Graphical Interactive Systems
Technische Universität Darmstadt

Visual Analysis Approaches to Multivariate Time Series Prediction

Visual Analytics – Interaktive Visualisierung sehr großer Datenmengen – Seminar SS 2018

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Outline

1. Introduction

2. Abstract Time Series
   - An Early Approach
   - A Popular Approach
   - Model Selection
   - A Specialized Approach
   - A Trendy Approach

3. Spatial Time Series
   - Forecasting and Detecting Hotspots
   - Mapping between Time and Space

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Introduction

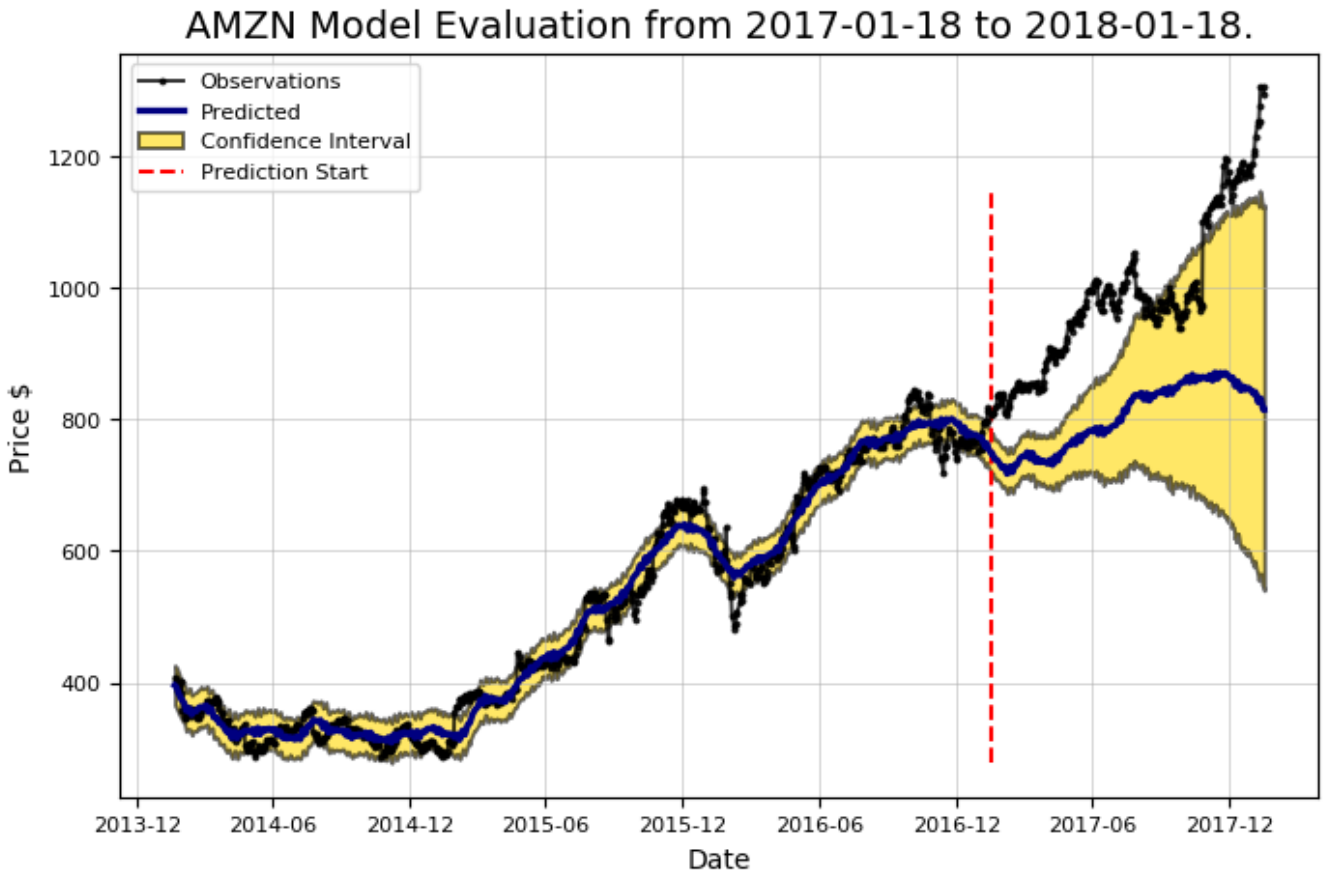

Figure 1: Amazon stock prediction
[*https://towardsdatascience.com/stock-prediction-in-python-b66555171a2*]

Introduction

Abstract Time Series:

- What is the overall global trend?
- Do I have cyclic patterns?
- What are important periods of time?

