

# **Health GeoJunction: Geovisualization of news and scientific publications to support situation awareness**

Michael Stryker Ian Turton Alan MacEachren  
Geography Department  
Penn State University

# Outline

---

- ▶ **Background**
  - ▶ Problem and research questions
  - ▶ Text extraction and visualization to support geospatial temporal data analysis
  - ▶ Geovisual Analytic approach to the surveillance of the Avian Flu pandemic threat
- ▶ **The Health GeoJunction application**
  - ▶ Conceptual underpinnings and implementation
  - ▶ Web portal for visualizing text extraction service output
  - ▶ Deriving insight from the space-time-object conceptual framework
- ▶ **Future objectives: capturing and sharing the analytic process**
  - ▶ Capturing, sharing, and revisiting insights as contextualized artifacts in the geovisual analytic environment
  - ▶ Annotation as a means to capture evolving user perspectives
  - ▶ Visual overview and filtering of annotation
  - ▶ Booking marking the visual state associated with an insight



Background: Geovisual Analytic Approach  
visualizing document collections

# Geovisual Analytic approach

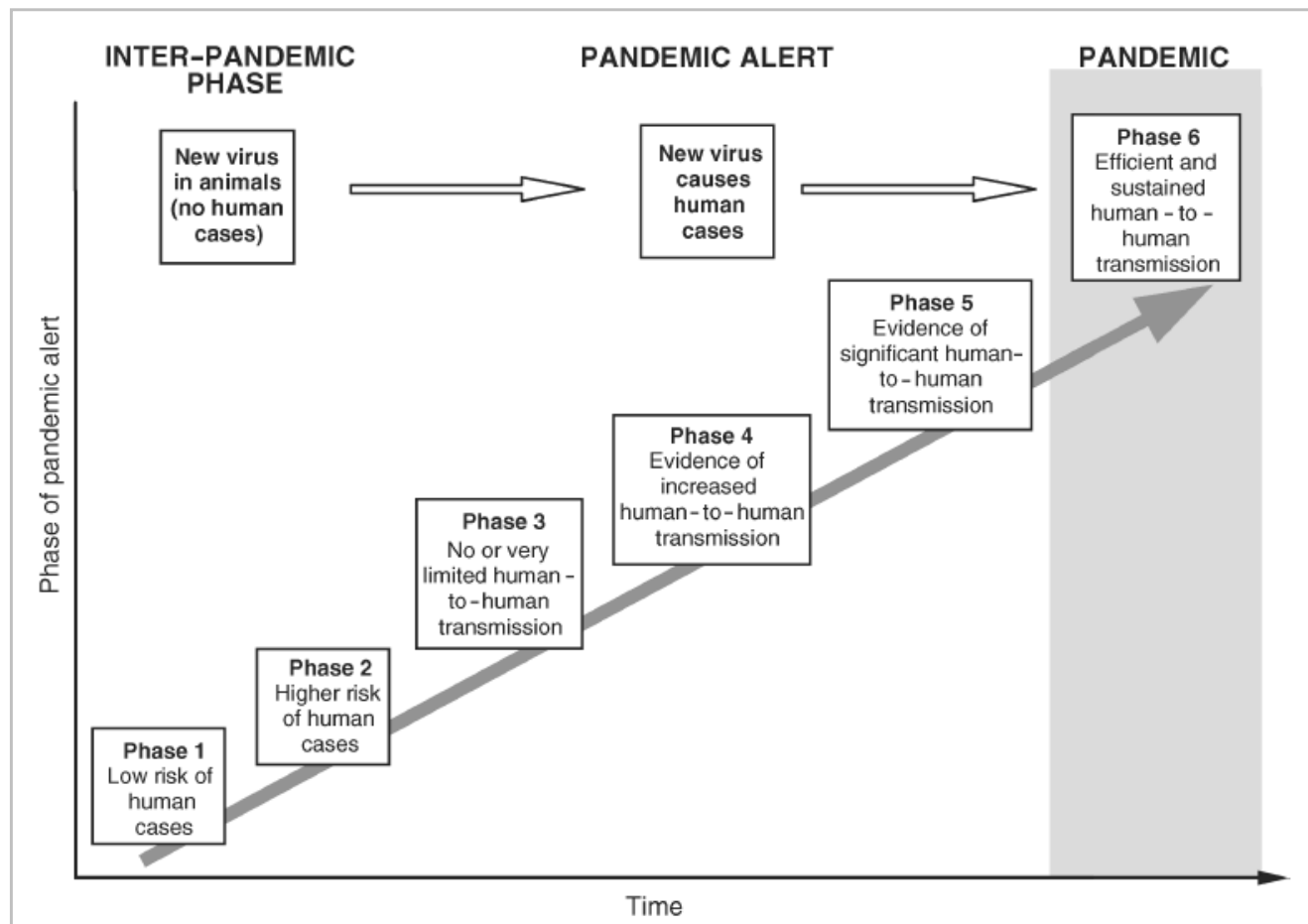
---

- ▶ Problem: Large collections of time sensitive reports and a growing body of specialized academic publications requires new tools for identifying relevant information particularly when the geographic context of this content is necessary
- ▶ Research questions:
  - ▶ How can you design a scalable web service based and highly interactive environment for searching documents based on geographic content in addition to temporal and key word criteria?
  - ▶ Approach: text extraction services to populate a data store of entities accessible through OGC compliant web services and computational tools for determining document relevance
  - ▶ What are effective visual interfaces for understanding the content of large document collections from entities extracted from this text?
  - ▶ Approach: provide coordinated views of document set conforming to the conceptual dimensions of place, time, and attribute (keyword)
  - ▶ How can you capture this process so that analysts can build upon prior insights derived within the interface and share these contributions in a collaborative fashion to build upon this knowledge over time?
  - ▶ Approach: enable analysts to annotate the visual analytic environment and discover and search these annotation stores



# Avian Influenza surveillance: Data and Tasks

- ▶ WHO protocol for monitoring zoonotic infectious disease threats provides a model for processing events



ness'  
 nt within a given  
 at hand with a  
 ocesses at work  
 e journals  
 ction of incident  
 dication) feed

- ▶ Graphic from Smallman-Raynor, M. and A. D. Cliff (2008)



# Health GeoJunction

Geovisual Analytic Web Application

