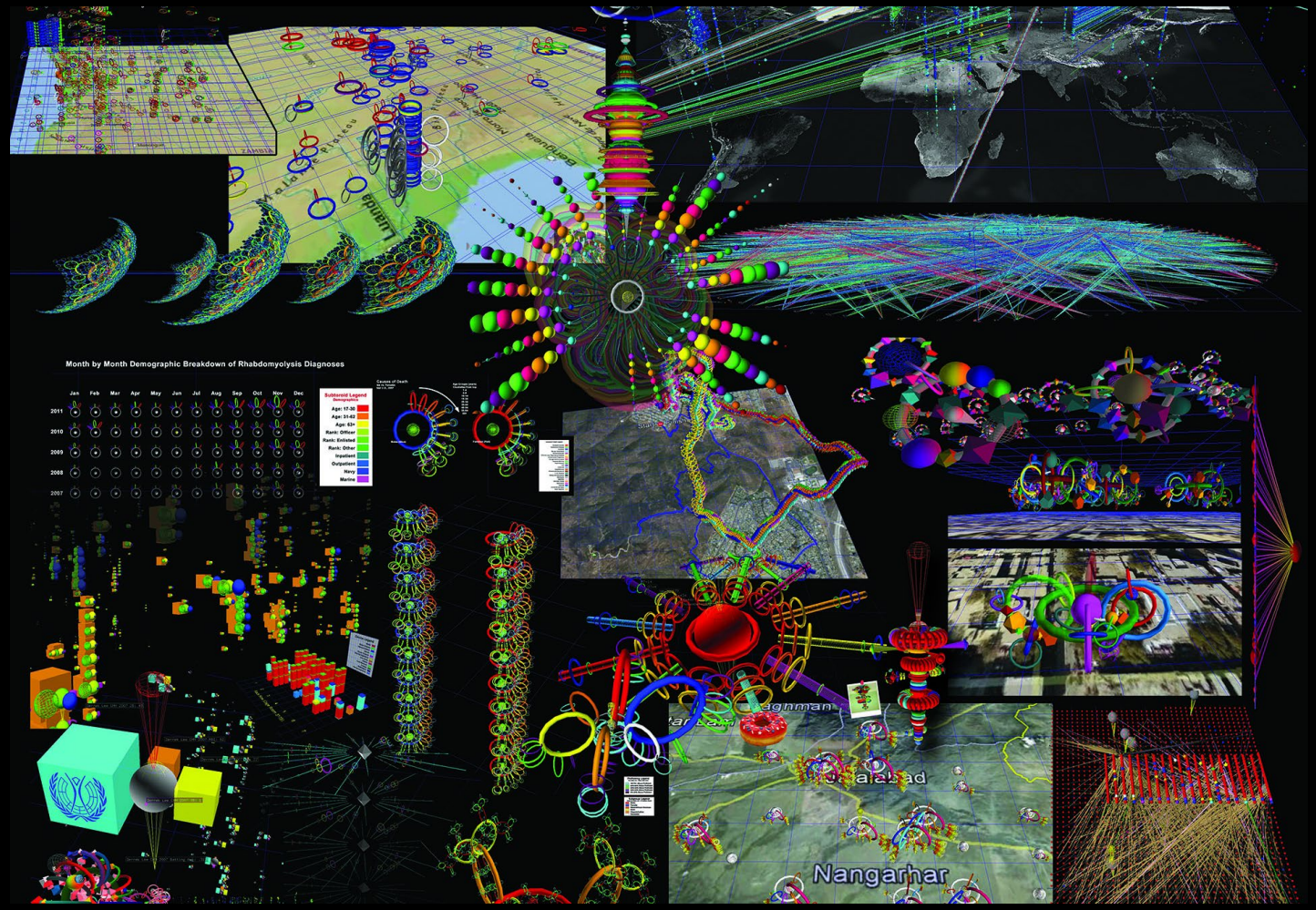
The Tree Becomes the Forest!

HyperGlyph: The Tree Becomes the Forest

"Toroids on Steroids"
"Spreadsheets Meet Cyberspace"

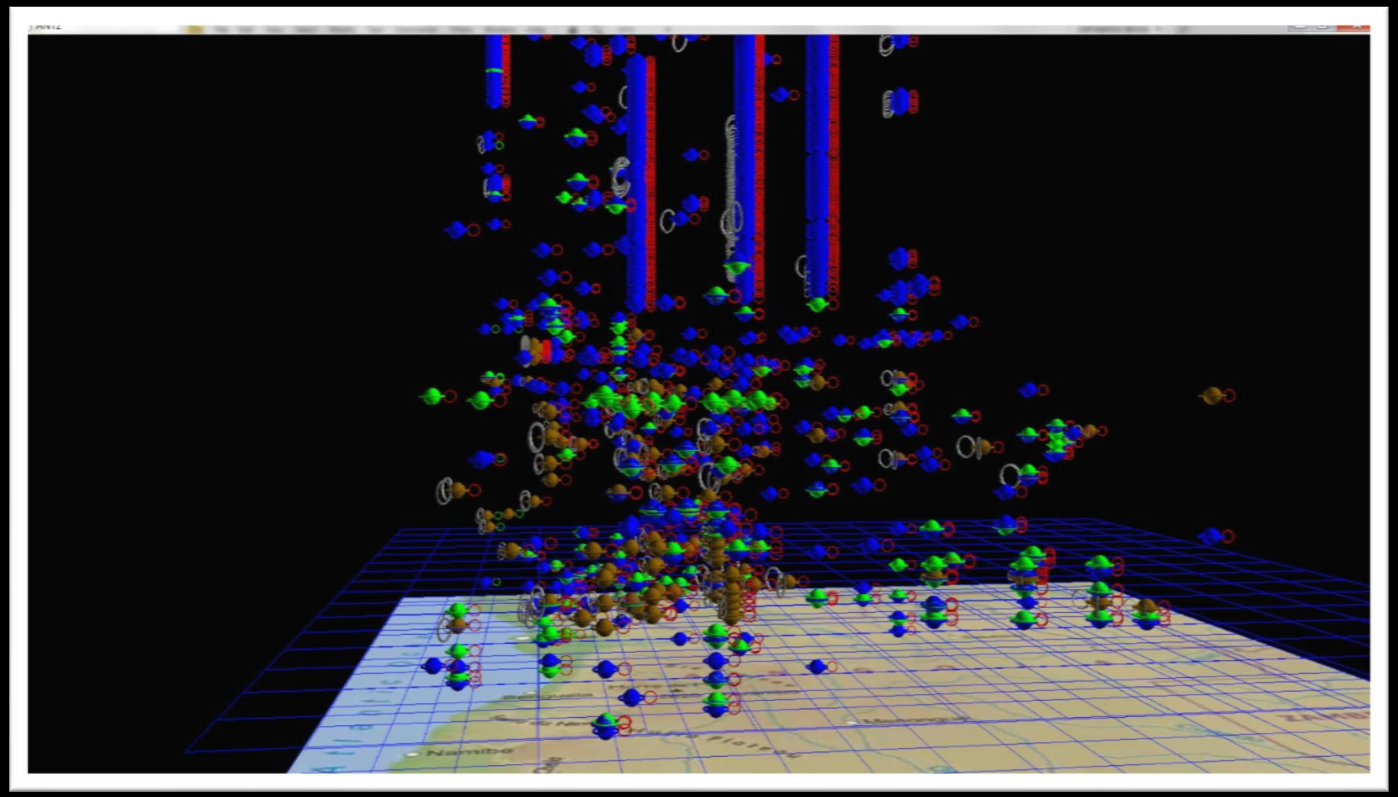
Features:

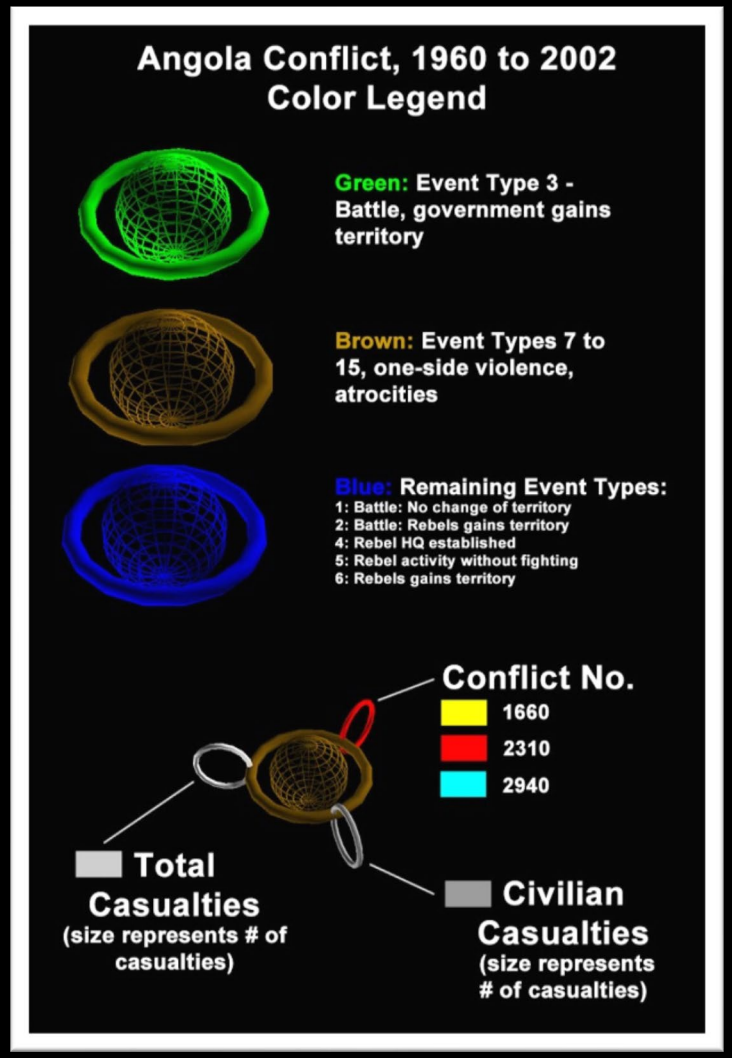
- Interactive
- Multi-modal
- Multi-dimensional
- Dynamic
- Embedded Information



