Talking effectively about risks:

An agent-based simulation of risk workshops using Bayesian networks

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Introduction

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Group work in risk analysis

Communication and consultation with stakeholders are essential during all phases of risk analysis. Risk assessment needs to bring together expertise from several domains and to include different perspectives on a risk (ISO09). Management should introduce "open communication […] to share risk information throughout the entity" (COSO17). What determines the effectiveness of such initiatives?

Risk workshops as a tool of risk assessment

A common approach to identify and assess risks are workshops, where people with different roles and hierarchies within the organization discuss and share their knowledge to evaluate risks (COSO17). Participants start with a list of predefined risks and discuss each risk for a limited time. The discussion ends with a decision on how to classify a risk, e.g., regarding its impact (Quail11).

Risk workshops as a source of error

Research on group work suggests that groups not always succeed in correctly aggregating all available information. Practitioners of risk workshops are cautioned to be mindful of potential sources of errors that can lead to incorrect risk assessments (Quail11). As incorrectly assessed risks can have severe consequences, it is important to understand which factors impact the **effectiveness of risk workshops** and collaboration in risk analysis in general.

Studying risk assessment

It is difficult to determine the effectiveness of risk assessment practice, as **real-world situations lack an ideal result** to compare the outcome of the risk assessment against, e.g., the actual probability of a risk is unknown even after the event.

Theoretical Background

Ideal Speech Situation

Habermas describes characteristics of an ideal speech situation, which leads to true consensus:

"**Every subject** with the competence to speak and act is allowed to **take part** in a discourse.
Everyone is allowed to **question** any assertion whatever.
Everyone is allowed to **introduce any assertion** whatever into the discourse.
Everyone is allowed to **express attitudes, desires, and needs**.
No speaker may be prevented, by internal or external coercion, **from exercising rights as laid down** [above]."

(Habermas90)

Limits of actual discussions

However, discussions usually do not meet these ideal requirements:

The Givens (group and environment)
- Unequal distribution of knowledge within group
- Impact of hierarchy within the group
- Impact of relationship of participants

Intervening Factors (process and procedure)
- Limited persuasiveness of arguments
- Limits of the time and effort that can be spend on the discussion
- Impact of individual behavior on discussion

Outcomes
- Need to define measures of quality

Framework by (Handy86)

Model representation

These limitations are accounted for in the simulation model:

The Givens
- Variable: equal distribution of knowledge
- Variable: presence of hierarchy
- Variable: stable group

Intervening Factors
- Variable: weighting of received information

Simulation of a sequence of speech acts:
- Variable: decision-making rule
- Variable: interaction pattern

Outcomes (dependent variables)
- Probability of correct risk assessment
  - For high/low risks
- Time to decision (number of rounds)
  - For high/low risks

Methodology I

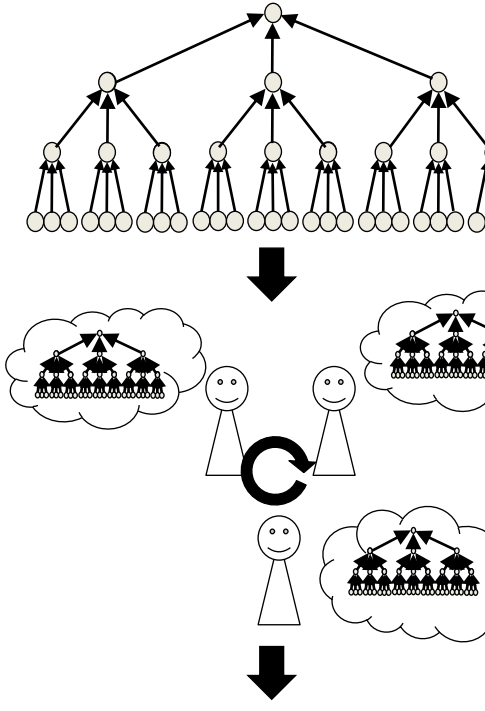
Simulation study

To assess the correctness of risk workshop results, the **best possible result** needs to be known, to serve as a benchmark.

One possibility to address this problem are simulation studies, as they allow to know the **ground truth** of a decision problem:

First, a **benchmark** with full information is derived (cf. (Labro07)).

