EG2013 Tutorial on VIDEO VISUALIZATION

5. Visual Analytics of Video Data

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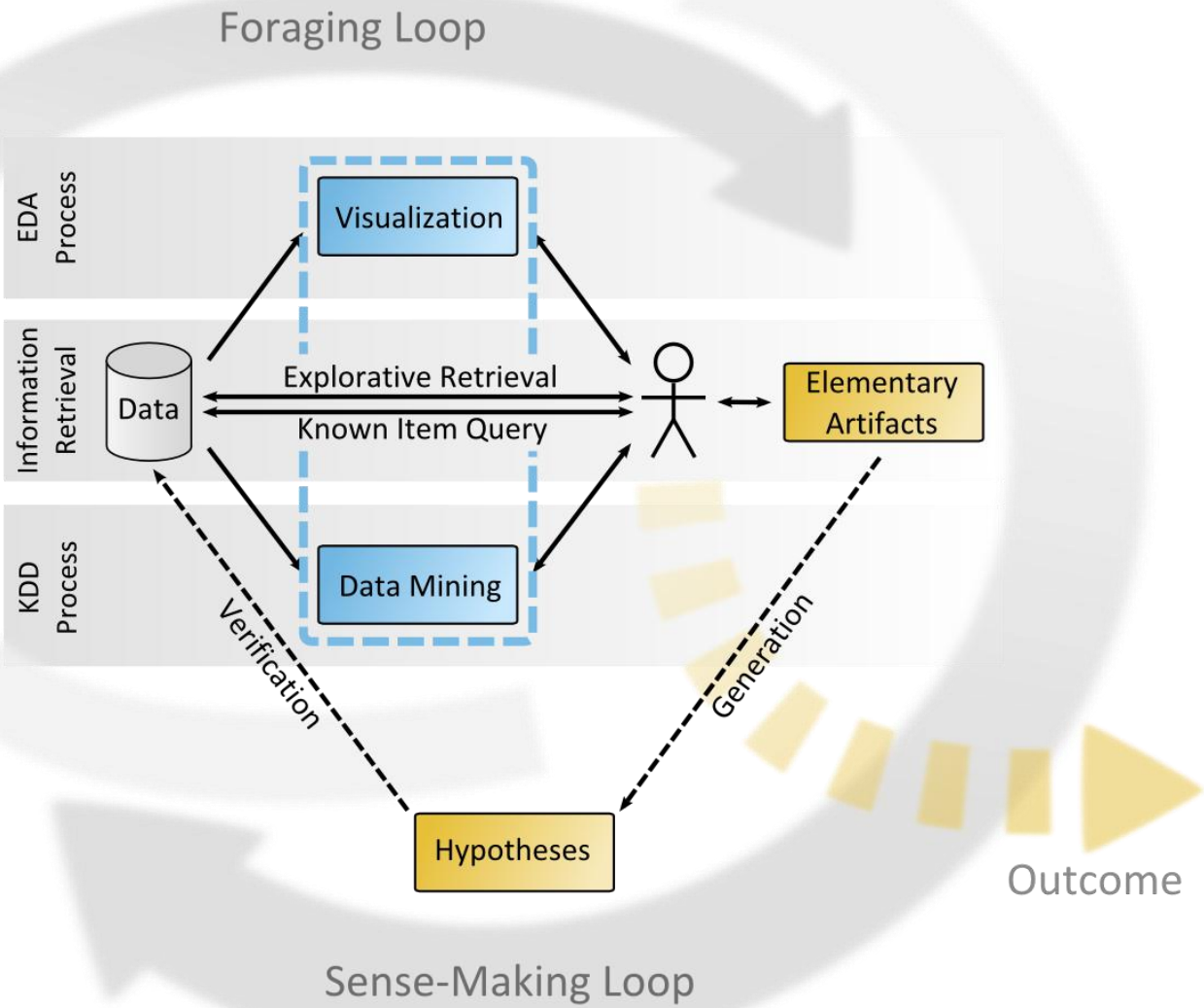
Video Analysis Challenges

- Vast amount of data
- Complexity of video data
  - Illumination, projection, noise
- Quality of search target definition
  - Ill-defined vs. well-defined search targets

- Completely automated or manual analysis fail
- Combination of strengths of both parts

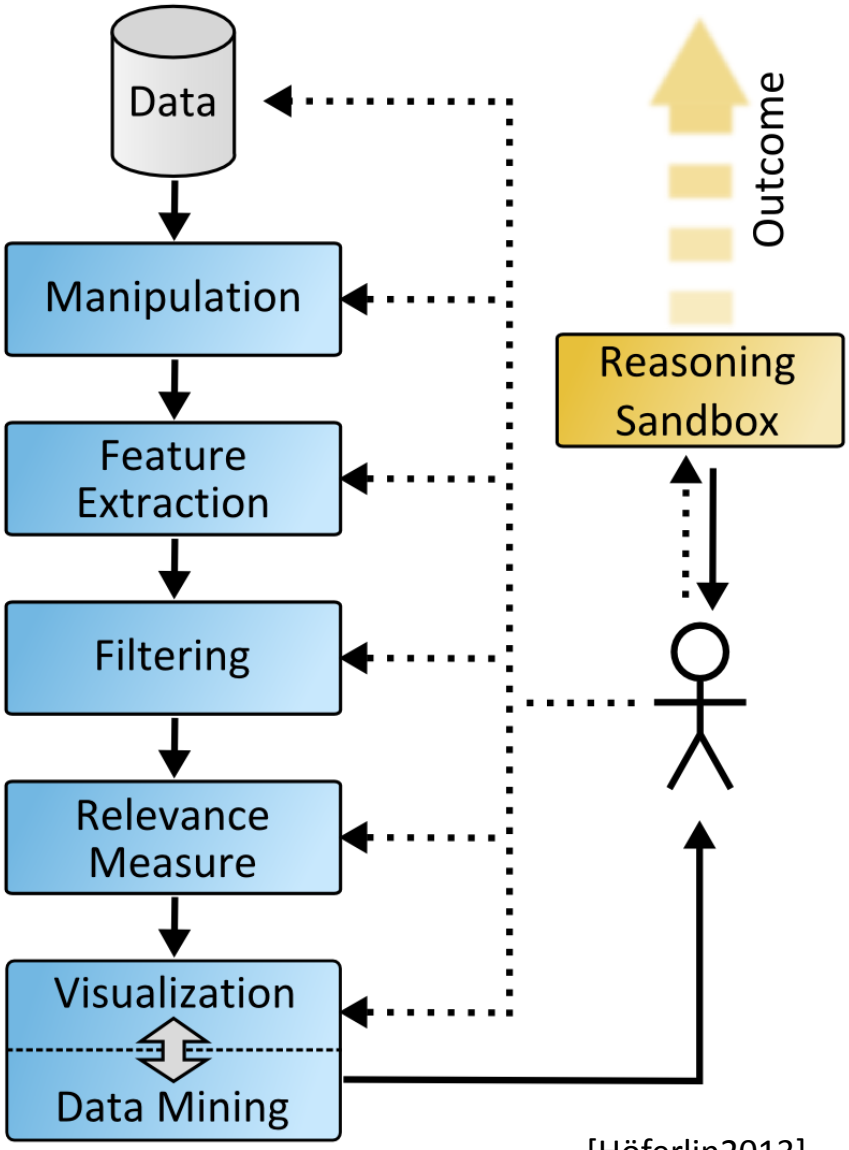
➢ Visual analytics of video data

Visual Analytics of Video Data



[Höferlin2013]