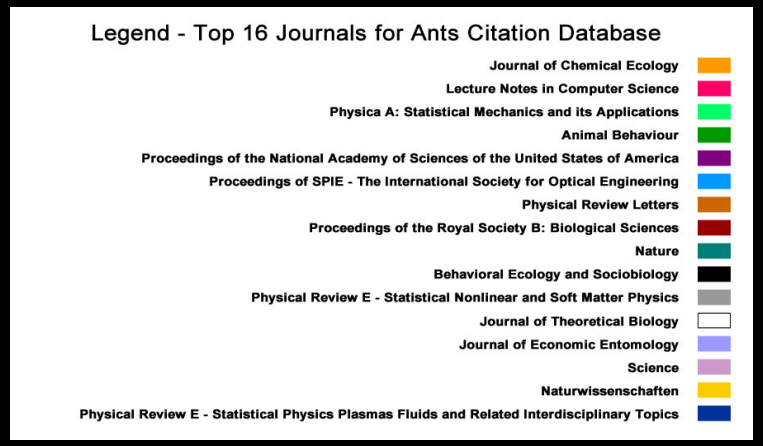
Angola Civil War, 1960 to 2002

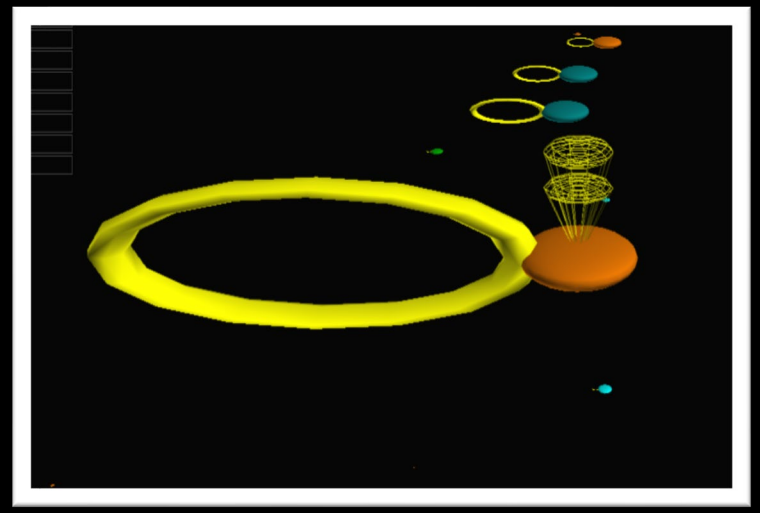
Data provided by Jenn Zeimke of
Crisis Mappers
Ph.D. Thesis

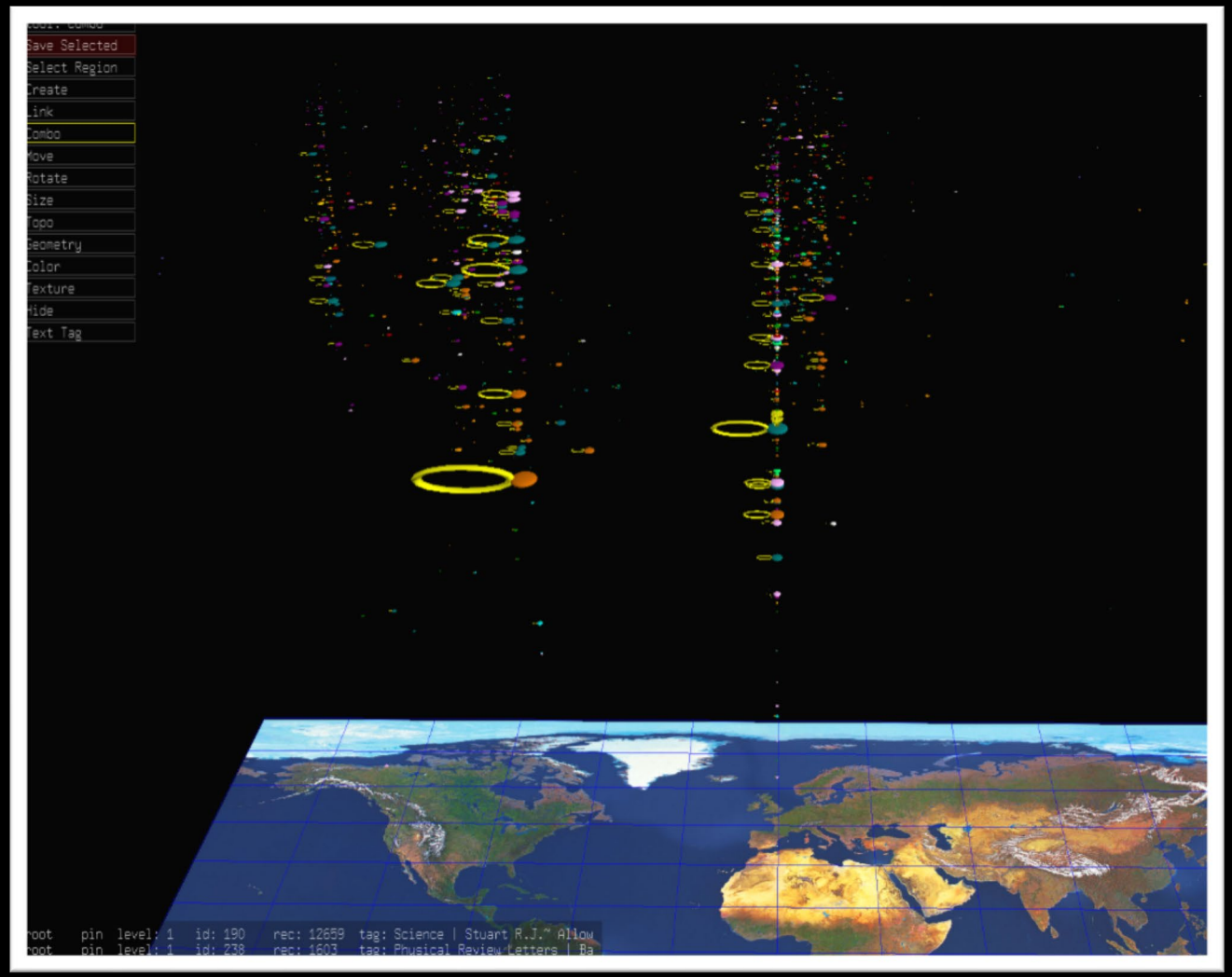




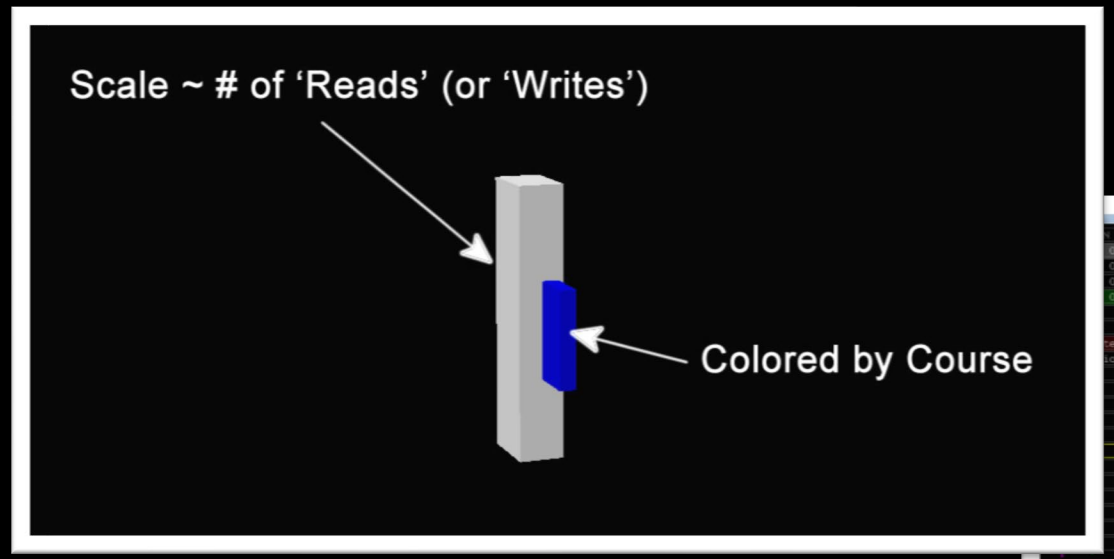
SCOPUS Search Results –
Ant Behavior, Sociobiology, Self-organized Criticality

