Micro scenarios for technology analysis:
Dual interpretation as personality factors and technology attributions on visual acceptance maps

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Micro scenarios for technology analysis

Background

- Currently, many challenges
  - Demographic change
  - Decarbonization
  - Digitalization

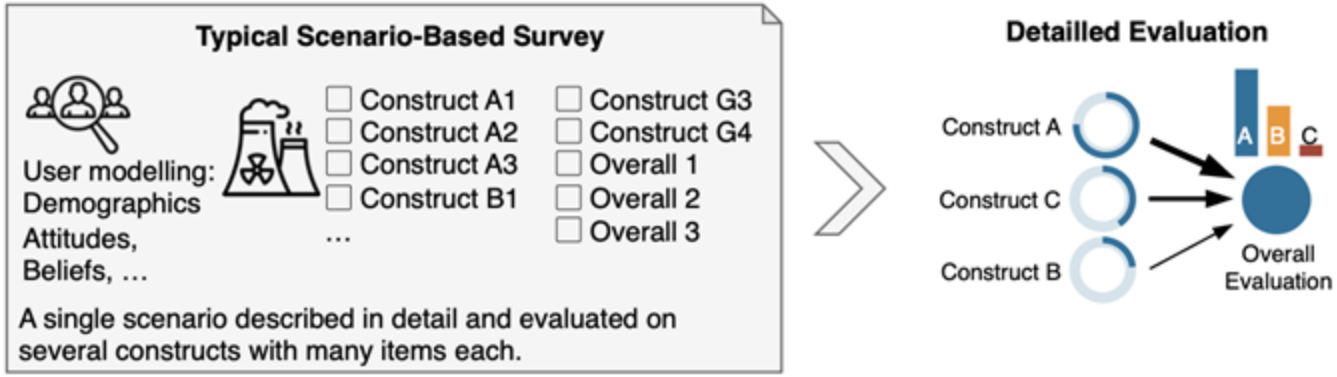
- Technology can help to overcome these;

  but often has (unwanted) side effects
- Responsible technology development essential
- Focus here: Early technology assessment based on scenarios

Micro scenarios for technology analysis

Typical approaches

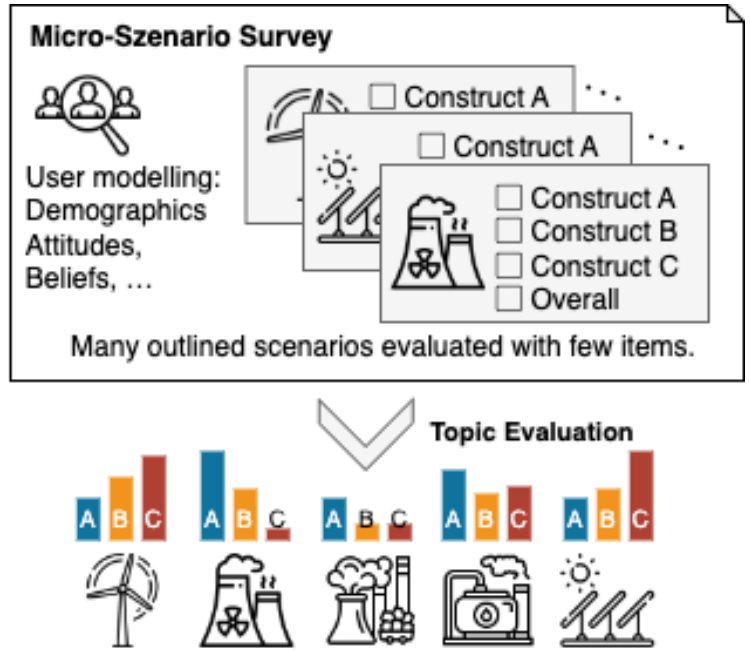
- Empirical evaluation of individual technologies through interviews, focus groups or questionnaires
- Questionnaires often based on TAM or TAM derivates
- Link to personality factors
- Methodological challenge:
  - Common Method Bias
    (Podsakoff et al. 2003, 10.1037/0021-9010.88.5.879)
  - Lexical analyses of the instruments provide surprisingly good models
    (*"We evaluate the menu and not the food."*)
    (Gefen and Larsen, 2017, 10.17705/1jais.00469)



Micro scenarios for technology analysis

What are micro scenarios?