Spatial Time Series:

- What are regions with unusually high occurrences of events?
- How are these regions developing?
- Where are new hotspots occurring?

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An Early Approach

Figure 2: Workplace environment
[*Ichikawa et al., 2002*]

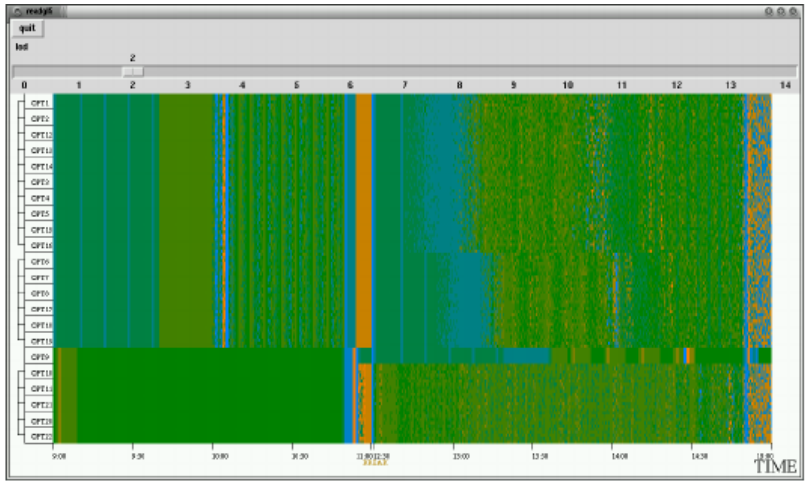

Figure 3: Color band display
[*Ichikawa et al., 2002*]

- Goal: Trend detection, correlation detection
- Compare multiple variables and different time series
- External simulations

