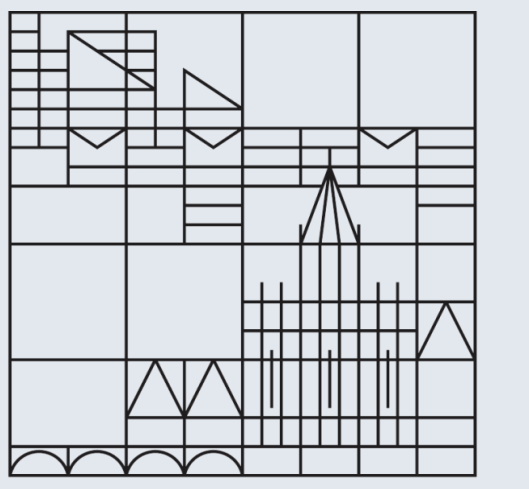


Uncertainty Propagation and Trust Building in Visual Analytics

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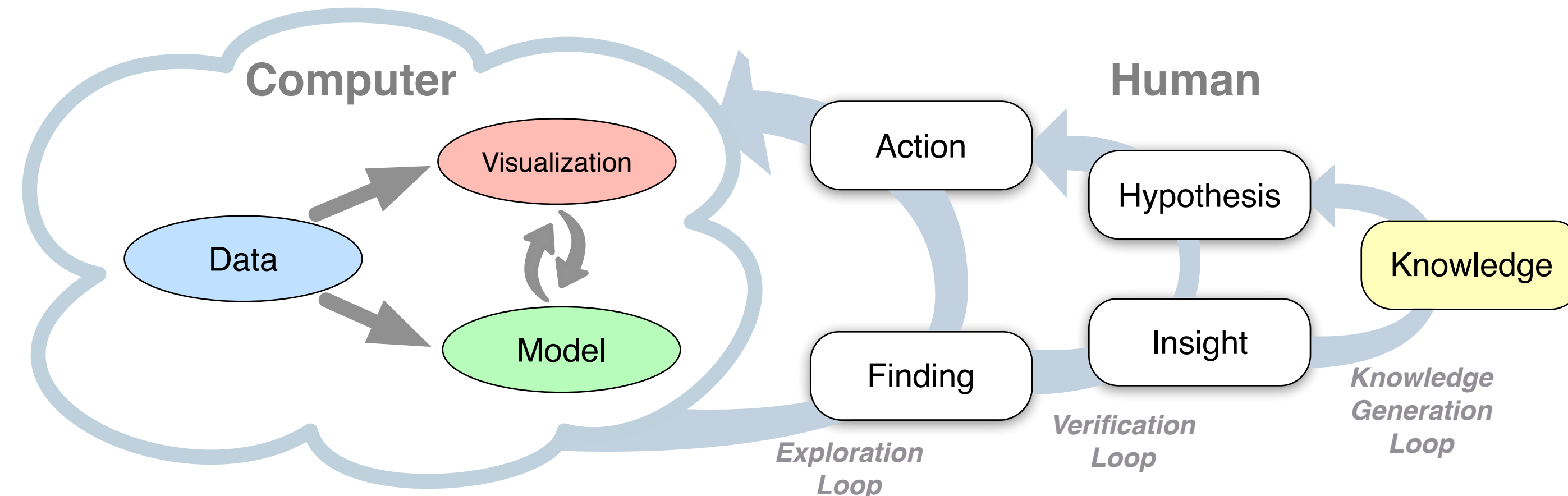
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1

Knowledge Generation in Visual Analytics

Figure 1: The knowledge generation model for visual analytics defines and relates computer and human concepts [1]

- Visual Analytics aims to generate new valid **knowledge** also defined as justified belief
- **Uncertainties** build up at the system side
- Humans have to **trust** in the insights gained by using the system