# Health GeoJunction Interface

The Health GeoJunction interface provides multiple coordinated views organized around the conceptual dimensions of place, concepts, and time.

The screenshot displays the Health GeoJunction interface, which is organized into several key sections:

- Map View:** A map of Southeast Asia showing the number of PubMed abstracts for various countries. A legend indicates that red circles represent 'About country' and blue circles represent 'From country'. The size of the circles corresponds to the number of abstracts, with a scale from 15 to 60. A 'WMS Map' dropdown is also visible.
- Search and Filter Section:** At the top right, it shows 'All Documents: 5567'. Below this, a list of search terms is displayed, including 'disease outbreak', 'avian influenza', 'influenza virus', 'influenza vaccinated', 'influenza viruses', 'chick embryo', 'poultry disease', 'antiviral agent', 'virus replicated', 'h5n1 virus', 'human influenza', 'cell line', 'base sequence', 'world health', 'viral protein', 'h5n1 influenza', 'species specific', 'united state', 'influenza a', and 'influenza pandemic'. A 'Term frequency: 53' slider is present below the terms.
- Apply Filters:** A section with checkboxes for 'Places', 'Concepts', and 'Time'. Below these, specific filters are applied: 'Country+Neighbors: HK', 'h5n1 virus', and 'Feb/2007-Jan/2007'. A 'Cancel Request' button is also visible.
- Filtered Documents:** Shows 'Filtered Documents: 53'. A list of filtered terms is displayed, including 'h5n1 virus', 'h5n1 influenza', 'avian influenza', 'influenza viruses', 'virus infect', 'influenza vaccinated', 'antiviral agent', 'disease outbreak', 'influenza virus', 'human influenza', 'neutralization test', 'virus strain', 'base sequence', 'h5n1 infected', 'virus h5n1', 'virus isolate', 'virus replicated', 'antiviral drug', 'cell line', 'clinical sign', 'pandemic influenza', 'respiratory system', 'viral replication', 'adrenal glands', 'ai virus', 'control measure', 'cross reaction', 'dna vaccinated', 'domestic cat', 'enzyme inhibitors', 'genetics vector', 'genome segment', 'h5 virus', 'human transmissibility', 'molecular characterization', 'neuraminidase inhibitor', 'partial protection', 'pcr assay', 'risk assessment', 'species barrier', 'species specific', 'virus cultivated', 'virus vaccinal', 'virulent viruses', 'wild bird', '3d structure', 'seld ph', and 'adaptive mutations'. A 'Term frequency: 35' slider and a 'Rank Change: +100' indicator are also present.
- PubMed Abstract List:** At the bottom, there are tabs for 'PubMed Abstract List', 'Annotations', 'History', and 'Document Details'. Below these tabs, a table is shown with columns for 'Date', 'Title', and 'Author(s)'. The table is currently empty, with a 'Place Holder for query results title.' above it.