A Popular Approach

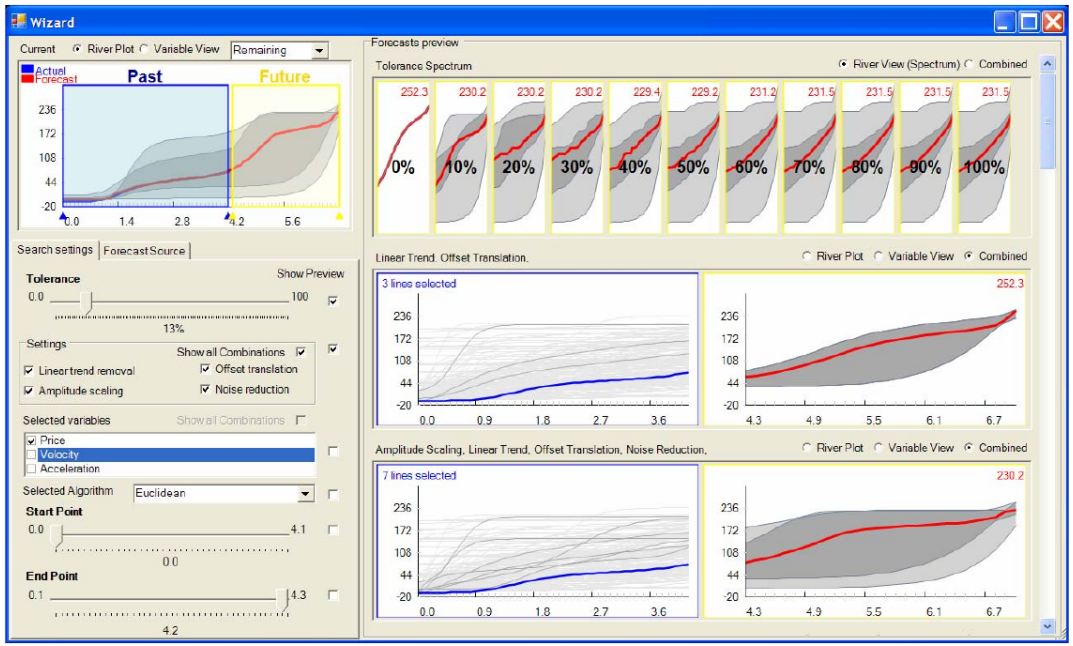

Figure 4: TimeSearcher3 simultaneous preview interface [*Buono et al., 2007*]

- Goal: Model selection
- Similarity based model and forecast
- Compare different parameters and subsets of data

A Timova Approach

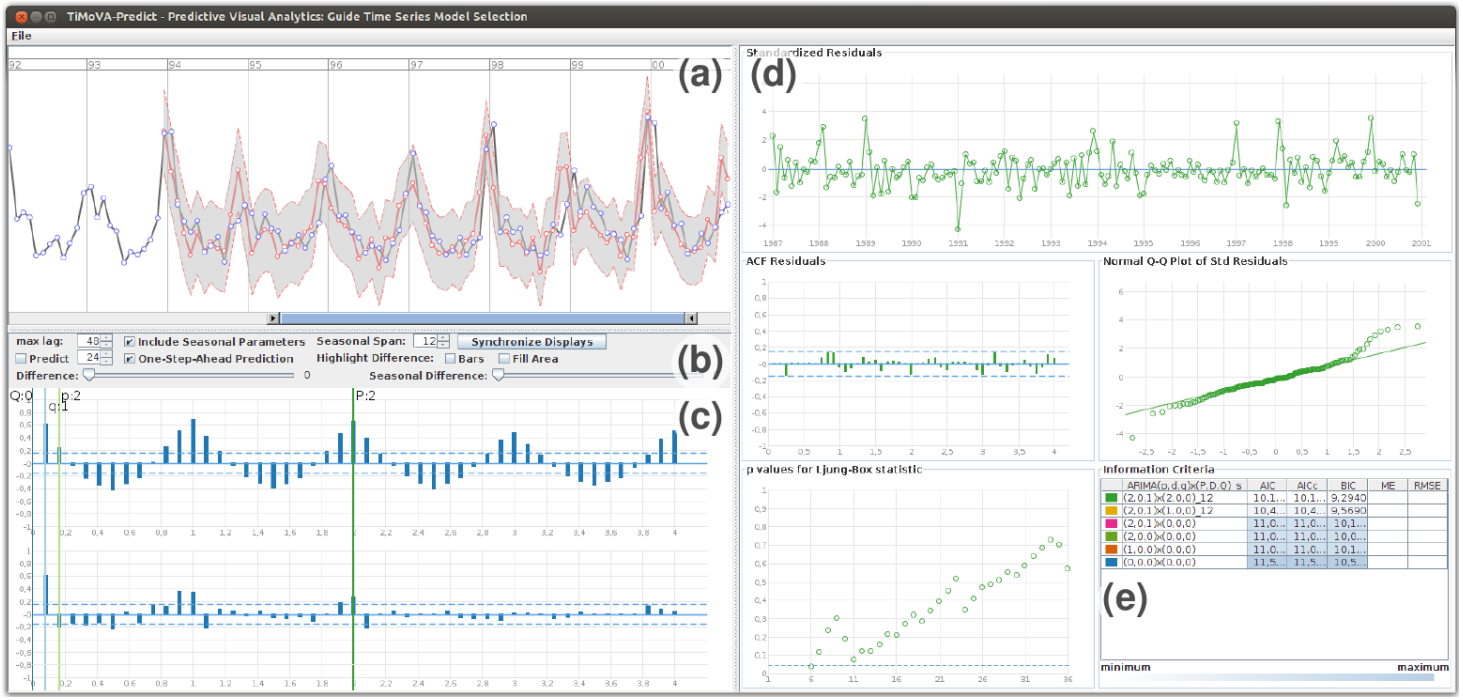

Figure 5: TiMoVA User Interface [*Bögel et al., 2013*]