- Instead of a *detailed* measurement of *one* scenario, *many* scenarios are *roughly* measured
- Micro scenarios often just one word or sentence
  ⇒ Capturing *affective* technology evaluation
- Few dependent variables
  - Single-Item Scales (best validated & orthogonal)
    (Ang & Eisend 2017, 10.2501/JAR-2017-001)
  - Semantic differentials
    (metric properties and suitable centers for visualisations)
    (Verhagen et al. 2018, 10.17705/1jais.00388)
  - Examples: Risk (dangerous-safe), benefit and valence
    (for modeling individual & technology-related tradeoffs)
- Often used “intuitively”/without a theoretical basis
  (for example, Sigrist 2007, 10.1111/j.1539-6924.2006.00859.x)
  Therefore: Systematic foundation and implementation recommendations!



Brauner P (2024) Mapping acceptance: micro scenarios as a dual-perspective approach for assessing public opinion and individual differences in technology perception. Front. Psychol. 15:1419564. doi: 10.3389/fpsyg.2024.1419564

Micro scenarios for technology analysis

How can the data be interpreted?

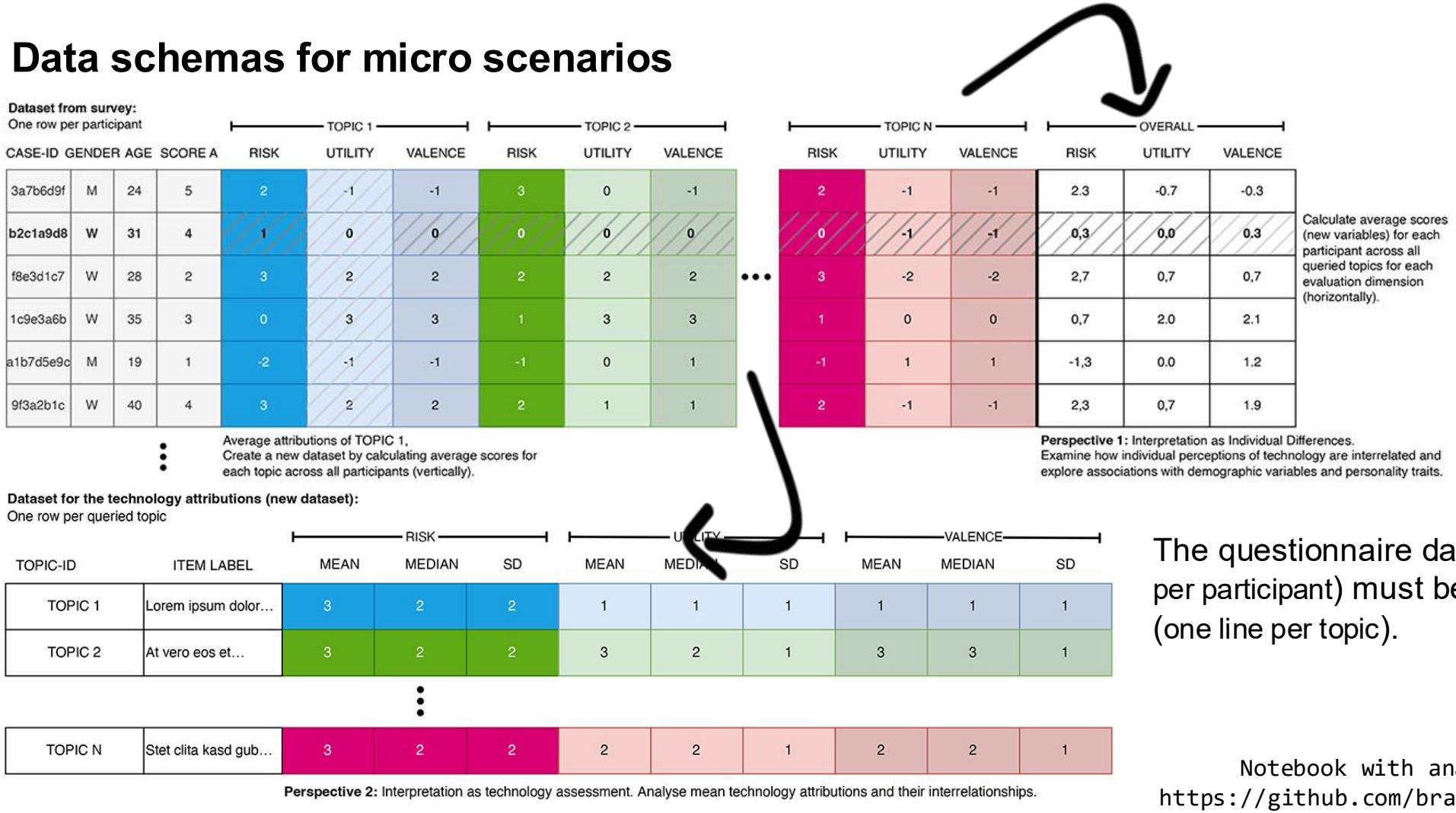
- **Overall mean:**
  The assessments are averaged across all technologies and all participants.
  Provides an evaluation of the topic or technology complex regarding the dependent variables; for example, whether the entire topic area is rated positively or negatively overall.