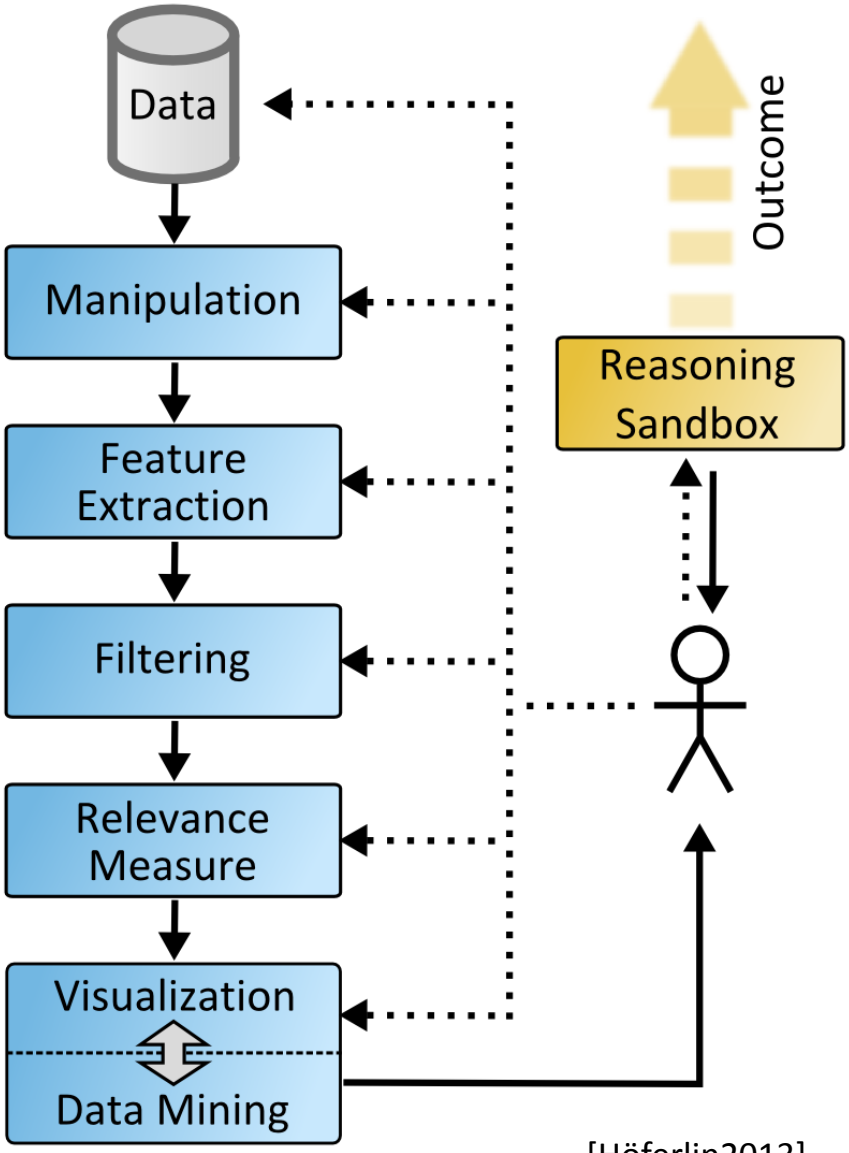
Video Visual Analytics Pipeline



[Höferlin2013]

- Important aspects for video analysis
  - Data scalability
    - Achieved by serialization, parallelization, data reduction
    - For human and machine
  - Task scalability
  - Situational awareness
- Video Visual Analytics Pipeline
  - Stream processing
  - Human analyst interact with all stages
  - Support for **foraging** and **sense-making** loop

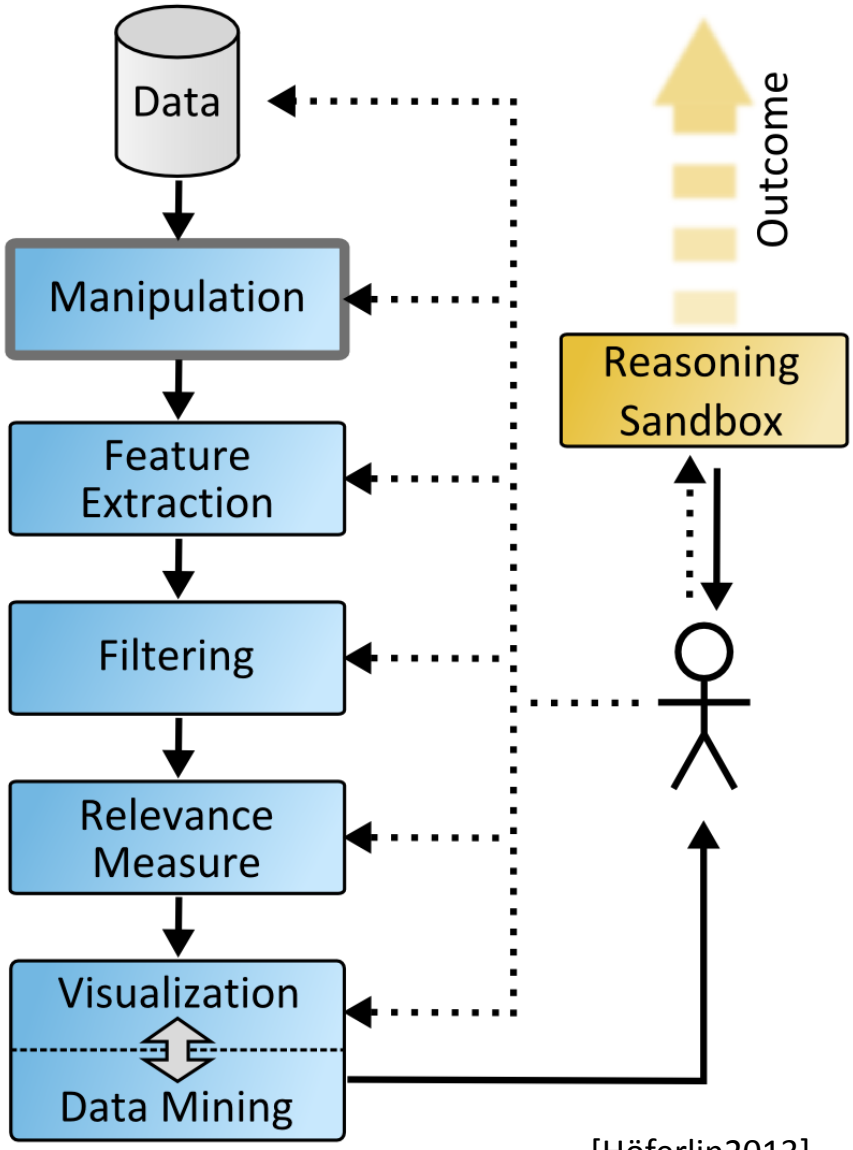
Data Streams



[Höferlin2013]

