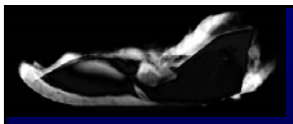

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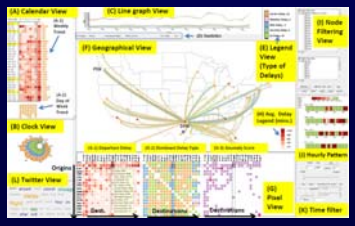
Visual Analytics for Command, Control, and Interoperability Environments
A U.S. Department of Homeland Security Center of Excellence

Visual Analytics for Security Applications



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Purdue University
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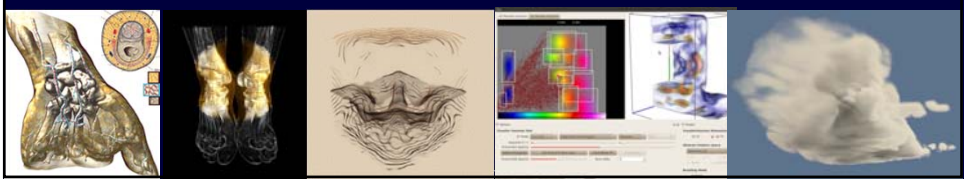


Context: Ray Tracing Jell-O Brand Gelatin

Computer Graphics, Volume 21, Number 4, July 1987

Ray Tracing JELL-O® Brand Gelatin

Paul S. Heckbert
Dessert Foods Division
Pixar
San Rafael, CA

ABSTRACT

Ray tracing has established itself in recent years as the most general image synthesis algorithm. Researchers have investigated ray-surface intersection calculations for a number of surface primitives, including checkerboards, glass balls, green fractal hills, mandrills, abstract blue surfaces, more glass balls, robot arms, pool balls, low-resolution clouds, morphine molecules, aquatic blobby things making strange noises, fantastic cities, and running skeletons. Unfortunately, *nobody has ray traced any food.* The *Dessert Realism Project* here at Pixar is addressing this problem. This paper presents new technology for ray tracing Jell-O® brand gelatin. We believe the method may have application to other brands of gelatin and perhaps pudding as well.

CR Categories: C.1 [**Processor Architectures**]: Multiprocessors – *Array and vector processors*; I.3.7 [**Computer Graphics**]: Three-Dimensional Graphics and Realism – *color, shading, shadowing, and texture*; J.3 [**Life and Medical Sciences**]: Health.

General Terms: algorithms, theory, food.

Additional Key Words and Phrases: ray tracing, lattice algorithm, Jell-O®, gelatin.

Introduction

Ray tracing has established itself in recent years as the most general image synthesis algorithm [Whitted, 1980]. Ray tracing food has remained an open problem, however. So far the most realistic foods were Blinn's classic orange and strawberry images, but these were created with a scanline algorithm [Blinn, 1978]. This paper presents new technology for ray tracing a restricted class of dessert foods, in particular Jell-O® brand gelatin.

Our paper is divided into three parts: methods for modeling static Jell-O®, simulation of Jell-O® motion using impressive mathematics, and ray-Jell-O® intersection calculations.

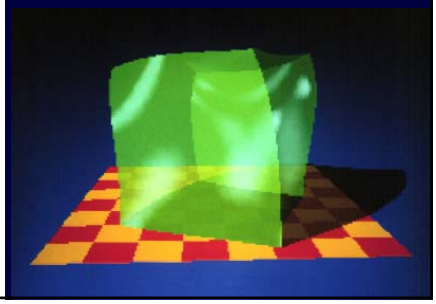
Jell-O® Shape

To model static Jell-O® we employ a new synthesis technique wherein attributes are added one at a time using abstract object-oriented classes we call *ingredients*. *Ingredient* attributes are combined during a preprocessing pass to accumulate the desired set of material properties (consistency, taste, torsional strength, flame resistance, refractive index, etc.). We use the RLS orthogonal basis (raspberry, lime, and strawberry), from which any type of Jell-O® can be synthesized [Weller, 1985].

