

2016 TRI National Training Conference
October 20th, 2016

TOWARD INTERACTIVE AND INTELLIGENT VISUAL ANALYTICS OF TRI DATA

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MOTIVATION

The mission of EPA is to protect human health and the environment

<https://www.epa.gov/aboutepa/our-mission-and-what-we-do>

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This goal is met in several ways, including:

(1) Facilitating broader participation with widespread access to accurate, relevant data

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MOTIVATION

The mission of EPA is to protect human health and the environment

This goal is met in several ways, including:

(1) Facilitating broader participation with widespread access to accurate, relevant data

(2) Implementing effective regulations informed by modern scientific information

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ROLE OF VISUAL ANALYTICS

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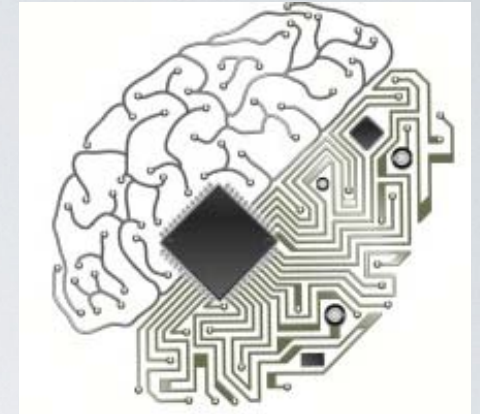
Visualization and Visual Analytics:

- Facilitate exploration, insight, and knowledge discovery
- Aid generation of mental models of information
- Are fun and engaging to interact with

ROLE OF VISUAL ANALYTICS

How does that work?

- Cognitive offloading



<https://esistme.files.wordpress.com/2016/07/1306.jpg?w=350&h=200&crop=1>

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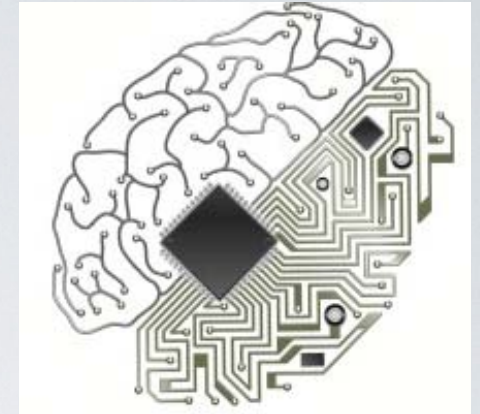
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ROLE OF VISUAL ANALYTICS

How does that work?

- Cognitive offloading
 - Countering human memory limitations and bias



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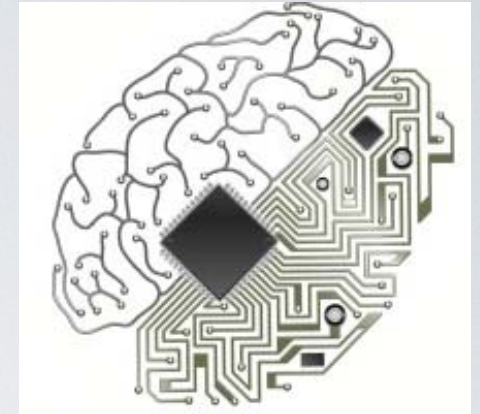
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ROLE OF VISUAL ANALYTICS

How does that work?



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- Complementary representation

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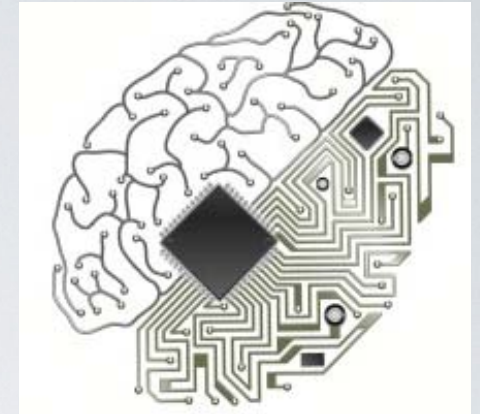
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ROLE OF VISUAL ANALYTICS

How does that work?



- Cognitive offloading
 - Countering human memory limitations and bias
- Complementary representation
 - Filter task-irrelevant information

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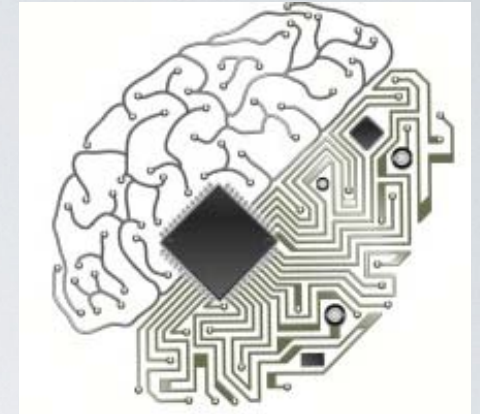
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ROLE OF VISUAL ANALYTICS

How does that work?