- Data
  - Selection: one or multiple data streams
  - Temporal synchronization

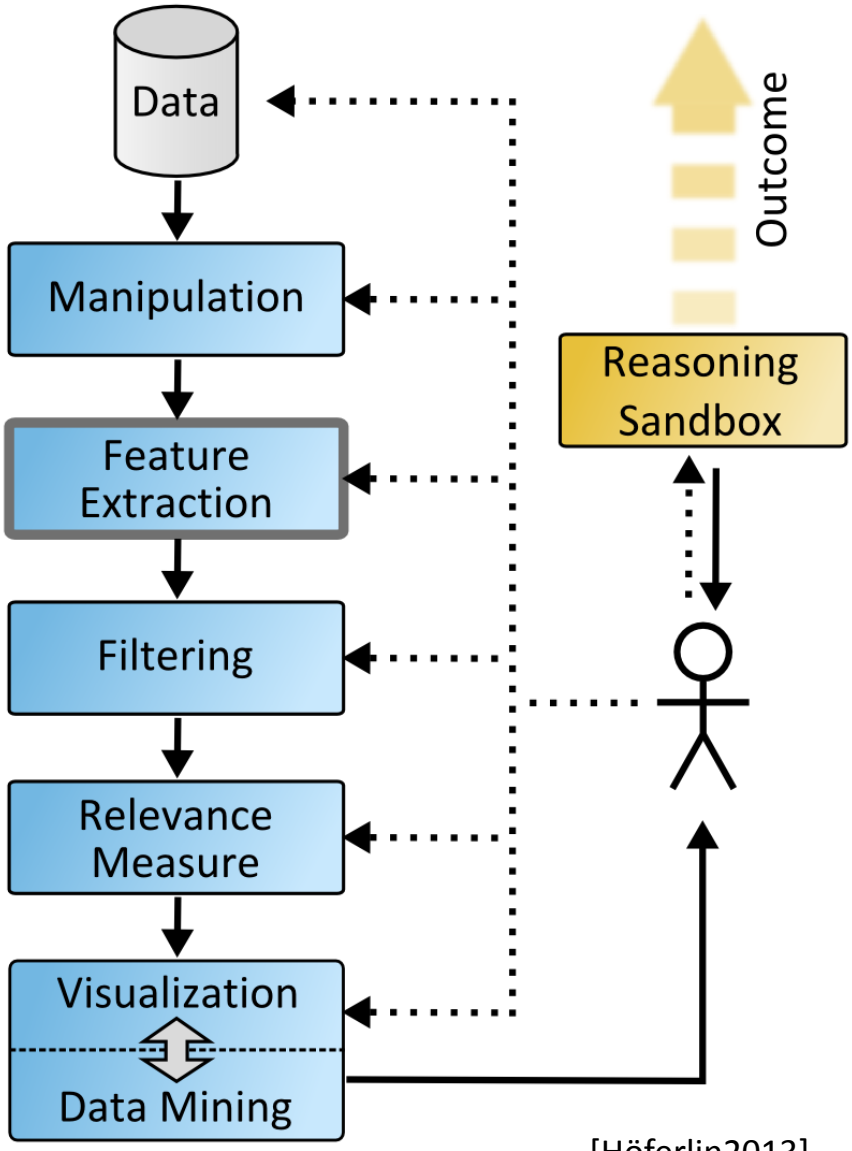
Manipulation



[Höferlin2013]

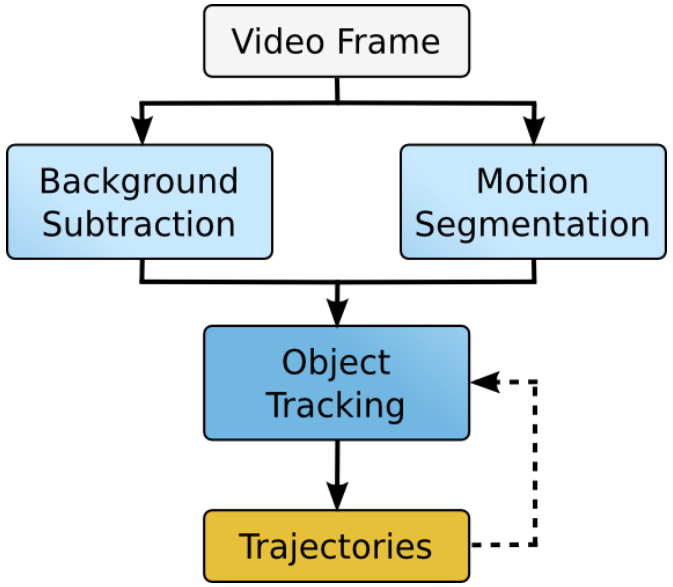
- Manipulation
  - Does not change data type
  - Enhance raw data

Feature Extraction



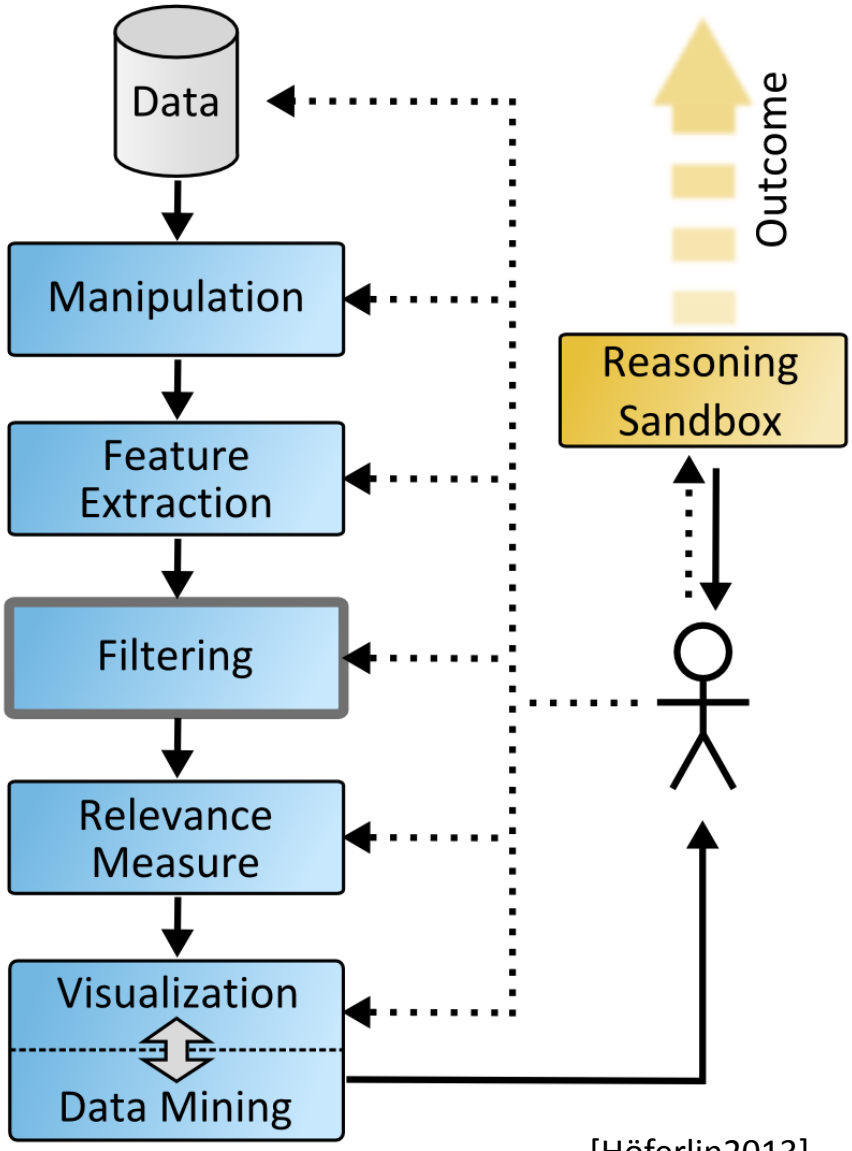
[Höferlin2013]

