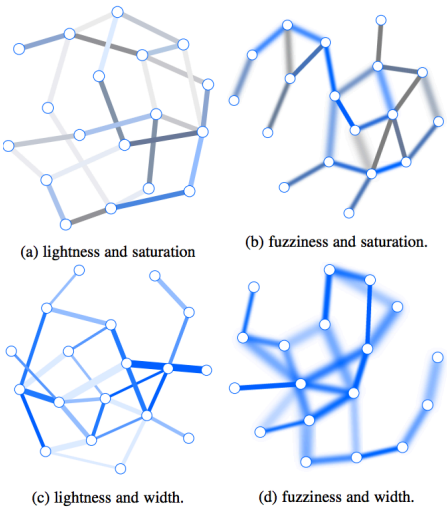
Uncertainty Part II: Node-Edge Graphs & Terrain

Today

- Reading for Today
  - "Representing Uncertainty in Graph Edges: An Evaluation of Paired Visual Variables"
  - Related Paper: "Quantitative Texton Sequences for Legible Bivariate Maps"
- Prof Franklin's work on Observer Siting
  - An example of uncertainty visualization
- Emergency Management Visualization
  - Sean Kim's masters project
- Readings for Tuesday after Break

Reading for Today

- "Representing Uncertainty in Graph Edges: An Evaluation of Paired Visual Variables" Guo, Huang, and Laidlaw, IEEE TCVG 2015



Bertin's Original Visual Variables

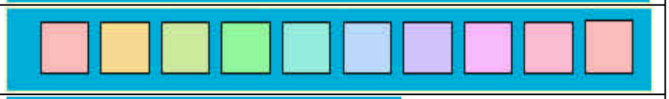
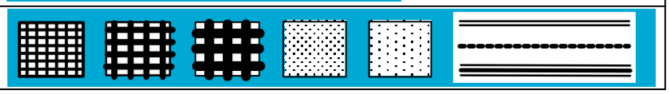
Position changes in the x, y location	
Size change in length, area or repetition	
Shape infinite number of shapes	
Value changes from light to dark	
Colour changes in hue at a given value	
Orientation changes in alignment	
Texture variation in 'grain'	

Table 1: These are Bertin's visual variables

https://cdn.mprog.nl/dataviz/excerpts/w2/Carpendale_Considering_Visual_Variables.pdf

color based
focus based
geometry

- Visual Variables:
  - J. Bertin [1967/1983]
    - location/position, size/width, color hue, color value/ brightness, grain, orientation, and shape
  - J. L. Morrison [1974]
    - Color saturation, arrangement
  - Cleveland & McGill [1984]
    - Angle, volume curvature
  - A. M. MacEachren [1992]
    - Focus/fuzziness, resolution, transparency
  - M. Carpendale [2003]
    - Motion, depth, occlusion

- Encode "strength" (placeholder data)
  - Width, hue, or saturation
- Encode uncertainty using a visual variable
  - Lightness, fuzziness, grain, or transparency

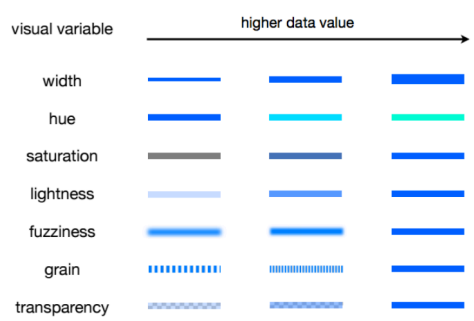


Fig. 1: An illustration of how each of the seven visual variables progress with increasing data value.

- Their conclusions only apply to line based marks

- Which visual variables are most salient? Are most discriminable?
- Disassociativity of each pair of visual variables: Can you differentiate changes in one variable while ignoring changes in another variable?
- Are some visual variables more appropriate (more natural/intuitive?) for certain data?
- Evaluate by studying response time, accuracy
- How much can we (should we?) pack into a single visualization?
- Tangent: Are we good at multitasking?

- Random graphs
- Each edge one of 5 values for "strength" and "uncertainty"
- Locate one edge of a specific value (max or min) of strength or uncertainty that must be identified (or determined to be missing)
  - "find extremum"
  - "retrieve value"
  - "visual search"
- Which graph has overall higher strength or uncertainty?
  - "characterize distribution
  - "identification-comparison"
  - "visual aggregation"
- Varied the relative discriminability of the two variables
  - Perception of the weaker one is better when they are more similar

- Large number of hypotheses
- 20 participants, 1 hour each, 5760 trials
  - Short teaching/training session with feedback on correctness
  - (personally don't want to have to administer a user study!)
- Provide explicit design recommendations, useful reference
- Not surprised that lightness interferes with hue and width confused with fuzziness; Surprised that grain performed well
- Well written
  - clearly state hypotheses, justified their conclusions well
  - I could recreate the results from this paper
  - "open questions" instead of future work
- How would the results be different with people with visual training (not novices)?
- How would the results be different for colorblind users?
- Would have liked to see a real-world example of this graph style. And specifically high density graphs (requires thin edges).