- Cognitive offloading
 - Countering human memory limitations and bias
- Complementary representation
 - Filter task-irrelevant information
- Direct, intuitive manipulation of relevant views

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ROLE OF VISUAL ANALYTICS

Visualization and Visual Analytics:

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- Aid generation of mental models of information
- Are fun and engaging to interact with

We can address EPA goals with visual analytics systems

EXTANT TRI ANALYSIS TOOLS

The EPA hosts numerous applications for TRI and related datasets

❖ The TRI National Analysis tools [1]

- ❖ Maps of TRI chemical usage across the United States
- ❖ Tools are provided to search by state, city, county or zip-code

❖ My Right To Know (MyRTK) [2]

- ❖ Allows searching for facilities around a specific location

❖ TRI NET

- ❖ Allows search by radius for facilities around a particular location, integrates additional layers such as environmental justice, chemical toxicity data, etc

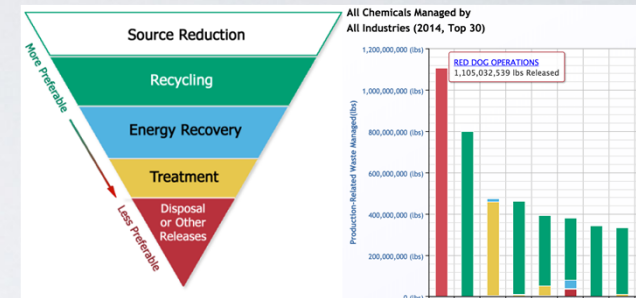
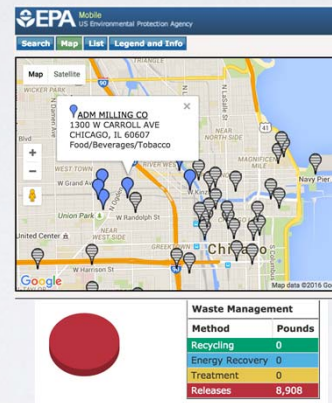
❖ Pollution Prevention (P2) tool [3]

- ❖ The P2 tool reports chemical reductions for selected industry, facility, or state. Data for individual facilities can be extracted via drill-down operations, and comparisons made between facilities

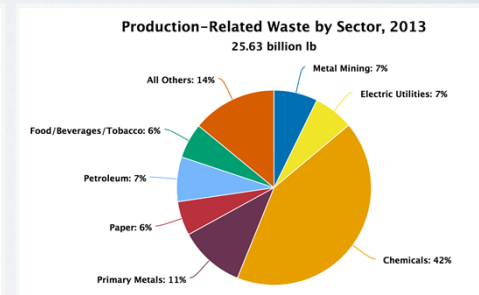
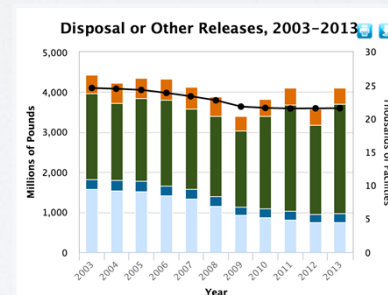
❖ Toxic Trends Mapper

❖ Enviromapper

2



3



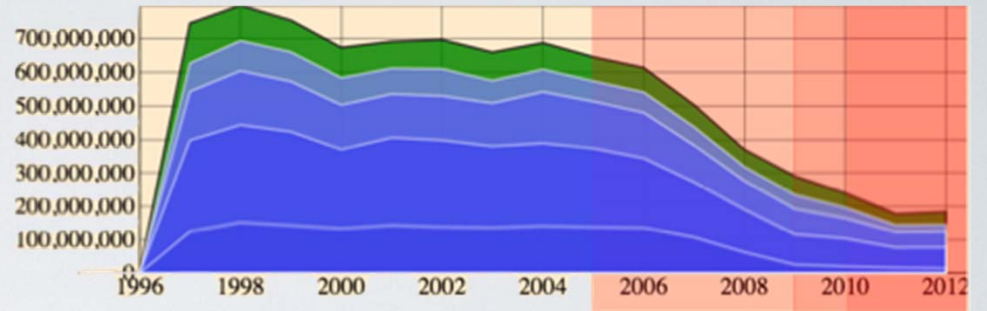
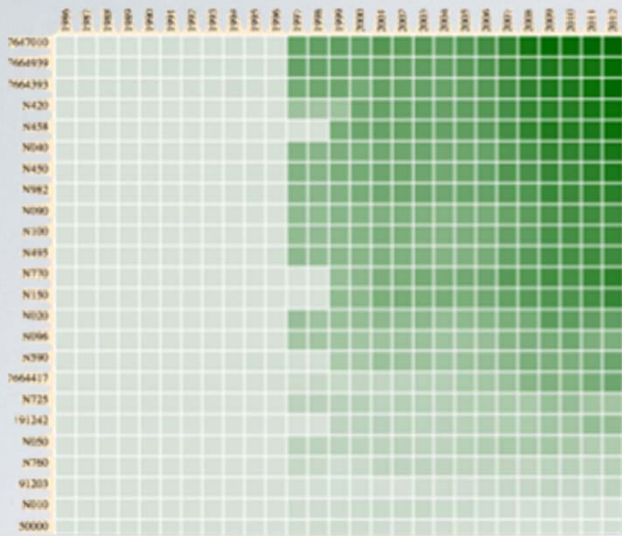
1