Ingredients are propagated through a large 3-D lattice using vectorized pipeline SIMD parallel processing in a systolic array architecture which we call the *Jell-O® Engine*. Furthermore, we can compute several lattice points simultaneously. Boundary conditions are imposed along free-form surfaces to control the Jell-O® shape, and the *ingredients* are mixed using *relaxation* and *annealing* lattice algorithms until the matrix is chilled and *ready-to-eat*.

Jell-O® Dynamics

Previous researchers have observed that, under certain conditions, Jell-O® *wiggles* [Sales, 1966]. We have been able to simulate these unique and complex Jell-O® dynamics using

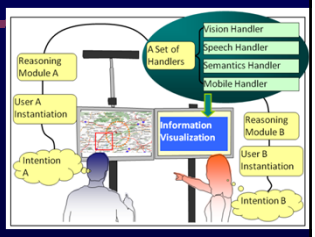


So What? Who Cares? Visual Analytics for Transportation Security

- Problem:
  - Flood of data
  - Automated analysis without context
  - Inability to fuse/correlate information
  - Utilize real-time, streaming data
  - Need data-driven policy and decision-making

- Solution:
  - Provide actionable information
  - Shared, synchronized situational awareness
  - Intuitive, user-guided decision-making environment
  - Harnesses decision-makers knowledge and experience
  - Incorporate predictive, task-guided, tailored analytics

Human-Computer Collaborative Decision-Making Environments



Balance of automated computerized analysis and human cognition to amplify human-centered decision making

Leverage both

- Human knowledge and visual analysis to increase analytical efficiency and guide simulations and analysis
- Interactive simulations, dimensional reduction, clustering, analytics to improve decision making

Create interactive operational, planning & decision making environments

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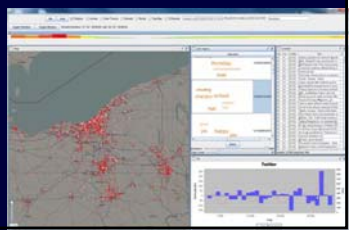
Visual Analytics Uses for Public Safety

- Risk visualization and analysis
- Predictive analytics
- Uncertain decision making
- Alternative evaluation and consequence investigation
- Trend analysis, clustering, anomaly detection
- Multisource, multimedia massive data integration & analysis
- Purpose: Planning for resiliency, training, detection, investigation, response, recovery, remediation



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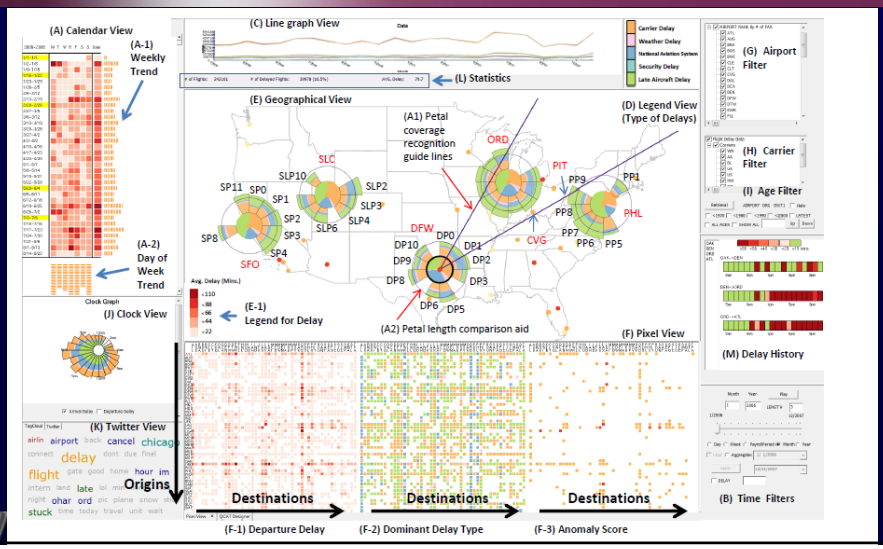
Example: Airport Delay VA-