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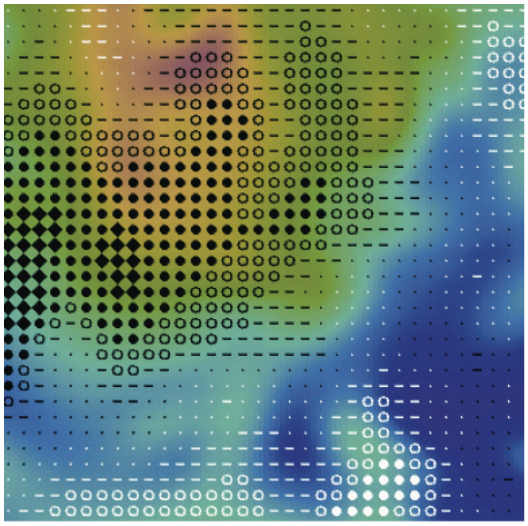
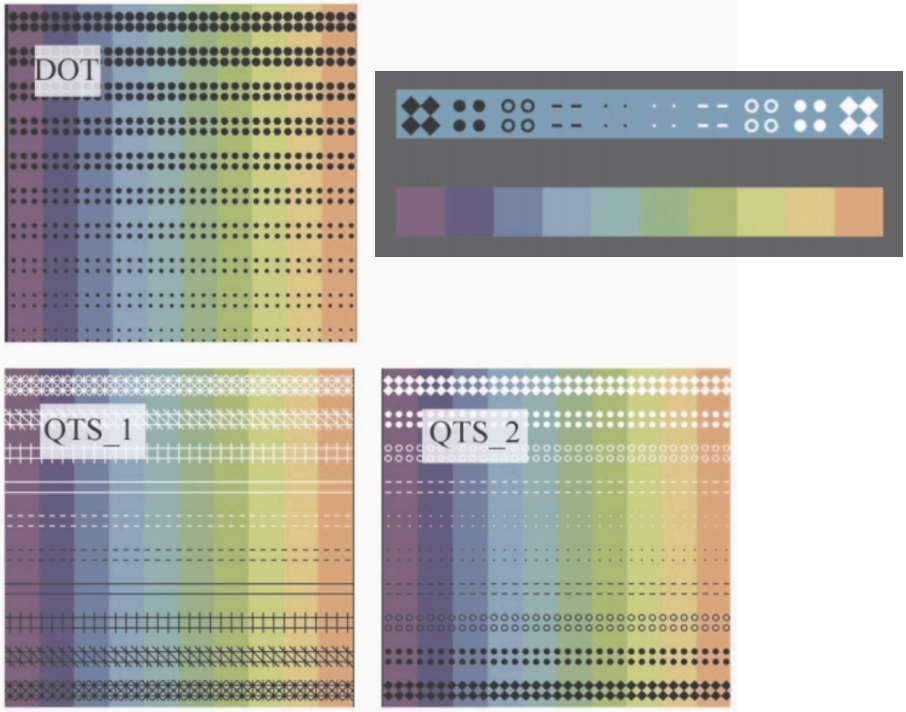
- Colin Ware, "Quantitative Texton Sequences for Legible Bivariate Maps," *IEEE Transactions on Visualization and Computer Graphics*, 2009.





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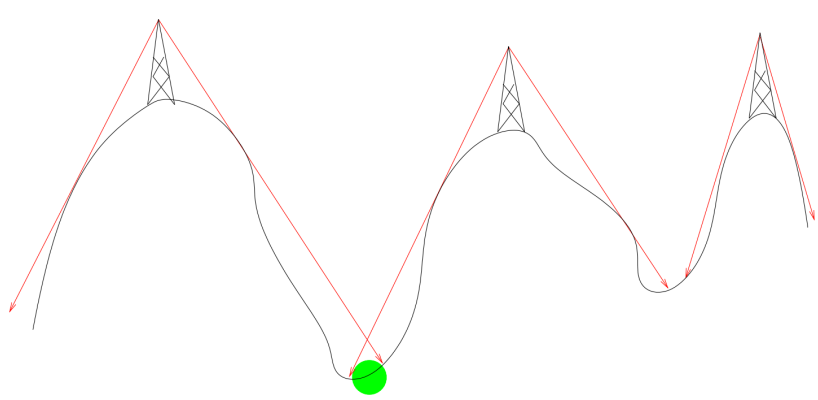
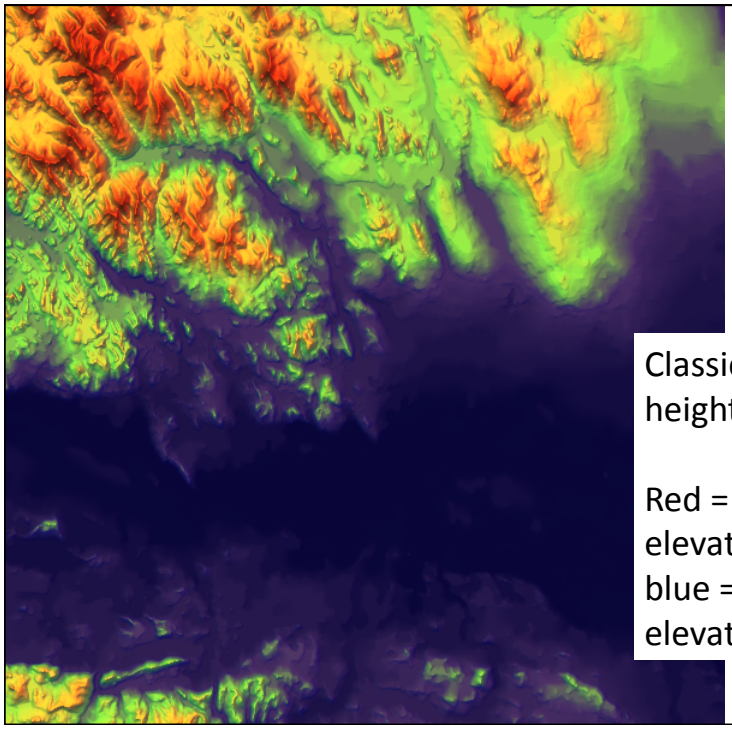
Optional Reading for Today:

- "Siting Observers on Terrain"
  Wm Randolph Franklin, RPI ECSE

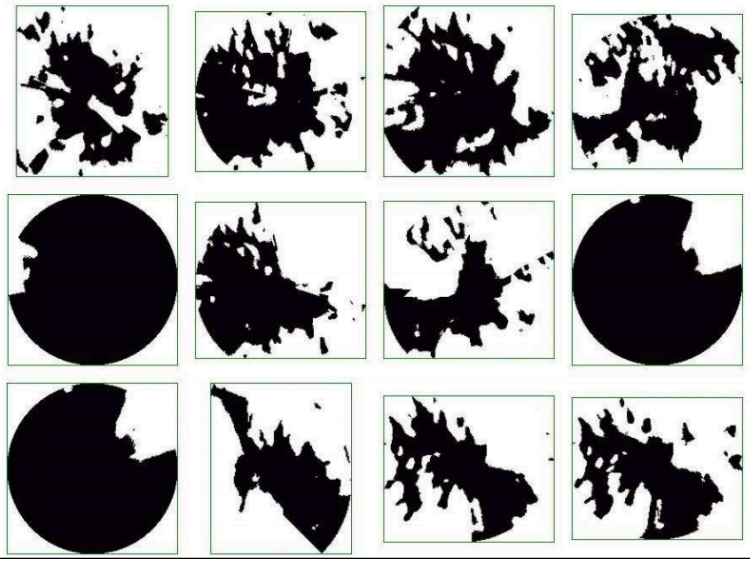


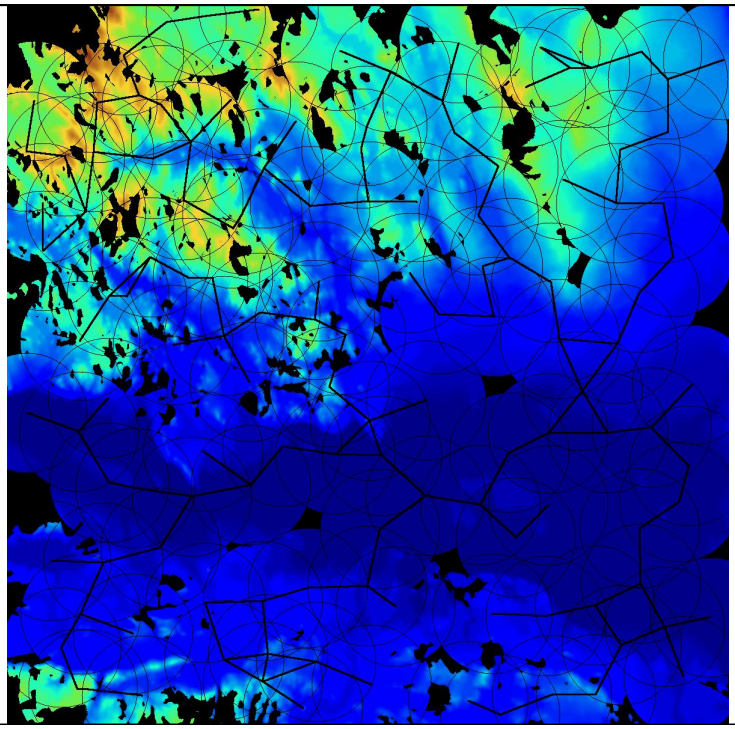


Classic terrain height visualization

Red = higher elevations
blue = lower elevations

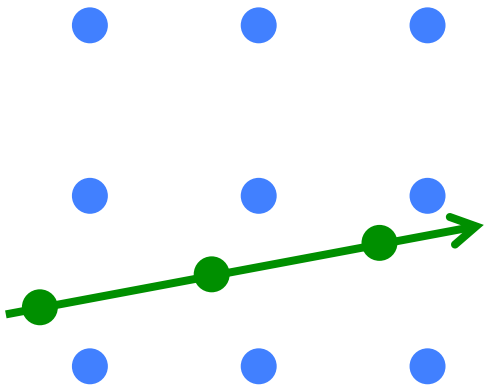
Observers have a specified maximum straight line sight distance
Some observer placements see more (black)
Some are occluded





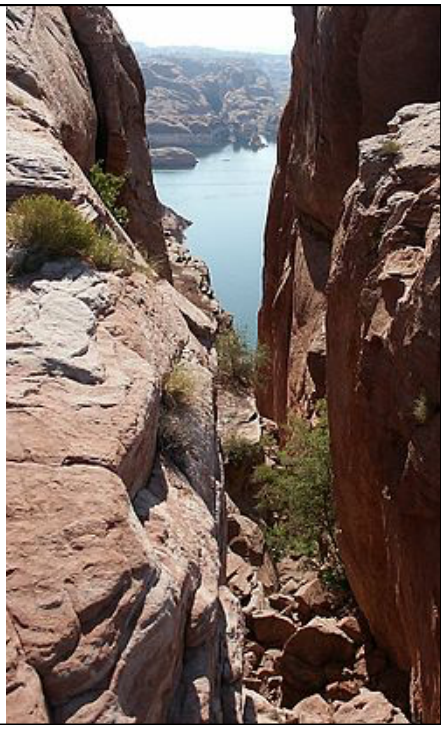
- Let's place "observers" (e.g., cell phone towers) on a complex terrain
  - Where should they be placed to maximize coverage?
    - What if the observers need to see each other? (form a connected network for communication)
  - How much error is introduced because of the original sensor measurements (discrete sample points might miss significant ridges or valleys)?
  - How much error is introduced if the dataset is compressed for storage or transmission and then lossily reconstructed?
    - Erroneous visibility, Erroneous occlusions
  - Knowing the terrain and placement of "red team" observers what path should the "blue team" take to avoid being seen?
  - Knowing that it will be used to do siting tasks, can you design a better compression algorithm that reduces lossy artifacts that cause significant errors?