- Goal: Model selection
- Box-Jenkins-Method

A Specialized Approach

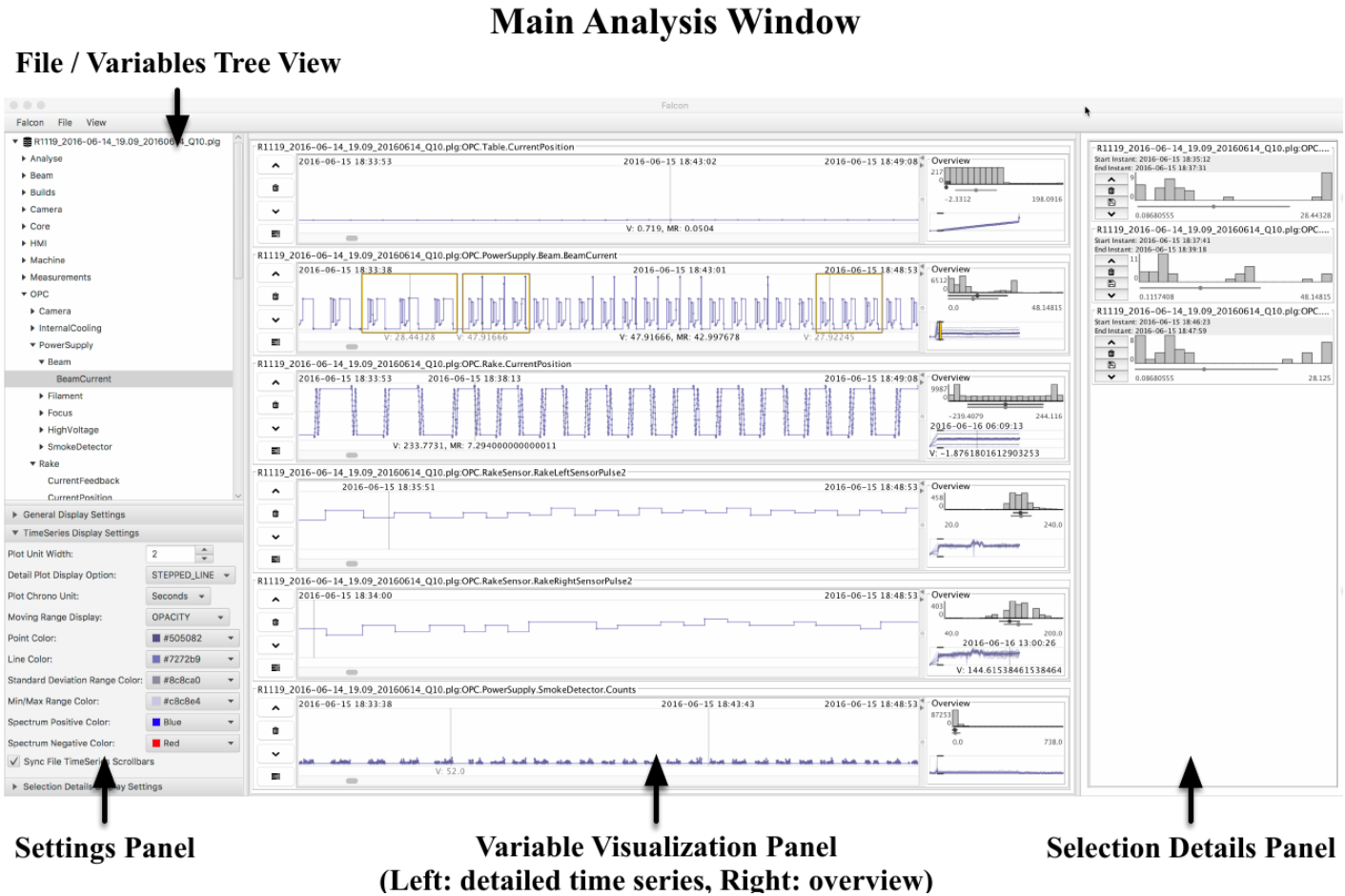

Figure 6: Falcon main window visualization [*Steed et al., 2017*]