<https://www.epa.gov/toxics-release-inventory-tri-program/tri-data-and-tools>

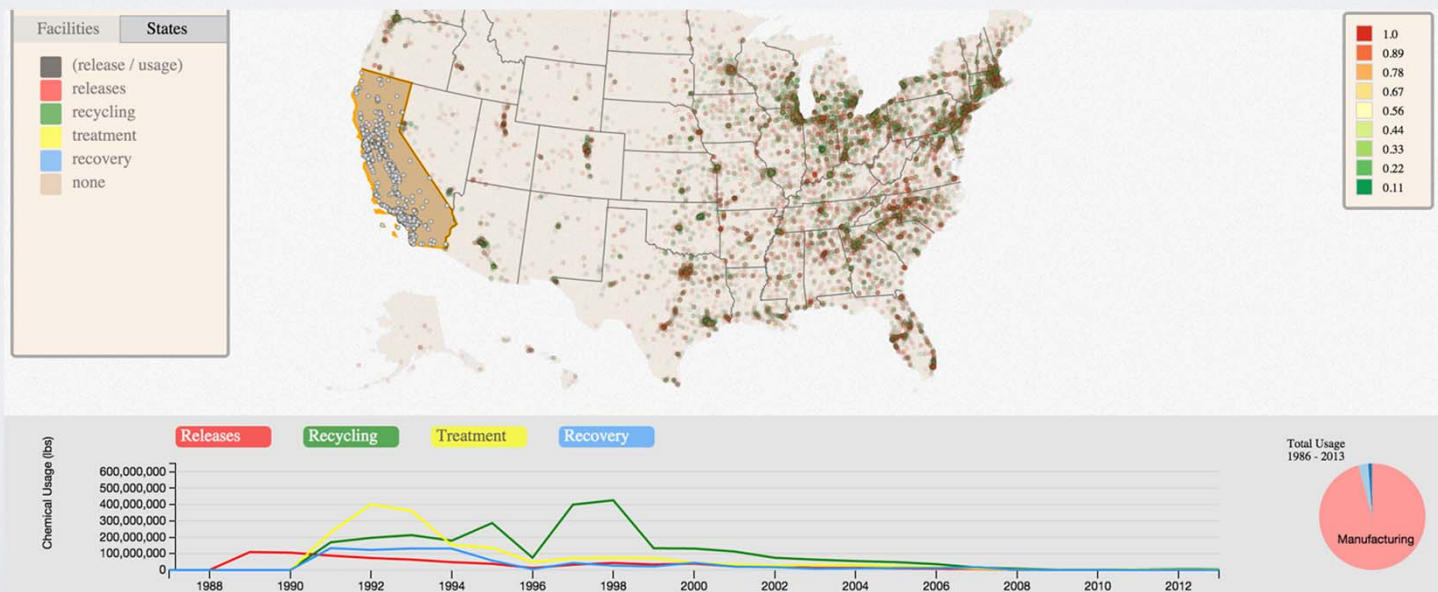
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OUR TRI ANALYSIS TOOLS



OUR TRI ANALYSIS TOOLS



TRI-DIRECT

TRI-DIRECT

What is it designed to
accomplish?

Who is it targeted toward?

How does it work?

Burlinson, David, Kalpathi Subramanian, and Aidong Lu. "TRI-Direct: Interactive Visual Analysis of TRI Data." *Electronic Imaging* 2016.1 (2016): 1-8.

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What is it designed to
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Began as a semester project

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Began as a semester project

Aimed at users unfamiliar with TRI

Exploratory focus

- High-level comparisons of chemical usage:

Releases, recycling, treatment, and recovery
Aggregated yearly per facility, per industry, and per state

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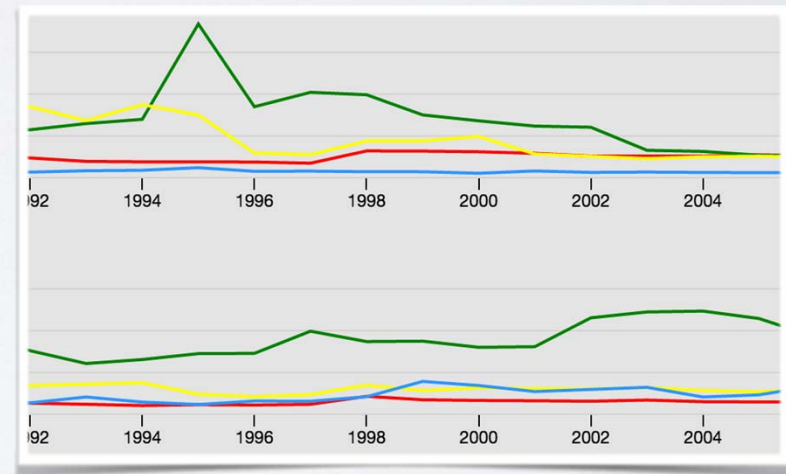
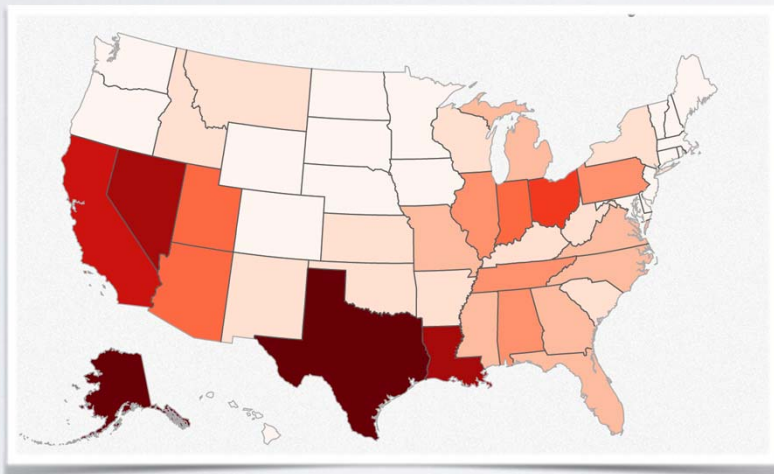
TRI-DIRECT

How does it work?