Regular grid of height samples



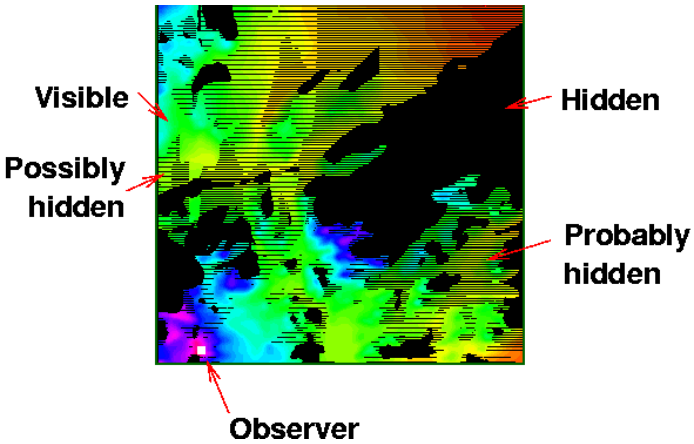
Query for occlusions along sight line

Data interpolation might be incorrect!



Hue = terrain height
Value (binary color/black) = visibility
Grain/texture = uncertainty

If height is changed by epsilon, the visibility flips!



The visibility of one half of the points in uncertain!

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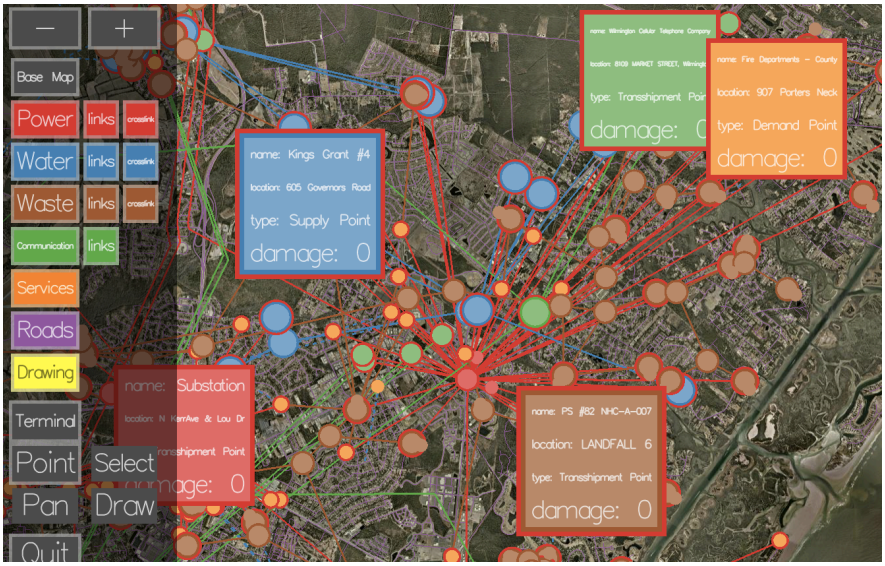
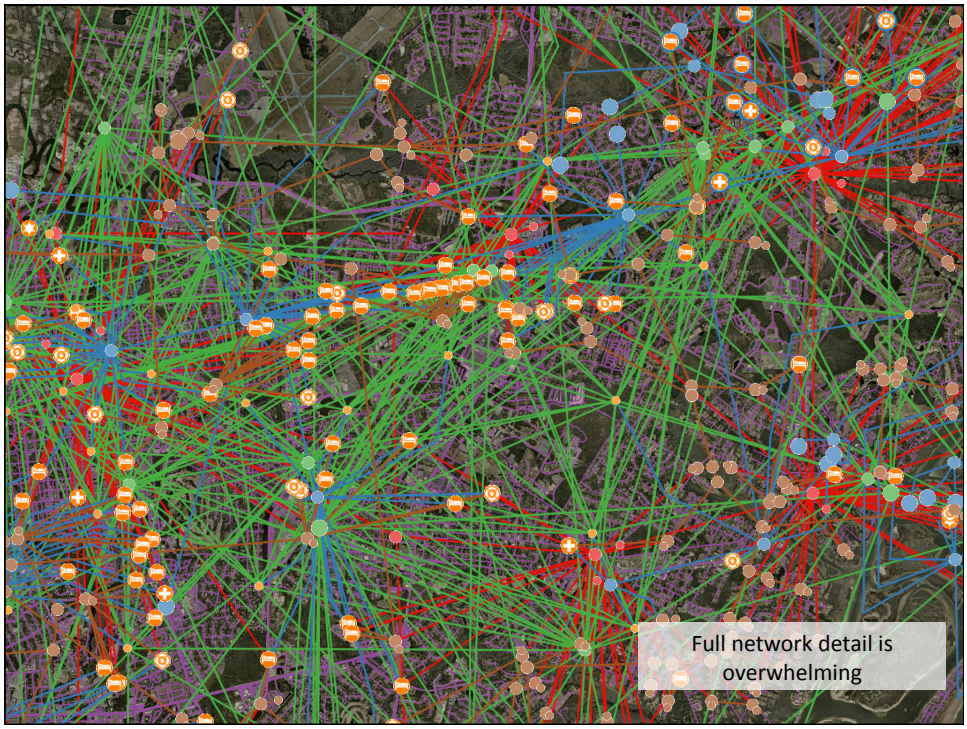
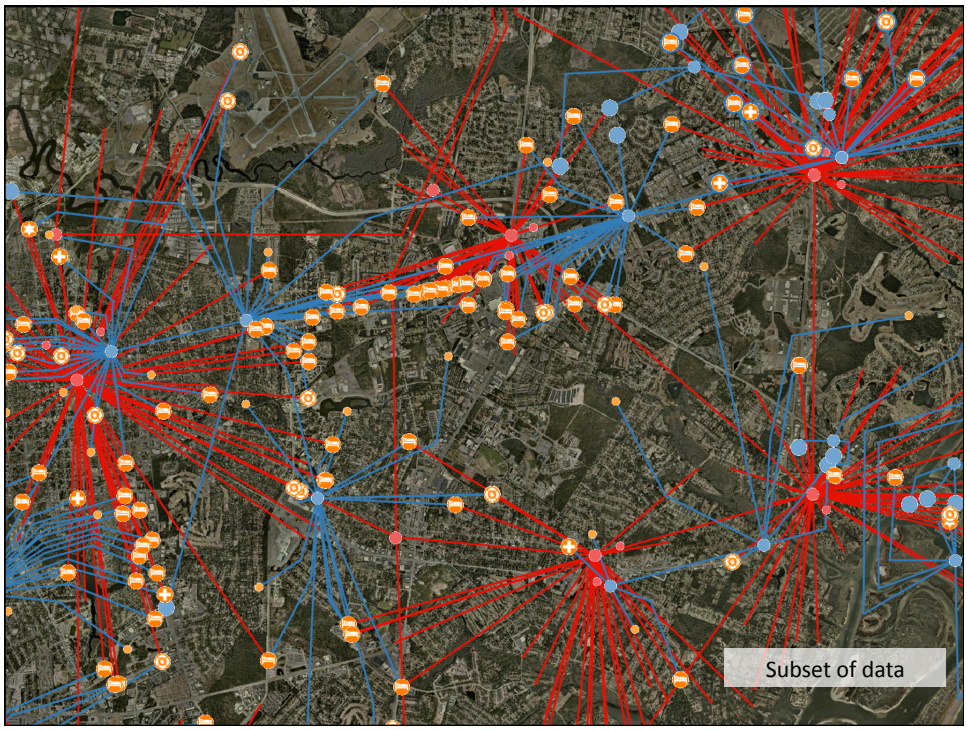
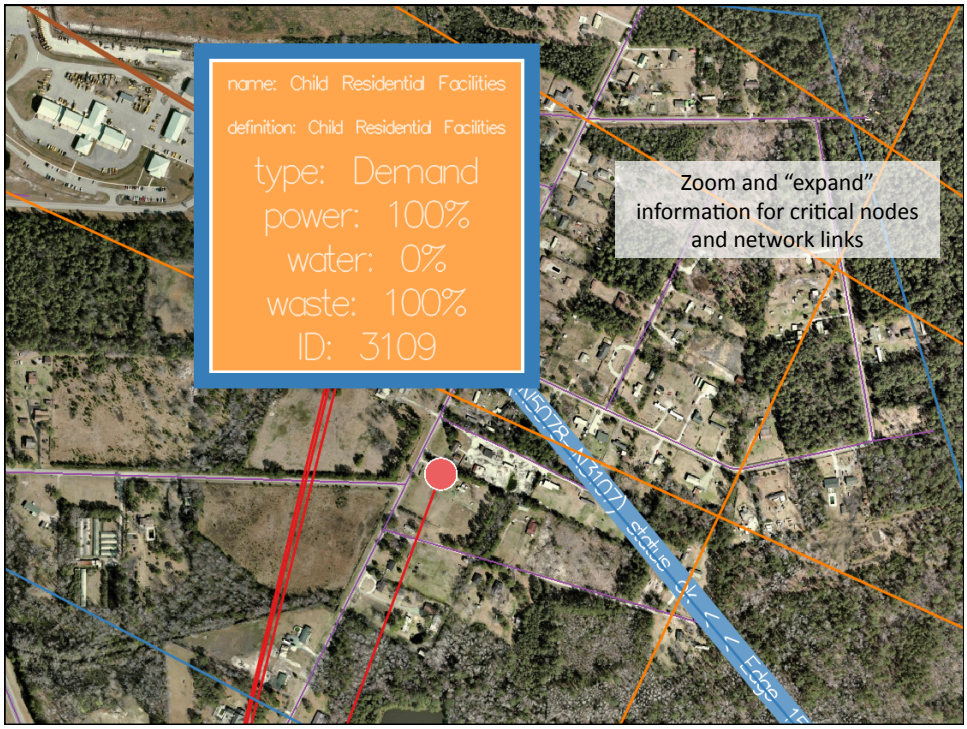
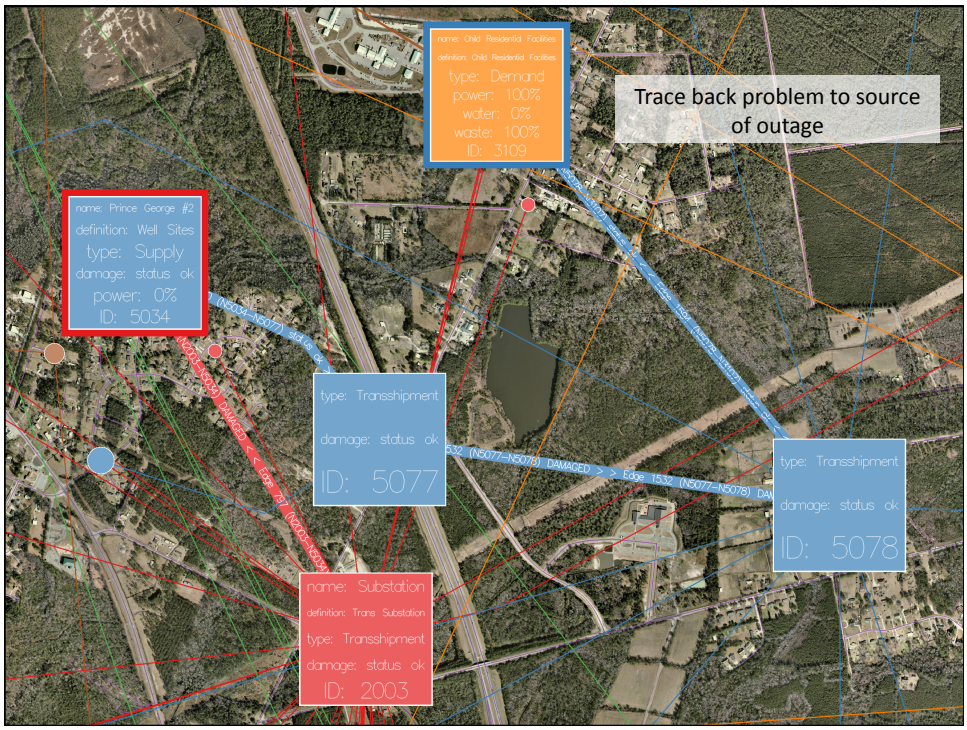
Emergency Response Decision Making

