hciLab

SimTech
Cluster of Excellence

University of Stuttgart
Germany

Investigating Representation Alternatives for Communicating Uncertainty to Non-Experts

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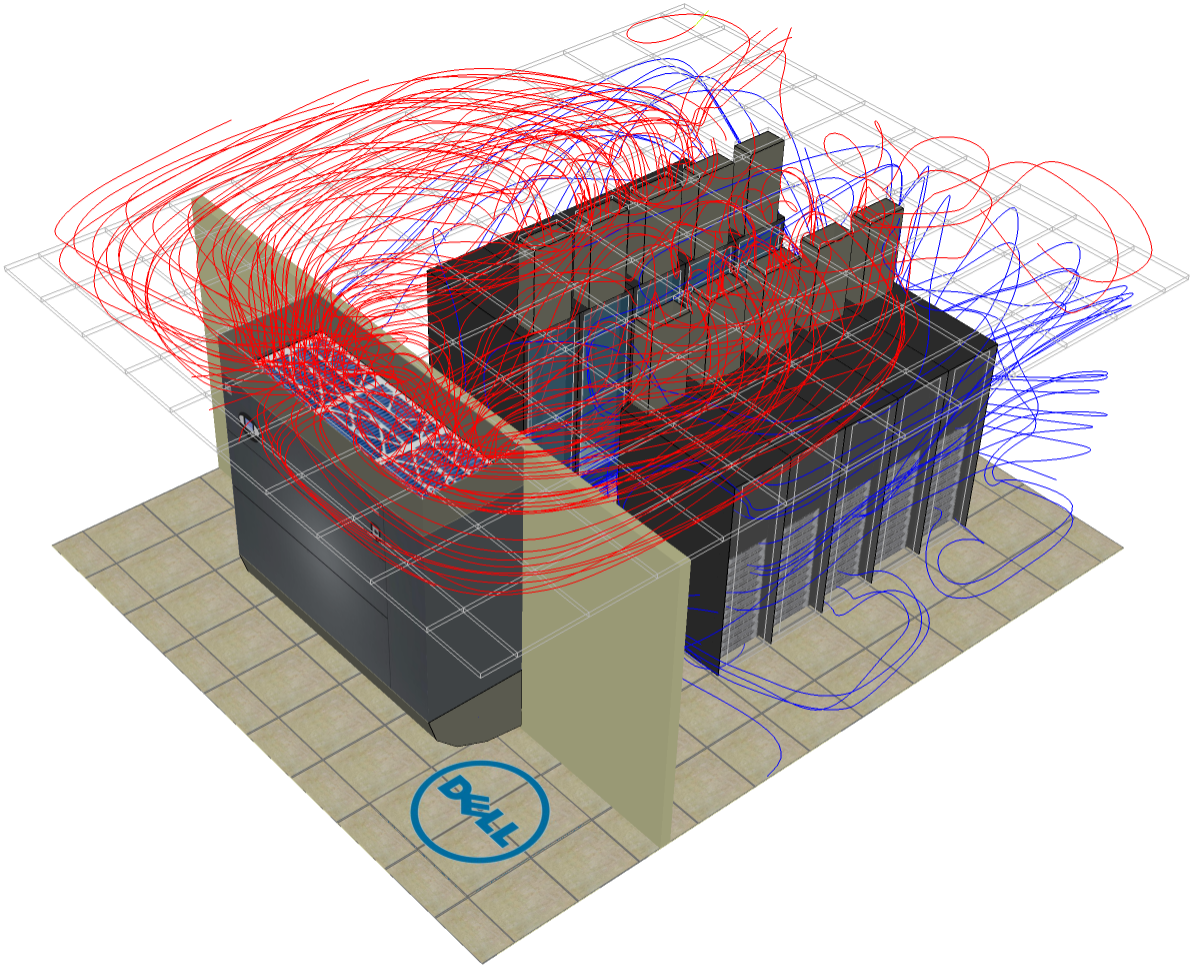
Institute for Visualization
and Interactive Systems