Fully interactive single-page application

Two main display elements:

- Map visualization
- Analytics panel



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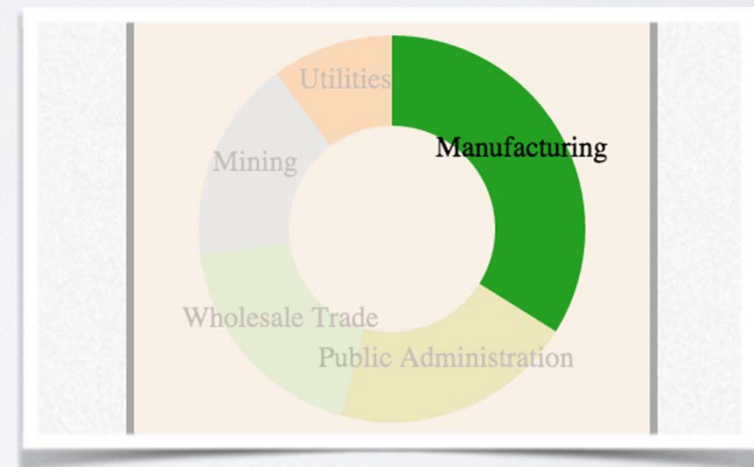
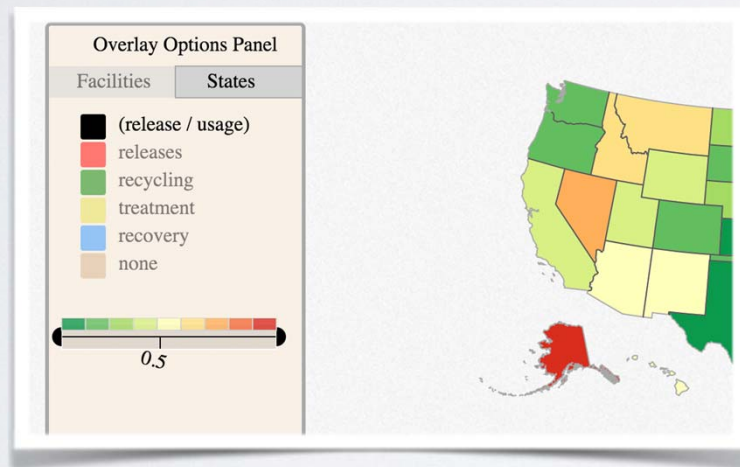
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How does it work?

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Supplemental display panels:

- additional options
- auxiliary data representations

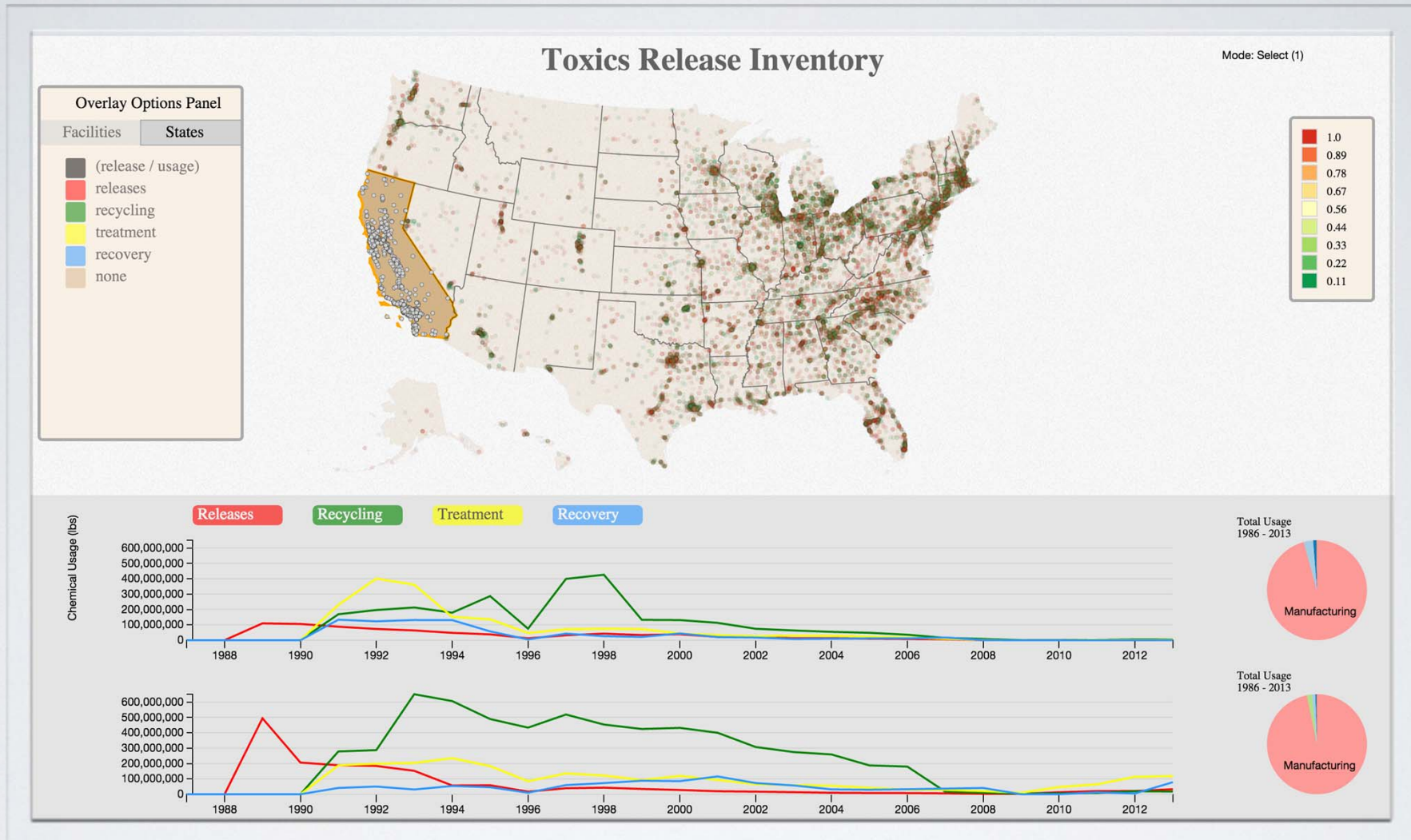


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How does it work?