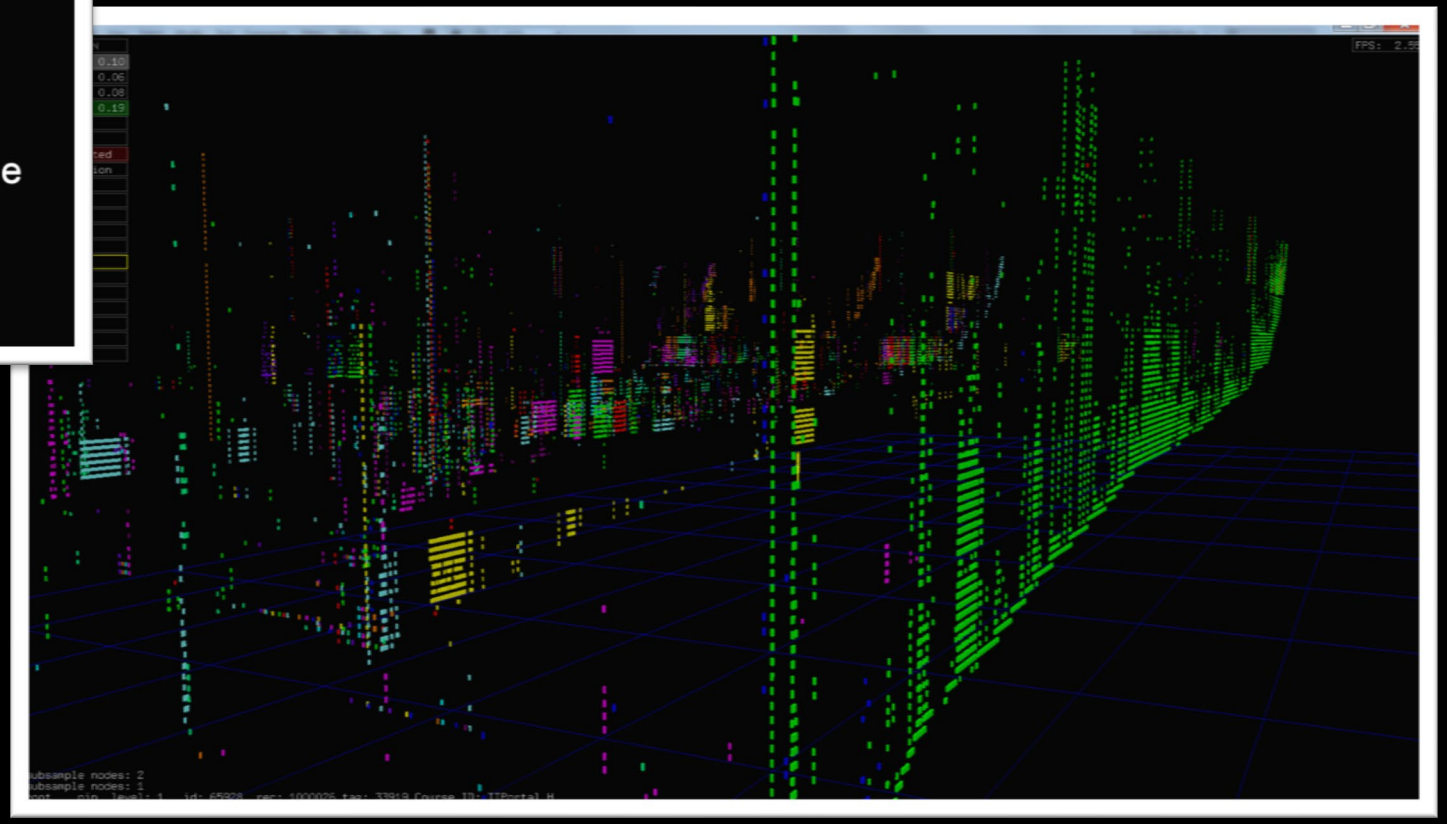




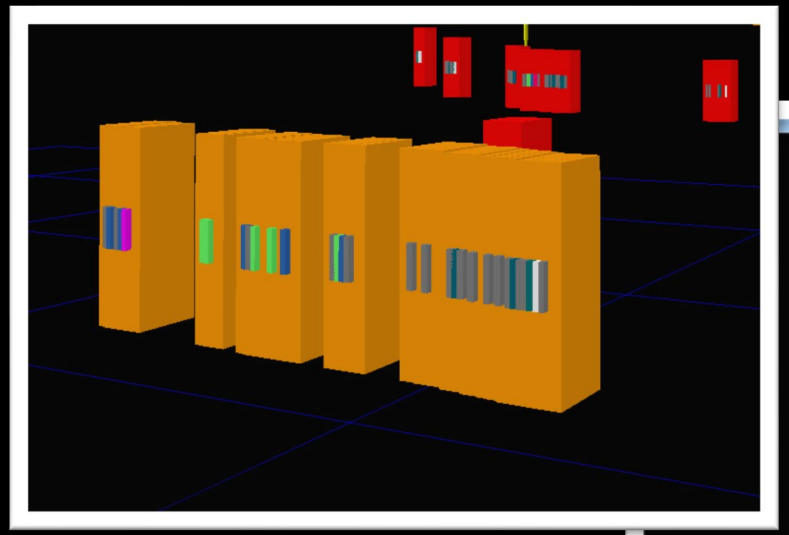


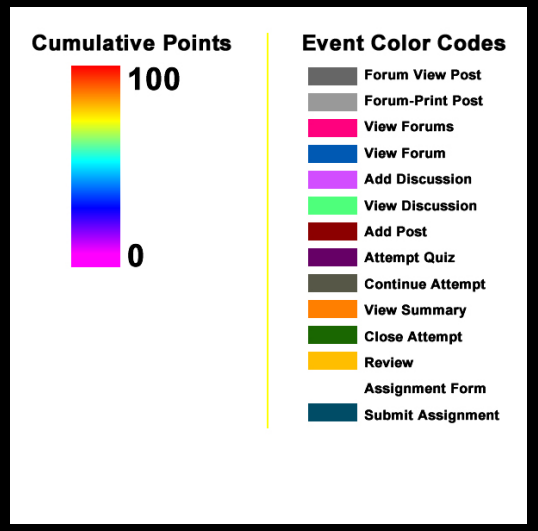
SDSC TeacherTECH Moodle Database: 100's of Courses, 1000's of Students