# Health GeoJunction:

Geovisual Analytic approach → Computational tools + Highly Interactive Visual interface

---

## Server Functionality

- ▶ **Data sources:**
  - ▶ PubMed abstracts
  - ▶ OIE situation reports
  - ▶ WHO Avian Flu bulletins
- ▶ **Text processing (FactXtractor)**
  - ▶ Extracting keywords
  - ▶ Extracting, disambiguating, and geocoding geographic entities
  - ▶ Storing entities and bibliographic metadata in a PostGres database
- ▶ **Web services:**
  - ▶ Geographic queries via Geoserver
  - ▶ non-spatial queries
  - ▶ WMS reference map

## User Interface:

Developed with Adobe® Flex® technologies for the Flash® player web browser extension

- ▶ **Map**

Port of OSGeo OpenLayers to ActionScript3
- ▶ **Hierarchical gazetteer**
- ▶ **Comparative Tag clouds**
- ▶ **Time series**
- ▶ **Document result set**
- ▶ **User annotation**





# Health GeoJunction:

Geovisual Analytic approach → Computational tools + Highly Interactive Visual interface

---

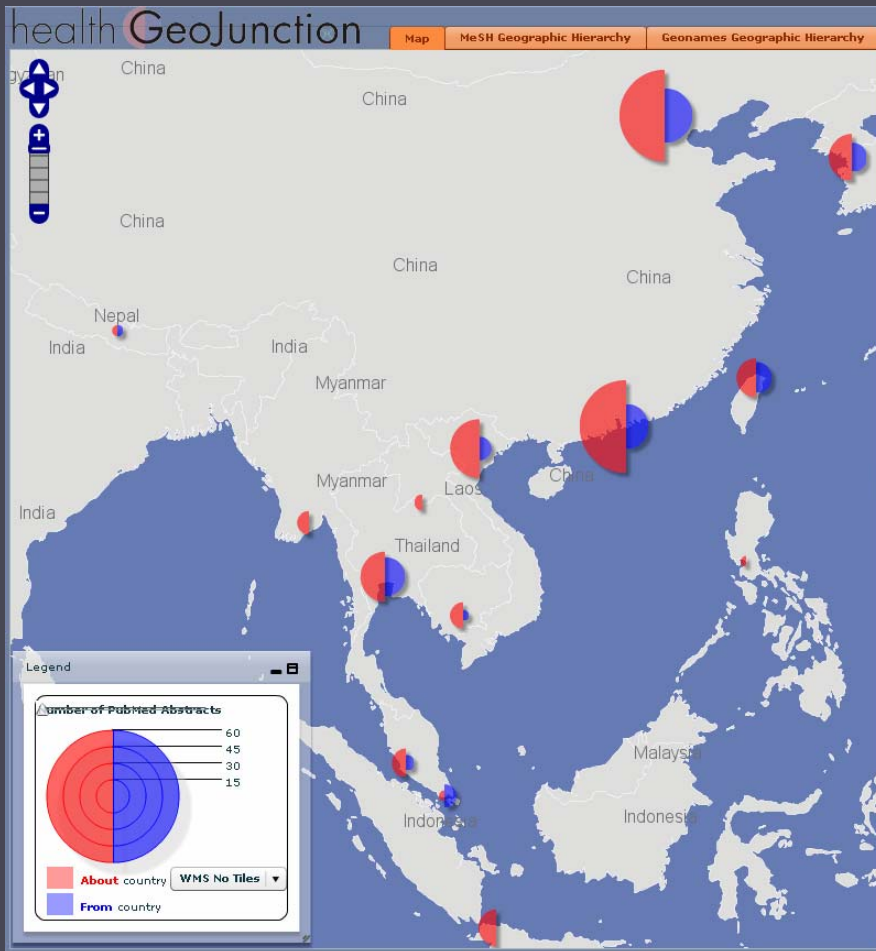
## Primary functionality

- ▶ **Space-time-concept query:**
  - ▶ Space: 'about', 'from', within country, within neighboring countries
  - ▶ Time: user defined intervals
  - ▶ Concept:
    - ▶ MeSH (Medical Subject Headings)
    - ▶ Automated tagging: one term, two term, Yahoo tag service
  - ▶ Facet-like tracking of query parameters
- ▶ **Overview + detail comparative tag clouds**
  - ▶ 'Overview': tag cloud for full document set
  - ▶ 'Details': tag cloud for filtered set
  - ▶ Rank comparison, sorting, highlighting by frequency
- ▶ **Query-by-example:**
  - ▶ Return related documents ordered by relevance (Lucene indexing technology)
- ▶ **Annotate**
  - ▶ Insert graphics within time series referencing short text entries