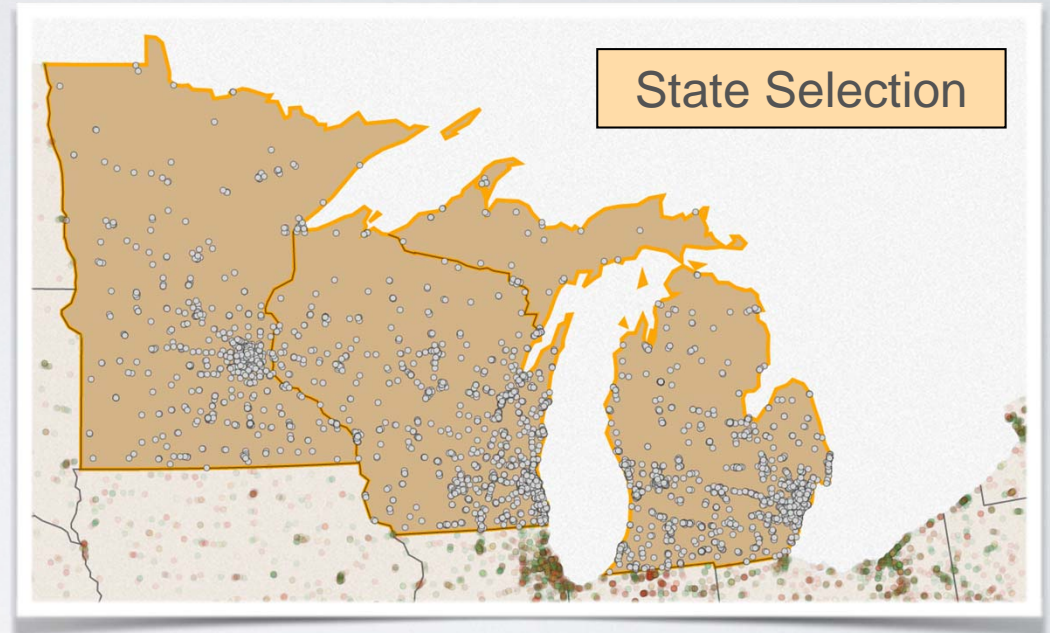
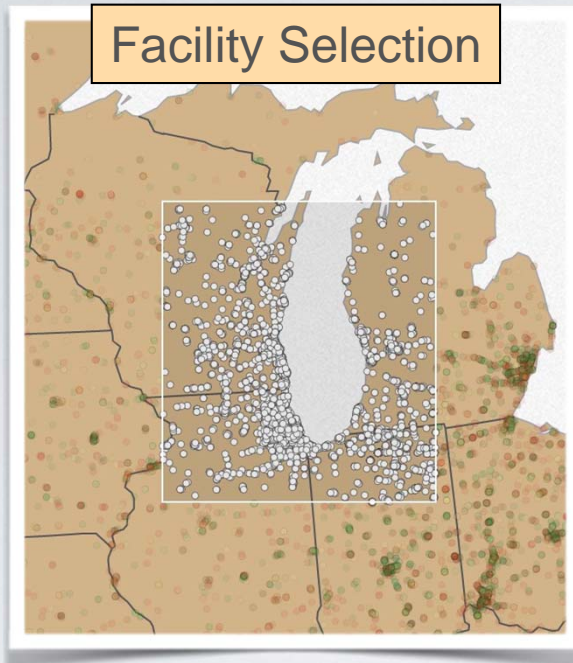
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TRI-DIRECT

How does it work?