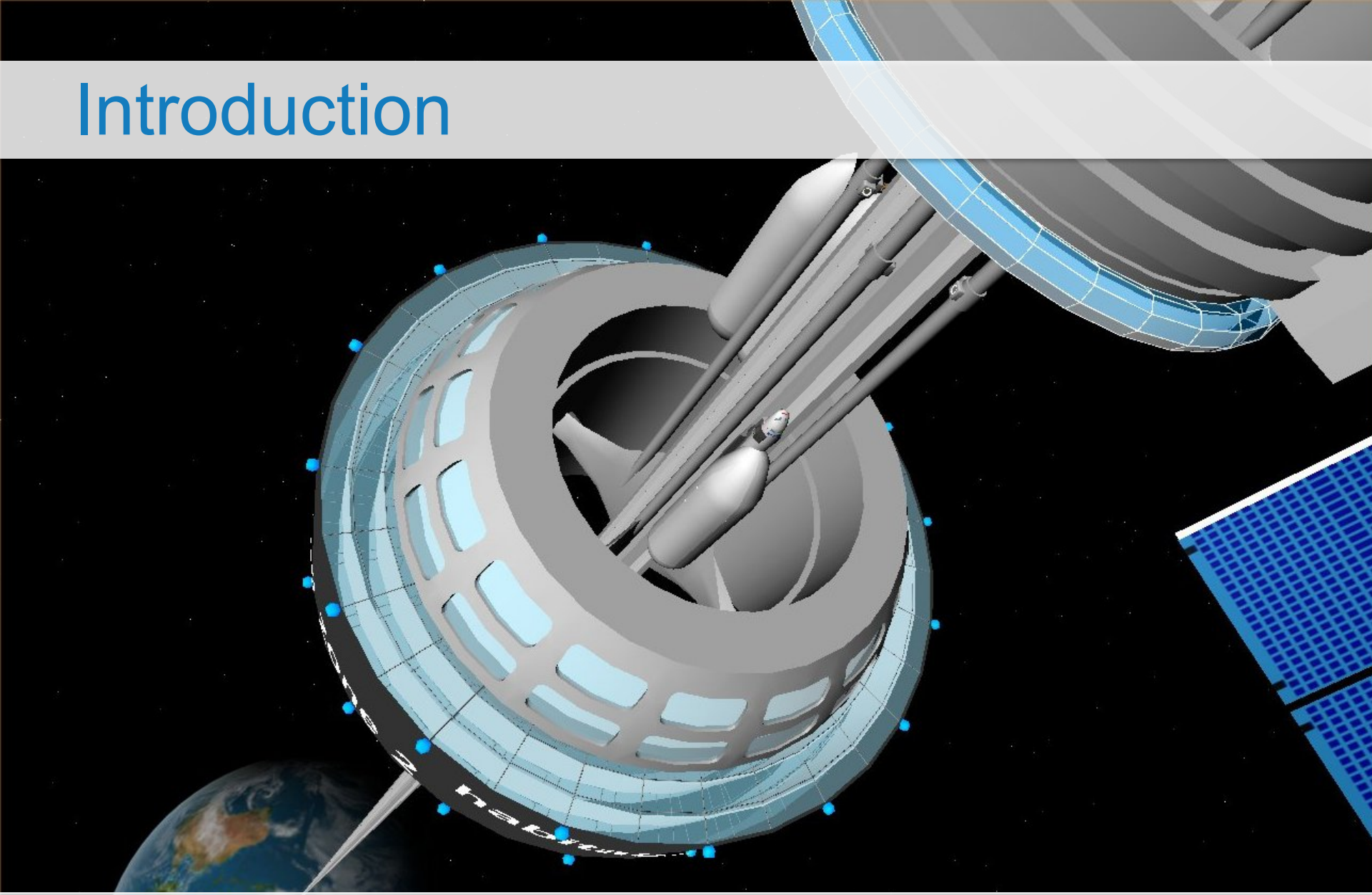
Simulation

Introduction



Hot Aisle Containment - Chimney, CC BY 2.0, talk2stu

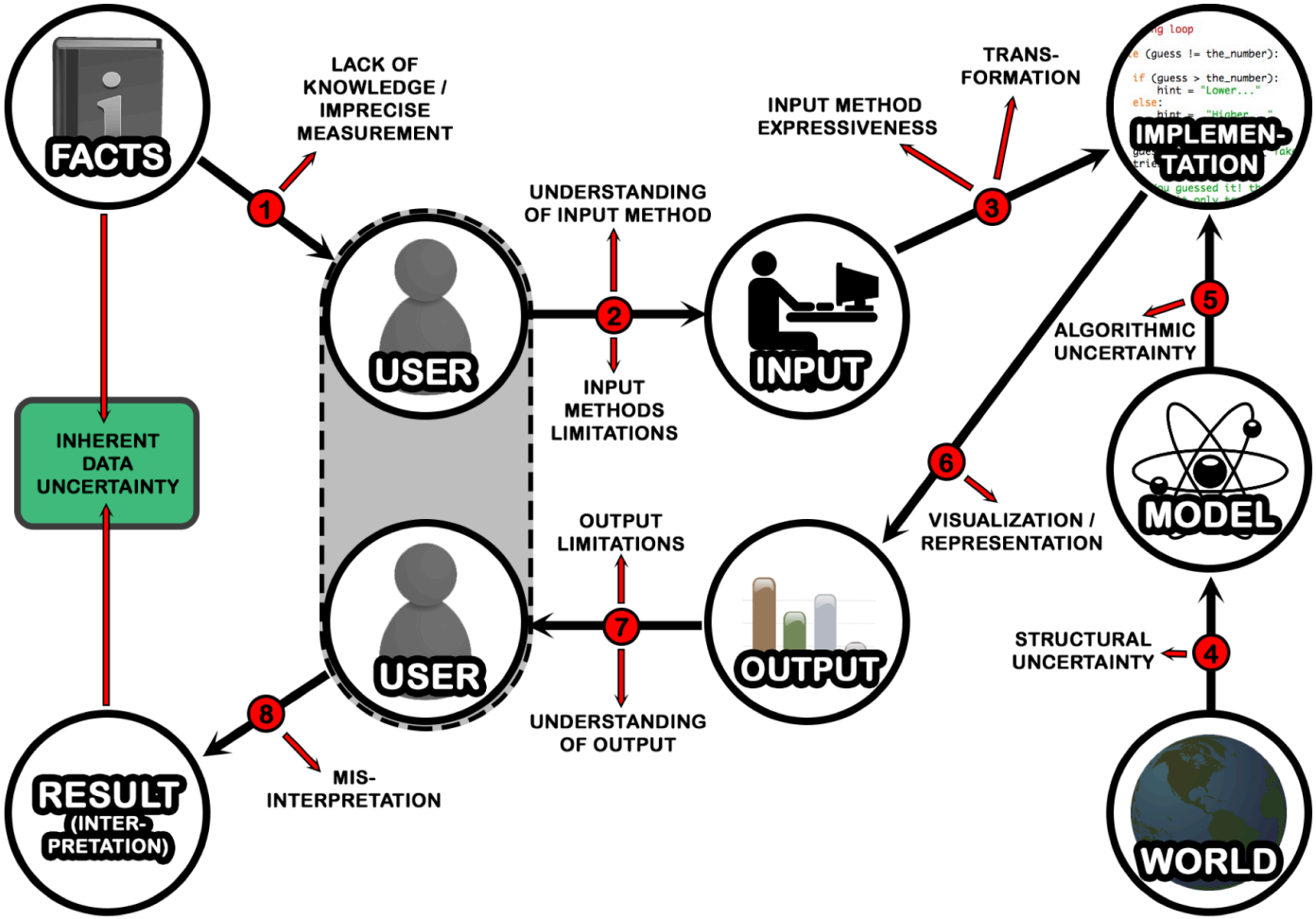
Introduction



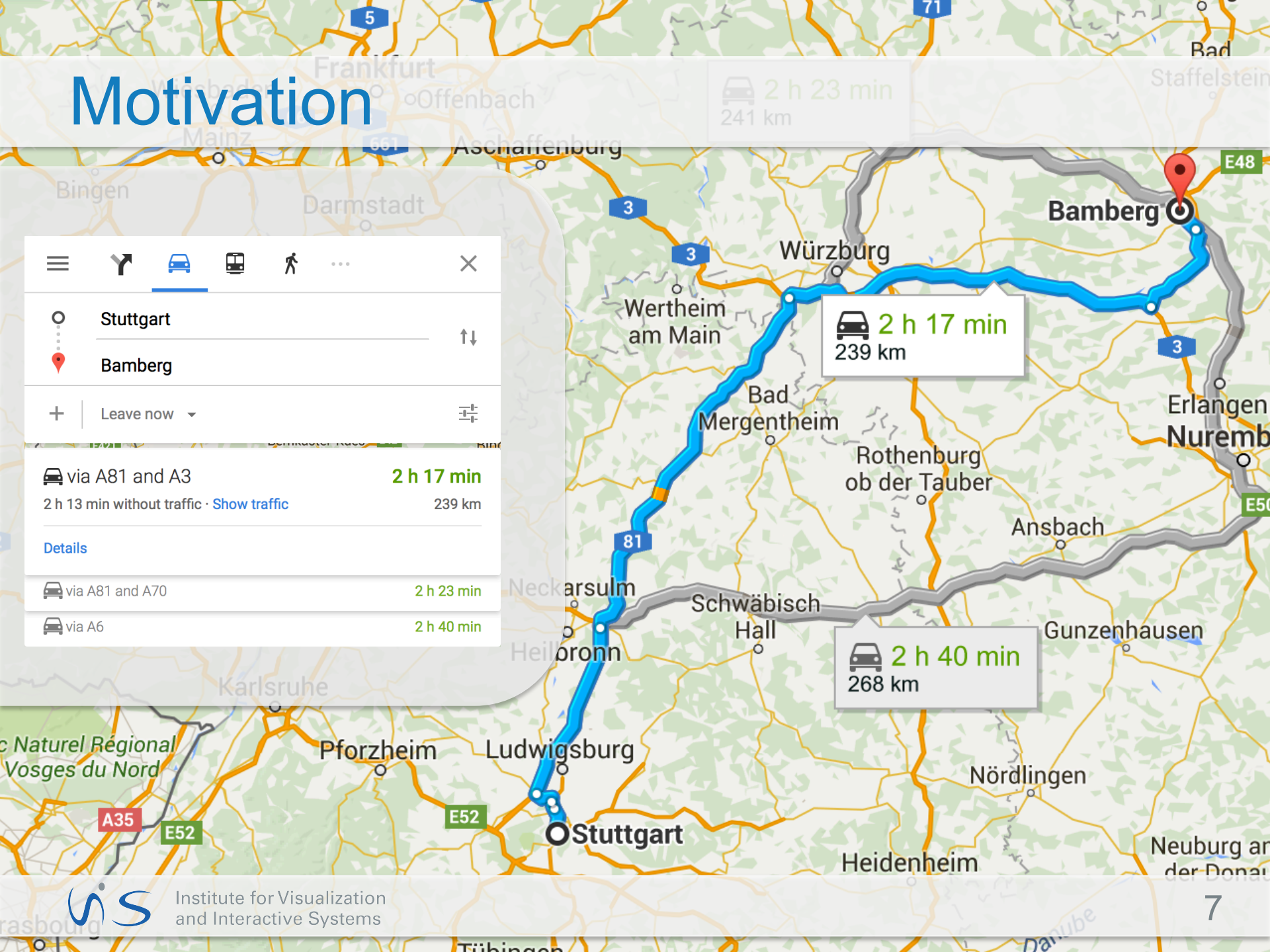
Space Elevator GEO Station, CC BY 2.0, Bruce Irving