A Specialized Approach

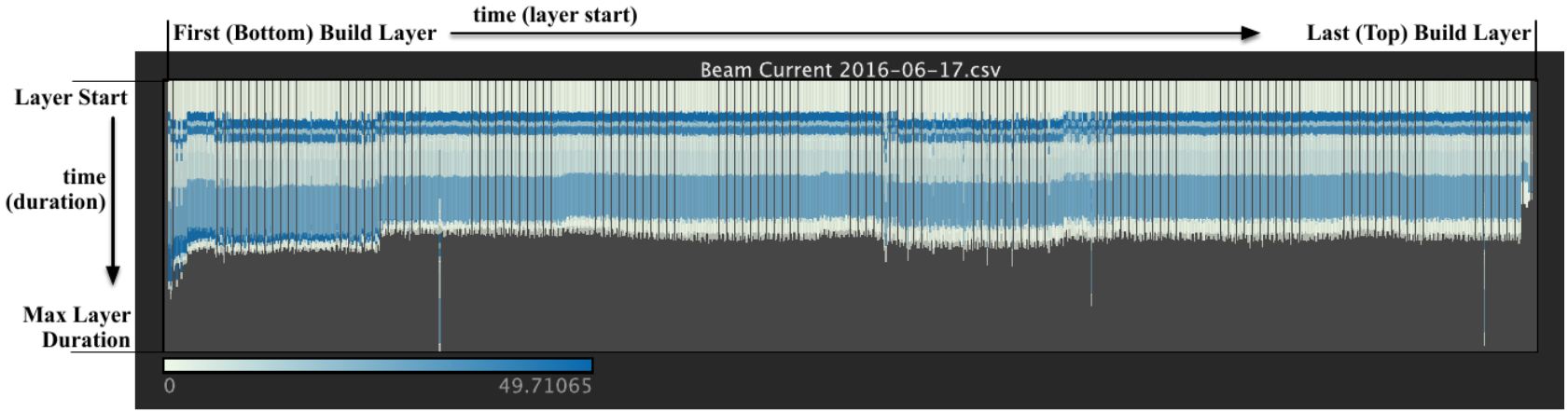

Figure 7: Falcon waterfall visualization [*Steed et al., 2017*]

- Find correlations between large amount of variables and time
- Application areas: predictive maintenance