Temporal Comparison between selections

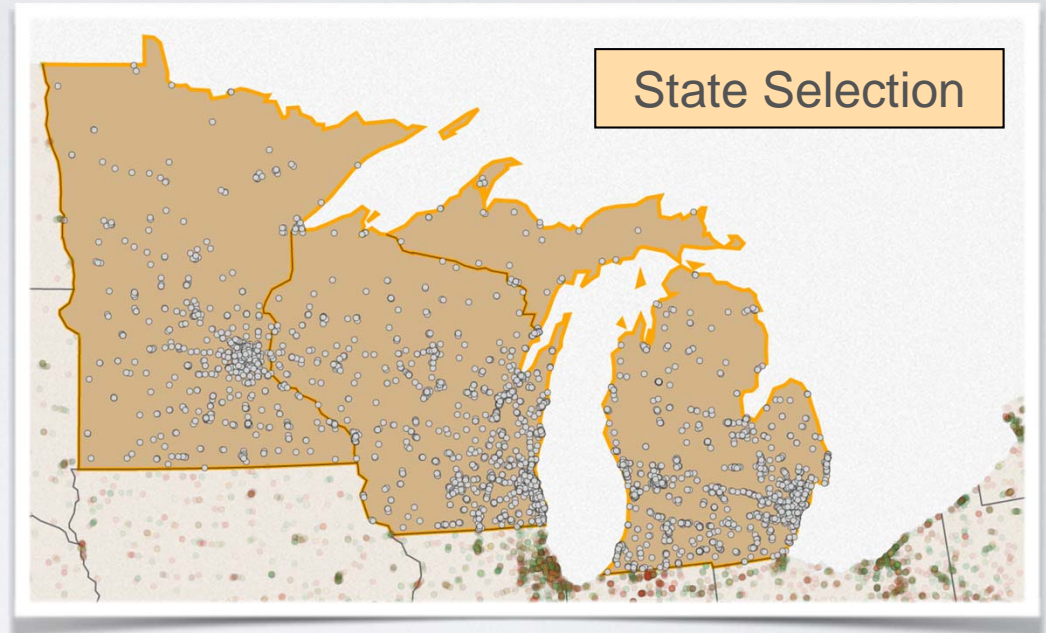
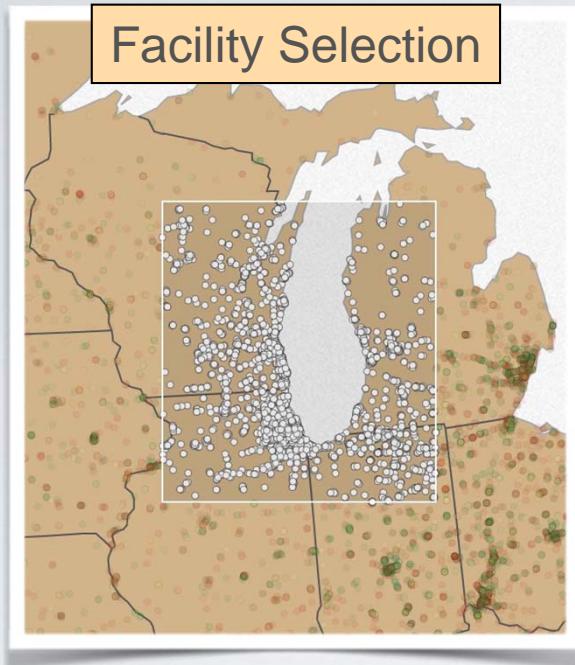
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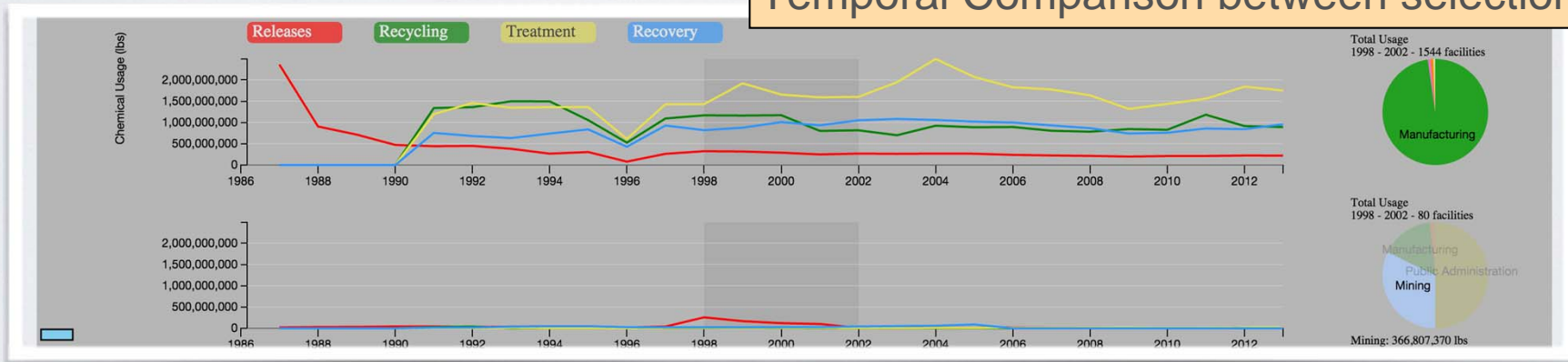


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TRI-DIRECT

(1) Broader participation in EPA goals with widespread access to accurate, relevant data

Informal user and case studies indicate preliminary success

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- Coordination of interactive visual displays facilitates rapid exploration and comparison

TRI-DIRECT

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Informal user and case studies indicate preliminary success

- Novice users can easily discover high-level trends and rates in chemical usage at country, state, county, and facility levels
- Coordination of interactive visual displays facilitates rapid exploration and comparison
- Detailed selections and filters present quantitative data for deeper insight

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EPA UNIVERSITY CHALLENGE

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What is it designed to
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EPA UNIVERSITY CHALLENGE

What is it designed to accomplish?
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TRI-Direct was a springboard for the EPA University Challenge

New system designed for expert users

David Burlinson, Kara Koehn, Kalpathi Subramanian, Aidong Lu, 'Are Environmental Regulations Working? A Visual Analytic Approach To Answering Their Impact on Toxic Emissions', Workshop on Visualization in Environmental Sciences(EnvirVis) 2016, (Part of EuroVis 2016), June 6-10, 2016, Groningen, the Netherlands.

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New system designed for expert users

Focus on a domain-specific reasoning process

- Creating and testing hypotheses
- Intelligent visualization recommendation system

Efficacy of environmental regulations

David Burlinson, Kara Koehn, Kalpathi Subramanian, Aidong Lu, 'Are Environmental Regulations Working? A Visual Analytic Approach To Answering Their Impact on Toxic Emissions', Workshop on Visualization in Environmental Sciences(EnvirVis) 2016, (Part of EuroVis 2016), June 6-10, 2016, Groningen, the Netherlands.

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Efficacy of environmental regulations

Short-term approach:

- Start with specific questions related to overarching goal
- Design visualizations to answer specific components
- Combine visualizations to support exhaustive mental models of task-relevant information