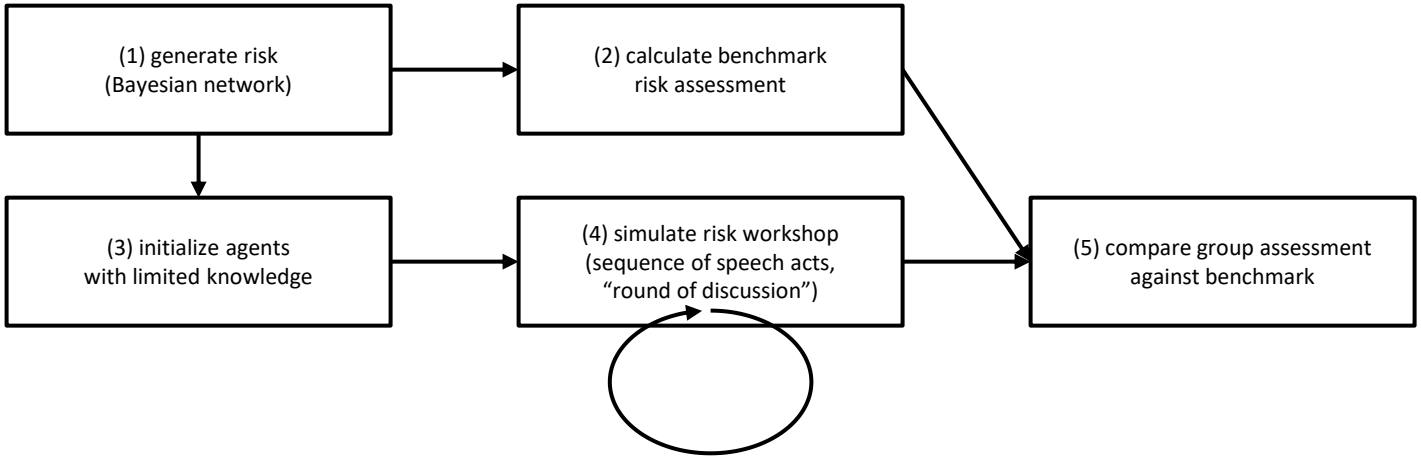
Subsequently, using numerical experiments, more realistic scenarios are generated to disentangle which factors drive **deviations from the benchmark**.



Methodology II

Simulated process

The risk workshop discusses a specific risk that is generated at the beginning of each run (1). As all characteristics of the generated risk are known, we can calculate an ideal risk assessment as a benchmark (2). We vary how knowledge is distributed between agents (3), how the risk workshop is structured and how the final decision is made by the group (4), and observe how the group effectiveness is impacted (5).



Results – ideal speech situation

The Givens
- Variable: equal distribution of knowledge
- Variable: presence of hierarchy
- Variable: stable group

Intervening Factors
- Variable: weighting of received information

Simulation of a sequence of speech acts:
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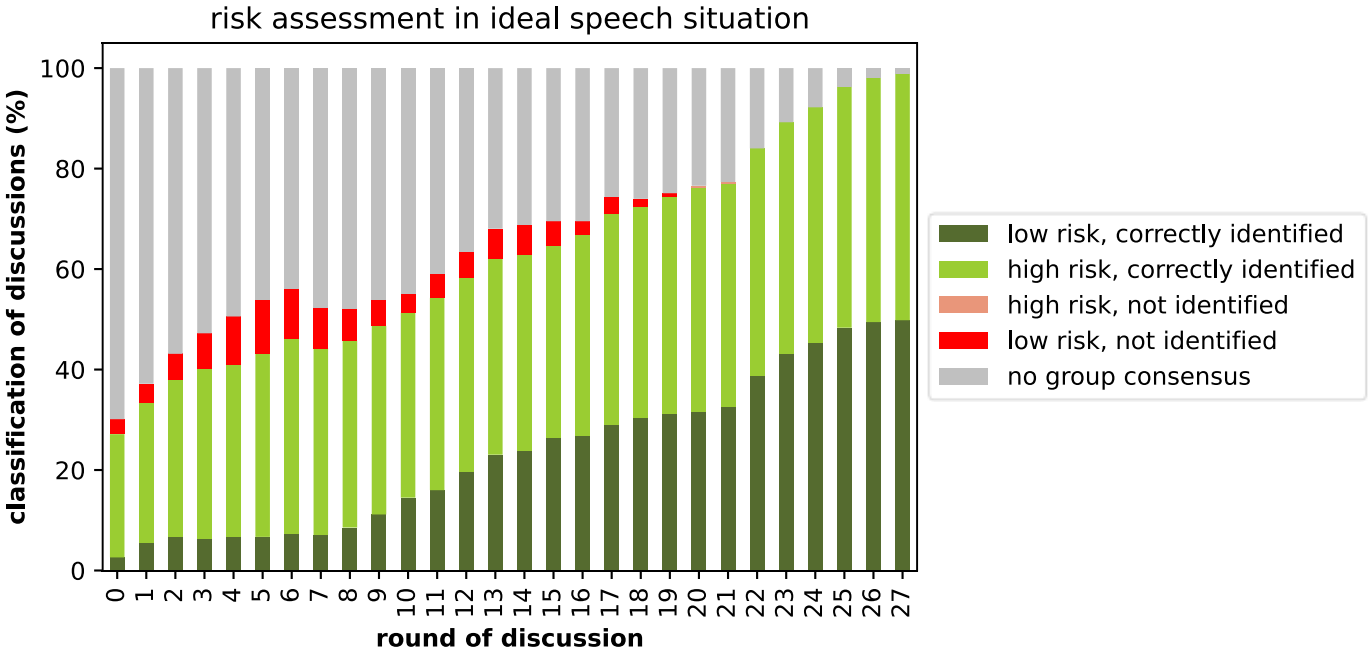
We generate benchmark risk assessments under ‘ideal’-conditions.