Multivariate Network Analytics with Information Theory Anomaly Detection

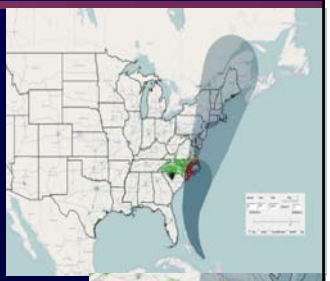


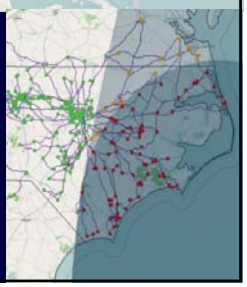
Example: VASA
Visual Analytics for Simulation-Based Action

Collaborating Institution(s): Purdue, Minnesota, UTexas, UNCC + German universities
End-User(s): Fast-food restaurant chain, emergency management and planning personnel

Impacts and Accomplishments:

- Support decision-making for extreme weather and natural disaster scenarios
  - Combine real and simulation data
  - Allow "what-if" exploration
- **System of systems**: binds together multiple simulations models from collaborators into coherent whole
  - **Minnesota**: food distribution model
  - **Texas**: simulated and historical weather (hurricanes, storms)
  - **UNCC**: critical infrastructure
  - **Purdue**: roads + interaction visual analytics tool
- **Challenge**:
  Combine interactive VA with complex simulation models





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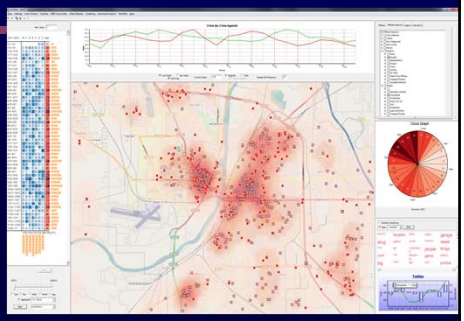
Example: Visual Analytics Law Enforcement Toolkit (VALET, iVALET)

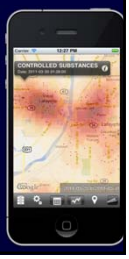
Impacts:

- In use to analyze crime patterns and to connect strings of activities (200+ downloads)
- Investigating correlation factors
- Analyzing time of day problems and improving accuracy of police record management system
- Novel statistical predictive model incorporated for planning
- Incorporating predictive alerts



VALET delivered:
- Spring 2011: WL, Lafayette Police
- Fall 2013: Ohio State Highway Patrol
- Spring 2014: NYPD
- Fall 2014: Evansville PD, New Albany PD

iVALET delivered:
- October 2011: Purdue, WL Police, Lafayette PD



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Catching Criminals on Video: Video Be on the Lookout (vBOLO)

- Collaborators:
  - Northeastern University
  - Purdue University
  - Rensselaer Polytechnic Institute
  - University of Notre Dame

- Current vBOLO system can currently find the correct person in a lineup of 10 automatically-detected candidates greater than 90% of the time for one camera

- Partner: Greater Cleveland Regional Transit Authority (GCRTA)

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Social Media Analysis and Reporting Tool

Partners: Purdue, U. Stuttgart, Penn State, USCG LANT, PAC, D8; Purdue Police, IMPD, BSA

IMPACTS:

- Used at Boy Scouts of America Jamboree 2013
- Used by U.S. Coast Guard
  - District 8 for events in 2014 -2017: Detected 3 gang related activities to date
  - PAC for Fleet Week October 2014, Kayactivists 2016
  - LANT for SAR hoax call investigations
- Presidential Inauguration 2017
- Purdue Police for home football games Fall 2014-2016
- Indianapolis Metropolitan Police for special events
- US CBP for investigations Fall 2014 (Boston, AMOC)
- USCIS with open source news
- Republican National Convention 2016
- Ohio State Football – more successful than commercial tools
- Others: Lafayette PD, USCIS, St. Clair County, American Red Cross, Oklahoma, Madison Wisconsin, and Tennessee Intelligence Fusion centers