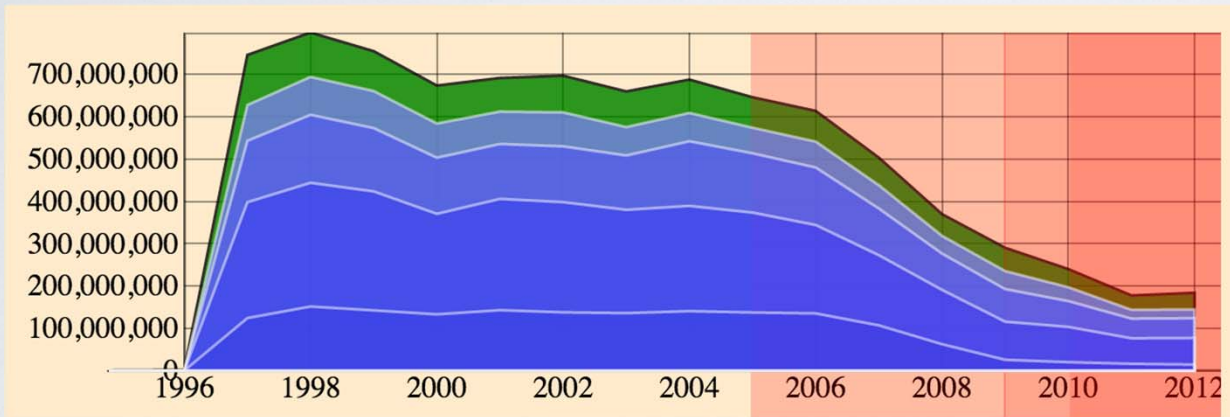
Example Question

- Q: *Are EPA regulations affecting the change in TRI air releases in the electric utilities sector?*
 - Q-1: How are air releases in TRI changing over time for the electric utilities sector? How does this relate to when EPA regulations were implemented?
 - Q-2: Is the change from just one facility or from a broader change in that sector happening at many facilities?
 - Q-3: What chemical or chemicals are driving that overall downward change?
 - Q-4: Is the change due to a change in production?
 - Q-5: Is the change due to implementation of pollution controls (like installing scrubbers)?
 - Q-6: How many scrubbers and when were they installed, especially of chemicals of interest? Does this correlate with the downward change? What EPA regulations does this correspond with?

EPA UNIVERSITY CHALLENGE

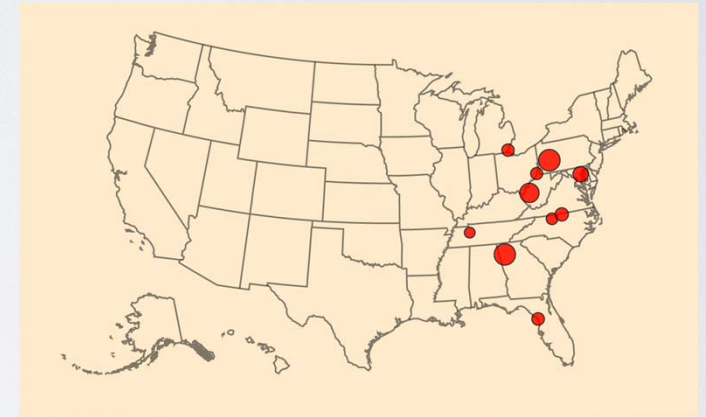
How does it work?

- Q-1: How are air releases in TRI changing over time for the electric utilities sector? How does this relate to when EPA regulations were implemented?
- Q-2: Is the change from just one facility or from a broader change in that sector happening at many facilities?



Contribution of top 10, 50, 100, 150 facilities vs all 648 facilities

Yearly air releases in pounds (fugitive and stack air releases)
Red overlay highlights implementation phases of CAIR rule



Locations of top 10 facilities contributing to air releases

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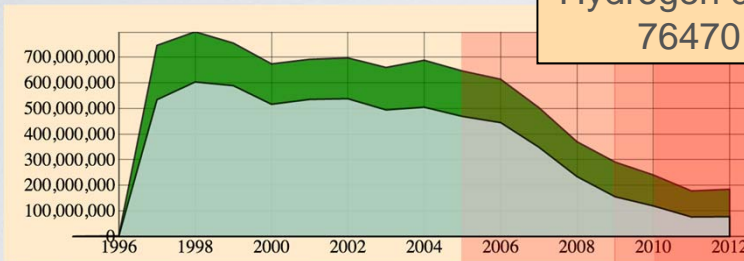
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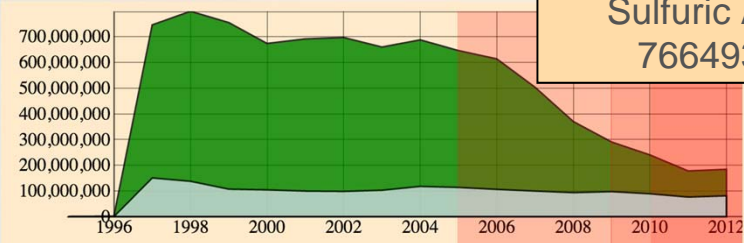
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- Q-3: What chemical or chemicals are driving that overall downward change?

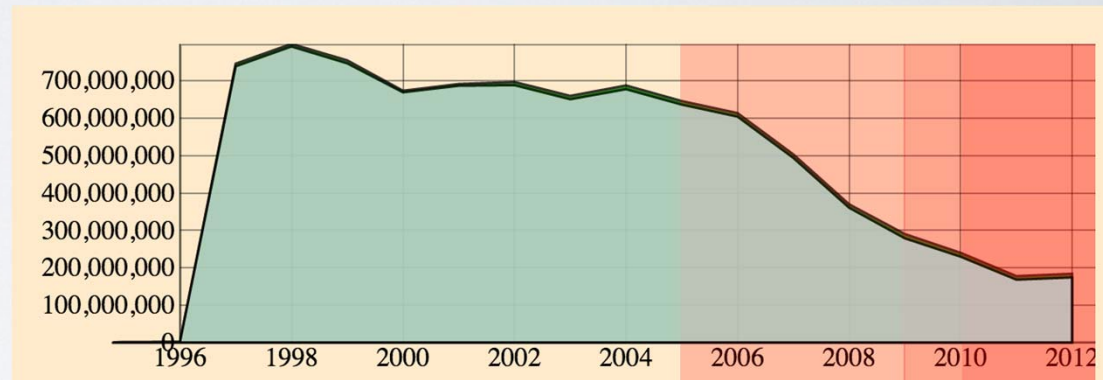
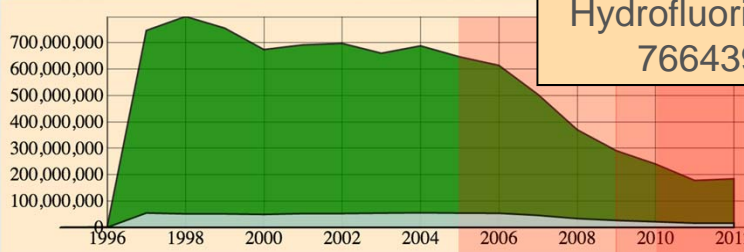
Hydrogen chloride
7647010