- **Interpretation as a personality trait (perspective 1, horizontal through the data):**
  Participants' judgments are averaged across the technologies surveyed and interpreted as an individual difference/disposition (reflexive measurement of a latent personality trait).
  Example: Individual differences in risk attributions can be correlated with other personality factors.

- **Interpretation as technology attribution and mapping (perspective 2, vertically through the data):**
  The judgments on the surveyed technologies can be interpreted as technology attributions.
  These technology attributions can easily be illustrated and further analyzed.
  Example: The risk attributed to a technology; attributions in relation to each other.

Micro scenarios for technology analysis

Data schemas for micro scenarios



The questionnaire data (individual answers, one line per participant) must be converted into topic ratings (one line per topic).

Notebook with analysis code freely available:
https://github.com/braunerphilipp/MappingAcceptance

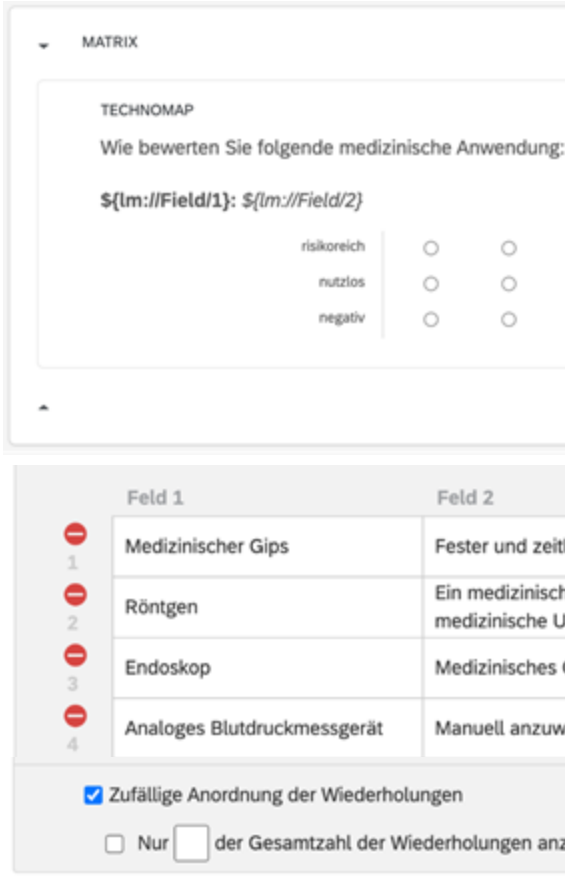
Micro scenarios for technology analysis

Example implementation — *simple for researchers and participants*

- Creation of a parameterized, repetitive question block (like a form letter)
  - Random order of topics
  - Multiple response items in the same order
  - *Quick and cognitively easy* to process despite many items (Tourangeau 2000, 10.1017/CBO9780511819322)

- Example implementation
  - “Repeat and merge” function (in Qualtrics; other tools similar)
  - Table with N technologies/topics & description
  - Full design, random sample from the topics, ...