- Feature extraction
  - For usage in later stages
- Important feature: trajectories



[Höferlin2011]

Filtering

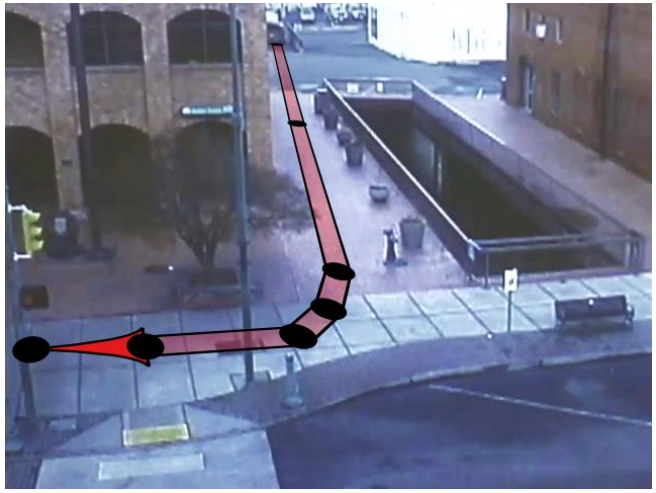


[Höferlin2013]

- Filtering
  - Data reduction
- Interaction guidelines
  - Easy-to-use filter definition
  - Confidence-incorporated filter definition
  - Decision-guided filter definition
  - Filter feedback

Filtering

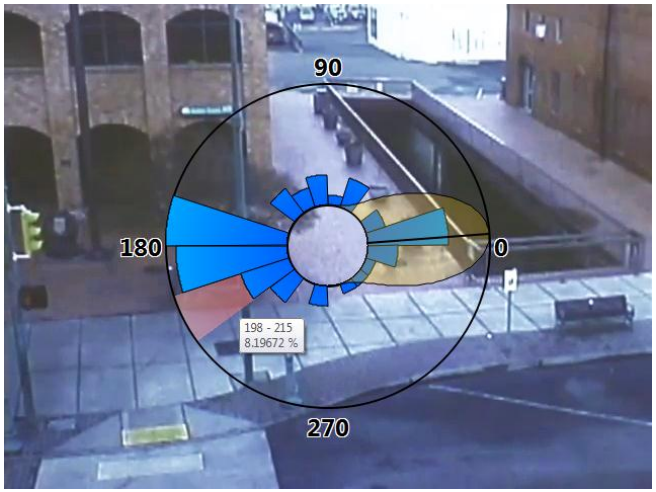
[Höferlin2013]



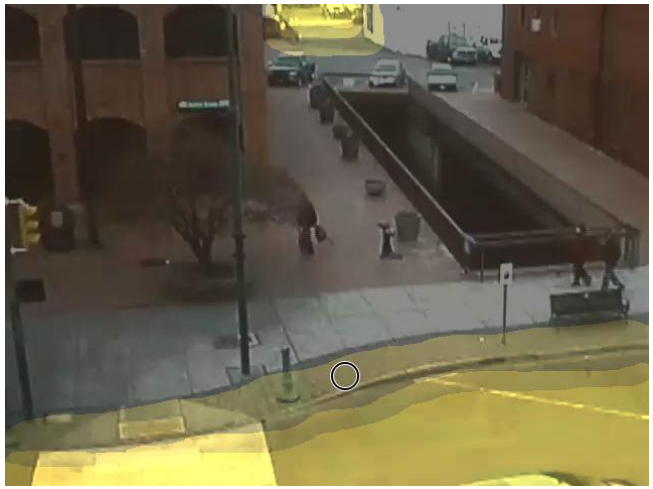
[Höferlin2013]

- Filtering
  - Data reduction
- Interaction guidelines
  - Easy-to-use filter definition
  - Confidence-incorporated filter definition
  - Decision-guided filter definition
  - Filter feedback
- Filter formulation
  - By example
  - By sketch

Filtering



[Höferlin2011]



[Höferlin2011]

- Filtering
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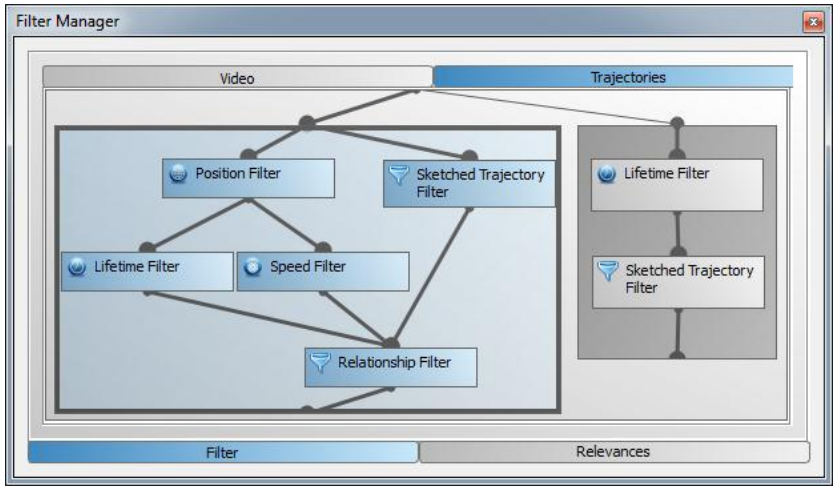
  - Filter feedback
- Filter formulation
  - By example
  - By sketch
  - By properties