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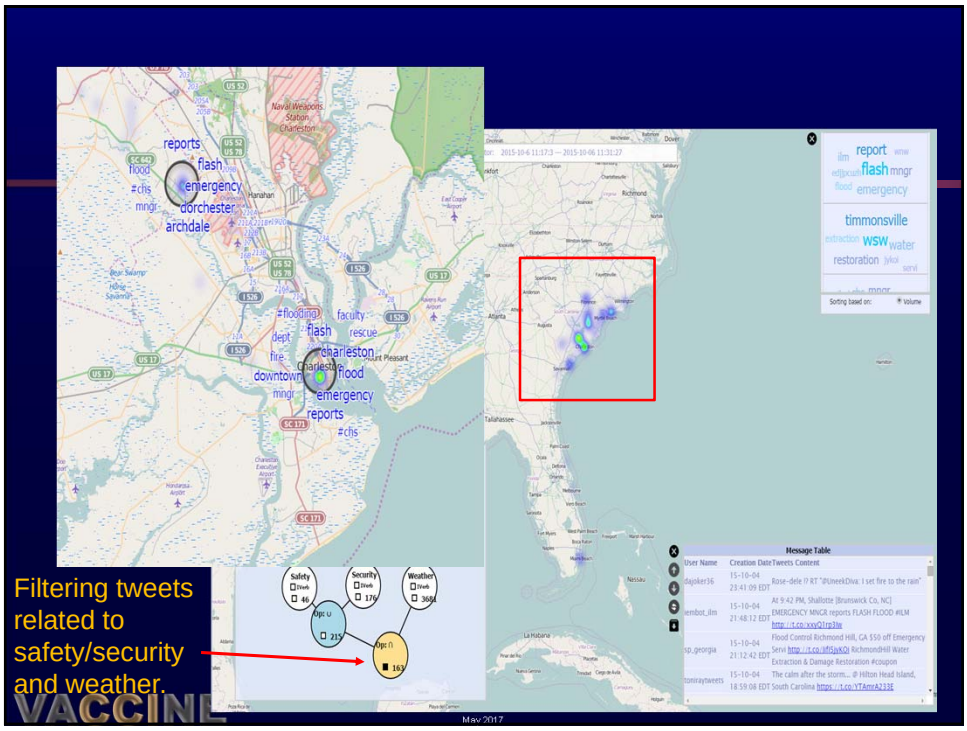
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wsw
water
restoration
Message Table
Safety