## Client Functionality

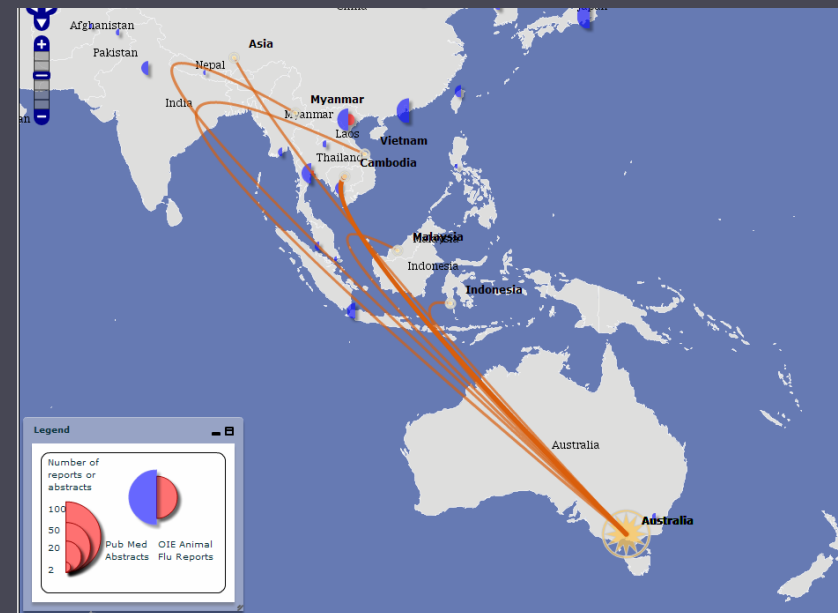
# Map and Hierarchical Gazetteer



Overview map



Gazetteer: hierarchal place name list



Geographic 'footprint' map

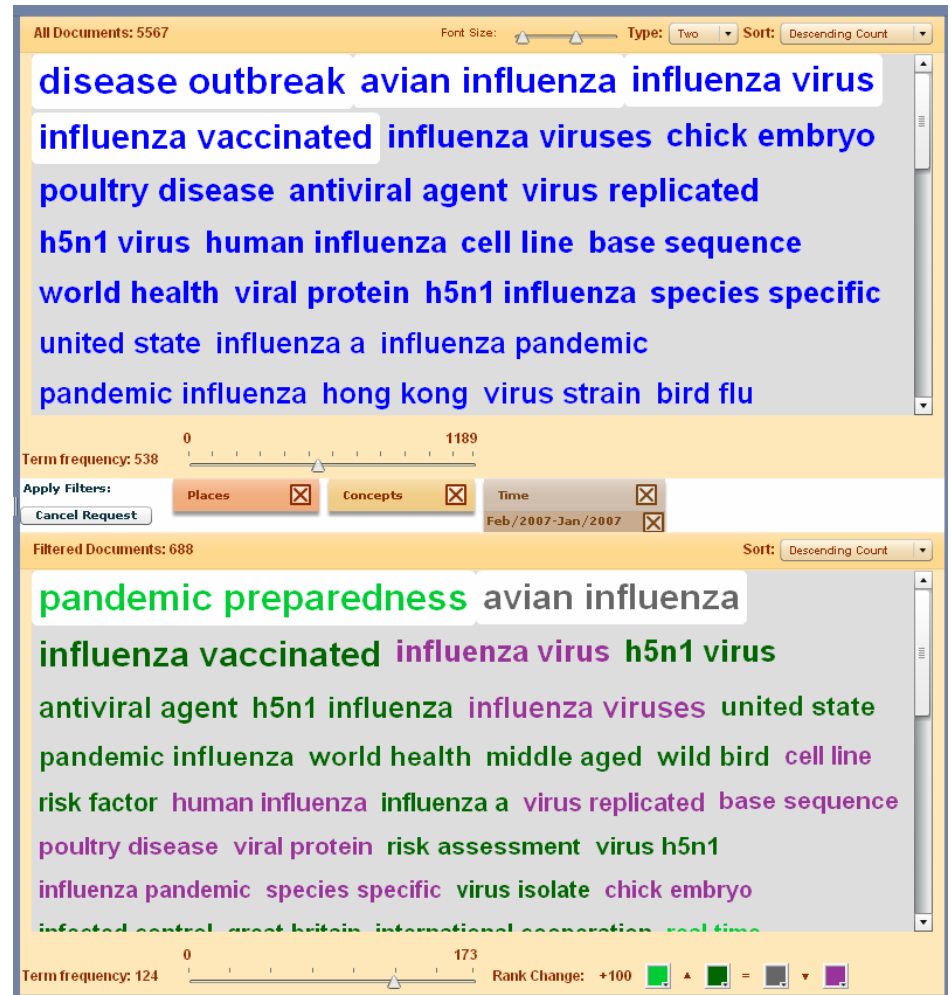
# Comparative Tag Clouds and Facet-like Query

## Tag Cloud

- ▶ All documents vs. filtered set
- ▶ Dynamic font size weighting to handle large and small variations in term frequency
- ▶ Term highlighting by frequency threshold
- ▶ Color coded categories for the change in rank order of terms
- ▶ Progressive filtering document set by selection of terms in either overview or filtered tag cloud

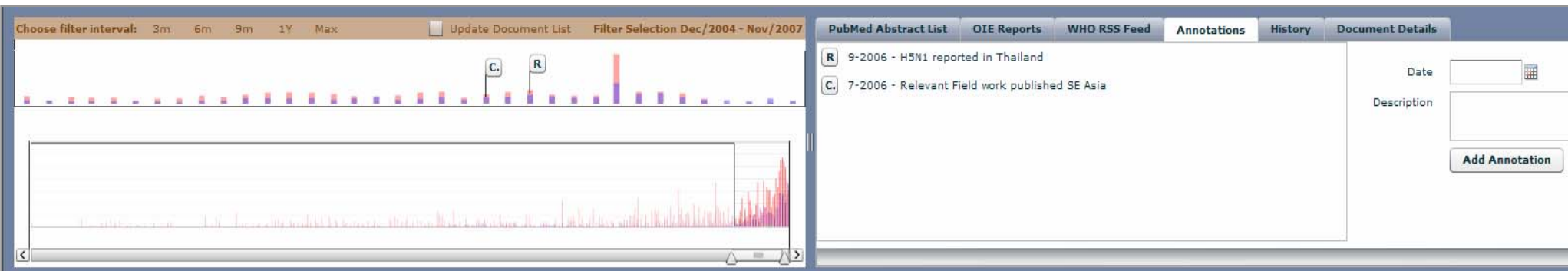
## Facet-like Panels

- ▶ Concept
- ▶ Place
- ▶ Time



# Time series and Annotations

- ▶ Preset Filter intervals
- ▶ User defined interval
- ▶ Stacked time series: Overview+detail
- ▶ Mouse-over details
- ▶ Paired bar chart of document counts with 'from' and 'about' locations
- ▶ Time series annotation



# Health GeoJunction: Coordinated views to support space-time-concept exploration

Temporal Filtering


Concept Filtering

Location Filtering

**Results:**

**1** What are the global temporal, geographic, and attribute components of Avian Flu events and science?  
*temporal (constraint)* *spatial (result)* *thematic (result)*

**Query by Time** **Overview Map** **Country Details**




Sequence (1) shows a stacked time line filtered for a ten month period resulting in a graduated symbol map of disease events and publications and a tag cloud of key terms for these articles. Conceptually, this is an example of constraining the temporal dimension to view the resulting spatial and thematic dimensions.