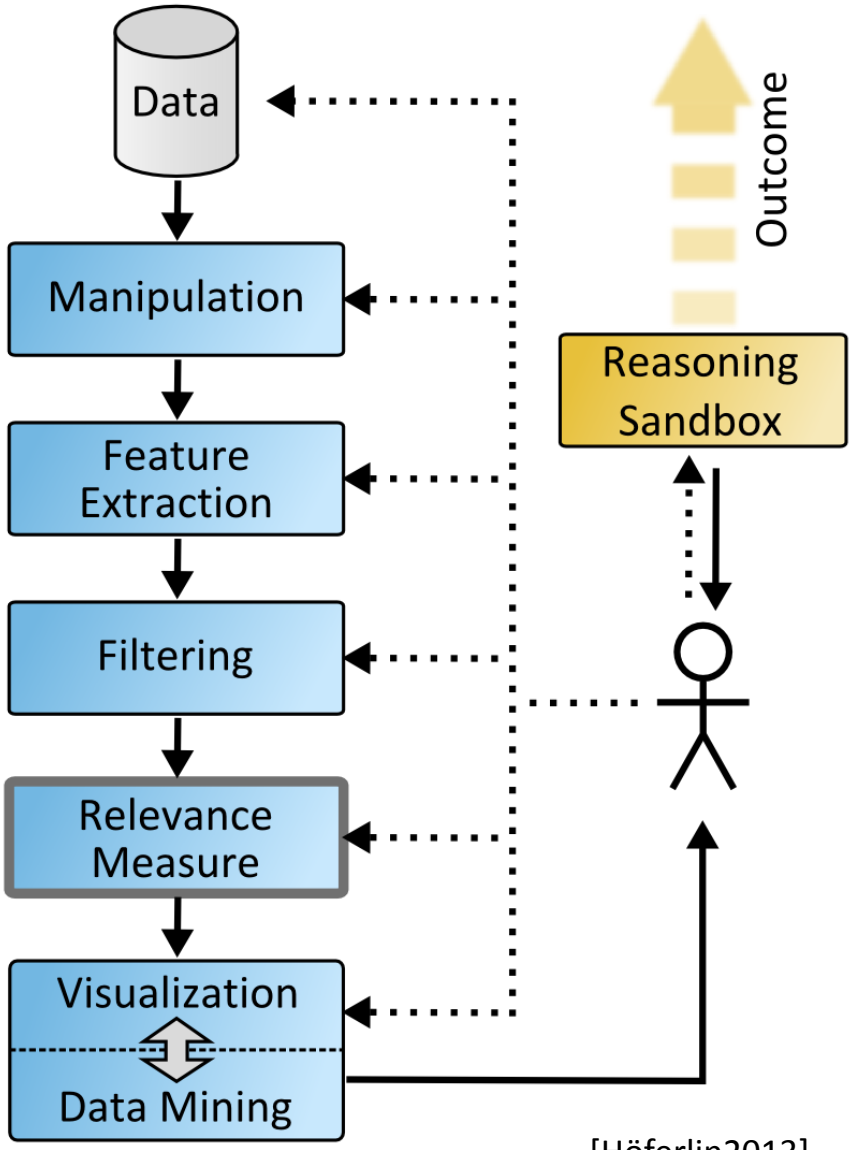
Filtering



[Höferlin2013]

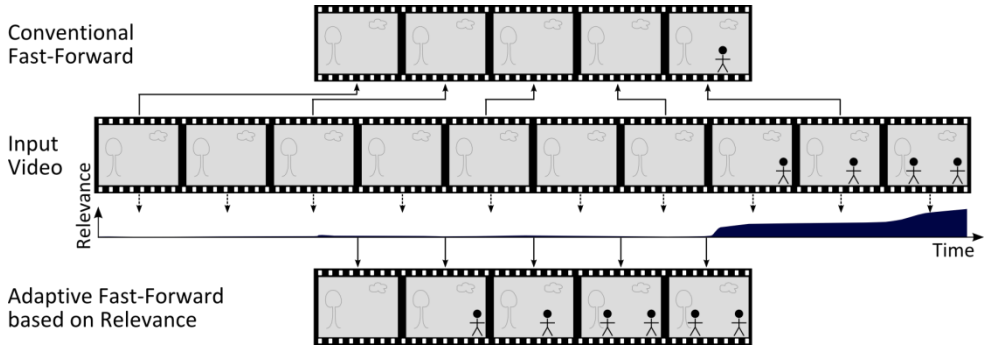
- Filtering
  - Data reduction
- Interaction guidelines
  - Easy-to-use filter definition
  - Confidence-incorporated filter definition
  - Decision-guided filter definition
  - Filter feedback
- Filter formulation
  - By example
  - By sketch
  - By properties
- Arbitrary filter combination
  - Filter graph

Relevance Measure



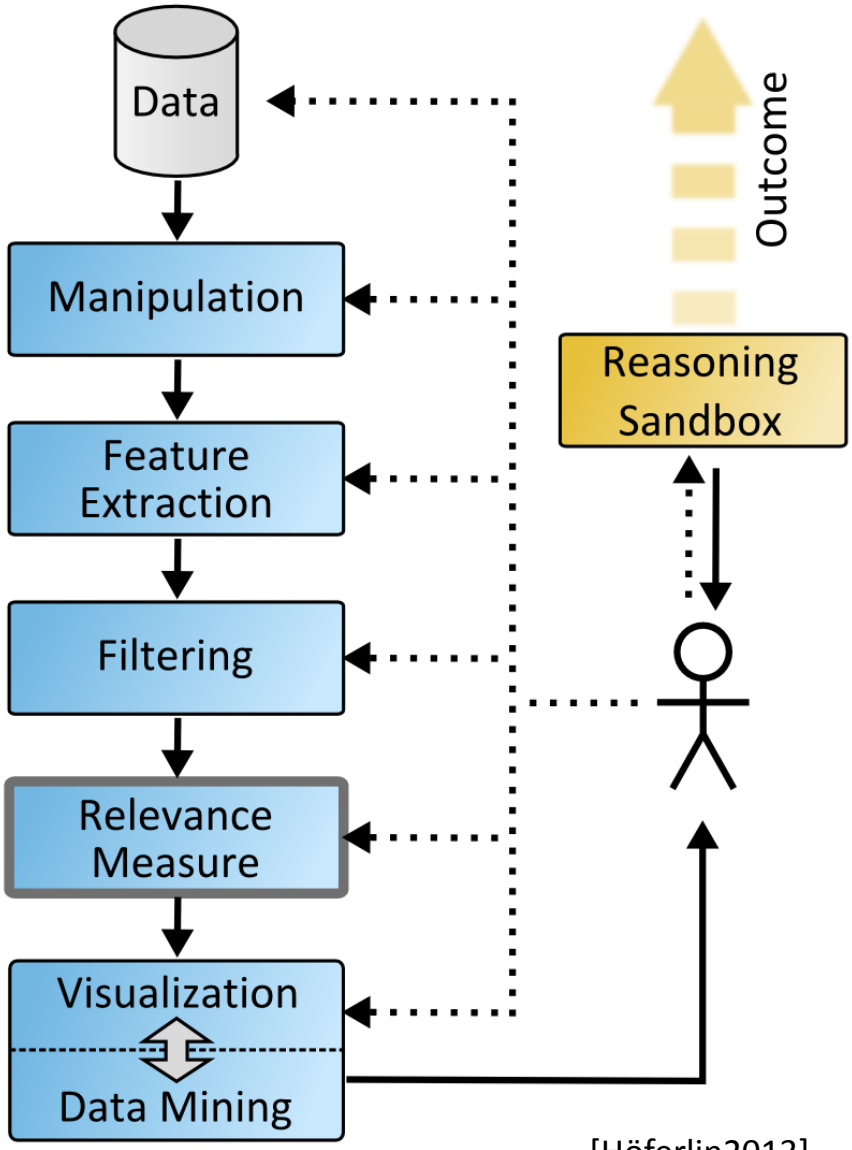
[Höferlin2013]

- Relevance Measure
  - Assignment of relevance to data elements (video frames, trajectories, …)
  - Applications
    - Adaptive fast-forward