Results – decision-making rules I

The Givens
- Variable: equal distribution of knowledge
- Variable: presence of hierarchy
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Intervening Factors
- Variable: weighting of received information

Simulation of a sequence of speech acts:
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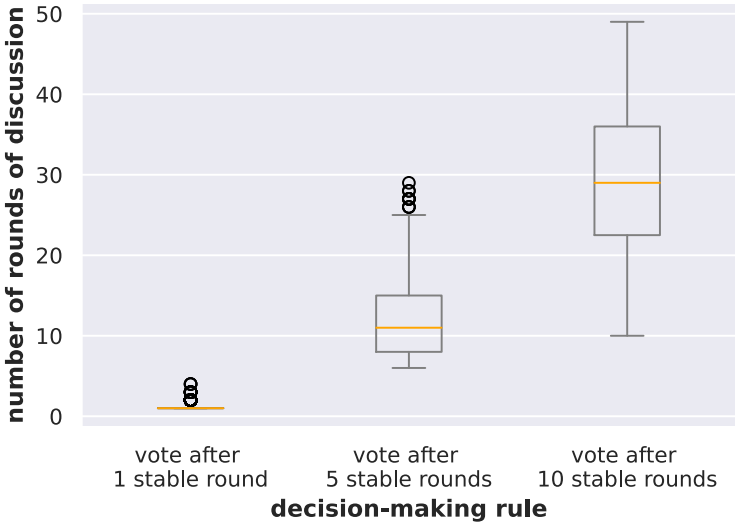
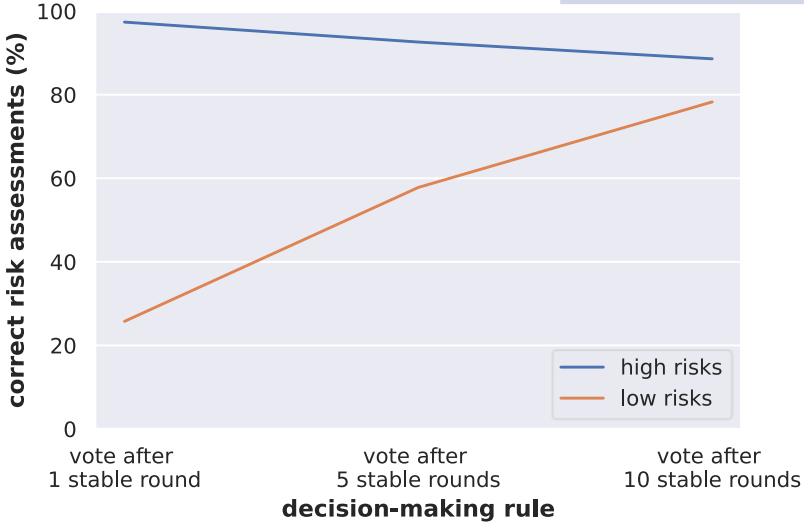
When to stop discussions?





- As time for discussion is limited, the group has to decide how long it should continue the discussion before making a decision.
- Depicted are results for groups that perform a majority vote after the group opinion has remained stable for 1, 5 or 10 rounds.
- Longer discussions improve the decisions for low risks but worsen decisions for high risks.
- This contrasts with the assertion of the ideal speech situation that discussions move towards a correct consensus (Habermas90)

Results – decision-making rules II

The Givens
- Variable: equal distribution of knowledge
- Variable: presence of hierarchy
- Variable: stable group

Intervening Factors
- Variable: weighting of received information

Simulation of a sequence of speech acts:
- Variable: decision-making rule
- Variable: interaction pattern

We compare several possible decision-making rules: Requiring consensus, performing a majority vote or letting a single participant (“risk owner”) decide.

