

Uncertainty-Aware Data Transformations for Collaborative Reasoning

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Objectives

- Mathematical foundation for uncertainty quantification, propagation and aggregation in visual analytic
- Visual mapping of uncertainty to enable analysts to gain insight from the data with correct confidence level
- Supporting collaborative reasoning
 - Incorporating and conveying uncertainty
 - Increasing confidence level (i.e., certainty) with collective knowledge and findings

Uncertainty-Aware Visualization of Networks

- Node-link graphs can represent some aspects of social networks, but not the underlying network.
- They carry an inherent uncertainty due to incomplete data, errors, or misleading structures
- Uncertainty analysis can help Improve visual reasoning about social networks



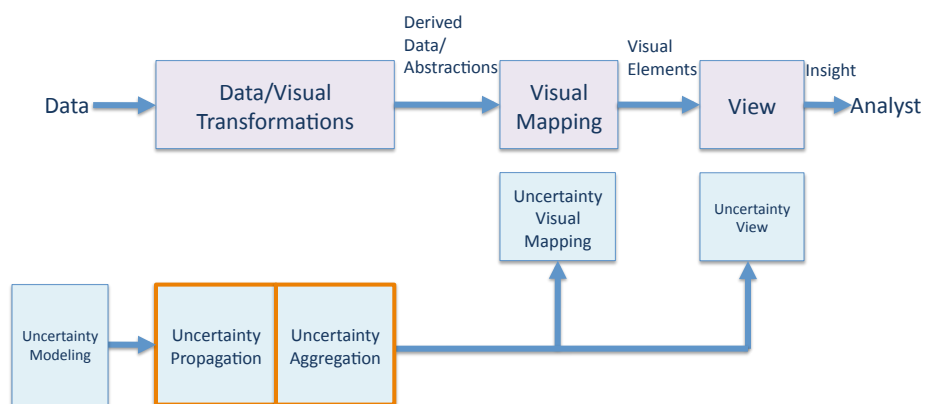
Outline

- A framework
- Modeling of uncertainty due to data transformations
- Visual reasoning about networks using centrality derivatives (with a video demo)

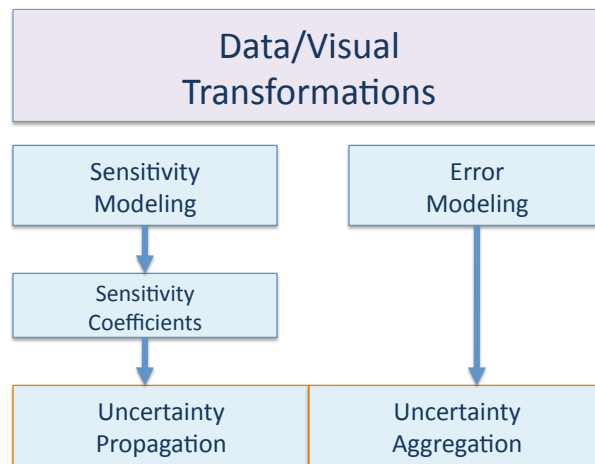
Uncertainty Framework for Visual Analytics

- Formalize the representation of uncertainty and basic operations
- Quantify, propagate, aggregate, and convey uncertainty introduced over a series of data transformations
- Enhance and evaluate visual reasoning using uncertainty with this framework
- Intend to support collaborative reasoning