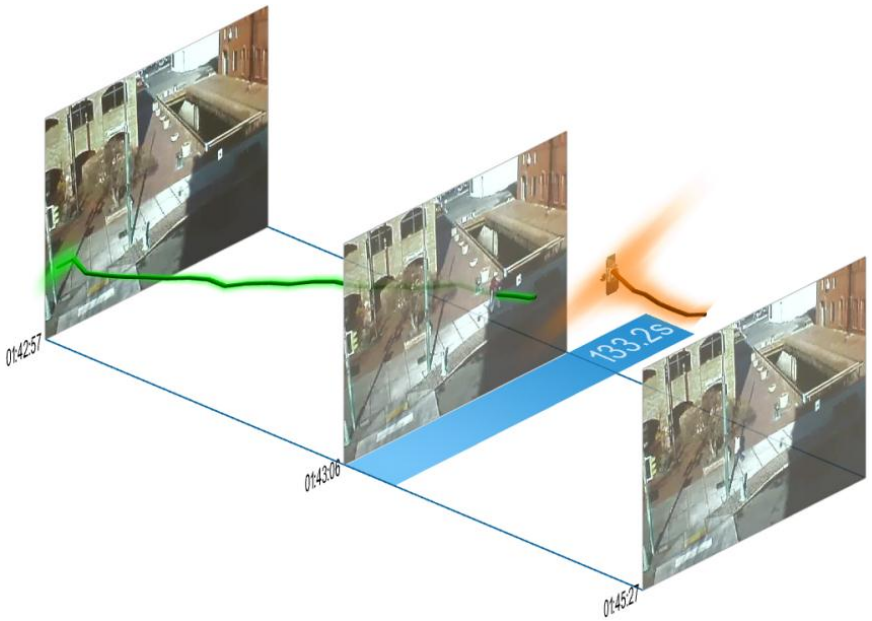
[Höferlin2011b]

Relevance Measure



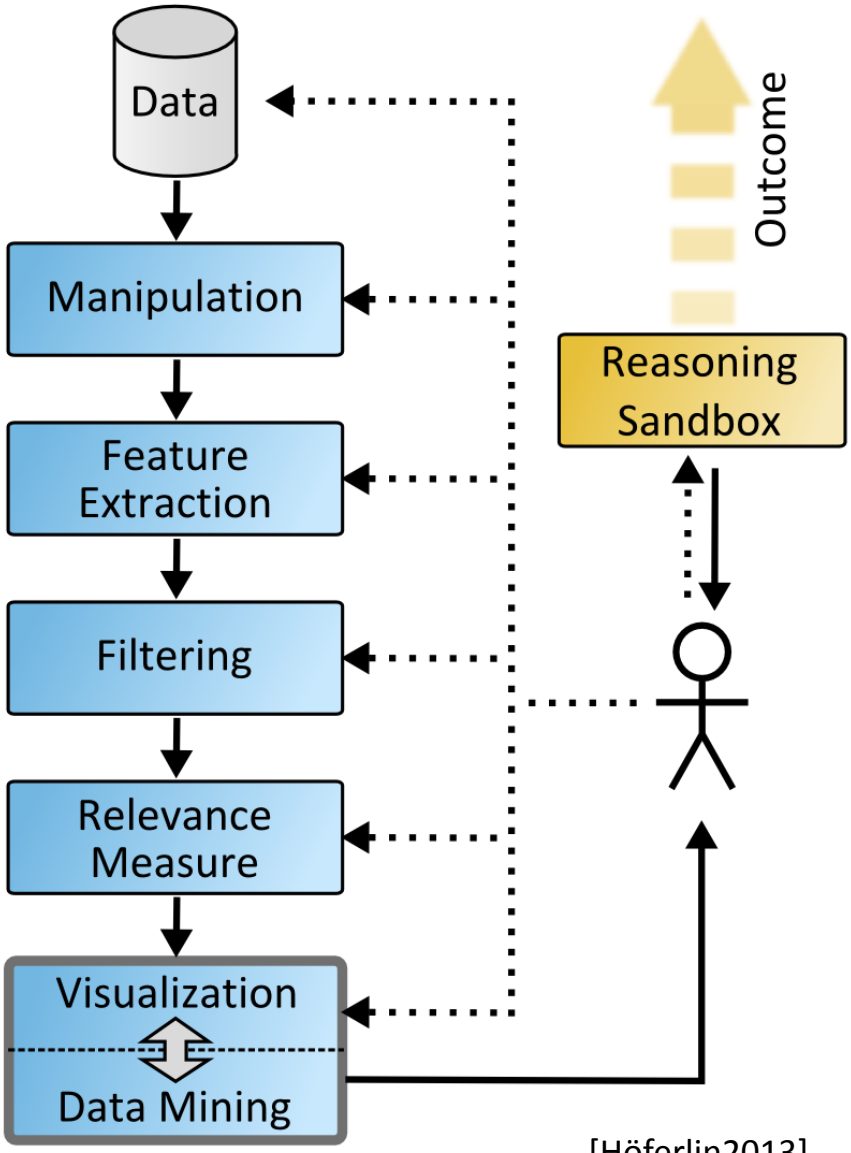
[Höferlin2013]

- Relevance Measure
  - Assignment of relevance to data elements (video frames, trajectories, …)
  - Applications
    - Adaptive fast-forward
    - Visual mapping (visualization)



[Höferlin2011]

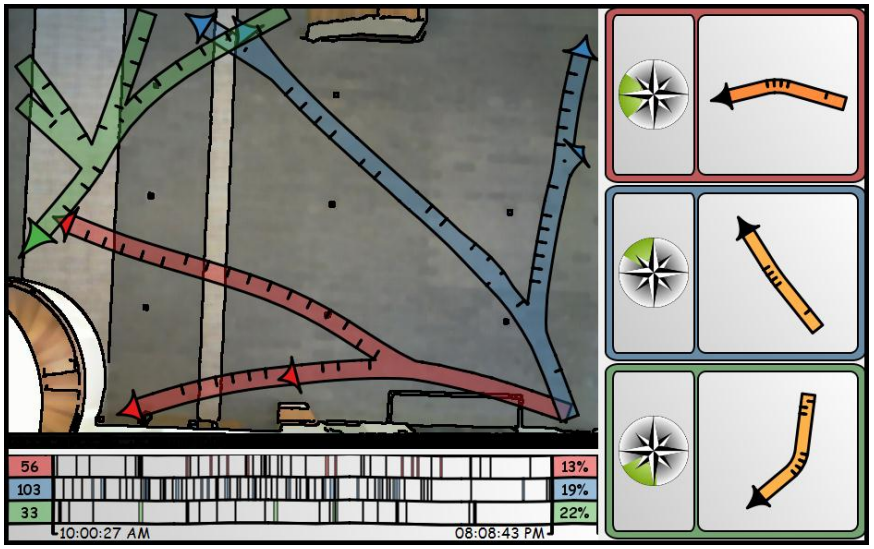
Visualization



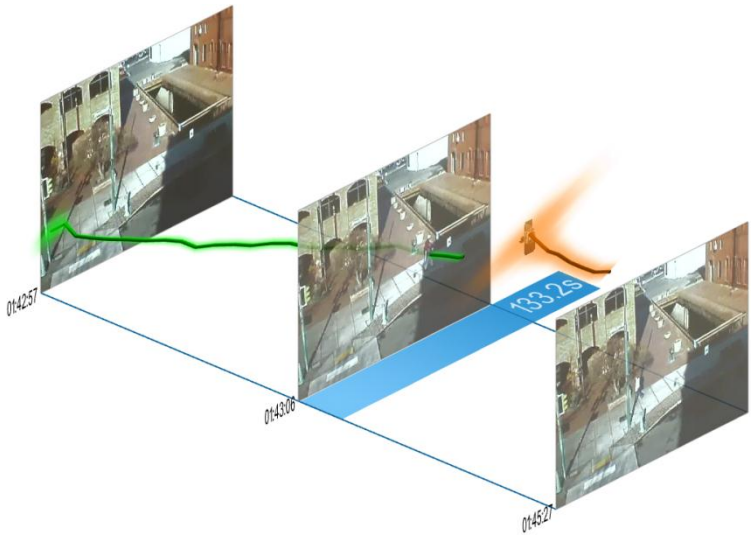
[Höferlin2013]