A Specialized Approach

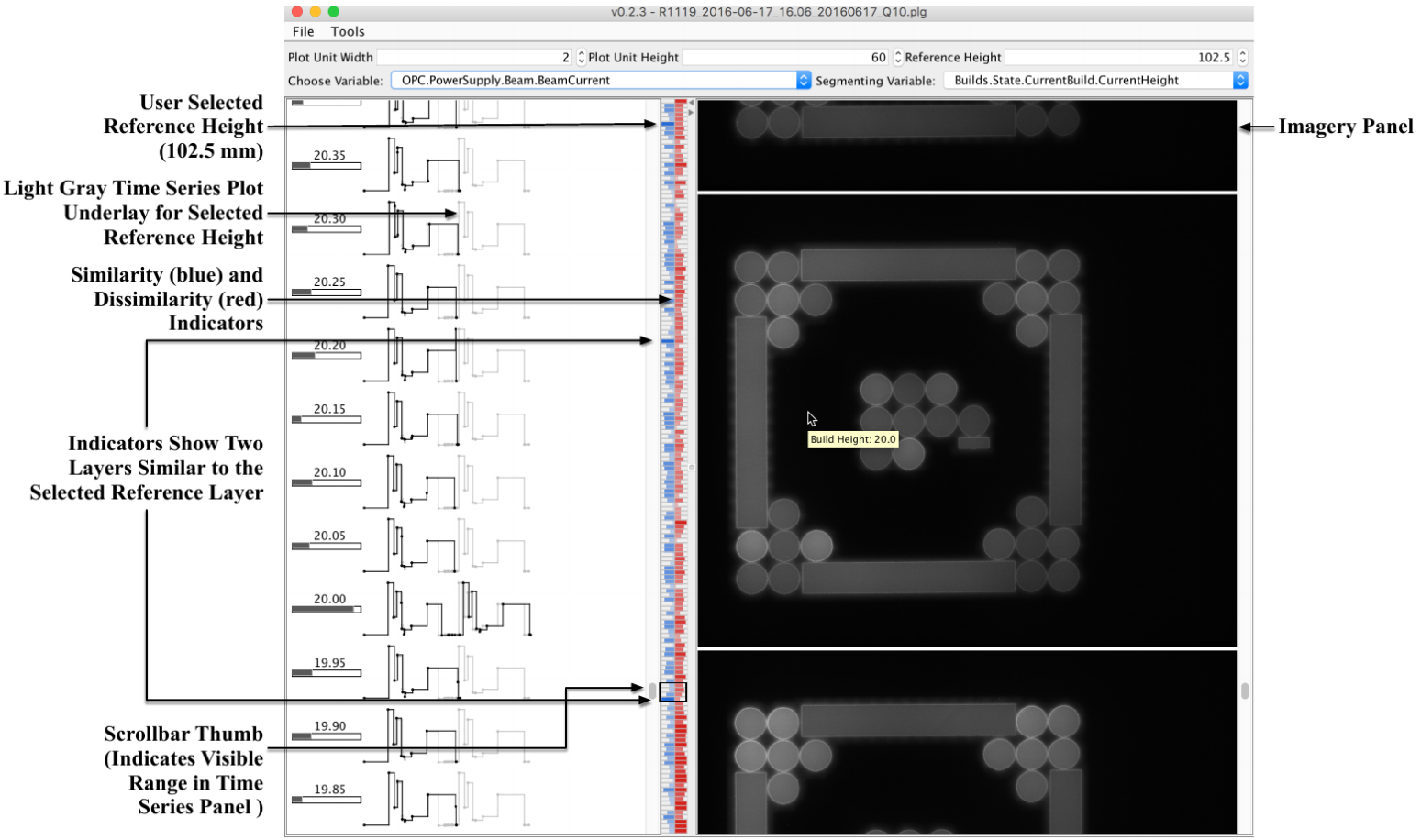

Figure 8: Falcon segmented time series view [*Steed et al., 2017*]