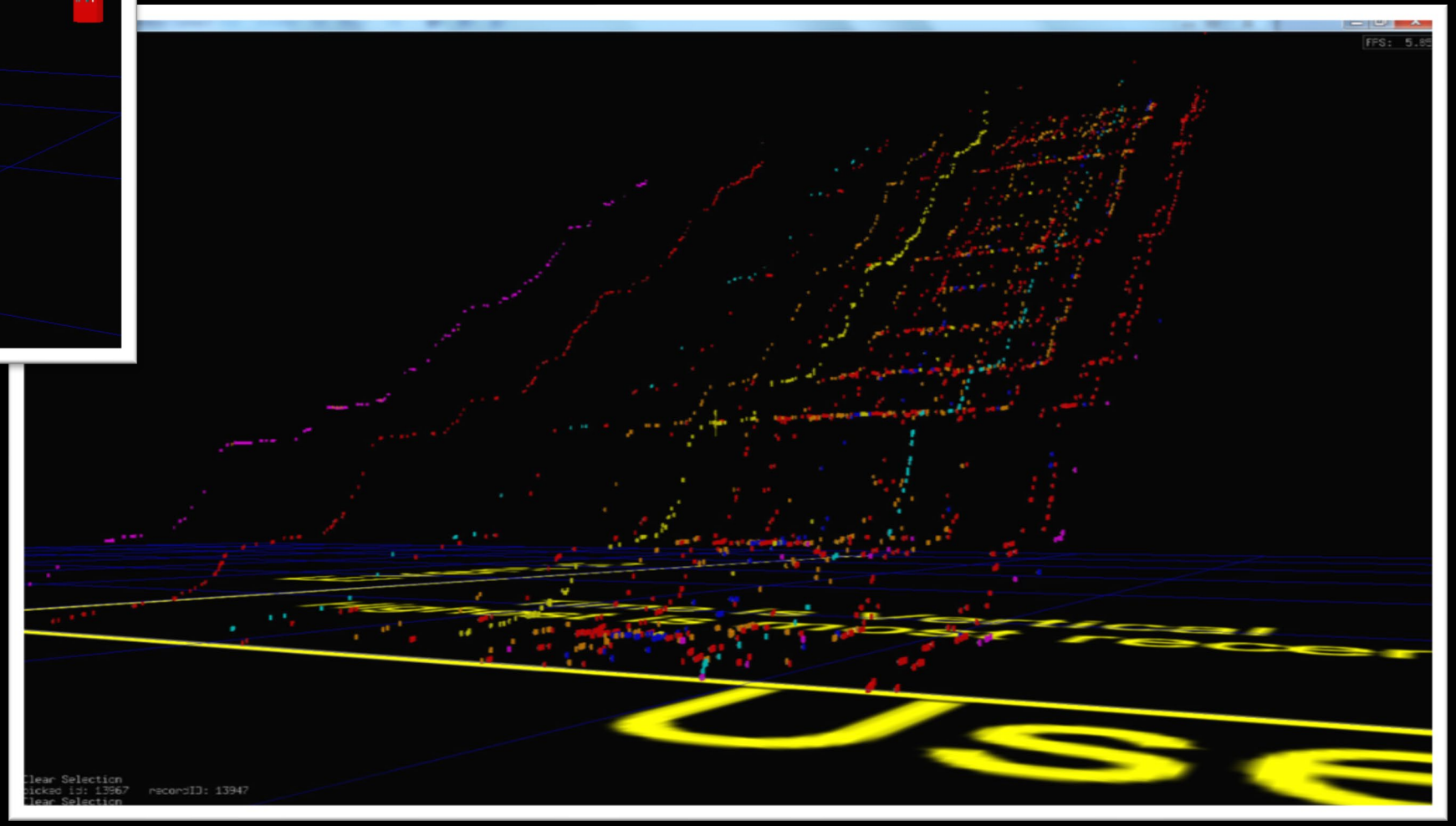




Moodle Course Visualization







Lahman Baseball Database

The Forest

X - Player, alphabetical, left to right

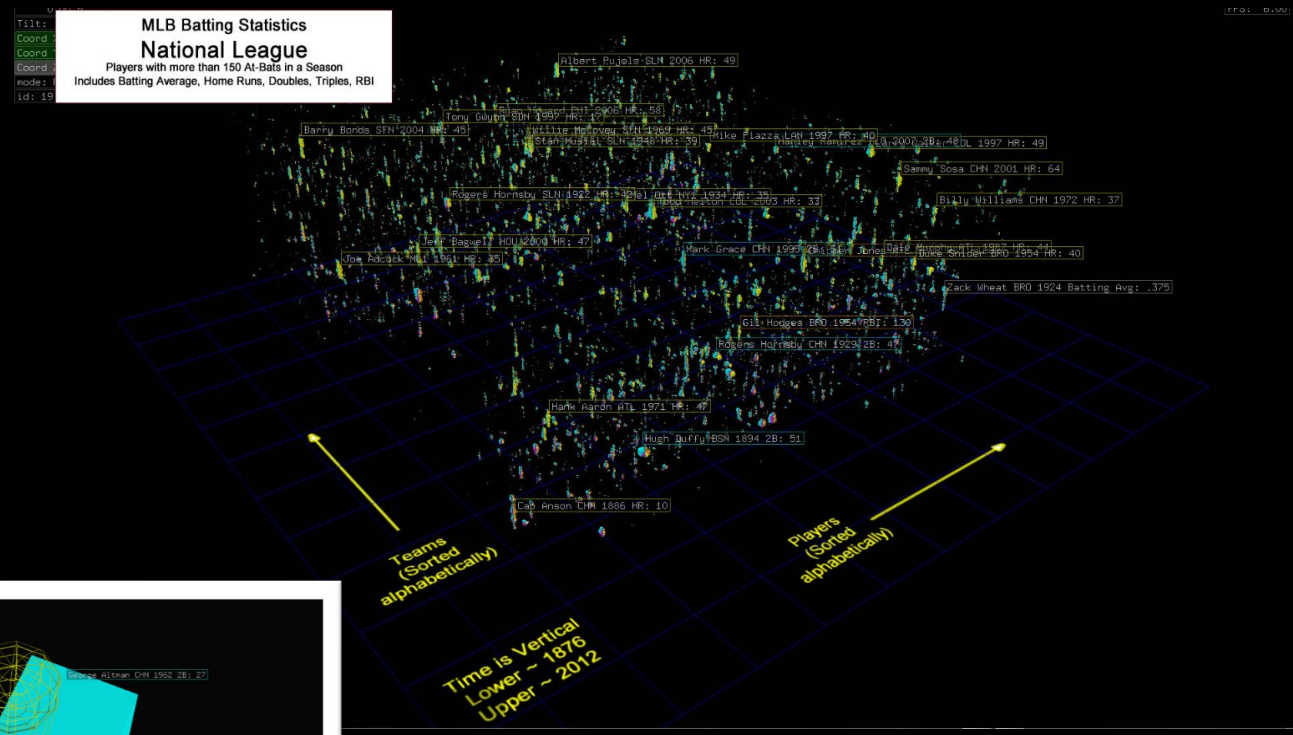
Y - Team, alphabetical, front to back

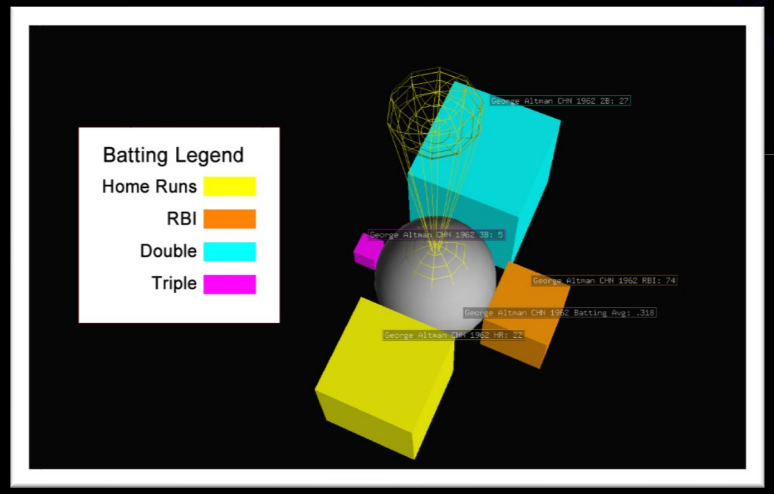
Z - Time (1886 to 2015)

The Tree

Five individual batting statistics

HR, RBI, Doubles, Triples, Batting Avg.





Global Terrorism Database

The Forest

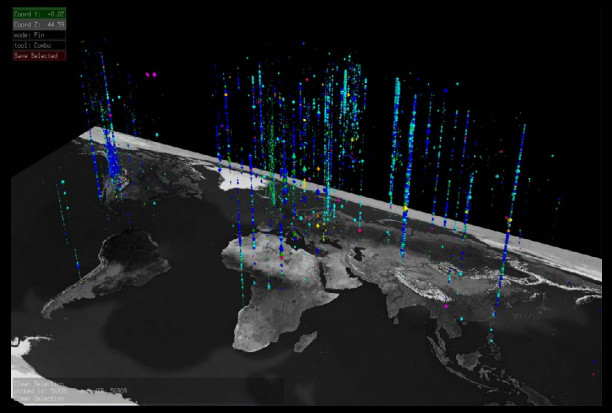
Cartesian Lat, Lon, Elev

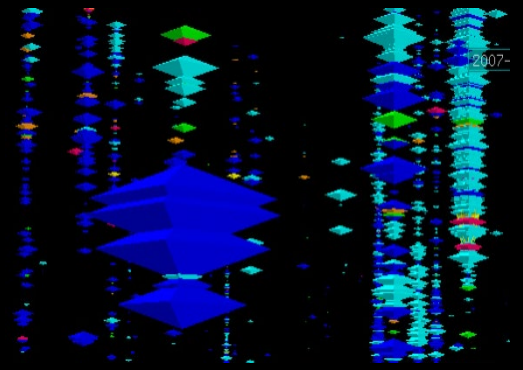
Circular Distribution of Terror Group Glyphs around

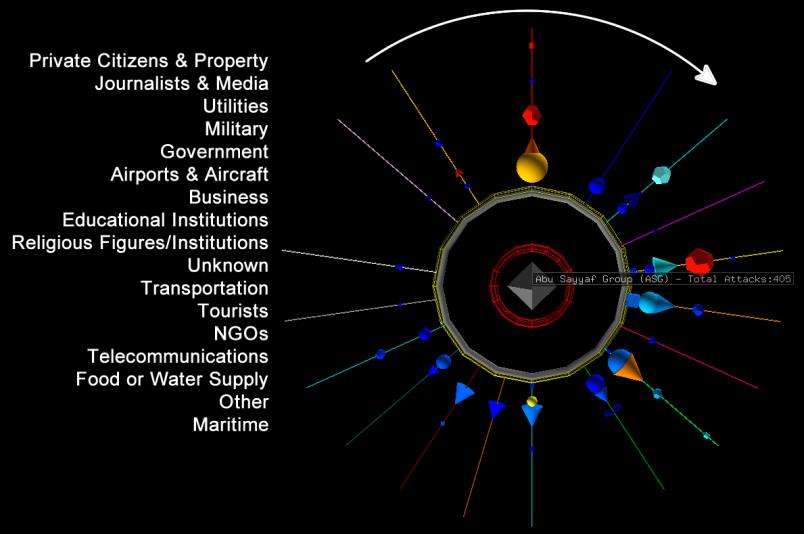
The Tree(s)

Simple Glyph (Size => # Killed, Color => Type of Terrorist Attack)

Complex Glyph (see diagram)







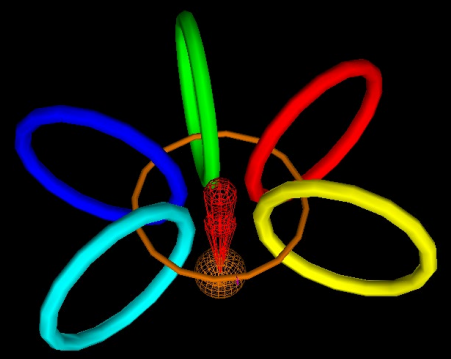
Syrian Civil War, 2013

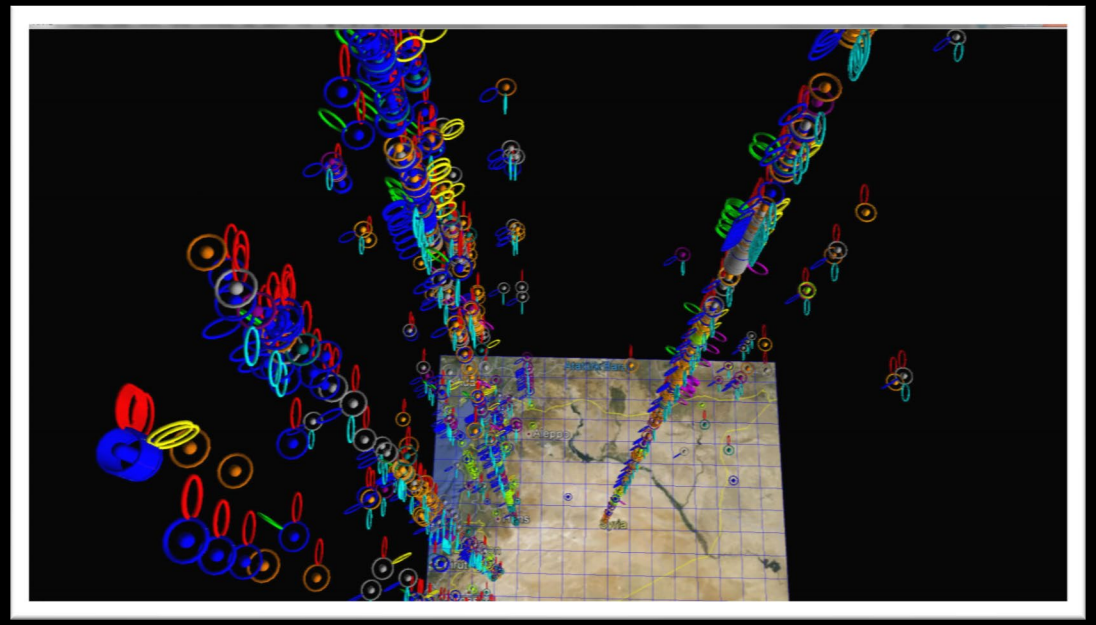
Legend

- Aggregate
- Eyewitness
- Announcement
- Article
- Killed
- Missing/Detained
- Twitter

Subtoroid Legend

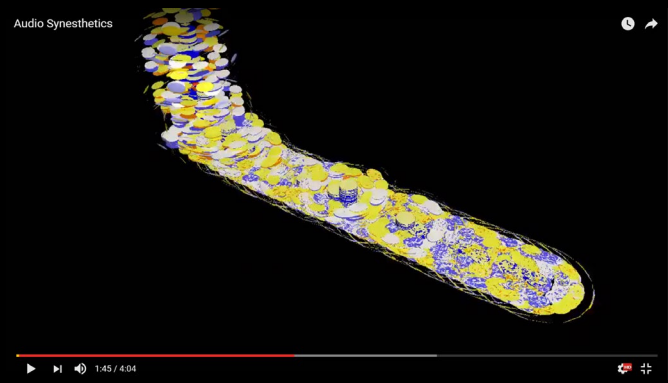
- Killed
- Tortured
- Missing
- Detained
- Refugee
- Child