Simulation

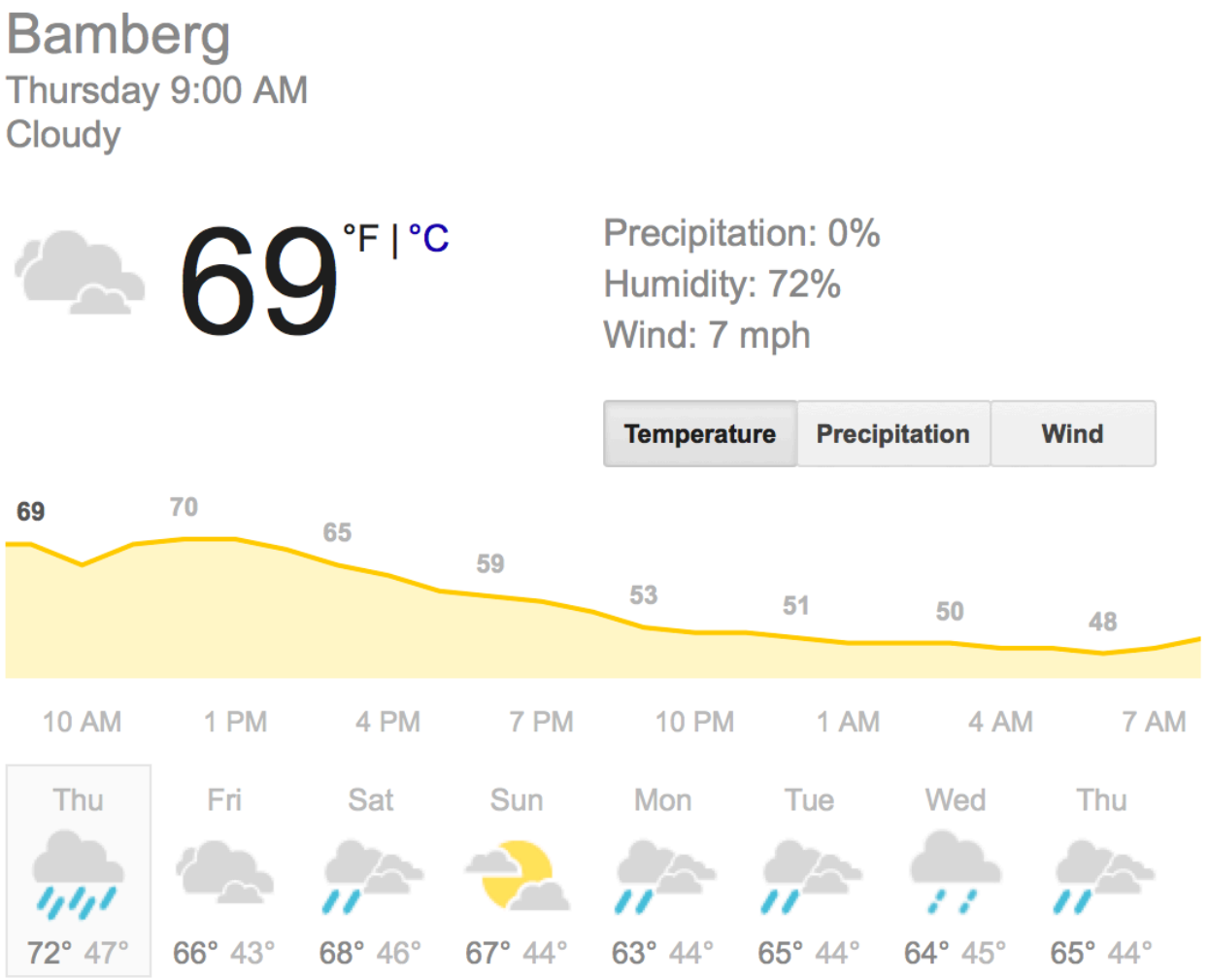
Motivation


FACTS
LACK OF KNOWLEDGE / IMPRECISE MEASUREMENT
1
USER
UNDERSTANDING OF INPUT METHOD
2
INPUT METHODS LIMITATIONS
INPUT
INPUT METHOD EXPRESSIVENESS
TRANS-FORMATION
3
IMPLEMEN-TATION
ALGORITHMIC UNCERTAINTY
5
MODEL
INHERENT DATA UNCERTAINTY
6
VISUALIZATION / REPRESENTATION
OUTPUT LIMITATIONS
7
USER
OUTPUT
STRUCTURAL UNCERTAINTY
4
WORLD
8
RESULT (INTER-PRETATION)
MIS-INTERPRETATION
UNDERSTANDING OF OUTPUT

Motivation


Stuttgart
Bamberg
Leave now
via A81 and A3
2 h 17 min
2 h 13 min without traffic · Show traffic
239 km
Details
via A81 and A70
2 h 23 min
via A6
2 h 40 min
2 h 17 min
239 km
2 h 40 min
268 km
Bamberg
Würzburg
Wertheim am Main
Bad Mergentheim
Rothenburg ob der Tauber
Ansbach
Schwäbisch Hall
Gunzenhausen
Nördlingen
Heidenheim
Stuttgart
Ludwigsburg
Pforzheim
Karlsruhe
Darmstadt
Frankfurt
Offenbach
Mainz
Aschaffenburg
Bingen
Erlangen
E48
E52
A35
81
3

Motivation


Bamberg
Thursday 9:00 AM
Cloudy
69 °F | °C
Precipitation: 0%
Humidity: 72%
Wind: 7 mph
Temperature
Precipitation
Wind
69
70
65
59
53
51
50
48
10 AM
1 PM
4 PM
7 PM
10 PM
1 AM
4 AM
7 AM
Thu 72° 47°
Fri 66° 43°
Sat 68° 46°
Sun 67° 44°
Mon 63° 44°
Tue 65° 44°
Wed 64° 45°
Thu 65° 44°

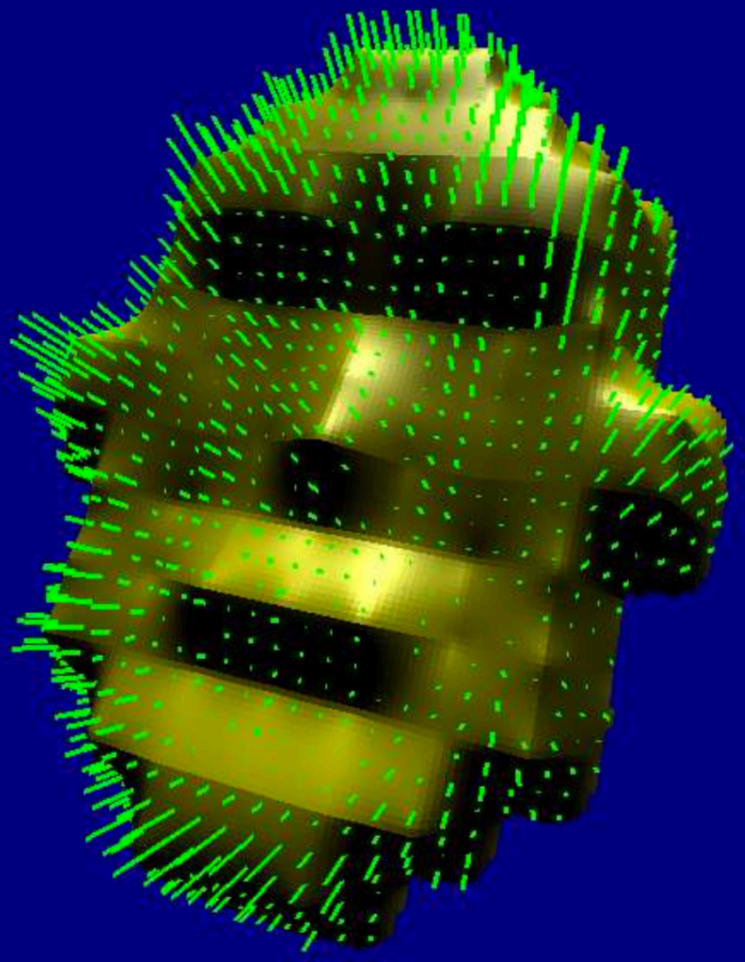
Motivation

773 kcal

zum Aufnehmen übrig

Related Work

- Visualizations of uncertain data for experts
  - Glyph visualizations on surfaces and vector fields