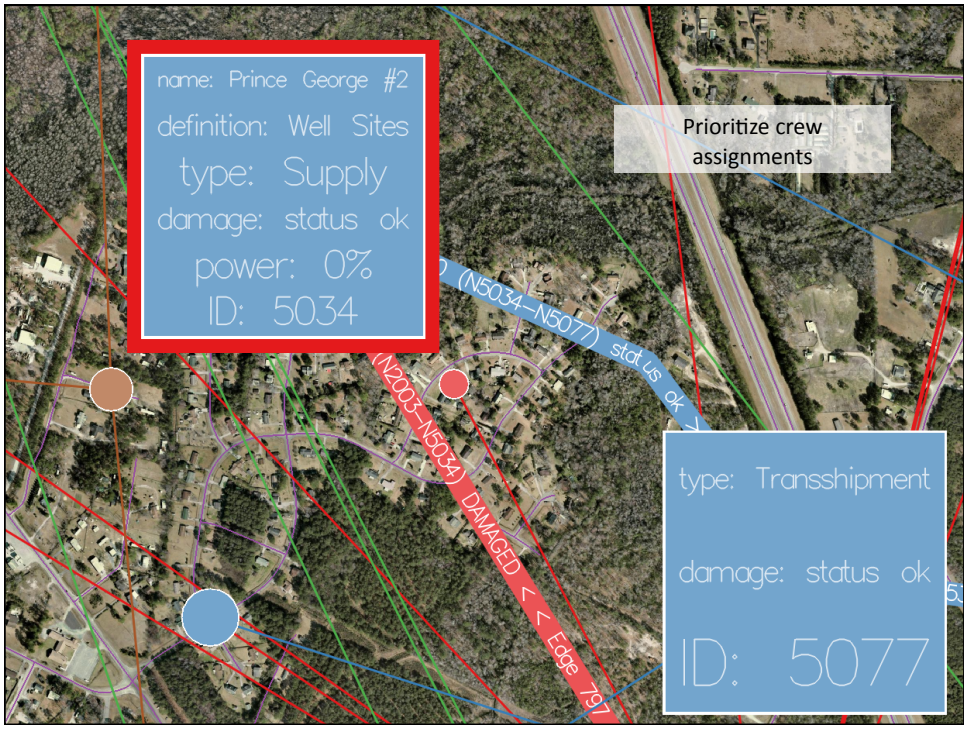


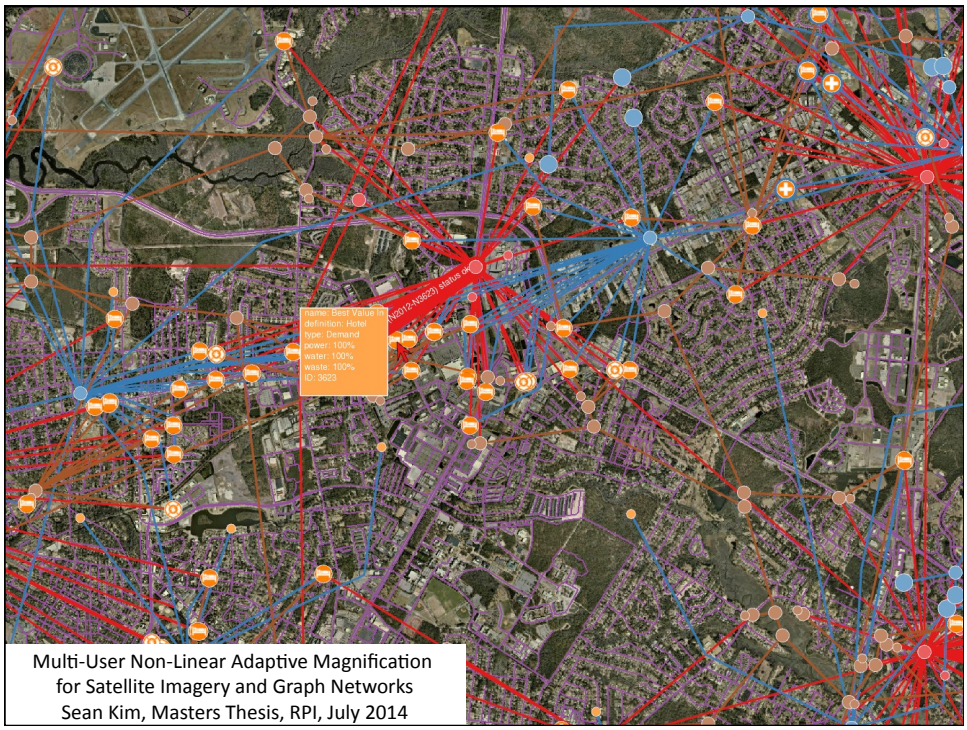

Full network detail is overwhelming


Subset of data

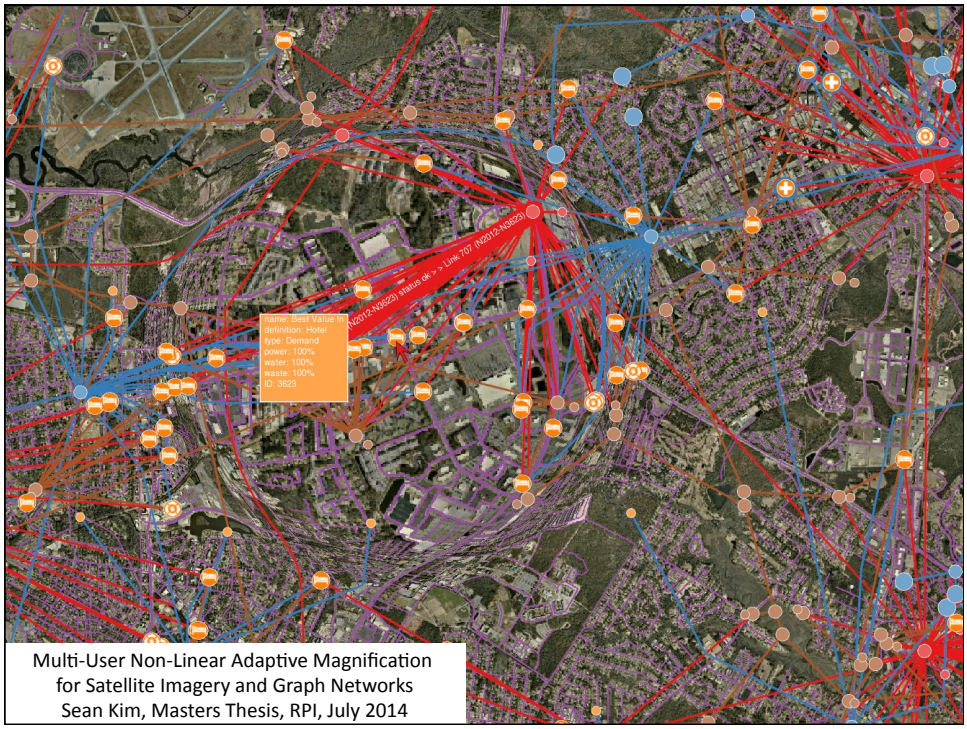

name: Child Residential Facilities
definition: Child Residential Facilities
type: Demand
power: 100%
water: 0%
waste: 100%
ID: 3109
Zoom and "expand" information for critical nodes and network links


name: Child Residential Facilities
definition: Child Residential Facilities
type: Demand
power: 100%
water: 0%
waste: 100%
ID: 3109