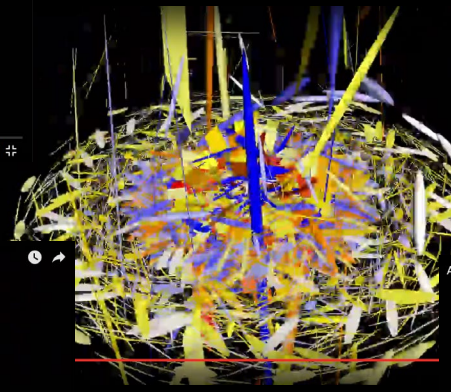


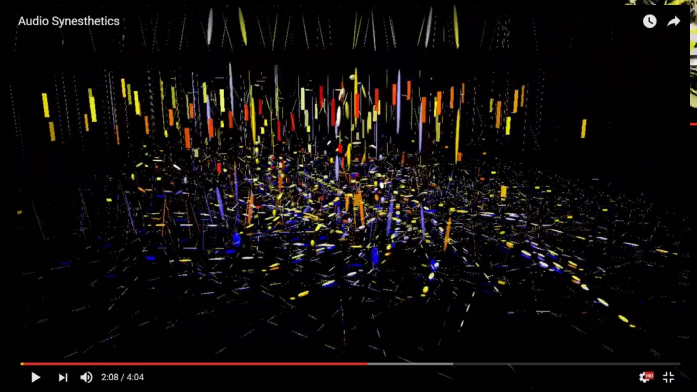


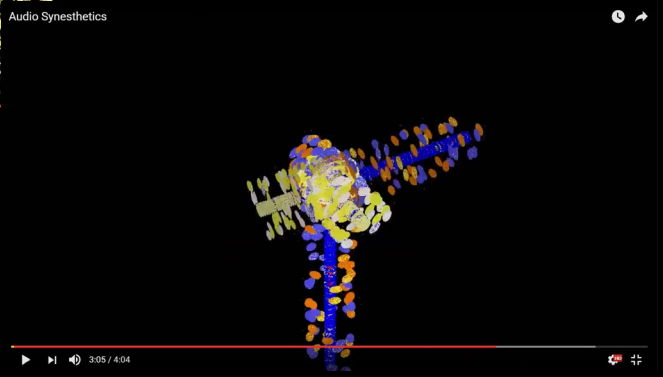
Audio Synesthetics: Music Visualization

Seeing music, a la Disney's Fantasia
https://www.youtube.com/watch?v=ee13Ksa5Iyo







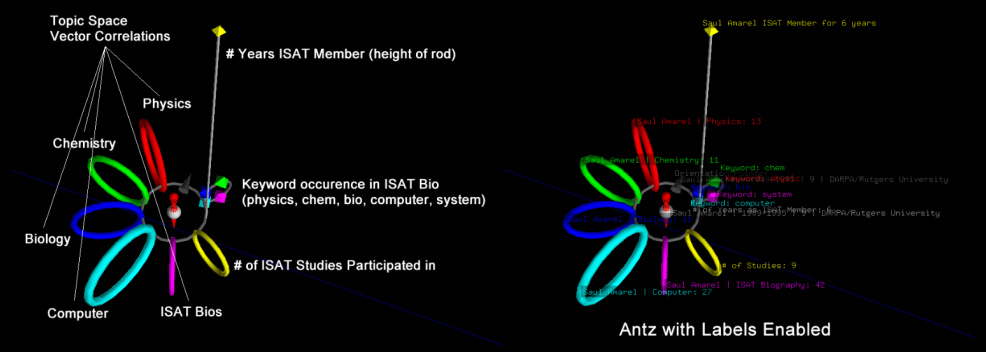


ISAT: Find the Fed

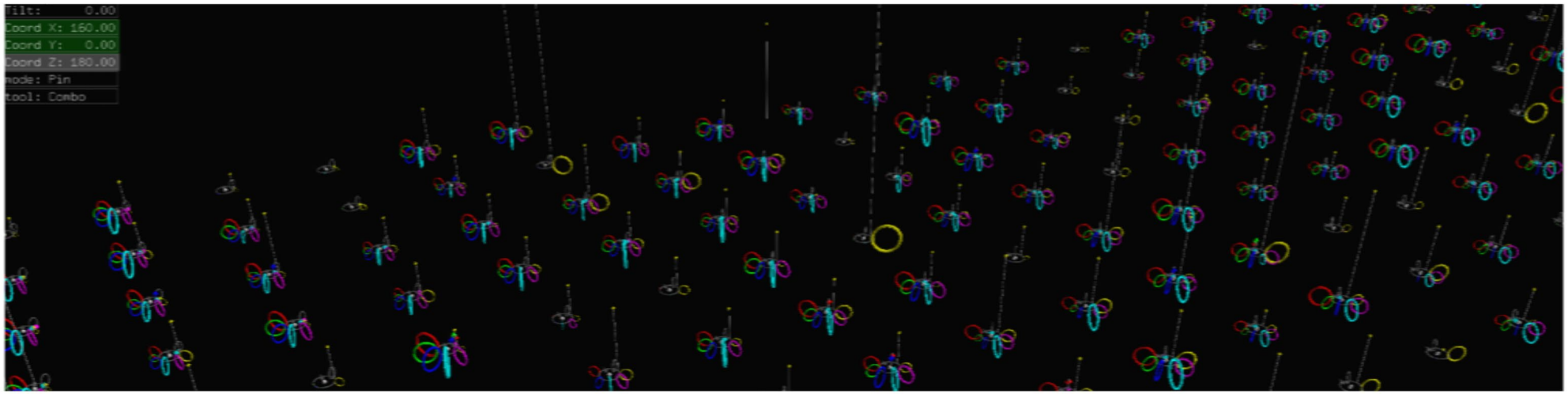
DARPA Information Science and Technology Advisory Group