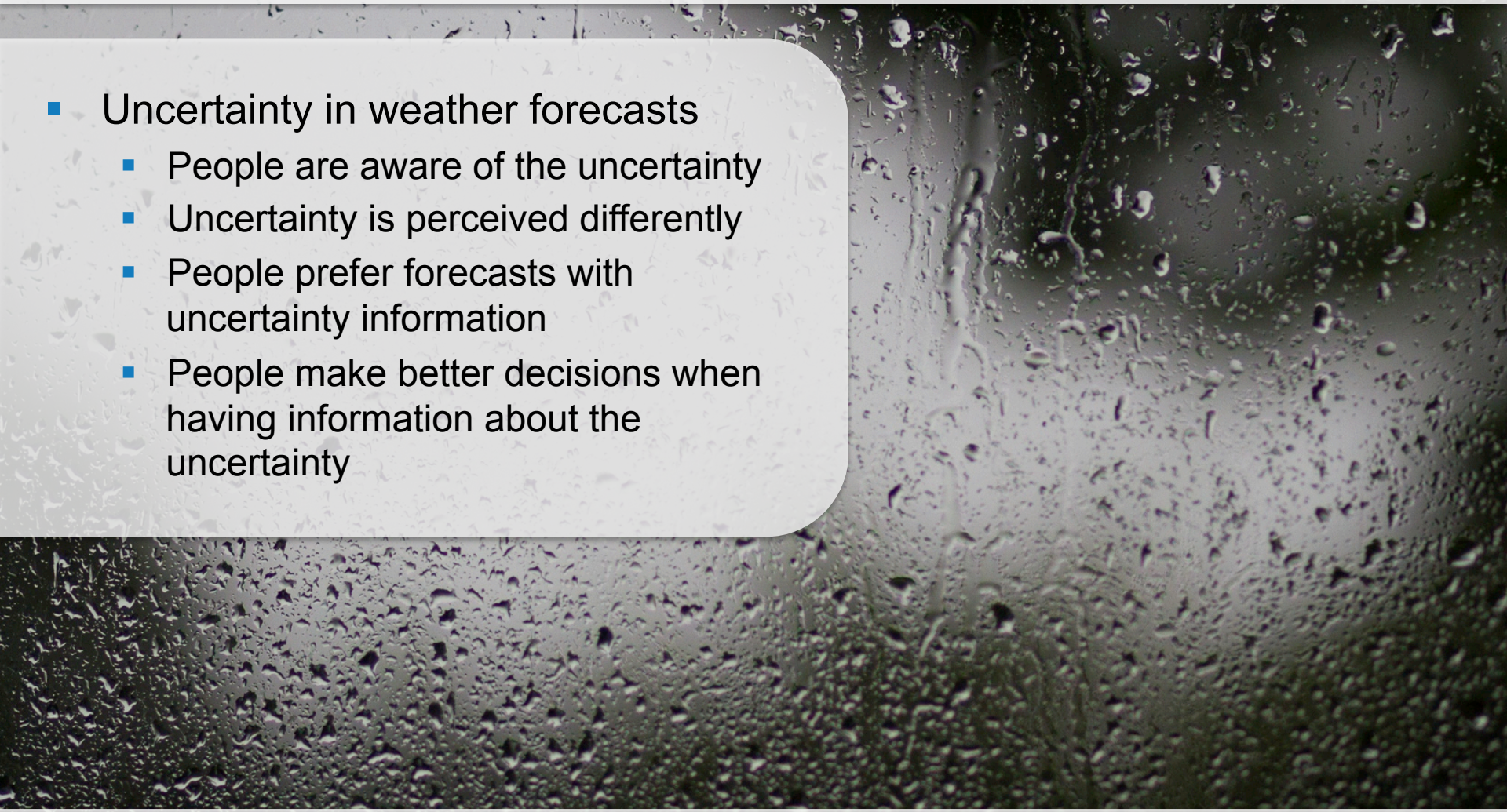
Pang, A. et al. ""Approaches to uncertainty visualization." *The Visual Computer 13.8*. 1997

Related Work

- Representations for non-experts
  - Quantitative
  - Qualitative
  - Positive or negative formulation

Related Work

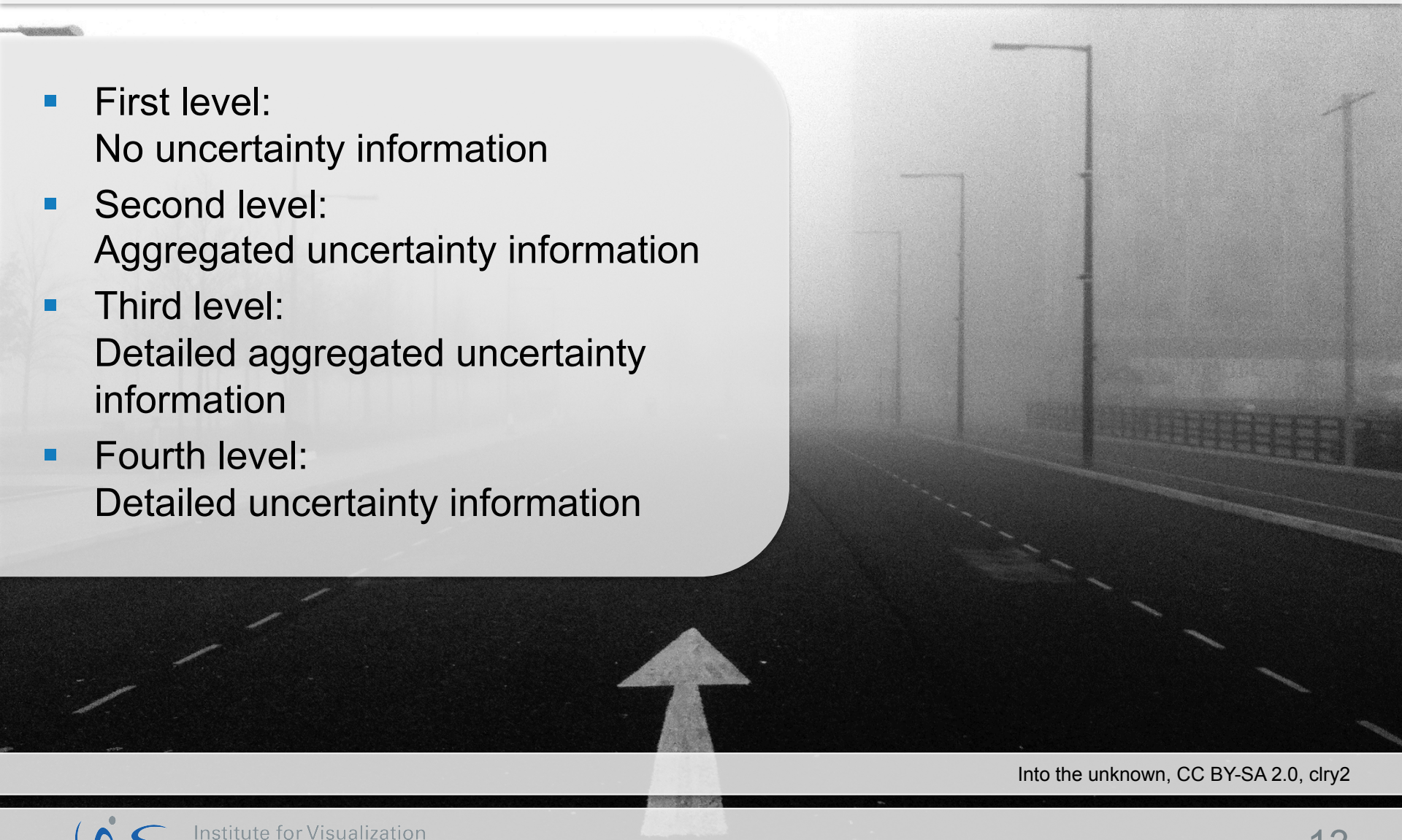
- Uncertainty in weather forecasts
  - People are aware of the uncertainty
  - Uncertainty is perceived differently
  - People prefer forecasts with uncertainty information
  - People make better decisions when having information about the uncertainty