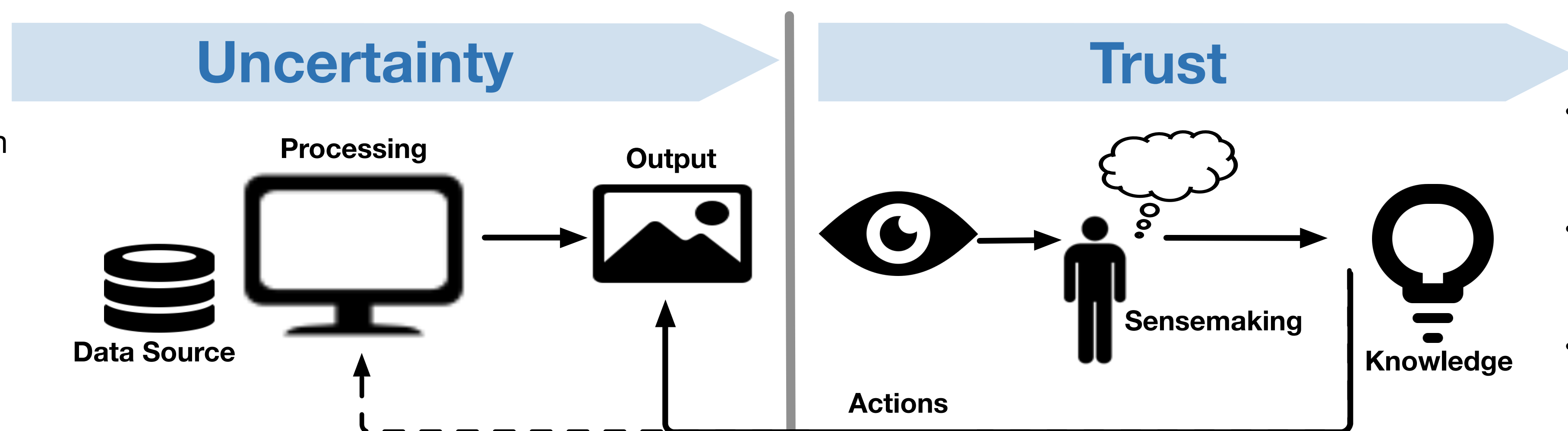


How to bridge the gap between uncertainty and trust with data and analytic provenance?

2

Figure 2: The role of uncertainty and trust along the visual analytics process related to data and analytic provenance

- Uncertainties occur at each component in analysis systems
- Output is processed by humans and includes all inherited uncertainties



- „Lack of trust“ on the human side
- Confidence builds up and transfers to trust
- Insufficient trust keeps humans in the loop

Data Provenance (System)

Missing data provenance information is leading to „over- or under-trusted“ facts derived from the system

Uncertainties at Several Stages

- Data Source, Pre-Processing, Mappings, Models & Visualizations may cause uncertainties
- Example: Models with varying parametrization, preprocessing methods or mappings may introduce, add or transform the original data

Uncertainty Awareness

- Do humans really understand all included uncertainties?
- Detect, derive, and visualize these uncertainties in order to improve the awareness of included uncertainties
- Provide tooltips that show the level of uncertainties or indicate the area of uncertainties via pipeline visualizations. Uncertainty could also be mapped to visual variables in visualizations (e.g., transparency)

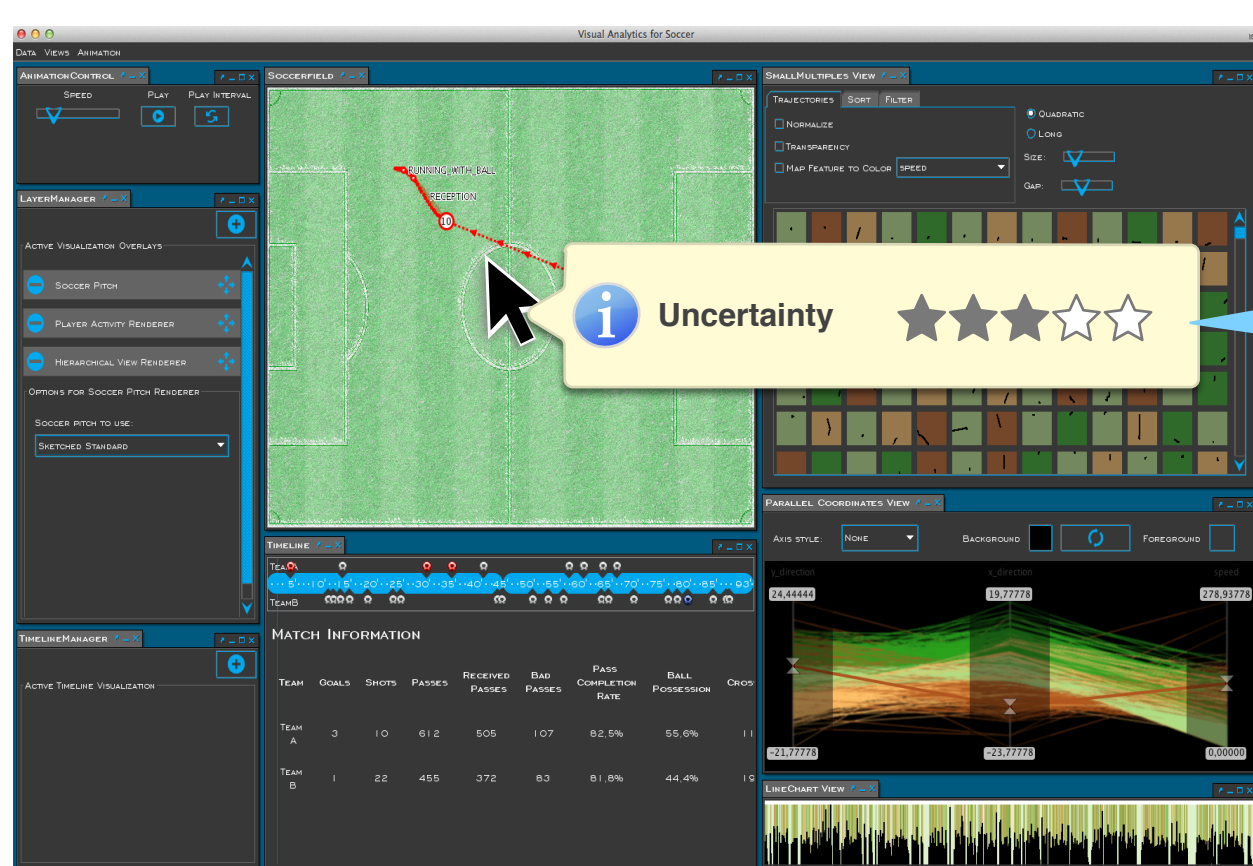


Figure 3: Example tooltips informing about included uncertainties



Analytic Provenance (Human)