- Specific introduction recommended before this block
  - Explanation of dependent variables



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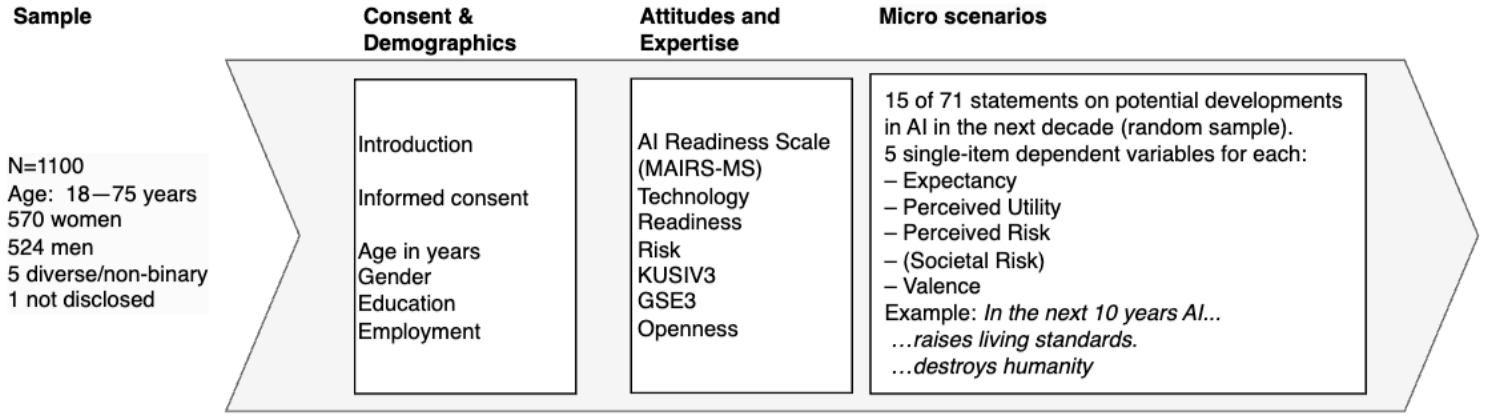
Micro scenarios for technology analysis

Example: Study on the perception and expectations of artificial intelligence

- Evaluation of 15 out of 71 future scenarios
  - „AI creates valuable works of art that are traded for money“
  - „AI has its own consciousness“
  - „AI makes political decisions“
  - „AI divides society“
  - „AI promotes innovation“

- Evaluation regarding
  - Individual risk
  - Utility
  - Individual value (positive–negative)
  - Probability of occurrence in a decade

- Sample
  - 1100 AI laypeople (+129 experts)