Bertha's remnants, CC BY-SA 2.0, Jun

Degree of Uncertainty

- First level:
  No uncertainty information
- Second level:
  Aggregated uncertainty information
- Third level:
  Detailed aggregated uncertainty information
- Fourth level:
  Detailed uncertainty information



Into the unknown, CC BY-SA 2.0, clry2

Representations I

Expected rainfall:

01.07.: Expected value: 3.5 mm
02.07.: Expected value: 3.9 mm
03.07.: Expected value: 6.1 mm

Into the unknown, CC BY-SA 2.0, clry2

Representations II

Expected rainfall:

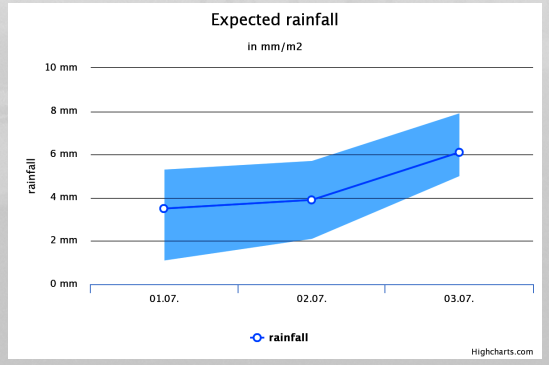
01.07.: Expected value: 3.5 mm
Standard deviation: 0.9 mm
02.07.: Expected value: 3.9mm
Standard deviation: 0.8 mm
03.07.: Expected value: 6.1 mm
Standard deviation: 0.6 mm

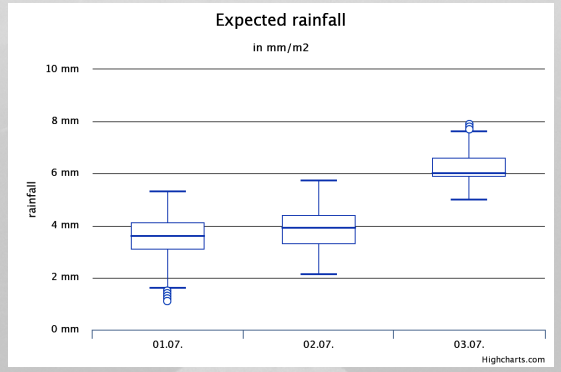
Expected rainfall:

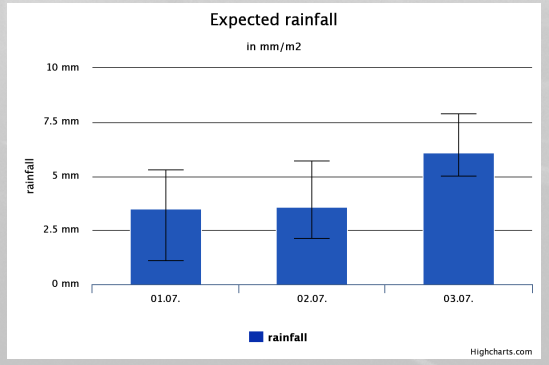
01.07.: 0.25-Quantile: 3.0 mm
0.50-Quantile: 3.6 mm
0.75-Quantile: 4.1 mm

02.07.: 0.25-Quantile: 3.4 mm
0.50-Quantile: 3.9 mm
0.75-Quantile: 4.3 mm

03.07.: 0.25-Quantile: 5.8 mm
0.50-Quantile: 5.9 mm
0.75-Quantile: 6.5 mm







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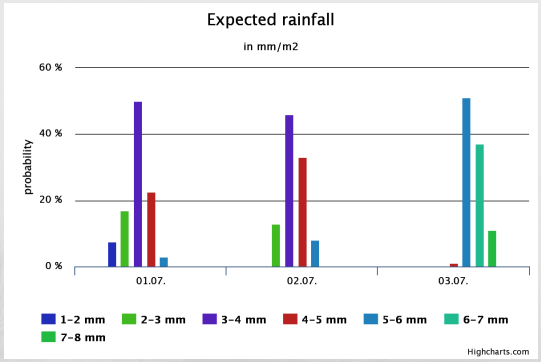
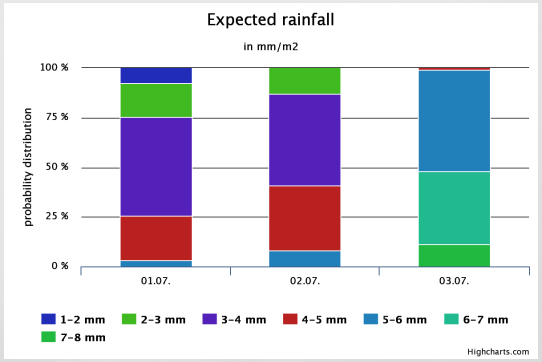
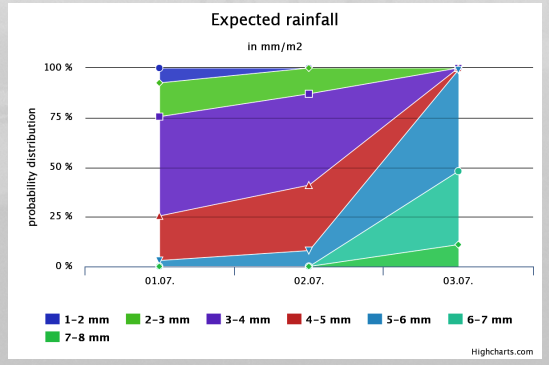
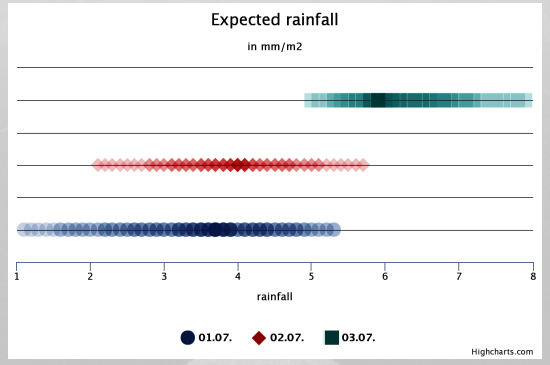
Representations III