Sulfuric Acid
7664939



Hydrofluoric Acid
7664393



Top 3 chemical releases vs all air releases
(lbs)

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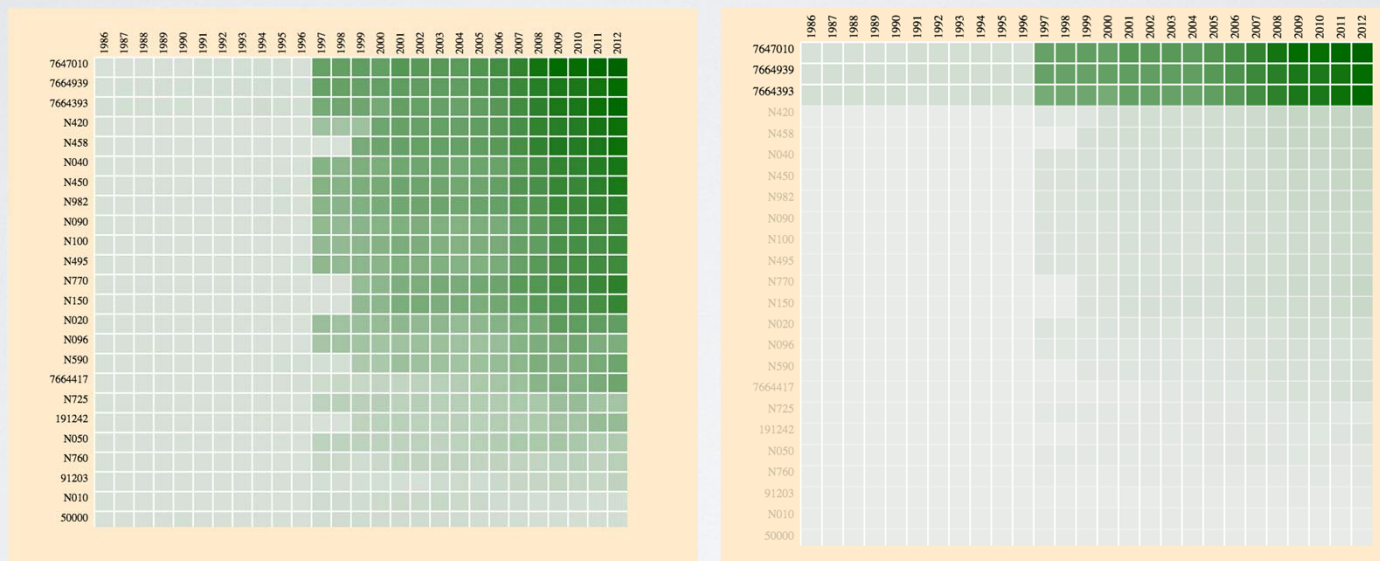
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How does it work?

- Q-5: Is the change due to implementation of pollution controls (like installing scrubbers)?
- Q-6: How many scrubbers and when were they installed, especially of chemicals of interest? Does this correlate with the downward change? What EPA regulations does this correspond with?



Number of scrubbers installed per chemical per year
(More scrubbers yields darker colors)
Ordered by aggregate air release

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How does it work?

Top-down application structure:

- Start by visualizing high-level metaphors for large trends in TRI data
 - Maps, top-k facilities/chemicals, temporal trends, chemical health categorization, treatment methods, etc

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Top-down application structure:

- Start by visualizing high-level metaphors for large trends in TRI data
 - Maps, top-k facilities/chemicals, temporal trends, chemical health categorization, treatment methods, etc
- Support refinement in each window
 - Filter - by geographic region, industry sector, specific facilities and chemicals, health impact, time period, etc
 - Alternate encoding -
 - Bar chart of yearly usage transforms to stacked bar chart showing usage types per year
 - Group stacked bar chart for each chemical at a facility

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EPA UNIVERSITY CHALLENGE

How does it work?

Long-term goals:

- Develop exhaustive task taxonomy and semantic network of TRI data elements
- Combine with visualization strategies for semantic relationships

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EPA UNIVERSITY CHALLENGE

How does it work?

Long-term goals:

- Develop exhaustive task taxonomy and semantic network of TRI data elements
- Combine with visualization strategies for semantic relationships
- Automatic presentation of interactive charts, maps, and graphs to support the reasoning process
- Create a model of user interactions
 - Easily return to previous states of inquiry
 - Train the recommendation system

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Wongsuphasawat, Kanit, et al. "Voyager: Exploratory analysis via faceted browsing of visualization recommendations." IEEE transactions on visualization and computer graphics 22.1 (2016): 649-658.

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EPA UNIVERSITY CHALLENGE

(2) Implementing effective regulations informed by modern scientific information

- We have validated our visualization solutions so far with a domain scientist
- We are working on a flexible data representation and back-end system to support our application
- We are also continuing to develop visualizations to support additional questions, subquestions, and reasoning processes related to environmental regulations

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CONCLUSIONS

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We have discussed some key EPA goals

We have motivated the continued development of strong visual analytics tools to support these goals

We have presented work on systems addressing these goals, and discussed our plans for the system under development

We welcome any thoughts, questions, and suggestions regarding our endeavors

CONCLUSIONS

Thank you very much for your time and attention!

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