decision-making rule	avg. number of rounds	% of correct assessments (high risk)	% of correct assessments (low risk)
stop at first group consensus	5.6	99.3%	52.4%
consensus after one stable round	1.2	65.9%	2.7%
risk owner decides after one stable round	1.2	85.0%	34.2%
vote after one stable round	1.2	97.4%	25.8%
consensus after 5 stable round	11.9	69.5%	27.1%
risk owner decides after 5 stable rounds	11.9	87.1%	57.3%
vote after 5 stable rounds	11.9	92.6%	57.8%
consensus after 10 stable rounds	29.5	75.4%	55.7%
risk owner decides after 10 stable rounds	29.5	86.8%	74.4%
vote after 10 stable rounds	29.5	88.6%	78.3%

- After some rounds of discussion, a majority vote achieves the best results.
- An emerging group consensus is not a strong indicator that the group will make the correct assessment.
- In practice, risk workshops use tools like votes, but decisions are ultimately the responsibility of a risk owner (Quail11)

Results – interaction pattern

The Givens
- Variable: equal distribution of knowledge
- Variable: presence of hierarchy
- Variable: stable group

Intervening Factors
- Variable: weighting of received information

Simulation of a sequence of speech acts:
- Variable: decision-making rule
- Variable: interaction pattern

We test several different behaviors regarding participation during the group discussion:

	Decision-making rule: vote after 10 stable rounds			
Who talks next during the discussion?	**avg. number of rounds (high risk)**	**avg. number of rounds (low risk)**	**% of correct assessments (high risk)**	**% of correct assessments (low risk)**
random choice of participants	27.1	31.4	90.0%	75.3%
priority to concerned participants	27.4	36.8	91.3%	86.0%
priority to participants with dissenting opinions	27.6	31.3	93.0%	77.3%
priority to participants with higher hierarchical position	28.7	33.0	88.1%	76.0%
priority to participants close to group opinion	26.5	29.5	85.3%	70.9%

- Groups perform better when concerned or dissenting participants are more likely to share knowledge with the group.
- Groups perform worst when those participants that are close to the group opinion talk more.
- This result is in line with common cautioning regarding groupthink in risk assessment (Janis72), (Hunziker19).

Results – group characteristics

The Givens
- Variable: equal distribution of knowledge
- Variable: presence of hierarchy
- Variable: stable group

Intervening Factors
- Variable: weighting of received information

Simulation of a sequence of speech acts:
- Variable: decision-making rule
- Variable: interaction pattern

The simulation study approach allows us to test group characteristics for their impact on group effectivity:

	Generalized Linear Model Regression Results			
	Coefficients	**Lower 95% CI**	**Upper 95% CI**	**p value**
Participants know each others expertise	0.0146	-0.198	0.227	0.893
Participants have different positions in hierarchy	-0.0022	-0.215	0.211	0.984
Knowledge is unevenly distributed	-0.4456	-0.656	-0.235	<0.001

Dependent variable: assessment_correct

- We find a strong effect of knowledge distribution within the group on the group effectivity: Groups perform better when knowledge is evenly distributed between the participants.

Contributions

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Limits of risk workshops

While there is no process that always leads to the correct risk assessment, risk assessment practitioners have to make a trade-off: Do they want to minimize undetected high-risks or misclassified low-risks?

- **True consensus is unattainable** under simulated real-world conditions for many risks.
- Processes are **either suited to correctly assess low or high risks**. Improving assessment for one group worsens assessment of the other.

Beyond ideal speech situation: How to implement your risk workshop

The idea of an ideal speech situation is a misnomer for a risk workshop: For the situation we are simulating, a limitless discussion does not necessarily lead to a correct consensus.

- Group work researches that long discussions do not indicate better decisions (Stasser92). We show that **decisions get worse during longer discussions for some risks**.
- It is recommended that one 'risk owner' makes the final decision, to assure accountability (Quail11). We show that this practice **does not prevent good decisions**. Requiring a consensus does not generally provide better decisions.
- Facilitators can improve the group's risk assessment by **encouraging participants with dissenting views or critical information to participate** more (in line with e.g. (Stasser85)).
- Discussions are most successful when relevant **knowledge is evenly distributed** among the participants.

Detailed analysis of group work

Our simulation allows us to analyze the effectiveness of group work in detail: We can **isolate the effects** of several changes to the risk assessment process within a single environment. The progress of the risk assessment within the risk workshop can be **assessed at every step** of the discussion. This allows us to explore how and why the effectiveness and efficiency is impacted by group characteristics and choices made by the workshop facilitator.

This way, we **overcome the lack of a benchmark** for studies of real-word risk assessment (e.g. due to aleatory uncertainty (Gardoni14)) and the practical limitations of laboratory experiments on group work regarding the possibility to vary and control influencing factors.

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