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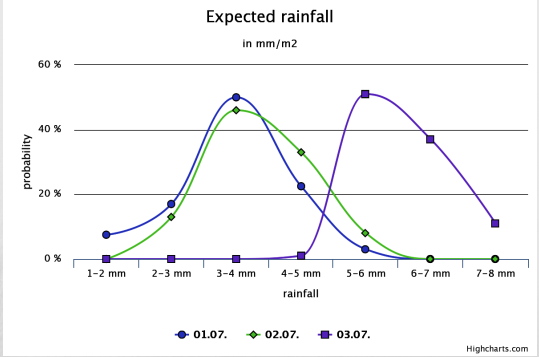
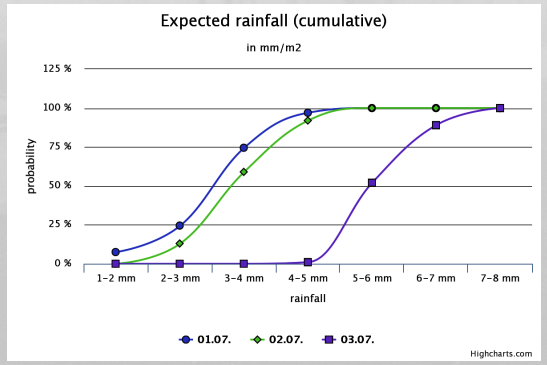
Representations IV





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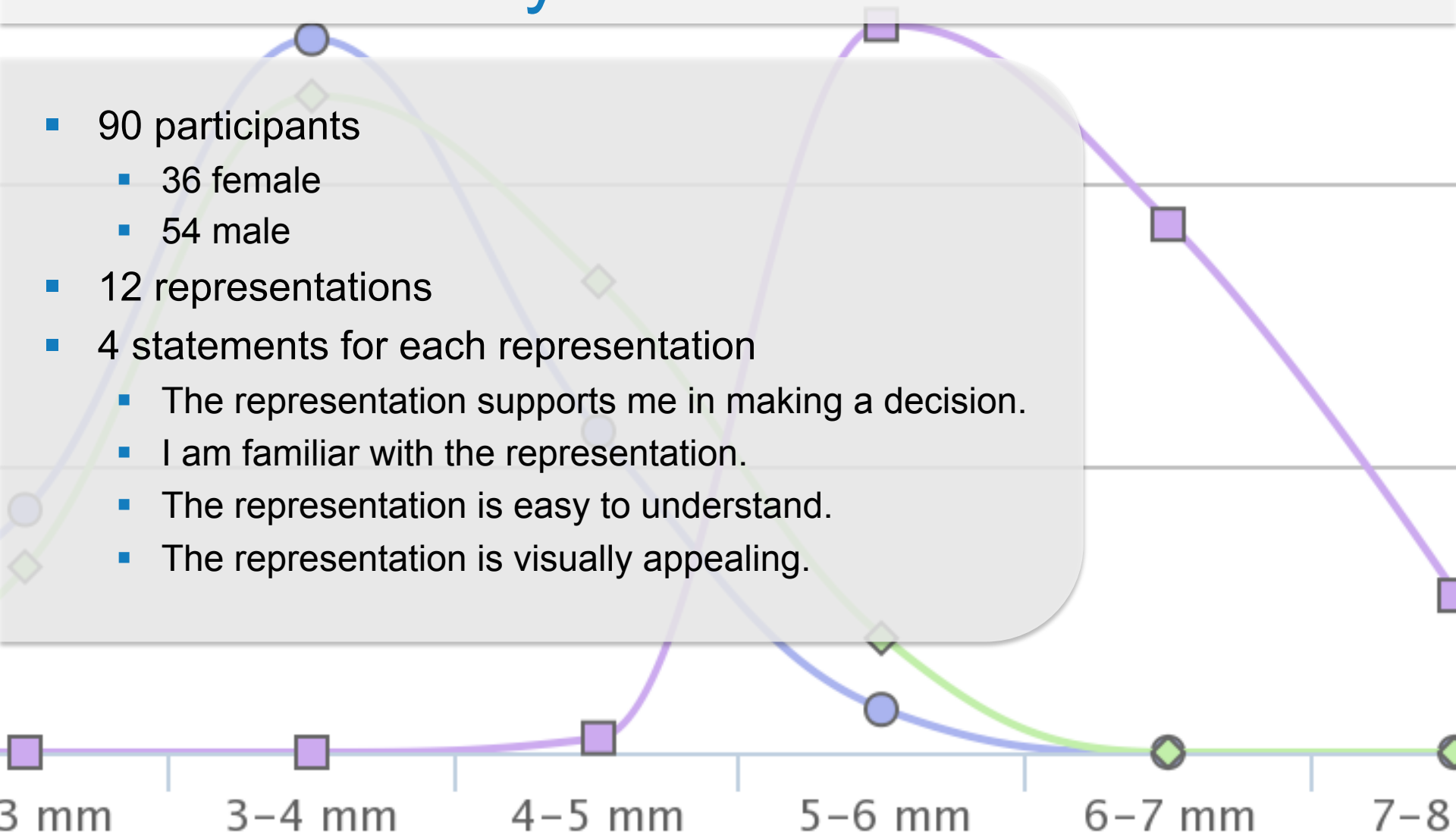
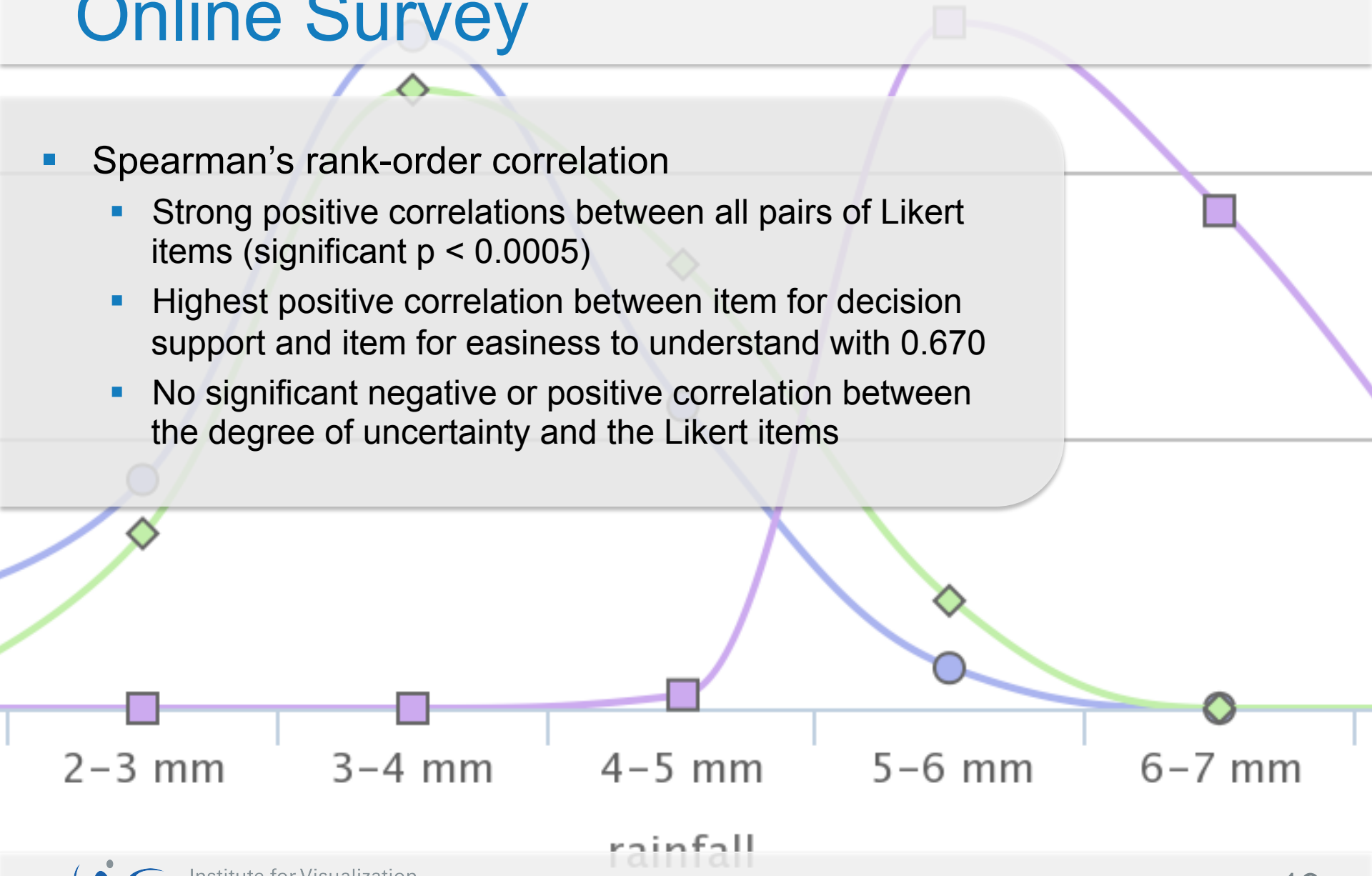
Online Survey

- 90 participants
  - 36 female
  - 54 male
- 12 representations
- 4 statements for each representation
  - The representation supports me in making a decision.
  - I am familiar with the representation.
  - The representation is easy to understand.
  - The representation is visually appealing.