Security
Weather
Filtering tweets related to safety/security and weather.
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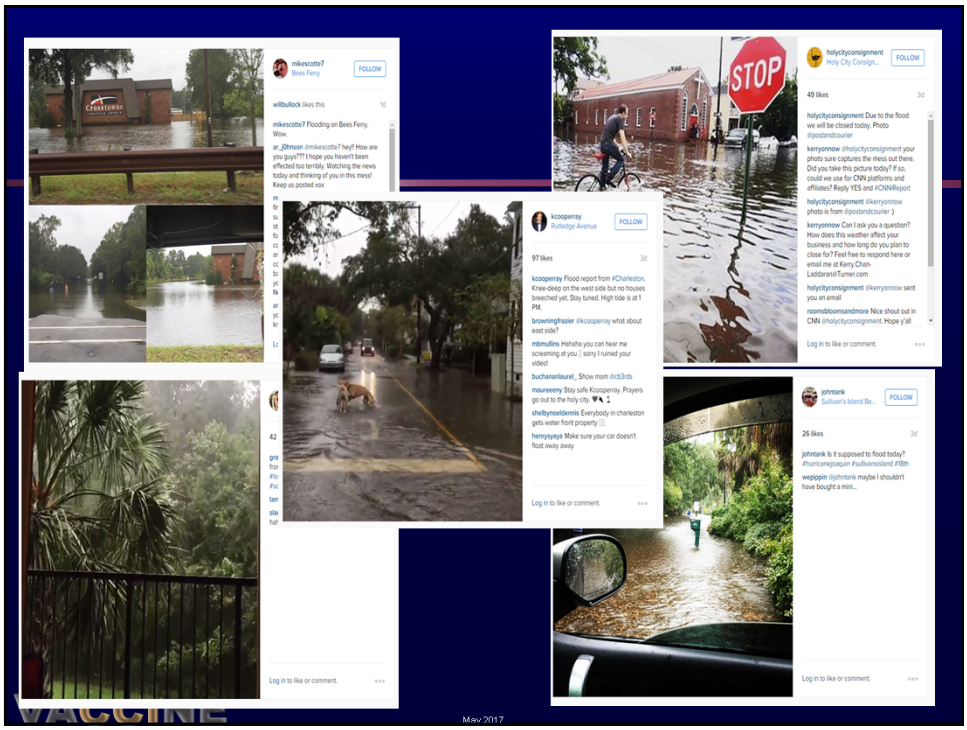
STOP