Graduated symbol maps: The first map shows paired graduated symbols for each country representing the number of avian flu disease incident reports and the number PubMed articles by author location. The second map image shows the result of navigating and zooming to a larger scale and then placing the mouse over a symbol to review a summary of the associated documents.

**Filtered Tag Clouds:** The upper tag cloud lists the top 100 most common keywords from all abstracts in the PubMed document set about avian flu. More common terms are displayed in a larger font. Those displayed in dark blue exceed a user defined threshold for the number of articles using a given keyword. The lower tag cloud limits results to selected time ranges.

**2** What documents use this concept?  
*thematic (constraint)*

**Query by Concept** **Document List** **Document Footprint**



Document List

| Document ID | Title                                       | Location  |
|-------------|---|-----------|
| 15876611    | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |
| 15876612    | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |
| 15876613    | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |
| 15876614    | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |
| 15876615    | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |


Document Footprint

Document Footprint: Area originates at the location affiliated with the author(s) and terminates at the location of place entities extracted from the abstract using FactOnStructure (Pan and Mills, 2007) and georeferenced with GeoNames.org web services.

**3** Where are the authors and what places are they writing about?  
*thematic (result) | thematic (constraint)* *spatial (result)*

**4** What reports have been issued about Avian Flu for this place? Articles?  
*spatial (constraint)* *thematic (result) | thematic (constraint)*

**Query by Place** **Article or Report List** **Article or Report**



Article or Report List

| Article ID | Title                                       | Location  |
|------------|---|-----------|
| 15876611   | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |
| 15876612   | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |
| 15876613   | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |
| 15876614   | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |
| 15876615   | Avian influenza A (H5N1) virus in Hong Kong | Hong Kong |

Article or Report

Document Footprint: Area originates at the location affiliated with the author(s) and terminates at the location of place entities extracted from the abstract using FactOnStructure (Pan and Mills, 2007) and georeferenced with GeoNames.org web services.

**Example queries:** The sequences listed above (1-4) are examples of some the ways the data are represented visually and how interacting with these allows the user to iteratively query across temporal, spatial, and attribute (thematic) dimensions.

# Work in progress

- Structured annotation
- Visual overview and filtering
- Managing histories of user interaction

# Visualizing, structuring, and managing geographic annotation

---

- ▶ **Annotating a dynamic, interactive geoanalytic interface**
  - ▶ What does the user need to do?
  - ▶ How should he or she be able to do these things?
  - ▶ How will he or she know these actions are possible?
- ▶ **Making sense of annotations: searching and summarizing**
  - ▶ How can relevant annotations be discovered and made available? (directed searches and serendipitous discoveries)
  - ▶ How can an overview of a subset of annotations be incorporated while still providing a usable interface?
- ▶ **Given these needs, how do you structure and manage annotation contributions?**
  - ▶ Argumentation model
  - ▶ Related work in library sciences



