Visualization of space-time patterns of West Nile virus

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CPSC 533c: Information Visualization
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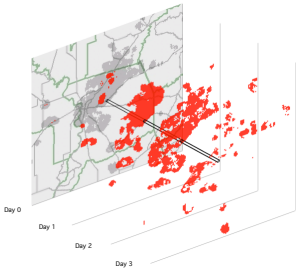
West Nile Virus: brief review

- WNV is dangerous to humans, but primarily transmitted between birds and mosquitoes
- Dead bird surveillance programs are used to track areas of human WNV risk
- Lag time exists between bird deaths and human infections
- Lag is poorly characterized and may vary from region to region

West Nile Virus Risk Analysis

- Dead bird tracking produces daily raster map of WNV activity
  - Binary risk/no risk classification ("lit" / "not lit")
- Given date and location of human cases in previous years:
  - What is the relationship between risk patterns and human cases?
  - Does the relationship vary spatially?
  - What patterns of risk are the best predictors of human infections?

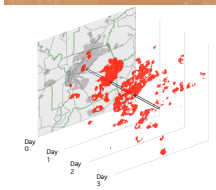
A New Approach: Risk Histories



For each human case, identify its raster cell

Extract that pixel from each daily risk raster

Risk Histories



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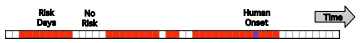
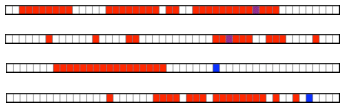
…result is a string of risk/no-risk values



Risk Histories

Risk histories can be juxtaposed in any order to look for similarities

Comparisons no longer bound by spatial proximity



Risk Histories: Sorting

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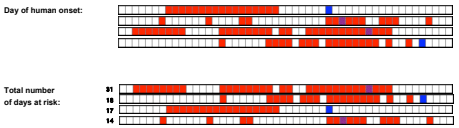

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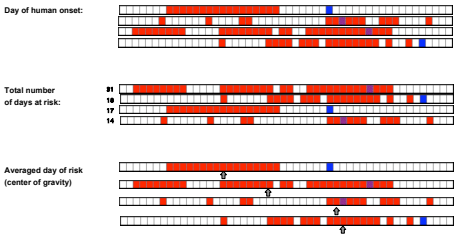
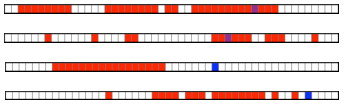


Risk Histories: Timeshifting

Risk histories can also be shifted in time

By aligning the dates of human onset, time values are now relative to human case, not relative to calendar time

Comparisons no longer bound by temporal proximity



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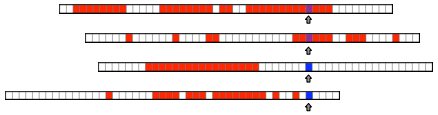


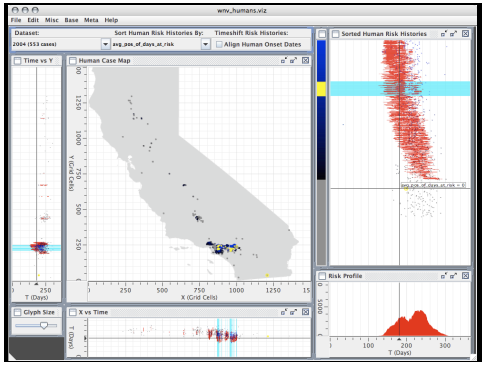
Visualization Goals

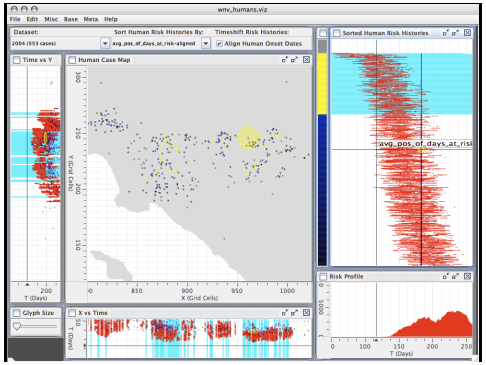
- Provide means to view and explore risk histories
  - Non-geographic spatial juxtaposition via sorting
  - Non-calendar temporal juxtaposition via timeshifting
- Multiple linked views
  - Provide context, links back to real-world space and time
  - Observed similarities in risk history view can be mapped back to real-world

Implementation

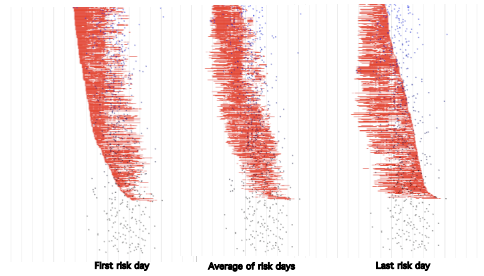
- Creation and sorting of risk histories performed by a suite of command-line utilities written in Perl
- Visualization created using Improvise
  - Java-based visualization environment
  - Visualizations are constructed interactively within Improvise
  - Live Properties provide multiply coordinated views and easy experimentation during visualization

Demo…

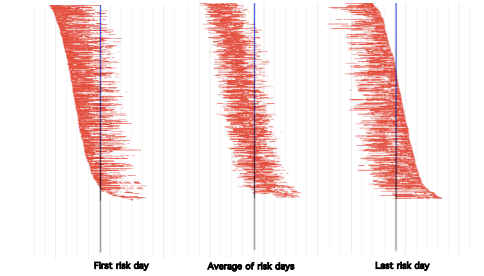




Sorts



Aligned Sorts



Strengths and Weaknesses

- **Software**
  - Improvise is powerful, but may limit future flexibility
    - Live Properties impose limits on interaction between views
    - Impossible for one view to modify certain attributes of another view, such as range of viewport.
- **Theory**
  - What if risk in adjacent cells matters?
    - Difficult to extend this technique
  - Perhaps only useful for large-scale analysis
    - Too much random noise in the data
    - Too many contributing factors
  - Even if a similar risk pattern is found in several human histories, currently no way to see how many times that pattern appeared and did not result in a human case

User comments

- Public health biologist working with West Nile virus
- Really liked multiple views
- Risk histories took some getting used to
- Found the profile view the most informative
  - View was provided for context; cannot provide information about specific relationship between risk and human onset
  - However, it is a useful overall view, made interactive here for first time
- My conclusion: the study of WNV lacks application of current infovis tools. Perhaps that needs to be remedied first before inventing new techniques.

Possible Future Improvements

- Clustering based on string similarity
- More flexible sorts, query-based selection
  - Example: sort by number of risk days in a 5 day window, 10 days before onset
- Fit curve to the sorted results
  - obtain quantitative value for comparison between datasets
- Integrate more geographical data
  - Select based on climate regions, population density
  - Selection based on county for public health officials