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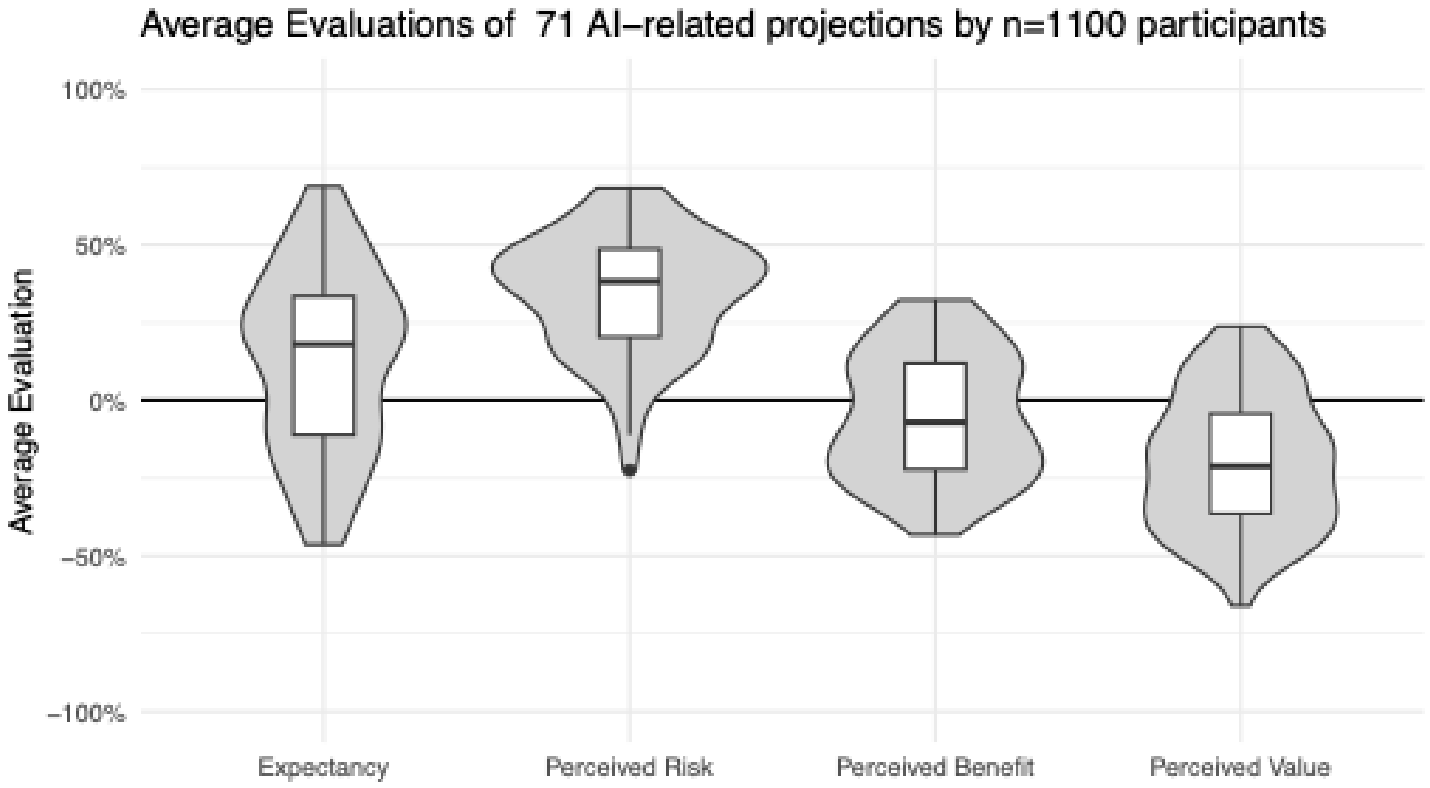
Results: Overall evaluation of the 71 scenarios

- Mean values across all topics and across all 1100 participants

- Across all AI scenarioes
  - Developments seen as rather likely and risky
  - Developments seen as rather useless and negative