A Trendy Approach

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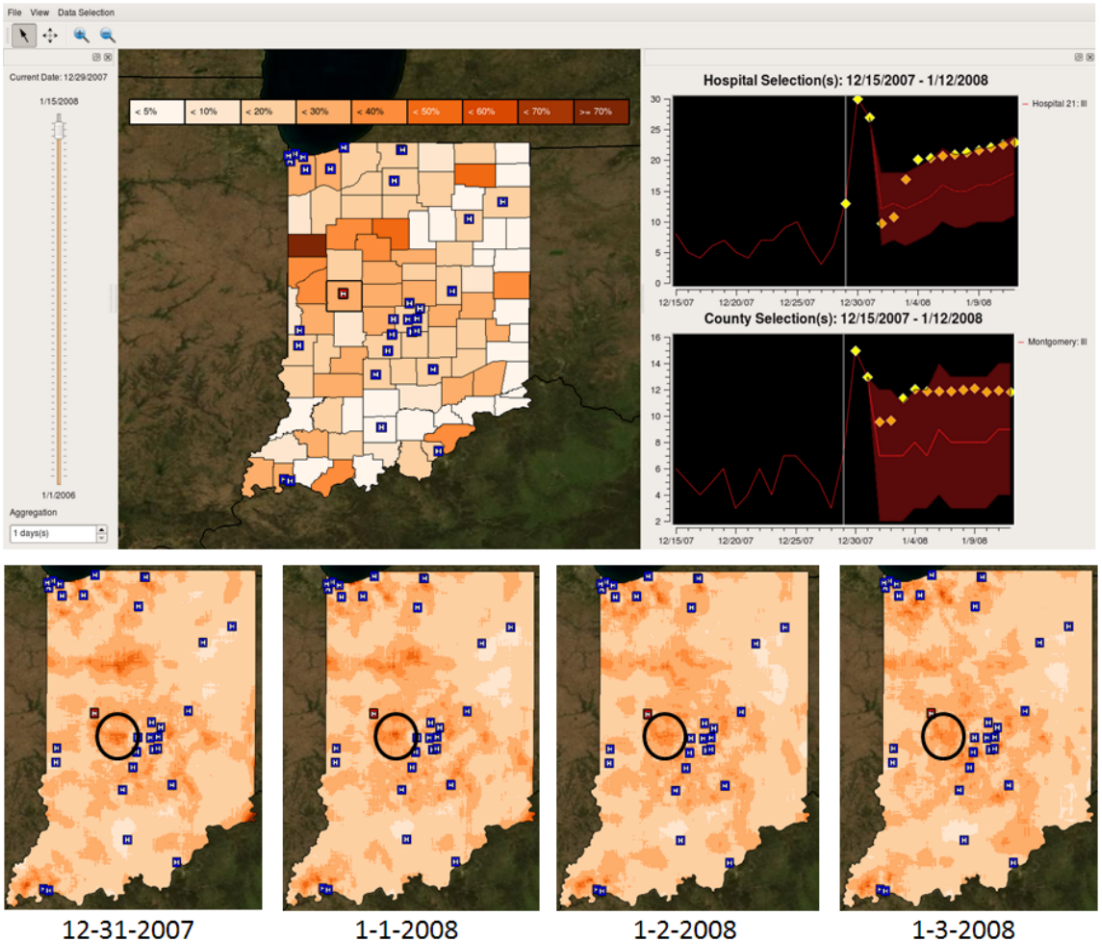
Forecasting and Detecting Hotspots



- Model based spatial approximation
- Direct linkage of time series prediction with spatial information
- Main focus: Hotspot detection and prediction

Figure 9: Forecasting Hotspots [Maciejewski et al., 2011]

Mapping between Time and Space

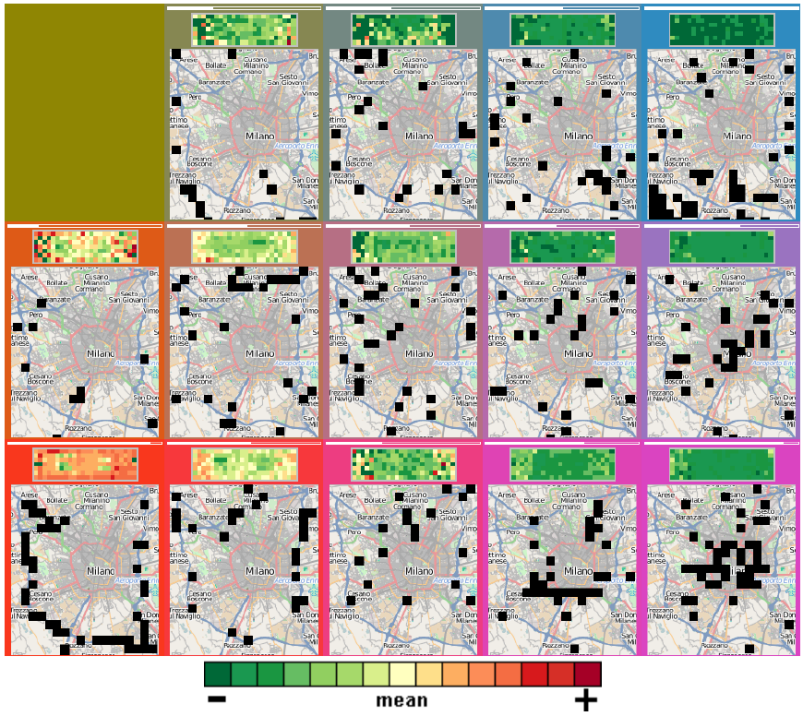


Figure 10: Time-in-space matrix [*Andrienko et al., 2010*]