- Prestigious
- Invitation-only
- Three year term

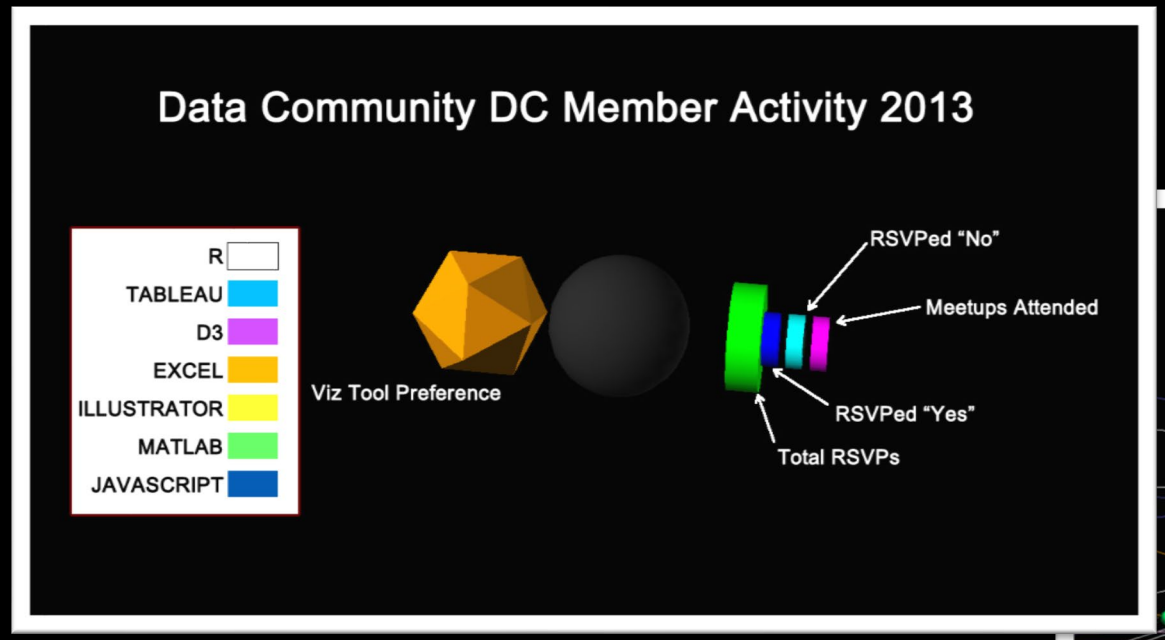
Antz ISAT Member Desciption

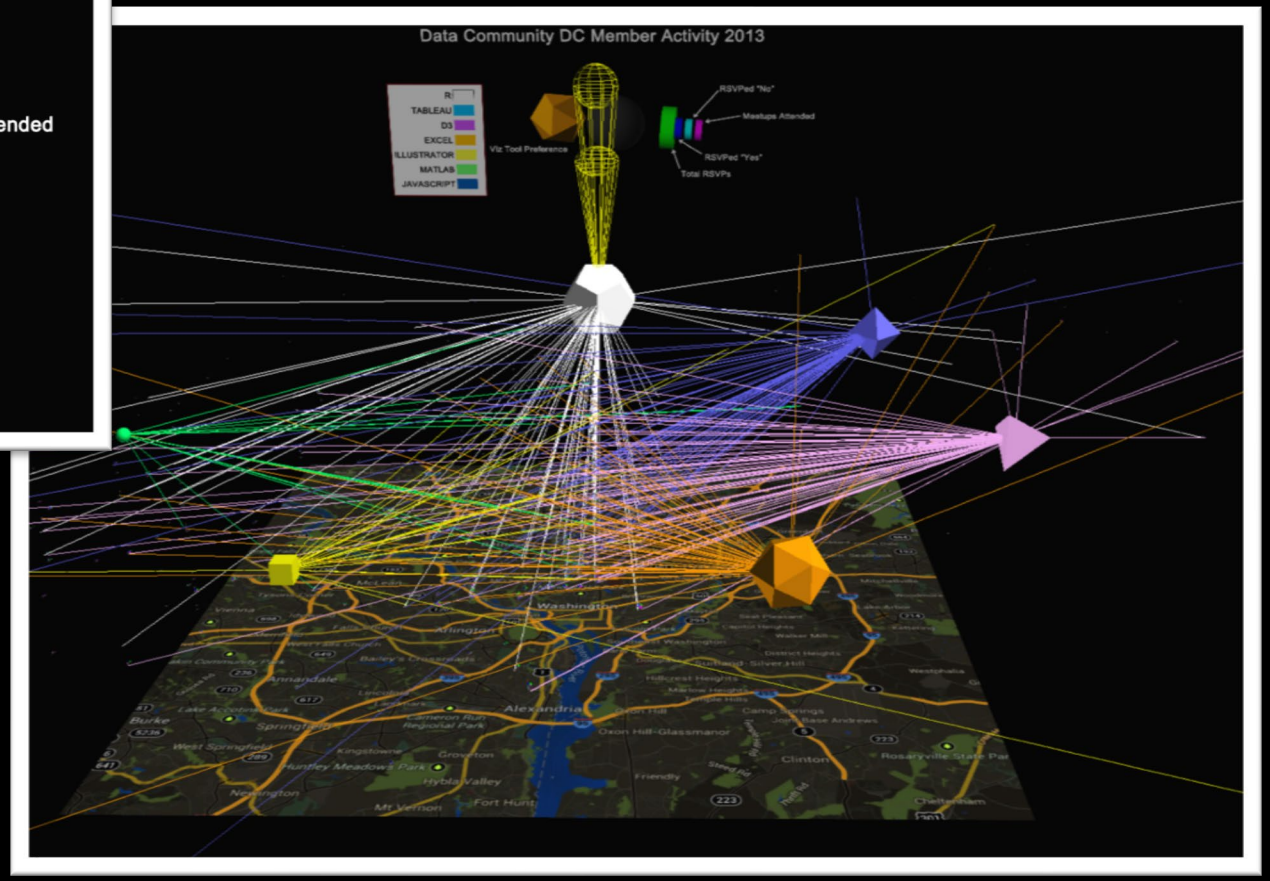


Antz with Labels Enabled

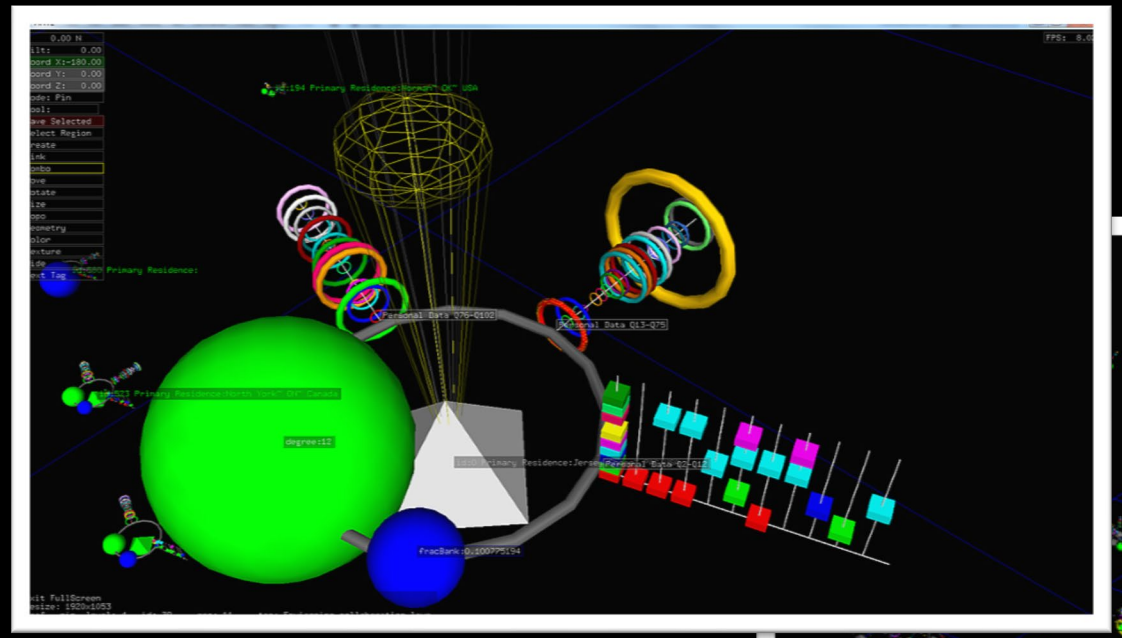


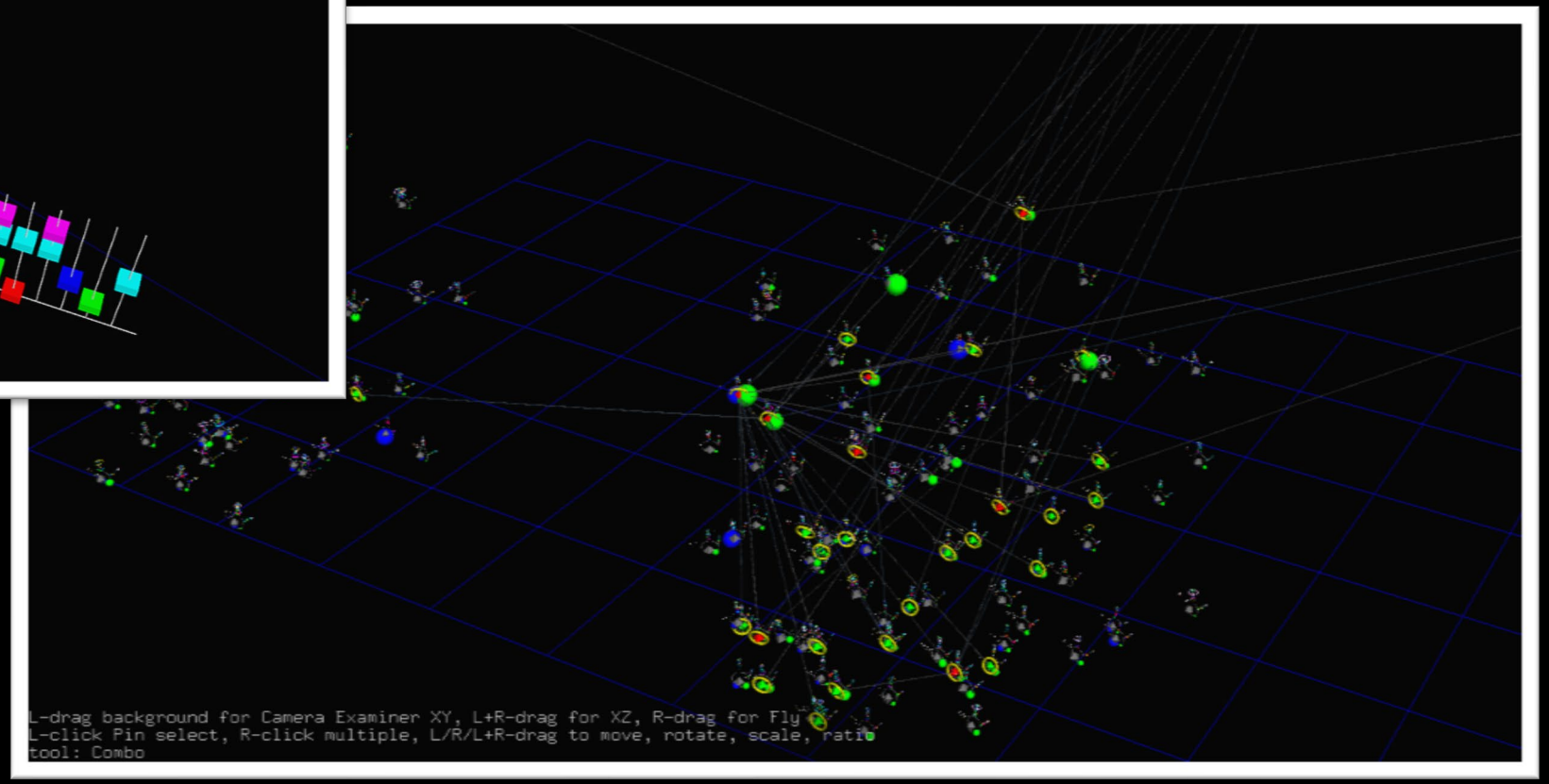
DC Data Visualization Meetup Membership