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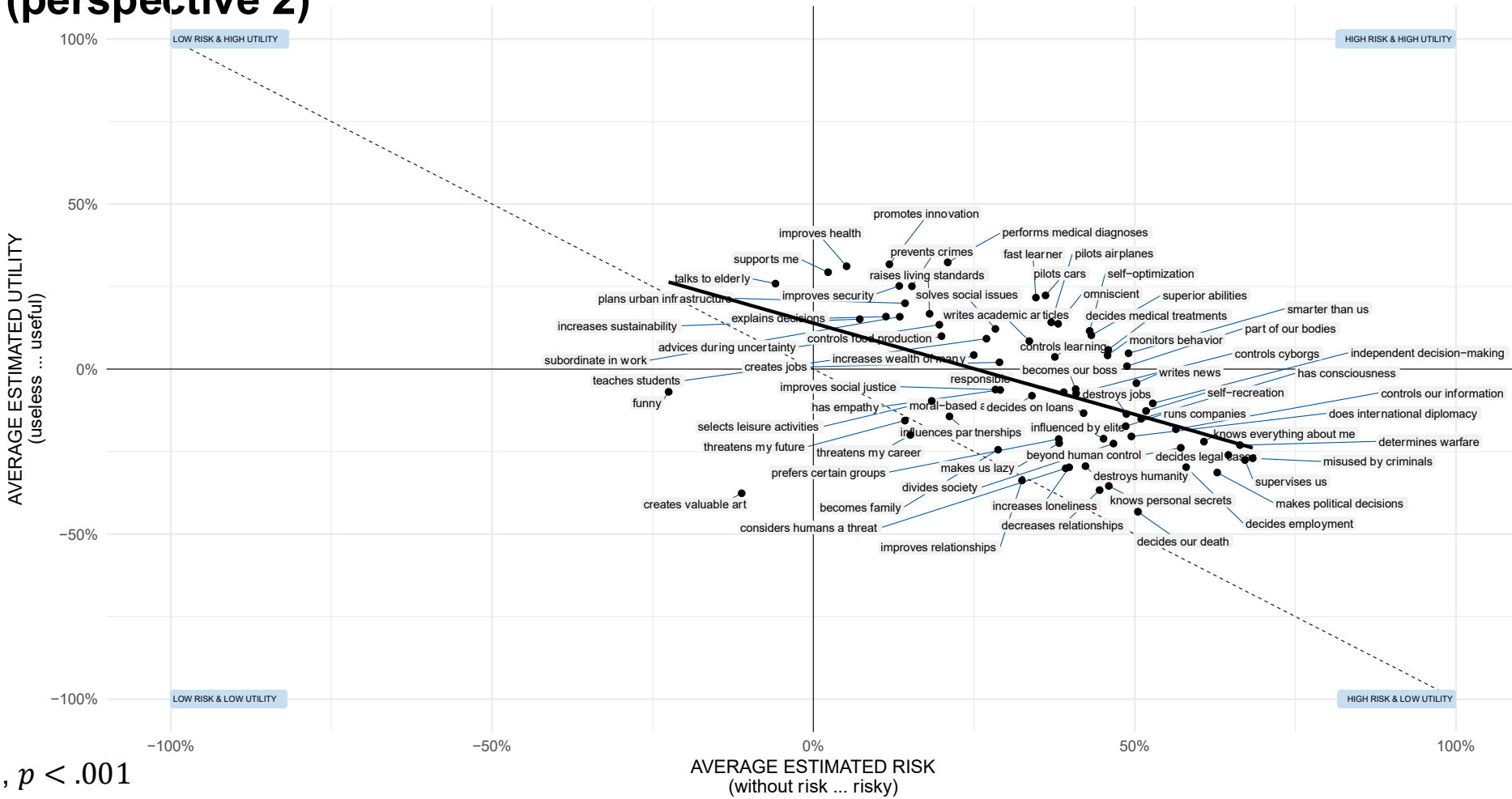
Micro scenarios for technology analysis

Technology attributions (perspective 2)

Interpretation:

- There are topics rated as both useful and useless.
- The vast majority of topics are rated as risky.
- There is a medium, negative correlation between perceived risk and usefulness.



$r = -0.525$, CI-95% = $(-.675; -.331)$, $p < .001$

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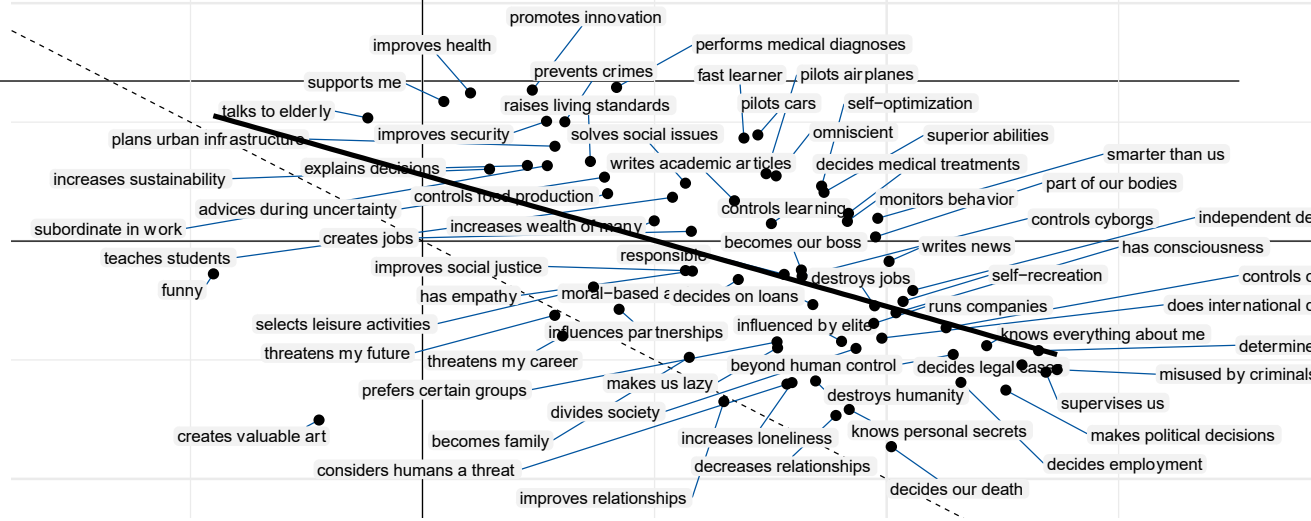
Micro scenarios for technology analysis