Online Survey

- Spearman's rank-order correlation
  - Strong positive correlations between all pairs of Likert items (significant $p < 0.0005$)
  - Highest positive correlation between item for decision support and item for easiness to understand with 0.670
  - No significant negative or positive correlation between the degree of uncertainty and the Likert items



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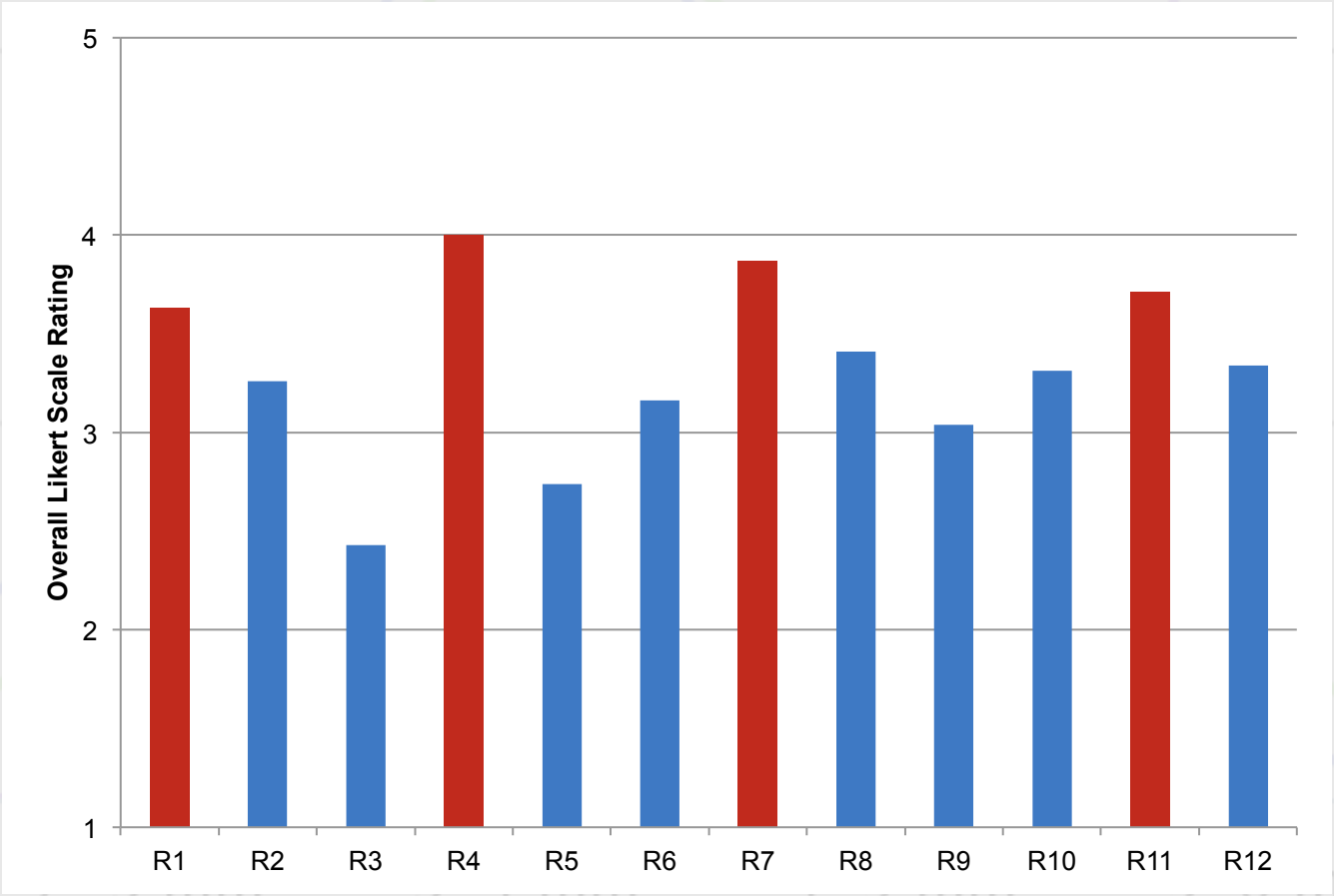

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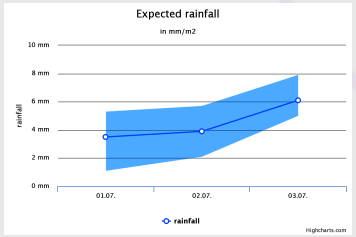
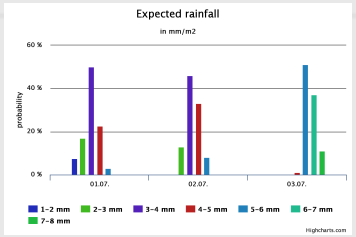
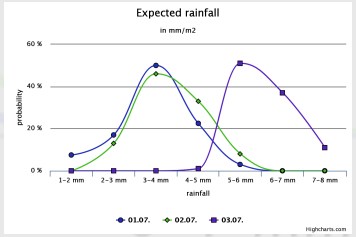