# Visualizing Annotation

---

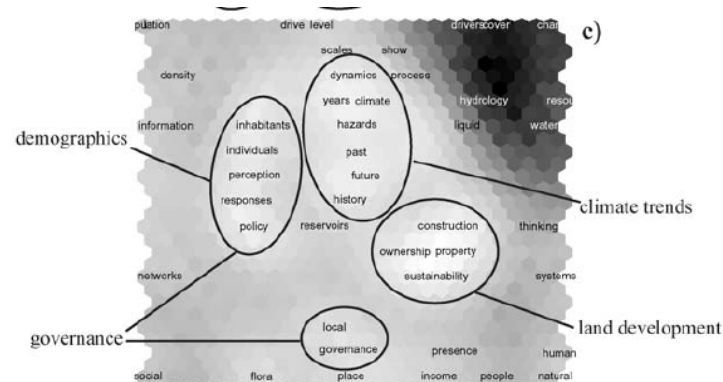
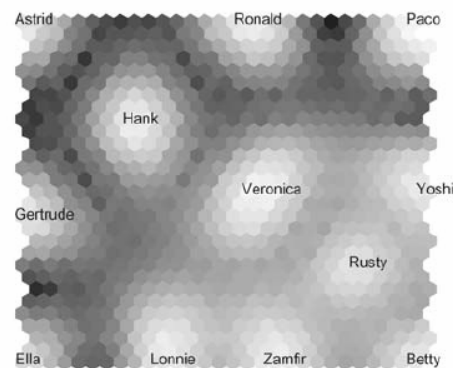
- ▶ Geographic context of individual contributions
  - ▶ Point, line, area geographic references
  - ▶ References to multiple places
  - ▶ References at multiple geographic scales
  - ▶ References to vague geographic regions
  - ▶ Incorporating localization for places
- ▶ Capturing issues and concepts within a given geographic context
  - ▶ Argumentation maps (Rinner, 2001)
  - ▶ Argumentation model: four types of contributions
    - (1) Questions
    - (2) Solution/Idea
    - (3) Evidence or values in support
    - (4) Evidence or values in opposition





# Visualizing Annotation (continued)

- ▶ Visual summaries (computational approaches for grouping and reducing the number of elements)
  - ▶ Self Organizing Map (SOM) to visualize clusters of concepts or individuals by similarity of contributions (Pike and Gahegan, 2003)
  - ▶ Reducing the number of elements to display
    - ▶ Filtering by relevance (using Lucene indexing technology for customized 'more like this' searches)
  - ▶ Hinting at elements as the user navigates to an area or happens upon similar search criteria



# Summary

---

- ▶ Health GeoJunction is a webportal that provides a visual analytic interface to web services that allow the exploration of entities extracted from a collection of documents
- ▶ Health GeoJunction core features include:
  - ▶ Text processing of document collections to populate a data store accessible through OGC compliant webservice
  - ▶ Geographically focused search through coordinated views that support space-time-concept queries
  - ▶ Overview+detail document collection view through paired tag clouds
  - ▶ Query-by-example provides related documents ordered by relevance
- ▶ An initial implementation of georeferenced annotations are proposed as an approach for capturing, managing, and visualizing user insight and facilitating collaboration within a visual analytic environment



# Acknowledgements

---

This work is supported by the National Visualization and Analytics Center, a U.S. Department of Homeland Security program operated by the Pacific Northwest National Laboratory (PNNL). PNNL is a U.S. Department of Energy Office of Science laboratory.

Scott Pezanowski provided actionscript library for OpenLayers functionality in Flex.



---

Thank you for you time.  
Comments and questions are welcome.

For more information:

Contact: [stryker@psu.edu](mailto:stryker@psu.edu)

Visit: <http://www.geovista.psu.edu/>



# References

---

- Endsley, M. R. (1995). "Toward a Theory of Situation Awareness in Dynamic Systems." *Human Factors* 37(1): 32-64.
- MacEachren, A.M., 2005. Moving Geovisualization toward Support for Group Work. In: J. Dykes, A.M. MacEachren and M.-J. Kraak (Editors), *Exploring Geovisualization*. Elsevier Ltd., Kidlington, Oxford, pp. 445-461.
- Pan, Chi-Chun, Mitra, Prasenjit. , October 30, 2007. 'FemaRepViz: Automatic Extraction and Geo-Temporal Visualization of FEMA National Situation Updates', *IEEE Symposium on Visual Analytics Science and Technology (VAST 2007)*, Sacramento, CA.
- Pike, W. and M. Gahegan (2003). *Constructing Semantically Scalable Cognitive Spaces*. COSIT 2003: Conference on Spatial Information Theory, Springer Verlag.
- Rinner, C. (2001). "Argumentation maps: GIS-based discussion support for on-line planning." *Environment and Planning B: Planning and Design* 28: 847-863.
- Smallman-Raynor, M. and A. D. Cliff (2008). "The Geographical Spread of Avian Influenza A (H5N1): Panzootic Transmission (December 2003f??May 2006), Pandemic Potential, and Implications." *Annals of the Association of American Geographers* 98(3): 553 - 582.

contact: [stryker@psu.edu](mailto:stryker@psu.edu)

---