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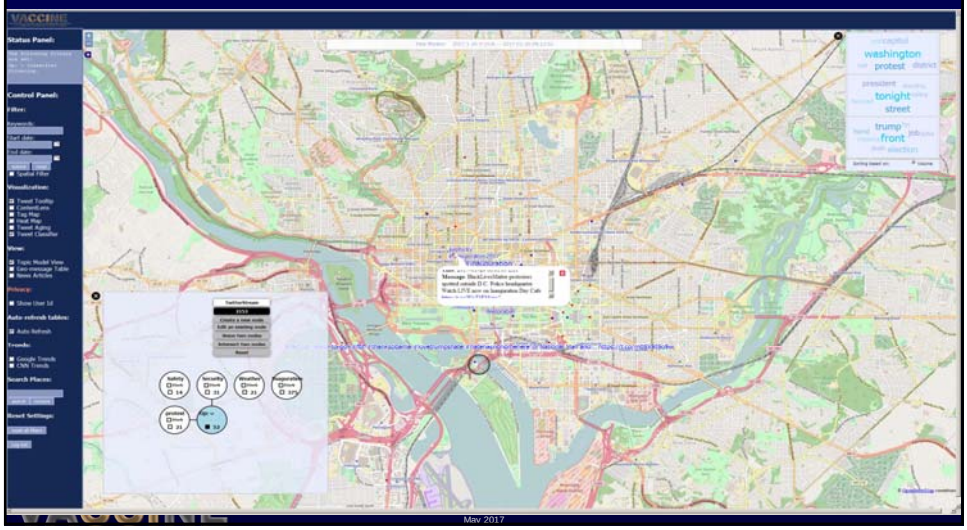
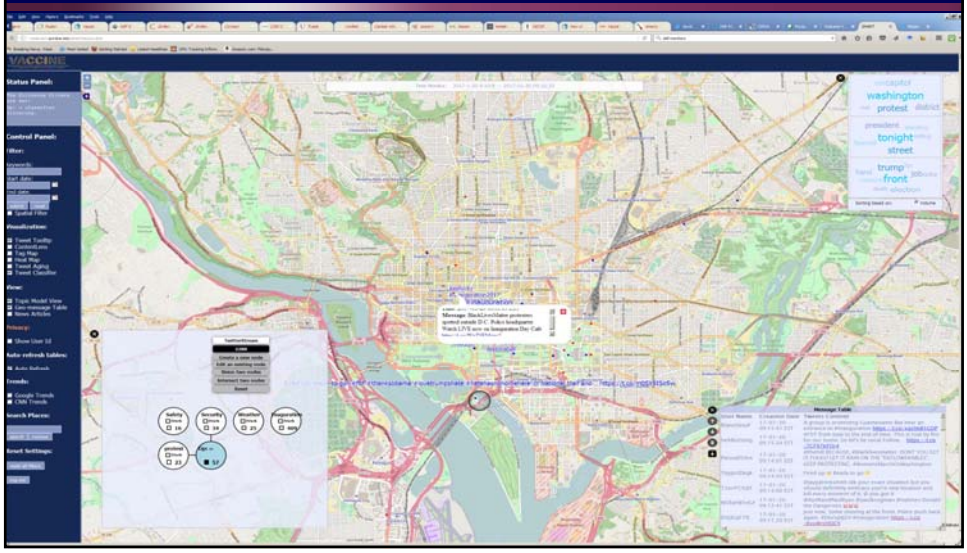
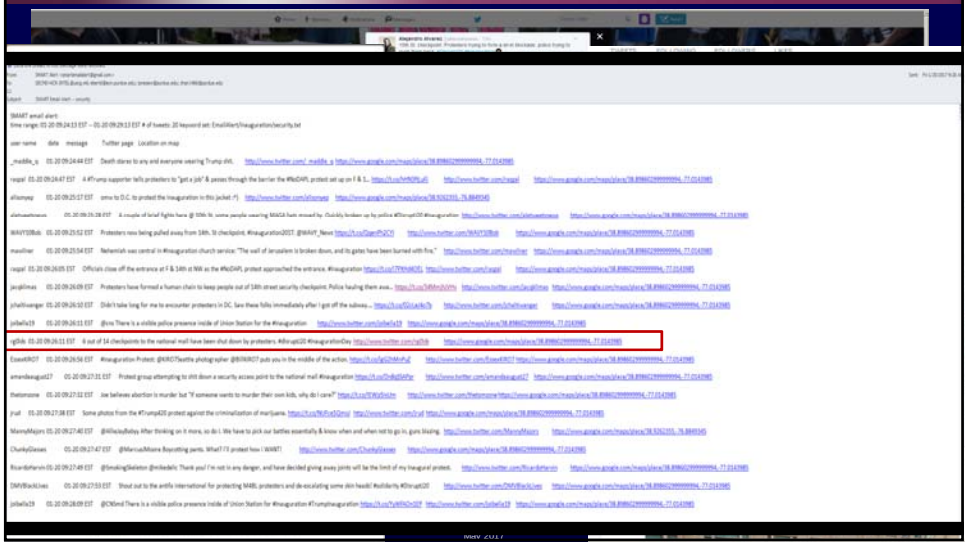
Presidential Inauguration and Protests