What determines the attributed value?

Linear regression with *Perceived Risk* and *Perceived Utility* as predictors and *Attributed Value* as dependent variable.



Regression table:

	β-Estimate	SE	t value	Pr(>|t|)
(Intercept)	0.014	0.0110	1.296	0.199
Risk	-0.504	0.0302	-16.710	<2e-16 ***
Utility	0.720	0.0286	24.840	<2e-16 ***

R^2=0.964, R^2_{adj}=0.963 (96%)
F(2,68)=916.9, p<.001

Interpretation:
Very high variance explanation!
96% of the explanation of *Value* stems from *Risk* and *Utility*.

The perceived utility outweighs the perceived risk (β=-.504) in the variance analysis (β=-.702).

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Correlation of AI ratings with personality factors (perspective 1)

Hierarchical regression:
- First step:
  Demography
- Second step:
  Demography +
  Supplementary explanatory user factors

Both models are significant. The second model explains significantly more variance than the first model.

Interpretation:
The influence of demographics (which cannot be changed) is reduced by the explanatory user factors (which can be changed by training, for example).

Table 4: Results of the Hierarchical Linear Regression Analysis for Individuals' Perceived Risk, Benefit, and Valence of AI, by Demographics (Age, Gender) and Technology Attitudes. Including Technology Readiness and AI Readiness improved the model's explanatory power and decreased the influence of age (and to a lesser extent, gender) on the three target variables (n=1094). "***" significant at $p < .001$, "*" significant at $p < .05$.

Independent Variable	Perceived Risk	Perceived Benefit	Perceived Valence
Step 1: Demographics			
(Intercept)	+0.074	+0.214***	+0.059
Age in Years (β)	+0.198***	−0.183***	−0.149***
Gender (β, dummy coded m=1, w=2)	+0.051	−0.055	−0.068***
R^2	0.041	0.036	0.026
$F(2, 1091)$	23.46 ***	20.19 ***	14.65 ***
Step 2: Explanatory Variables			
(Intercept)	+0.332***	+0.286***	+0.390***
Age in Years (β)	+0.159***	−0.109***	−0.088*
Gender (β, dummy coded m=1, w=2)	+0.022	+0.000	+0.021
Technology Readiness (β)	+0.058	+0.109*	+0.108*
AI Readiness (AIRS) (β)	−0.100**	+0.189***	+0.141***
ΔR^2	+0.018	+0.061	+0.042
R^2	0.059	0.097	0.067
$F(4, 1089)$	16.92 ***	29.22 ***	19.85 ***

Evaluation of the method

- Pragmatic approach:
  - Easy to set up for researchers
  - Easy to answer for participants (participation in the sample study took less than 10 minutes)
  - Use of accessible semantic differentials with meaningful scale midpoints

- Multiple interpretations
  - Interpretation as an overall mean value for the entire subject area
  - Interpretation as a personality trait (perspective 1)
    - Correlations with other personality traits
    - Identification of group or factor structures
  - Interpretation as technology attributions (perspective 2)
    - Visual positioning of the attributions on maps
    - Interpretation of distributions, correlations and outliers
    - Interpretation of regressions regarding intercepts and slopes

- However, no detailed evaluation of a single technology is possible!