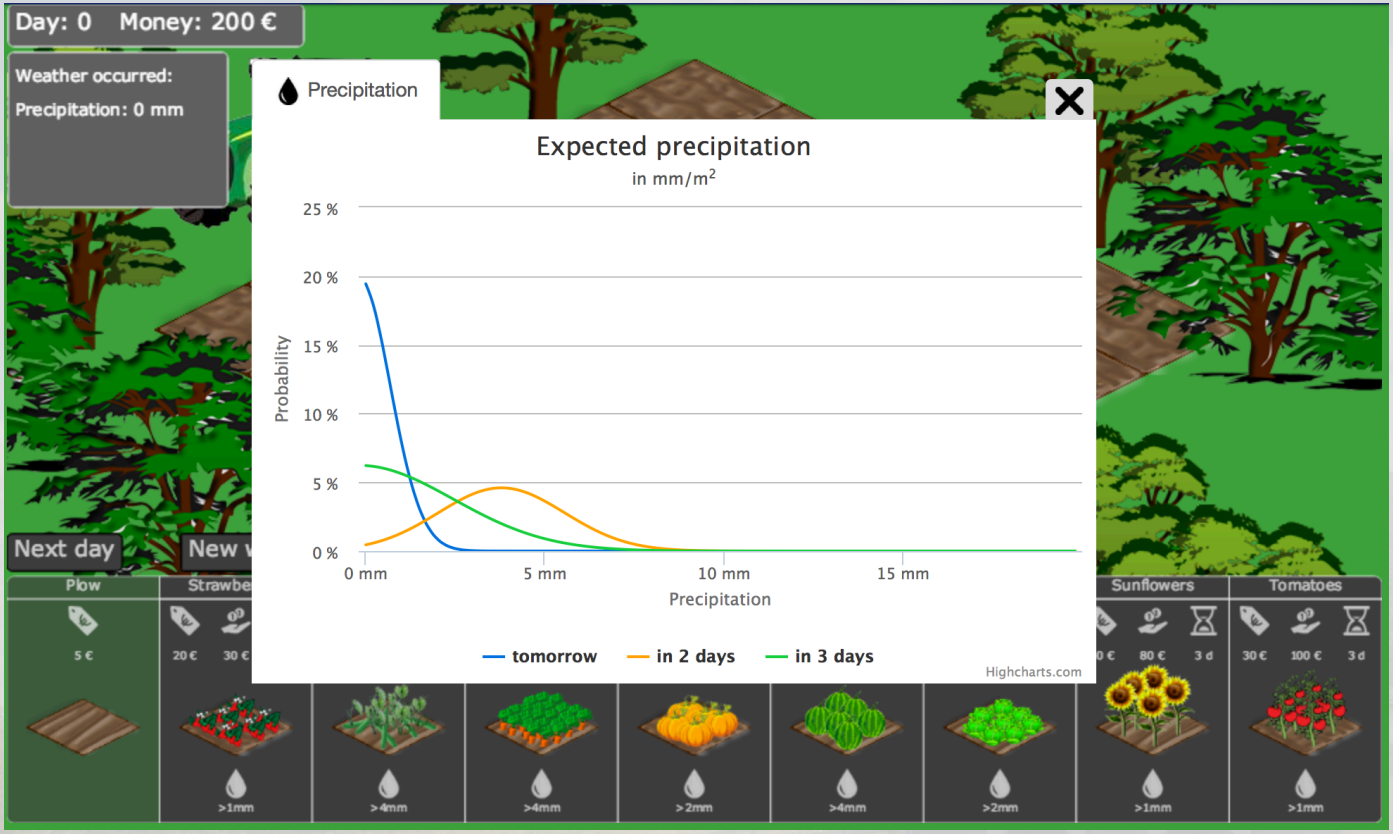


rainfall

Experiment

Heeg-View Holsteins, CC BY 2.0, B Garrett

Experiment



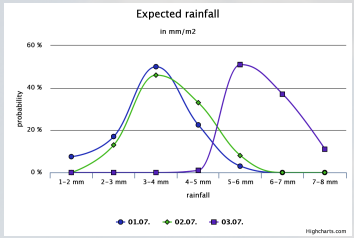
Heeg-View Holsteins, CC BY 2.0, B Garrett

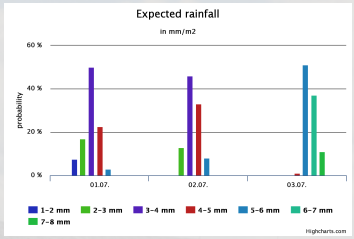
Experiment

- 12 participants
  - 8 male
  - 4 female
- Order of representations randomly assigned to participants
- 480 rounds of game play, with 442 rounds going into analysis

Experiment

- Calculating the optimal decision
  - 69% with R11
  - 64% with R7
  - 60% with R1
  - 57% with R4
- Representations liked by participants
  - R11: 8 participants
  - R7: 3 participants
  - R1: no participant
  - R4: 1 participant





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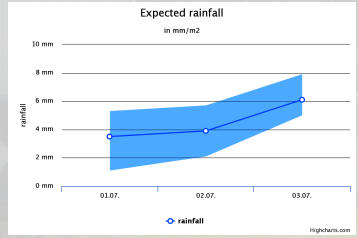
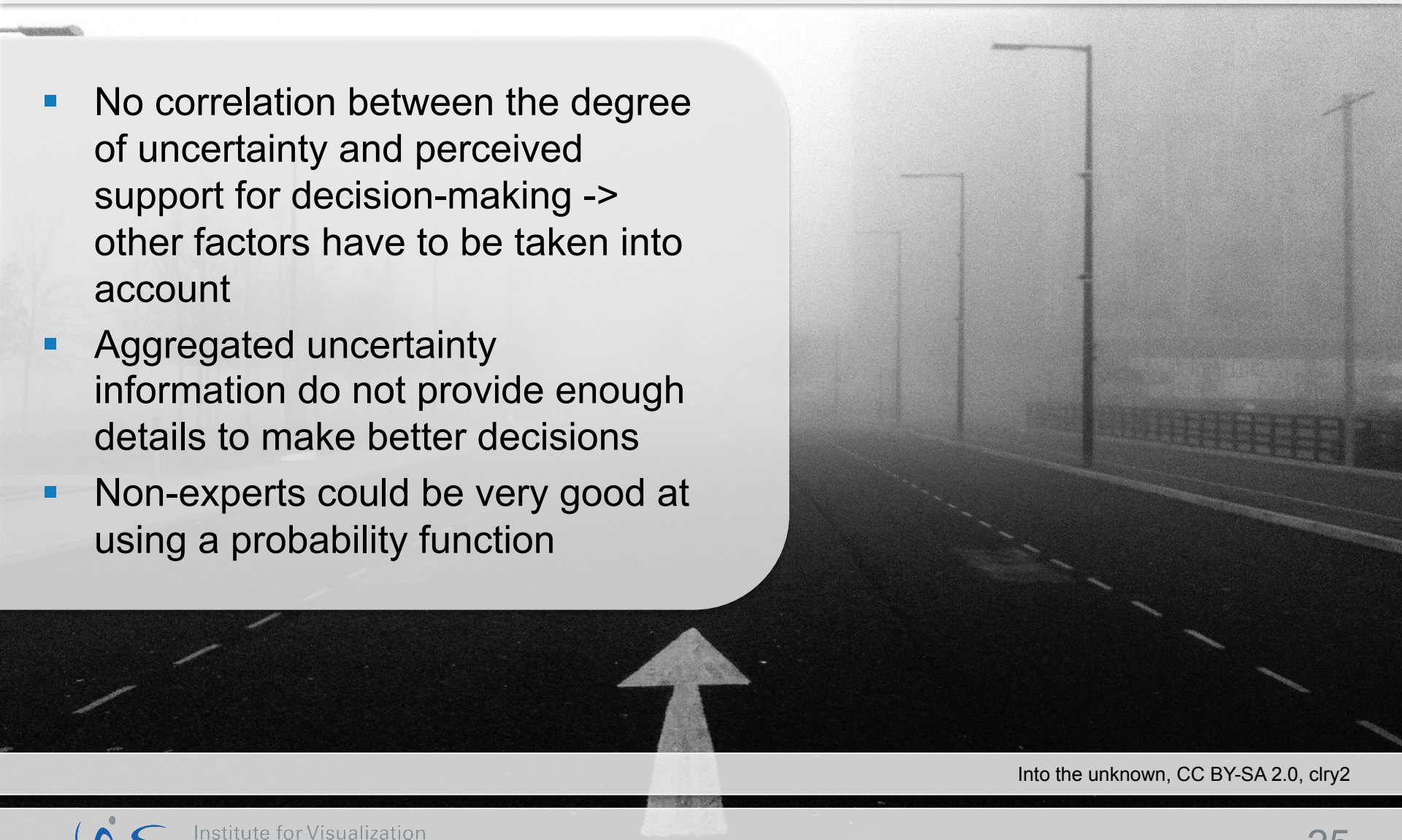


Conclusions

- No correlation between the degree of uncertainty and perceived support for decision-making -> other factors have to be taken into account
- Aggregated uncertainty information do not provide enough details to make better decisions
- Non-experts could be very good at using a probability function



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Takeaway Message

Visualizing the uncertainty does not necessarily help. Factors such as familiarity, easiness to use, and visual appeal have to be taken into account.

Contact: Miriam Greis, miriam.greis@vis.uni-stuttgart.de

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