Trace back problem to source of outage
name: Prince George #2
definition: Well Sites
type: Supply
damage: status ok
power: 0%
ID: 5034
type: Transshipment
damage: status ok
ID: 5077
type: Transshipment
damage: status ok
ID: 5078
name: Substation
definition: Trans Substation
type: Transshipment
damage: status ok
ID: 2003





Multi-User Non-Linear Adaptive Magnification for Satellite Imagery and Graph Networks
Sean Kim, Masters Thesis, RPI, July 2014



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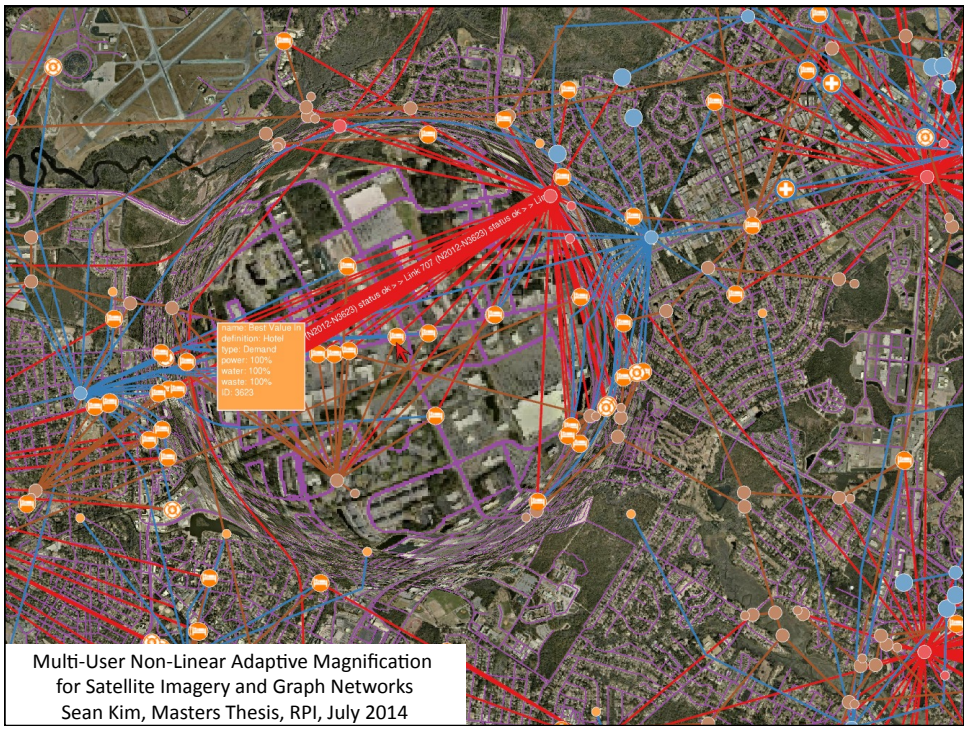