Human Footsteps

- Capture analytic trails in order to detect humans level of confidence
- Measure, improve, and guide the process on the human side
- Suggest automatically visualizations or interaction possibilities
- Detect analysis dead ends („humans stuck in a loop“)

Knowledge Externalization

- Externalize and manage knowledge (hypothesis, notes, visualizations, etc.)
- Provide a note taking environment that offers information that can be used and analyzed
- Develop and analyze uncertainty indicators (signal words)

User Involvement

- Enable quality or confidence ratings
- Warn users about unwarranted conclusions that are drawn from vague hypothesis which are based on facts that contain uncertainty and are connected to insufficient evidence

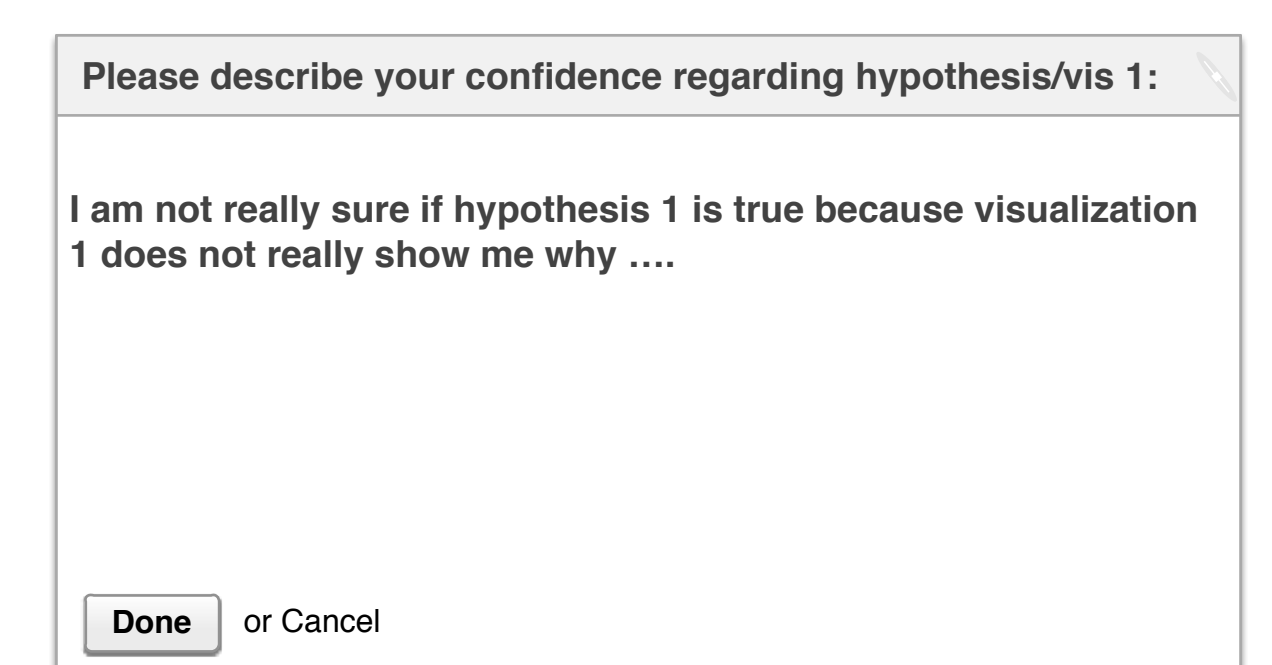


Figure 4: Footsteps (left), note-taking for knowledge management (middle), and an example to involve the user for quality/confidence ratings (right)

3

Research Questions

- How to define and aggregate uncertainty and trust measures?
- How to detect human levels of trust or knowledge?
- How to support human knowledge generation without annoying users?
- How to externalize knowledge and involve humans?
- How to capture, store and analyze human behavior in VA systems?

Research Plans

- Survey existing provenance components in VA literature with respect to their goals
- Describe the role of uncertainty and trust for each concept of the model
- Develop/integrate provenance functionalities into existing VA-tools
- Build a note taking environment that enables knowledge externalization and analysis of human thoughts connected to uncertainty measures on the system side

References

[1] Dominik Sacha, Andreas Stoffel, Florian Stoffel, Bum Chul Kwon, Geoffrey Ellis, Daniel A. Keim, "Knowledge Generation Model for Visual Analytics", IEEE Transactions on Visualization and Computer Graphics, vol. 99, no. PrePrints, p. 1, , 2014