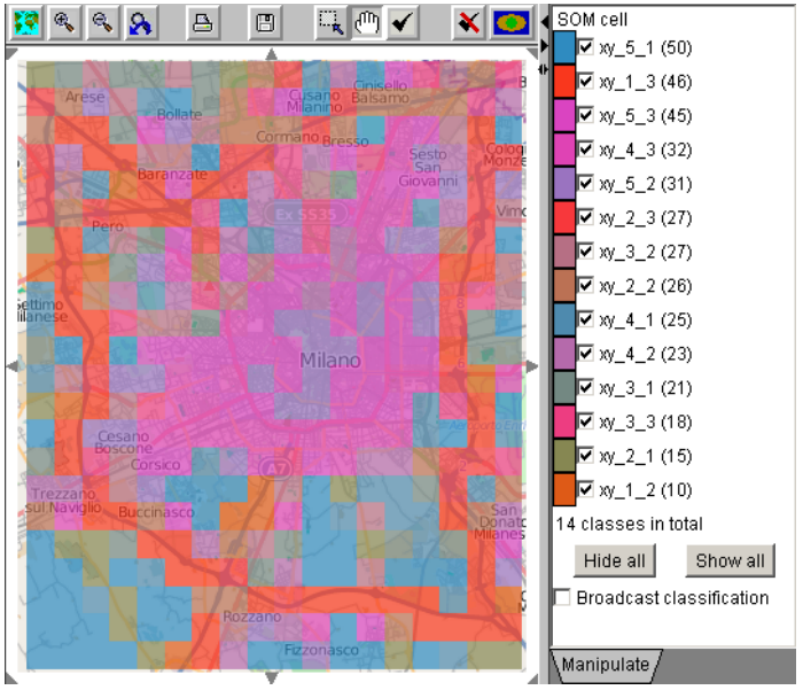


Figure 11: Spatial mapping of Time-in-space matrix [*Andrienko et al., 2010*]

- Clustering on spatial or temporal level
- Direct linkage of time series prediction with spatial information

Summary

- Turning points, seasonality and outliers make predictions complex
- How to deal with really large amounts of data?
- How to preserve peaks?

Bibliography I

G. Andrienko, N. Andrienko, S. Bremm, T. Schreck, T. von Landesberger, P. Bak, and D. Keim.
Space-in-time and time-in-space self-organizing maps for exploring spatiotemporal patterns.
In *Proceedings of the 12th Eurographics / IEEE - VGTC Conference on Visualization*, EuroVis'10, pages 913–922, Chichester, UK, 2010. The Eurographs Association and John Wiley and Sons, Ltd.

Paolo Buono, Catherine Plaisant, Adalberto Simeone, Aleks Aris, Galit Shmueli, and Wolfgang Jank.
Similarity-based forecasting with simultaneous previews: A river plot interface for time series forecasting.
In *Information Visualization, 2007. IV'07. 11th International Conference*, pages 191–196. IEEE, 2007.

Bibliography II

Yoshihiko Ichikawa, Tomoko Tsunawaki, Issei Fujishiro, and Hiwon Yoon.
A visualization environment for multiple daytime stock price predictions.
In *Proceedings of the 2nd VIIP International Conferences on Visualization, Imaging and Image Processing, Malaga, Spain*, 2002.

Yafeng Lu, Rolando Garcia, Brett Hansen, Michael Gleicher, and Ross Maciejewski.
The state-of-the-art in predictive visual analytics.
Comput. Graph. Forum, 36(3):539–562, June 2017.

R. Maciejewski, R. Hafen, S. Rudolph, S. G. Larew, M. A. Mitchell, W. S. Cleveland, and D. S. Ebert.
Forecasting hotspots: A predictive analytics approach.
IEEE Transactions on Visualization and Computer Graphics, 17(4):440–453, April 2011.

Bibliography III

Chad A Steed, William Halsey, Ryan Dehoff, Sean L Yoder, Vincent Paquit, and Sarah Powers.
Falcon: Visual analysis of large, irregularly sampled, and multivariate time series data in additive manufacturing.
Computers and Graphics, 63:50–64, 2017.

Thank you for listening

Questions?