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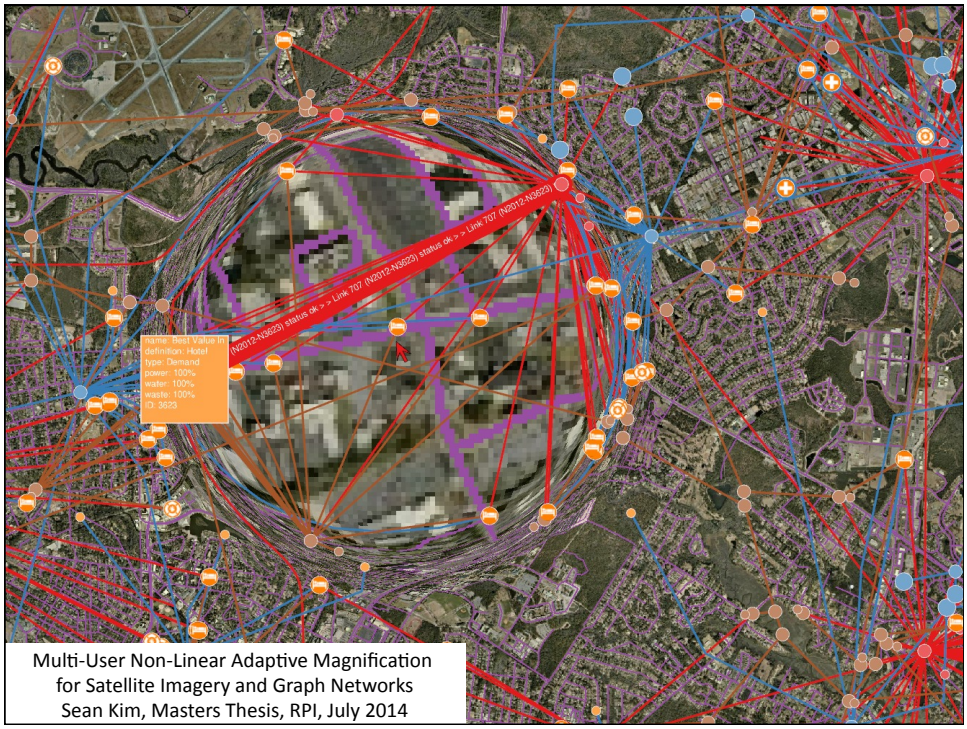

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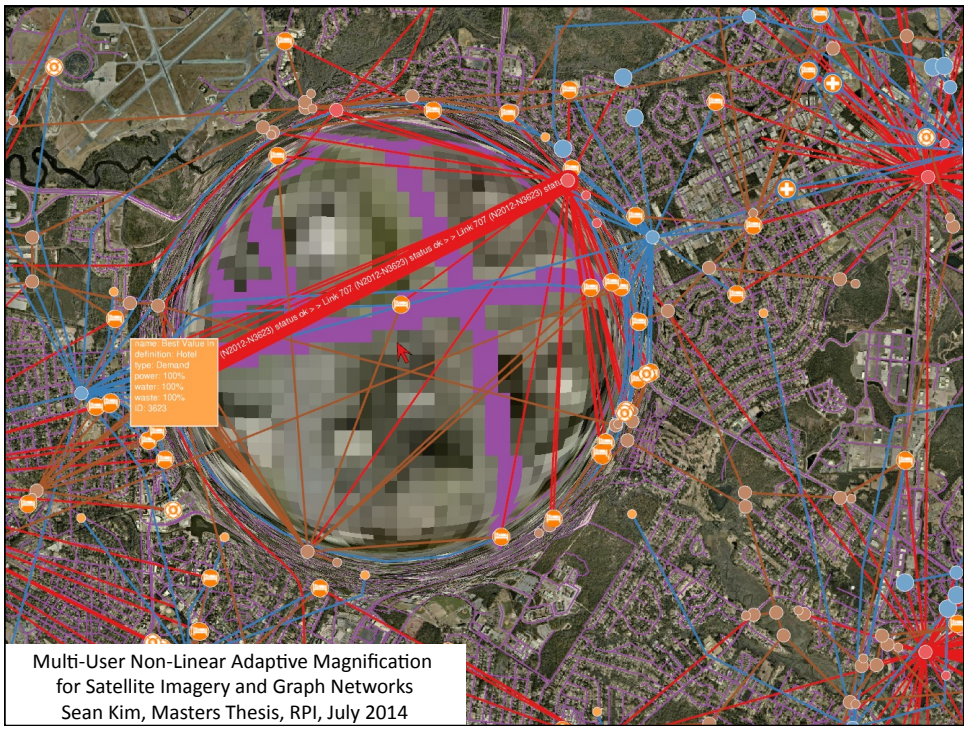

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- Visual.ly's Code of Ethics for Data Visualization Professionals
- Society of Professional Journalists' Code of Ethics

Short: Read both

- "Adaptive Privacy-Preserving Visualization Using Parallel Coordinates", Dasgupta & Kosara, TVCG 2011.
- "Agile Ethics for Massified Research and Visualization", Neuhaus & Webmoor, Information, Communication & Society 2012.

also…

Longer: Choose 1