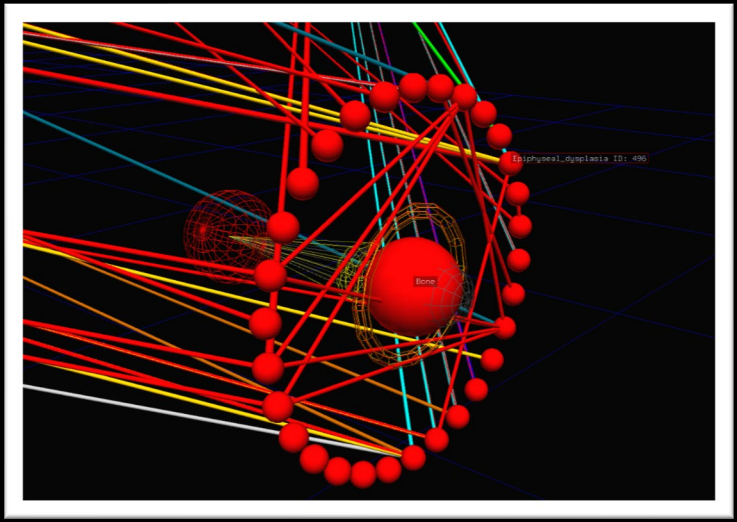


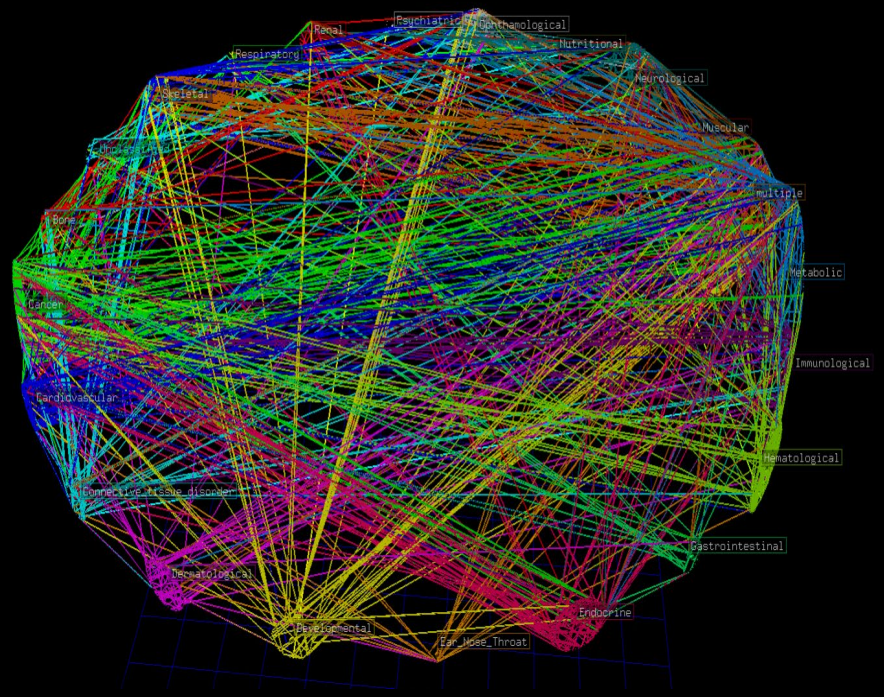
Hacking Creativity





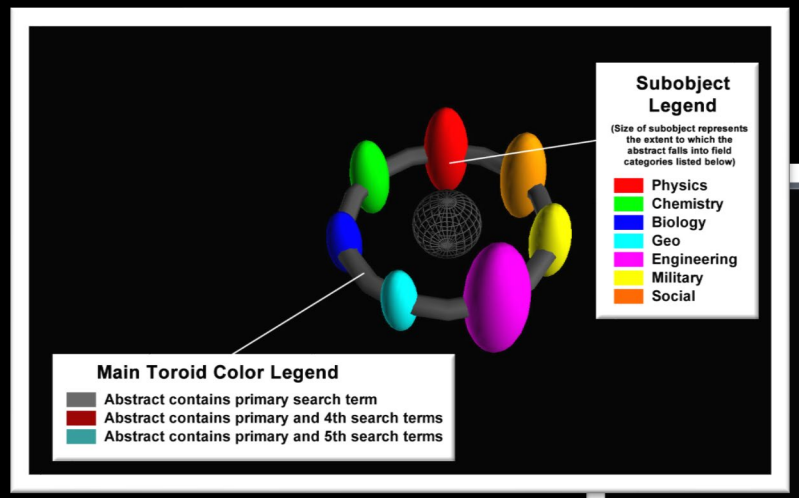
The Human Diseasome

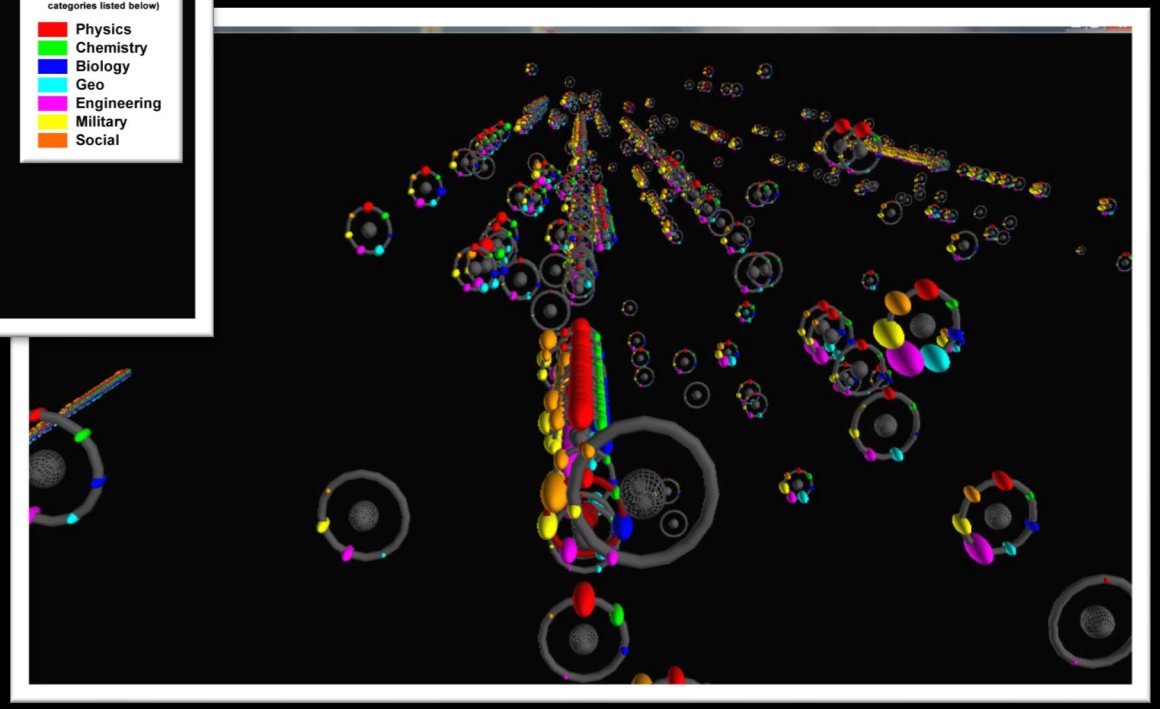




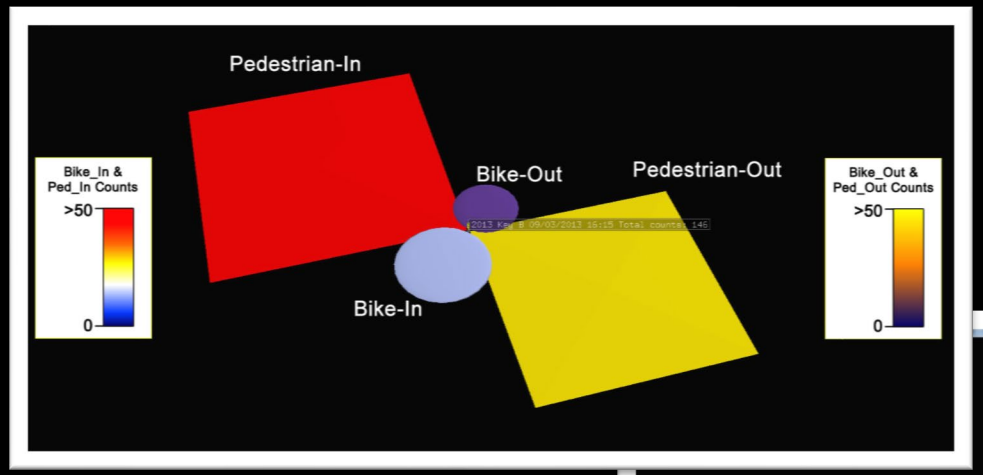
Defense Technology Information Center

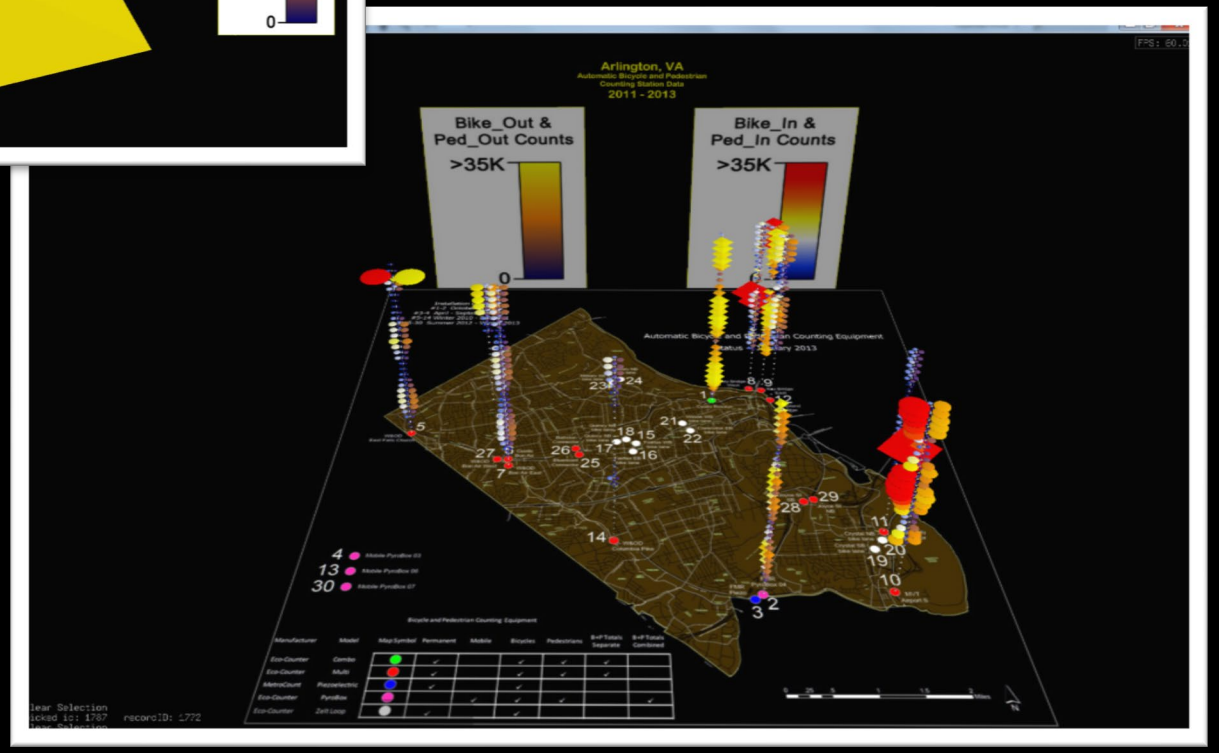
"Topic Space"