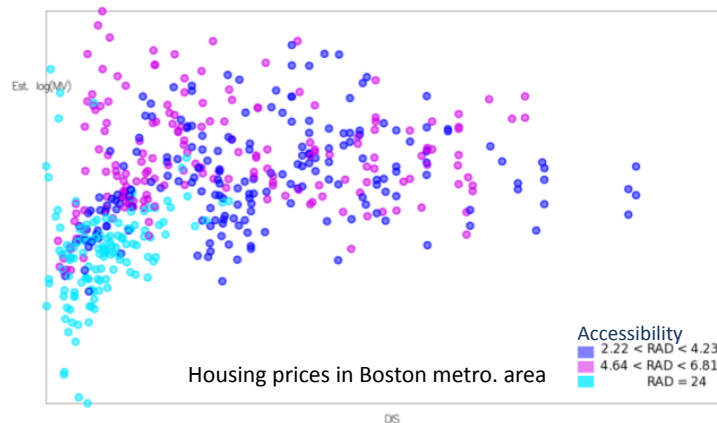
General Framework



General Framework

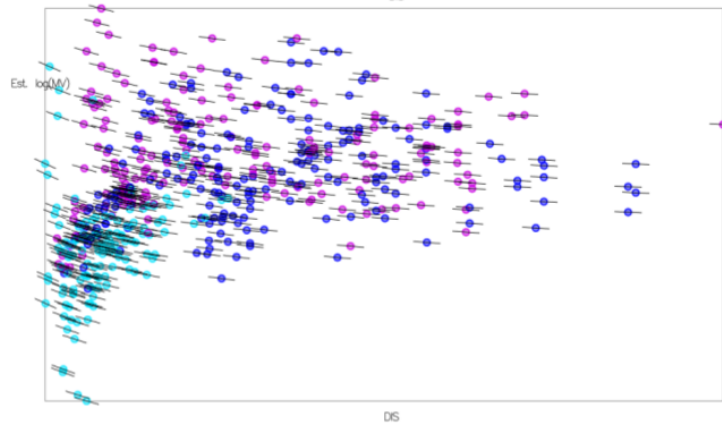


Modeling with Sensitivity Analysis



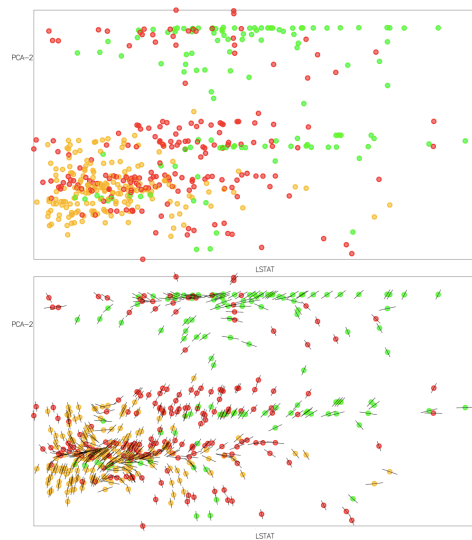
- Scattered plot does not clearly show trends
- Will the house value go up or down if we increase the distance/accessibility?

Derivative Visualization



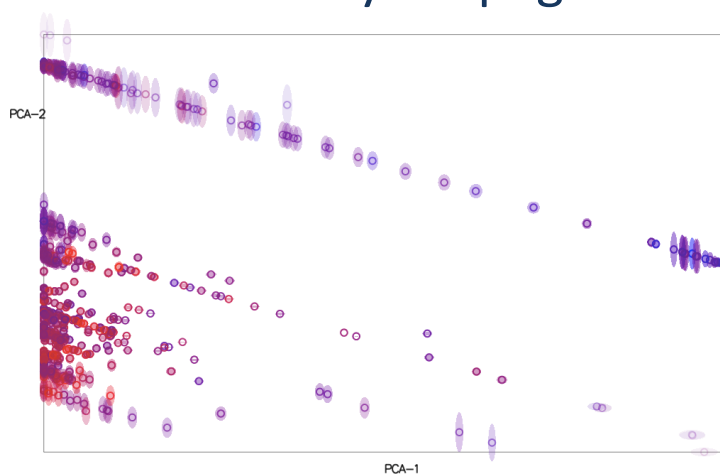
- Sensitivity analysis tells us trends in data given small variations
- Line segments are plots of computed derivatives of price with respect to distance

PCA Sensitivity to LSTAT



- Color denotes a clustering wrt the level of pollution
- Sensitivity analysis shows a critical region, where derivatives change sign

Uncertainty Propagation



- Uncertainty propagated by PCA
- Color represents price and ellipse shows uncertainty

Visual Reasoning Networks using Centrality Derivatives

- 5 minutes video

Conclusions

- Social and other scale-free networks have an inherent uncertainty, propagated through operations such as centrality, clustering and filtering.
- Analysis of such uncertainty helps us:
 - discover *competitive/cooperative* clusters
 - identify critical nodes
 - measure stability of a network
 - predict changes in importance for small perturbations.
- Machine learning for classifying nodes into meaningful/qualitative groups with the proper set of centrality metrics

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