- Visualization
  - Multiple coordinated views
    - Complementary perspectives
    - Synchronized
  - Visual data mining
  - Aggregation

Visualization



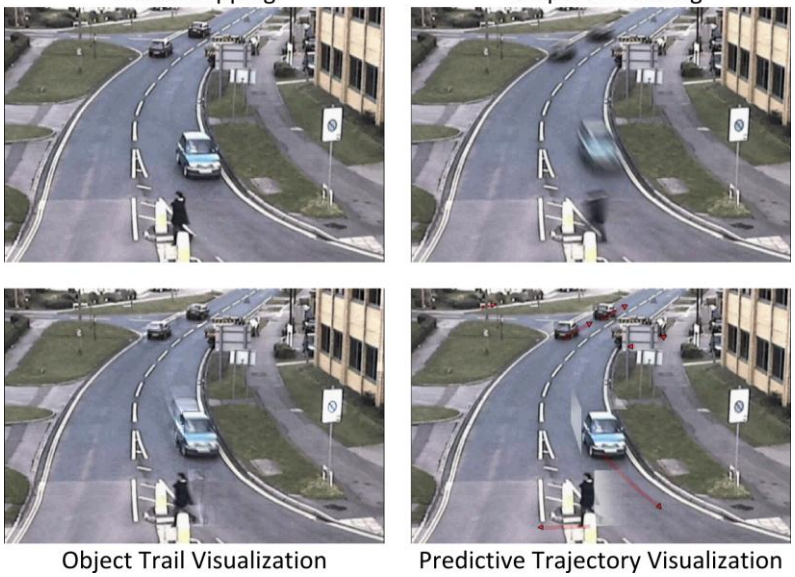
[Höferlin2013b]



[Höferlin2011]

- Visualization
  - Multiple coordinated views
    - Complementary perspectives
    - Synchronized
  - Visual data mining
  - Aggregation
- Interactive Schematic Summaries
  - Video exploration
  - Scatter/Gather of trajectories
  - Schematic summarization
- VideoPerpetuoGram
  - Dynamic video volume visualization

Visualization

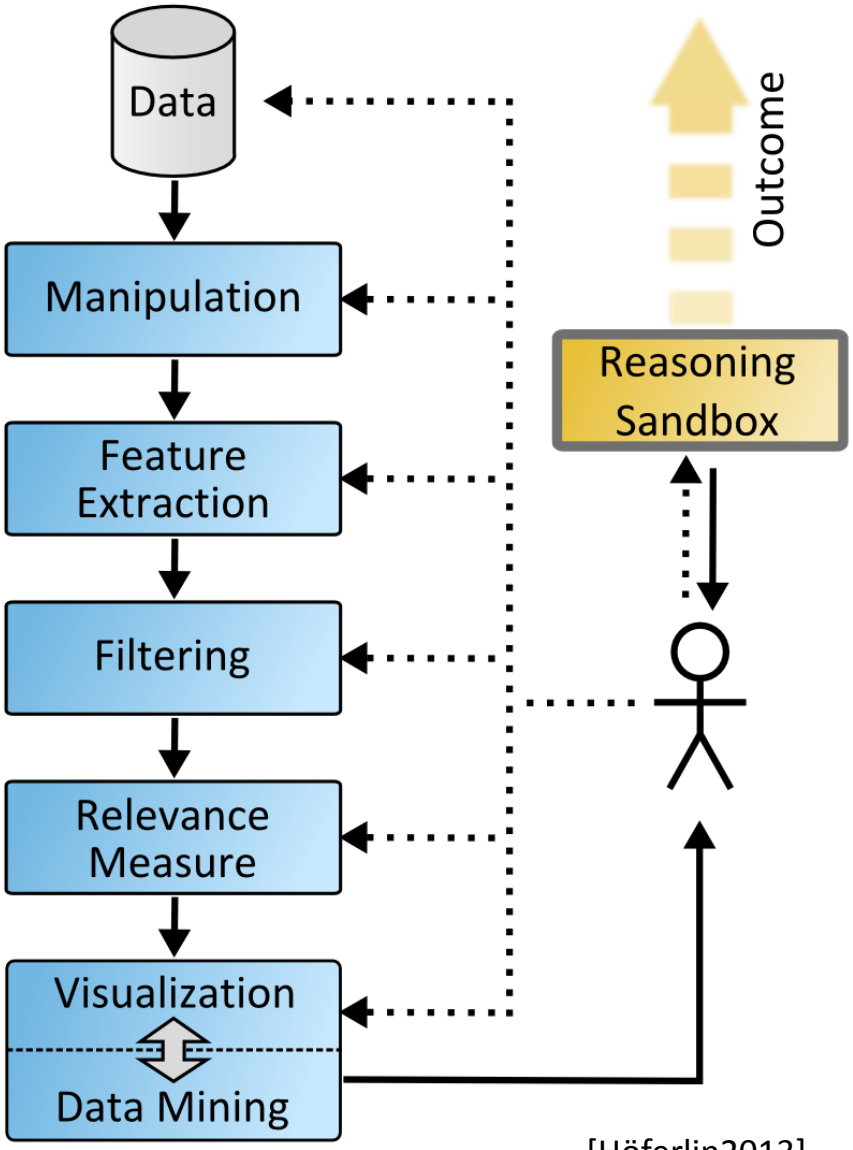


[Höferlin2012]


[Höferlin2011c]

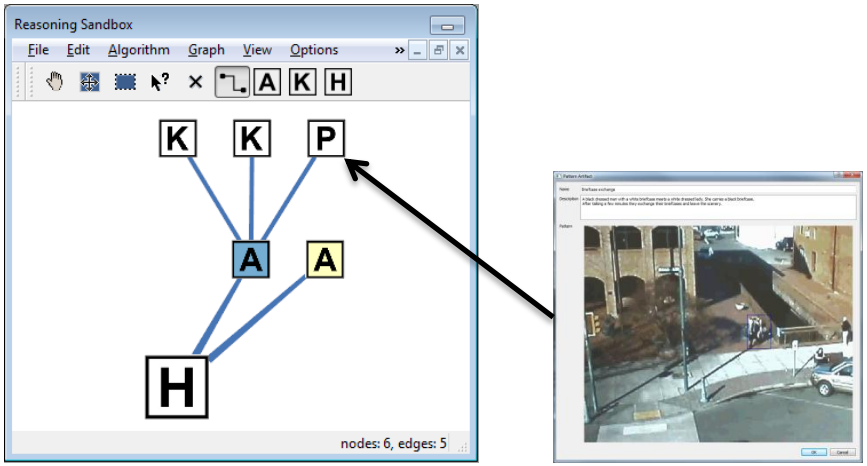
- Visualization
  - Multiple coordinated views
    - Complementary perspectives
    - Synchronized
  - Visual data mining
  - Aggregation
- Interactive Schematic Summaries
  - Video exploration
  - Scatter/Gather of trajectories
  - Schematic summarization
- VideoPerpetuoGram
  - Dynamic video volume visualization
- Fast-forward visualization
- Sonification
  - Situational awareness