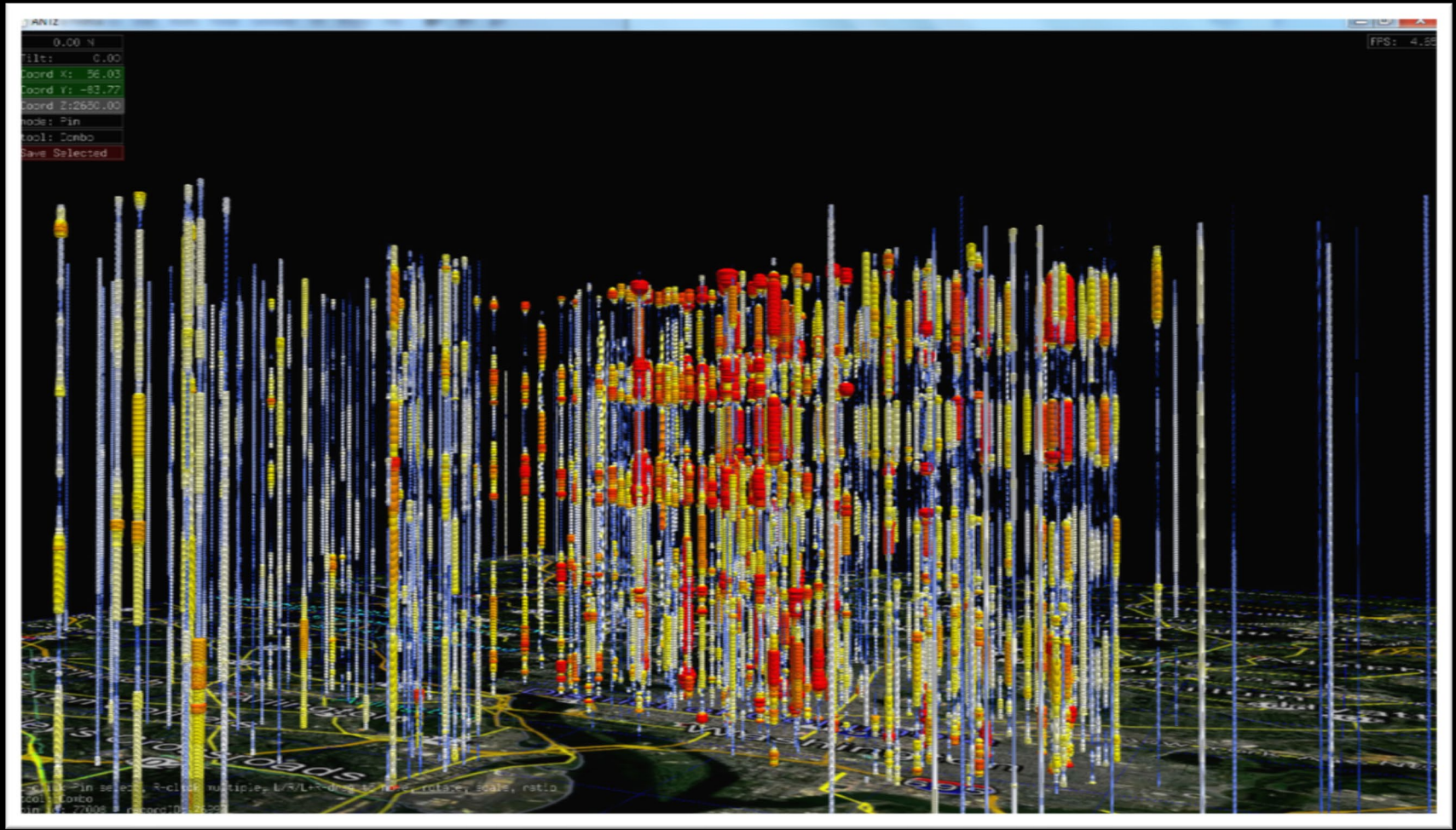


Arlington Trails Pedestrian and Bicycle Traffic



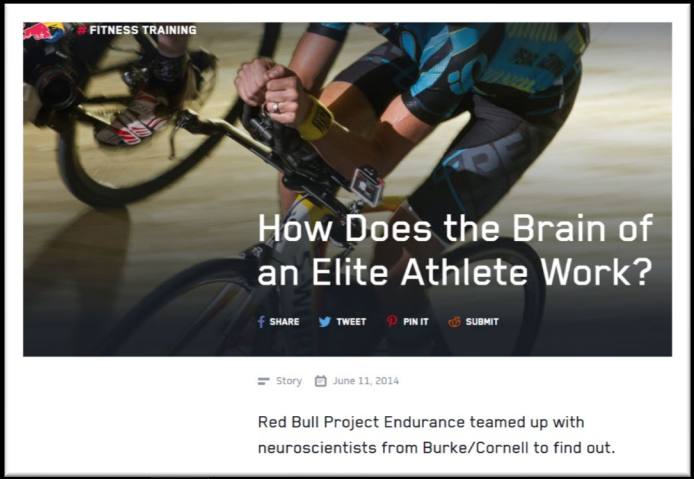


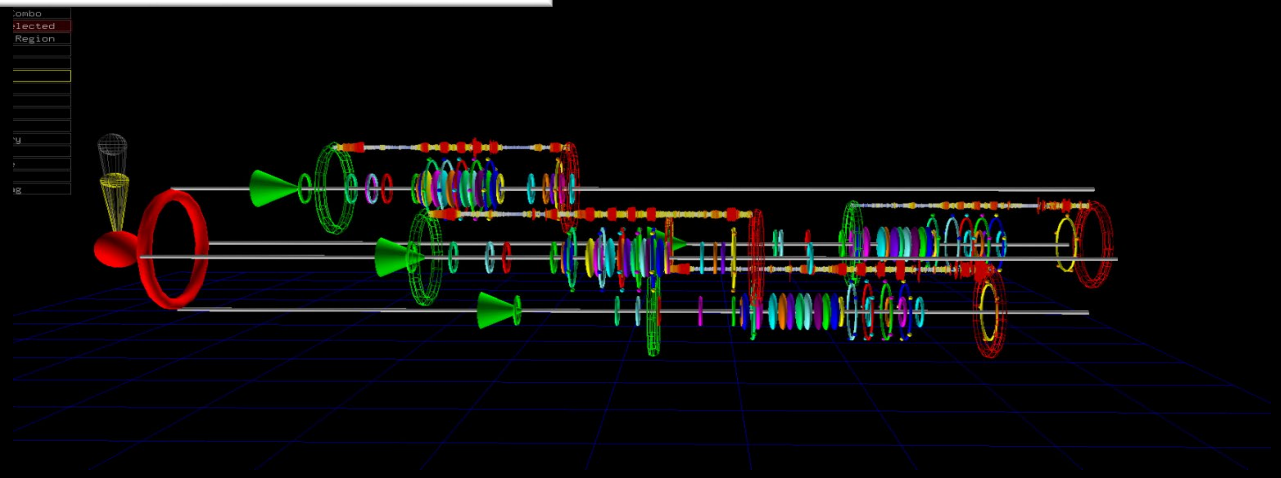
Capital Bikeshare Bicycle Traffic



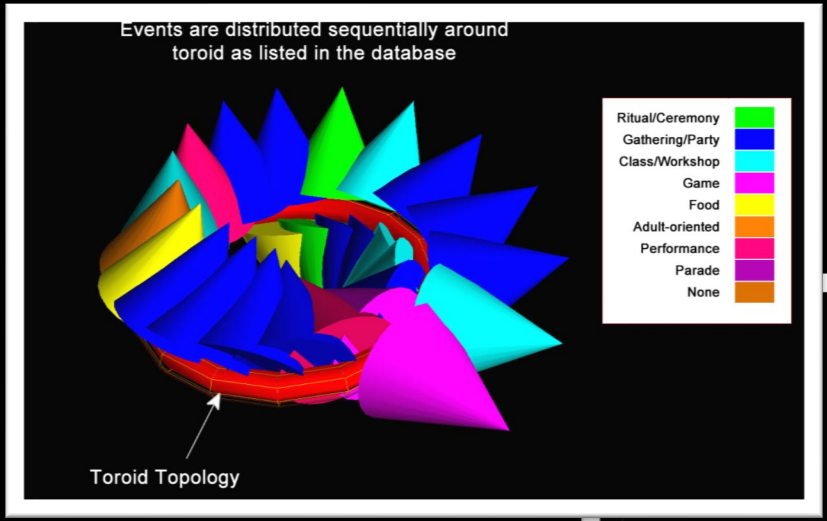
Glyph As Event: Red Bull Project Endurance

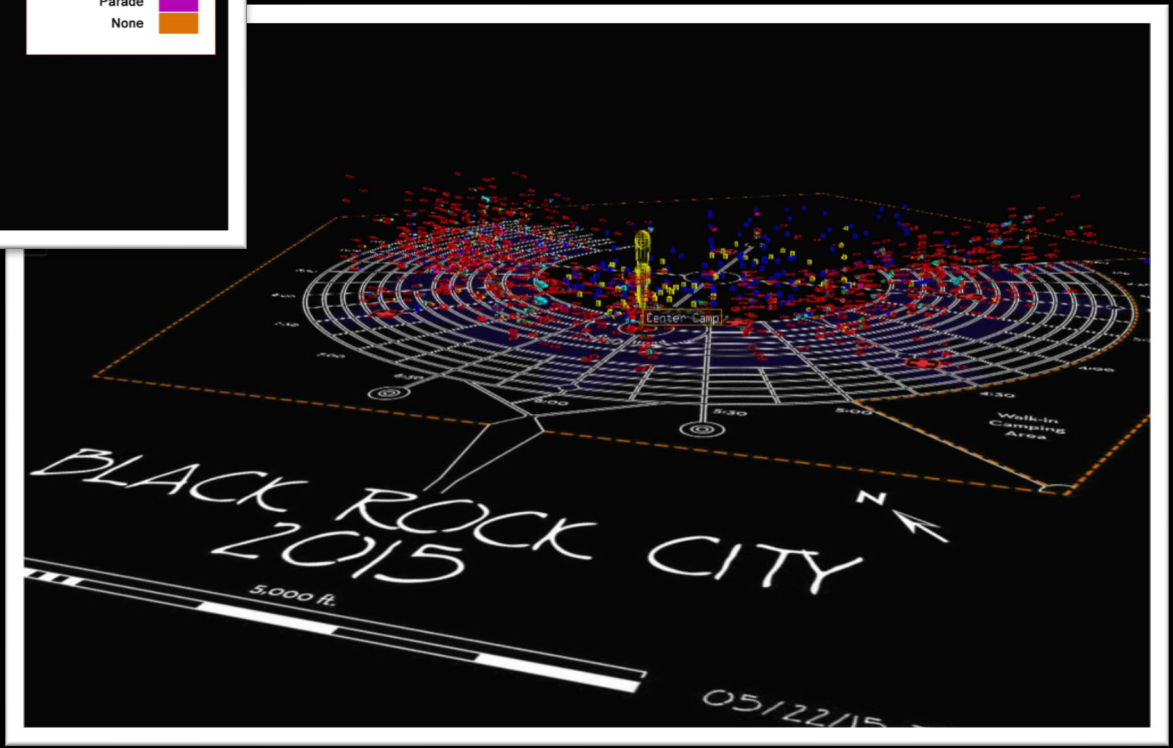
https://www.redbull.com/us-en/red-bull-project-endurance





Glyph as Event: Burning Man 2015





Useful Links

ANTz Main Page
http://www.openantz.com/

ANTz Github
https://www.github.com/openantz/

ANTzers Youtube
https://www.youtube.com/user/Antzers

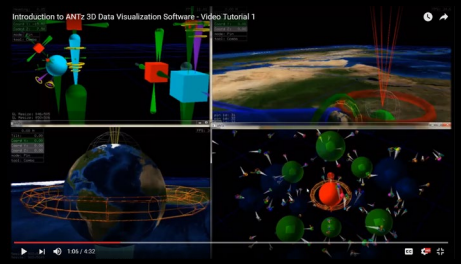
ANTz Tutorial and Sample Code
http://www.edworlds.com/antz/toroids/tutorials/index.html

Ant Research Citation Visualization First Attempt
http://www.edworlds.com/antz/toroids/more.html

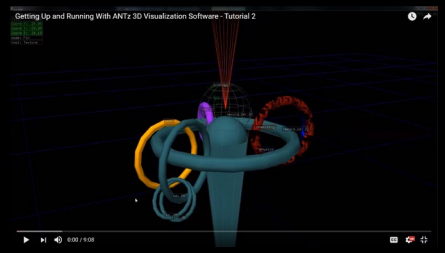
Dave Warner's Picasa Archive
https://get.google.com/albumarchive/100315004074259761063?source=pwa

Jeff's Google Photo Archive
https://photos.google.com/album/AF1QipP8D91YeXKA4skazgdS3rR2xl6n28mI3MMKvE1a

Introduction to ANTz 3D Data Visualization Software - Video Tutorial 1
https://www.youtube.com/watch?v=Zq_8AcZXbyg



Getting Up and Running With ANTz 3D Visualization Software - Tutorial 2
https://www.youtube.com/watch?v=1IuAOL4bc2s



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