General recommendations and possibilities

- Systematic creation of topic lists
  - No more than 15-20 topics per respondent (random subsampling possible)
  - >40 topics difficult to visualize
  - Remedy: Use underlying design space/factor structure: Systematic subset of corresponding prototypes
  - Caution: Selection bias can lead to spurious correlations in technology attributions (“Berkson's paradox”)

- Intensive pre-testing necessary
  - Are all dependent variables *understandable* and *unambiguous*?
  - Are the topics clearly explained?
  - Both must be interpreted by participants
    ⇒ Errors post-hoc more difficult to identify

- Supplementary options
  - Supplement judgments with “hard facts” (e.g., perceived and actual CO2 consumption of means of transport)
  - Contrast judgments of different groups (e.g., judgments of experts on x-axis, those of laypersons on y-axis)

    e.g., Brauner et al., (2024) Misalignments in AI Perception: Quantitative Findings and Visual Mapping of How Experts and the Public Differ in Expectations and Risks, Benefits, and Value Judgments, arXiv:2412.01459

Advantages and disadvantages of this method

Advantages:

- Not frequently used
- Many topics can be put into relation & outliers identified
- Two perspectives in one study
  - Individual differences
  - Subject ratings
- Easily accessible visualization of results
- Topic ratings can be examined in many ways
  - Correlations, regression, clustering, PCA, ...

Disadvantages:

- Not frequently used ("Beware of the reviewer")
- Possible criticism due to single-item measurements (no Cronbach's α, often low ICCs)
- No detailed, rather superficial, affective evaluation of many topics
- Visualization of variances difficult
  Points suggest falsely precise measurement (error bars/CIs for the points often unclear)

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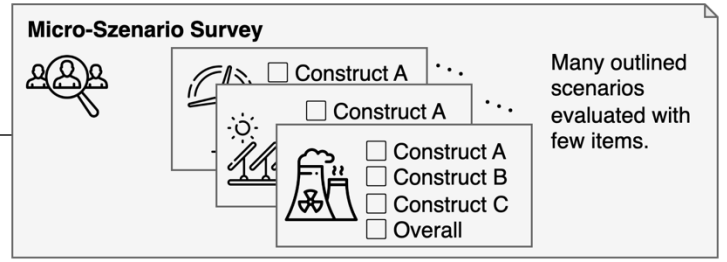
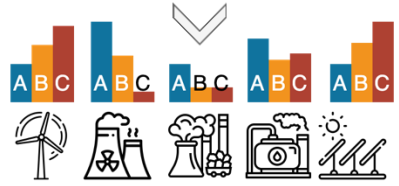
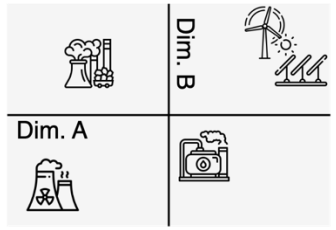


Thank you for your attention! - Summary

- Micro scenarios: many scenarios are roughly evaluated (with few items)
  - Few single-item scales as dependent variables (ideally as SemDiff)
  - Many scenarios are simultaneously quantified and comparable
  - Topic ratings can be displayed spatially & visually
  - Average rating of the scenarios can be interpreted as a user factor (reflexive measurement of latent constructs)





Base paper:
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Example of application:
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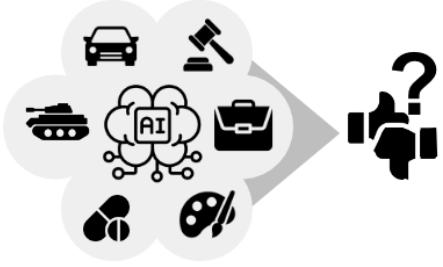
Mapping Public Perception of Artificial Intelligence: Expectations, Risk-Benefit Tradeoffs, and Value As Determinants for Societal Acceptance

OBJECTIVE



METHOD

N=1100 AI novices from Germany

Age: 18–75 years
Gender: 52% w, 48% m
AI and Technology Readiness

71 projections on capabilities and impact of AI

RESULT