Presidential Inauguration and Protests



Presidential Inauguration and Protests

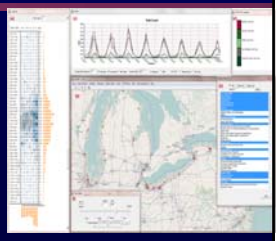


U.S. Coast Guard COAST/ SARVA (cgSARVA)

Partners: USCG LANT 7, USCG HQ 771 , USCG D9, USCG D5, RDC

IMPACTS:

- Analyzed impact of CG auxiliary stations on search and rescue mission in Great Lakes
- Used for resource allocation for SAR
- Provided new insights to SAR mission
- Hurricanes Sandy and Irene resource allocation decisions based on cgSARVA analysis and visualization
- Informed Commandant's budget testimony to Congress
- Key component of USCG D9 reallocation plan for 2011-12
- Key component of Coastal Operations Allocation Suite of Tools (COAST) – USCG HQ



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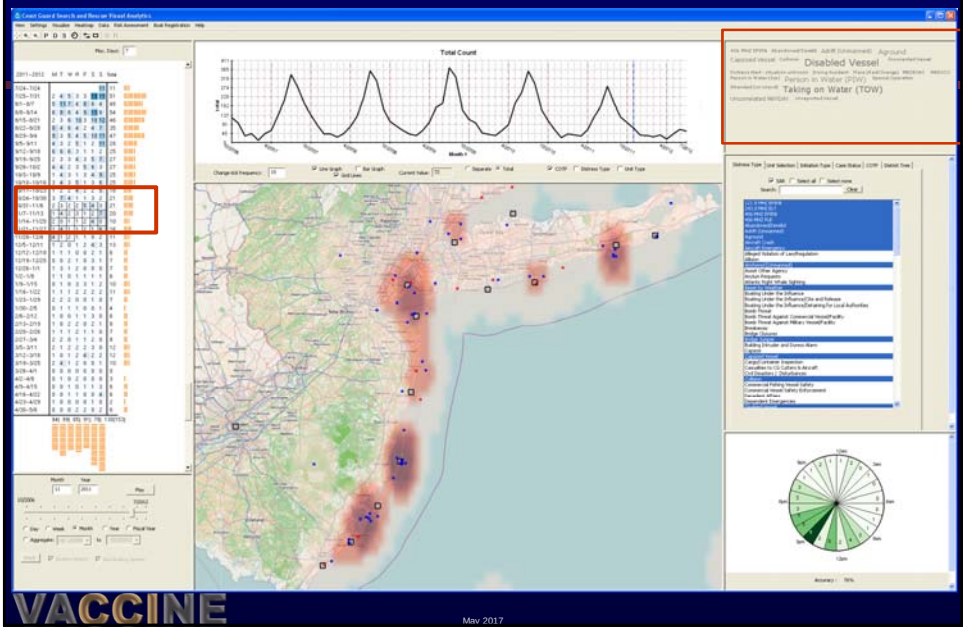
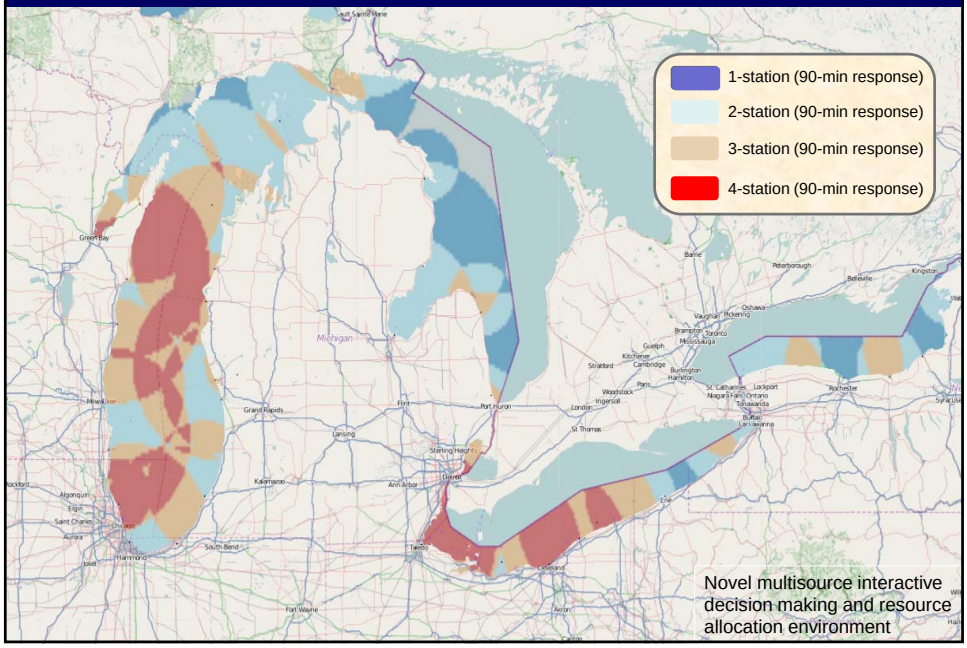
Example: Risks and Consequences From Sandy:

SAR Cases November 2011 NJ/NYC Area



Response Efficiency – Potential Future Assets



Conclusion:
What Our Visual Analytic Solutions Offer

- **We** enable users to be more effective through innovative interactive visualization, analysis, and decision making tools
- Provide the right information, in the right format within the right time to solve the problem
- Turn data deluge into actionable knowledge
- Enable users to be more effective
- Enable effective communication of information

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For Further Information

www.VisualAnalytics-CCI.org