Reasoning Sandbox



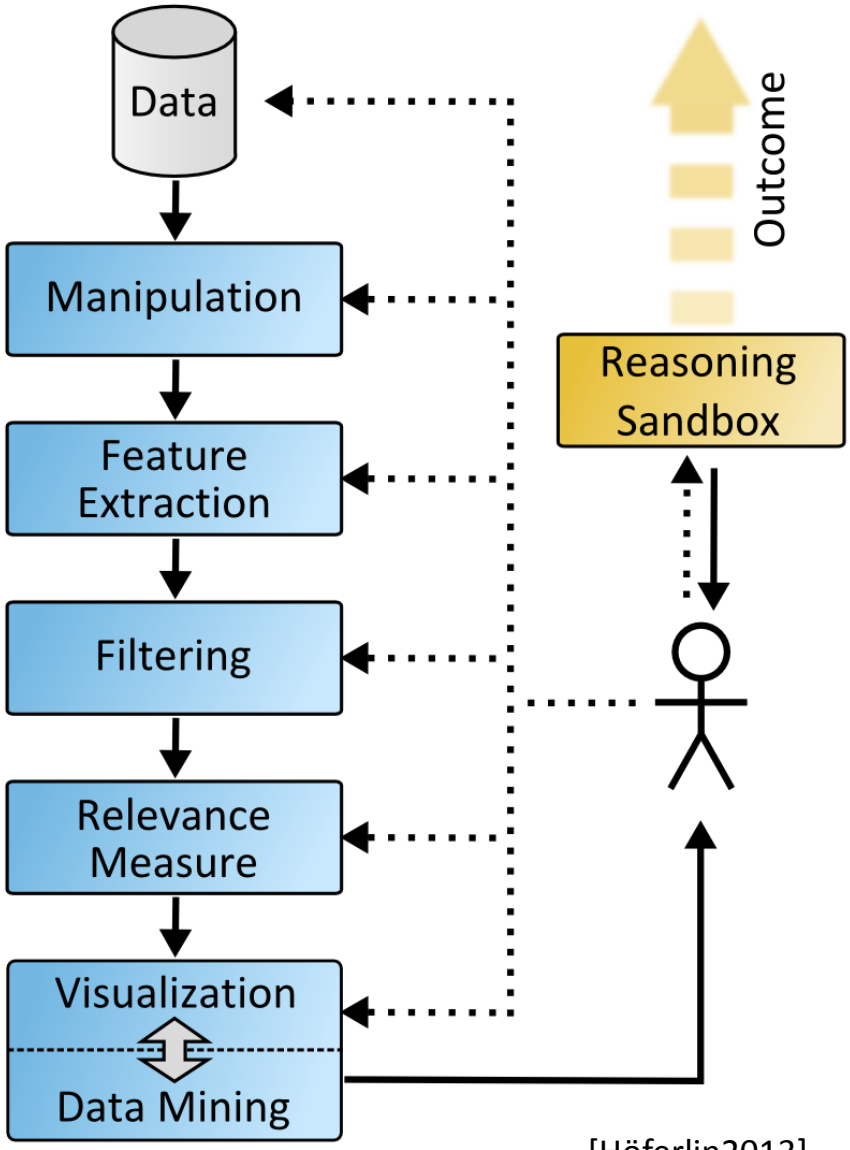
[Höferlin2013]

- Reasoning Sandbox
  - Support of analytic discourse and sense-making
  - Organization and integration of reasoning artifacts



[Höferlin2013]

Conclusion



[Höferlin2013]

Literature

- [Bosch2009] Bosch, H.; Heinrich, J.; Höferlin, B.; Höferlin, M.; Koch, S.; Müller, C.; Reina, G. & Wörner, M., Innovative Filtering Techniques and Customized Analytics Tools, *IEEE Symposium on Visual Analytics Science and Technology, 2009. VAST'09,* **2009**, 269-270
- [Botchen2008] Botchen, R. P.; Bachthaler, S.; Schick, F.; Chen, M.; Mori, G.; Weiskopf, D. & Ertl, T., Action-Based Multifield Video Visualization, *IEEE Transactions on Visualization and Computer Graphics, IEEE Educational Activities Department,* **2008***, 14*, 885-899
- [Daniel2003] Daniel, G. & Chen, M., Video visualization, *Proceedings of the 14th IEEE Visualization 2003 (VIS'03),* **2003**, 409-416
- [Höferlin2010] Höferlin, M.; Grundy, E.; Borgo, R.; Weiskopf, D.; Chen, M.; Griffiths, I. W. & Griffiths, W., Video Visualization for Snooker Skill Training, *Computer Graphics Forum,* **2010***, 29*, 1053-1062
- [Höferlin2011] Höferlin, M.; Höferlin, B.; Weiskopf, D. & Heidemann, G., Uncertainty-Aware Video Visual Analytics of Tracked Moving Objects, *Journal of Spatial Information Science (JOSIS),* **2011***, 2*, 87-117
- [Höferlin2011b] Höferlin, B.; Höferlin, M.; Weiskopf, D. & Heidemann, G., Information-Based Adaptive Fast-Forward for Visual Surveillance, *Multimedia Tools and Applications, Springer Netherlands,* **2011***, 55*, 127-150
- [Höferlin2011c] Höferlin, B.; Höferlin, M.; Raschke, M.; Heidemann, G. & Weiskopf, D., Interactive Auditory Display to Support Situational Awareness in Video Surveillance, *In Proceedings of the International Conference on Auditory Display (ICAD),* **2011**
- [Höferlin2012] Höferlin, M.; Kurzhals, K.; Höferlin, B.; Heidemann, G. & Weiskopf, D., Evaluation of Fast-Forward Video Visualization, *IEEE Transactions on Visualization and Computer Graphics,* **2012***, 18*, 2095-2103
- [Höferlin2012b] Höferlin, B.; Netzel, R.; Höferlin, M.; Weiskopf, D. & Heidemann, G., Inter-Active Learning of Ad-Hoc Classifiers for Video Visual Analytics, *IEEE Conference on Visual Analytics Science and Technology (VAST), 2012,* **2012**, 23-32
- [Höferlin2013] Höferlin, B.; Höferlin, M.; Weiskopf, D. & Heidemann, G., Scalable Video Visual Analytics, *Information Visualization Journal,* **2013***,* (to appear)
- [Höferlin2013b] Höferlin, M.; Höferlin, B.; Heidemann, G. & Weiskopf, D., Interactive Schematic Summaries for Faceted Exploration of Surveillance Video, *IEEE Transactions on Multimedia,* **2013**, (to appear)