# Risk and Decision Analysis
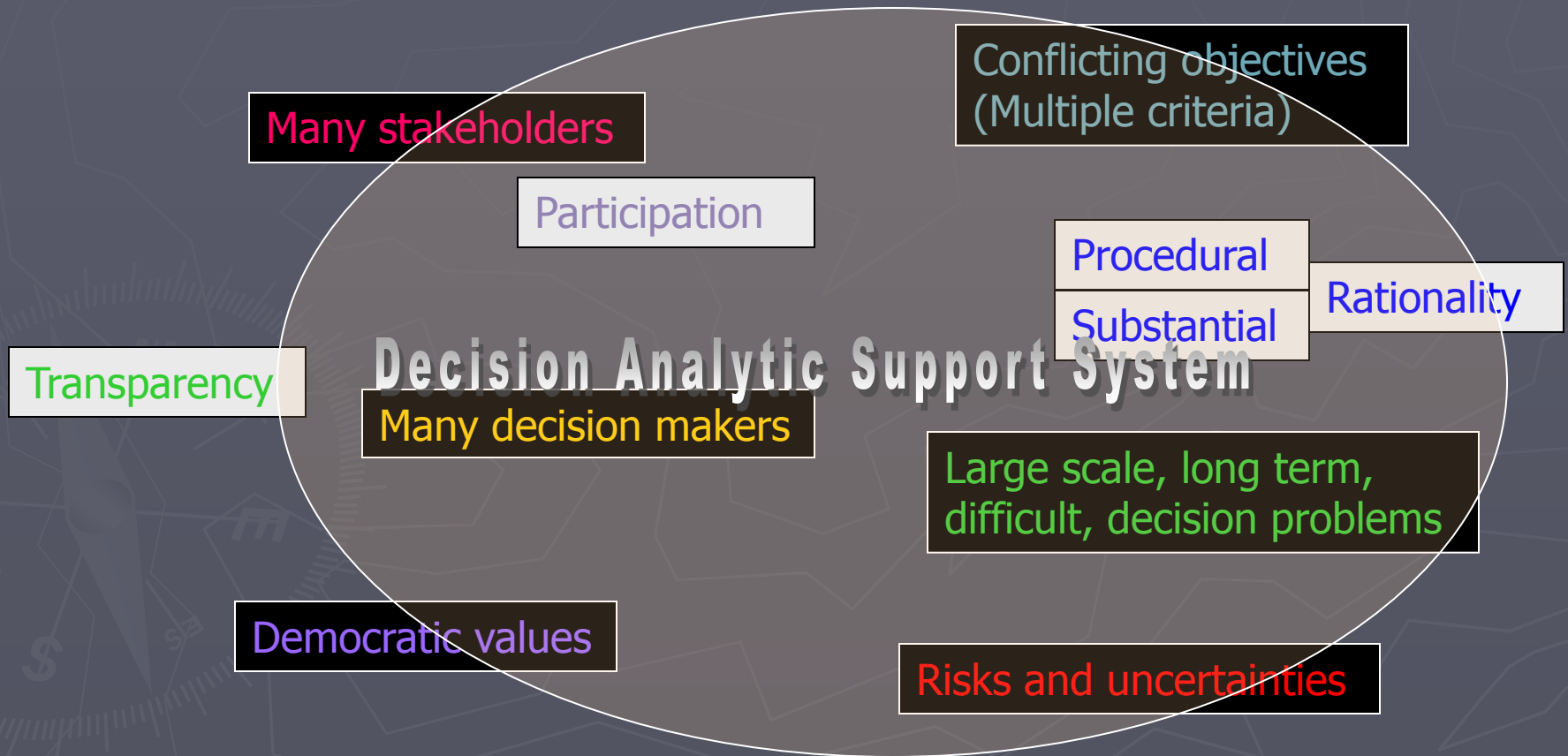## - Framework and Current Developments

RCRCenter 2010-11-11
Aron Larsson, PhD
aron.larsson@miun.se

Risk and Decision Analysis Lab
Dept. of Information Technology and Media, Mid Sweden University

DECIDE Research Group
Dept. of Computer and Systems Sciences, Stockholm University

# Diffucult Decisions

Many stakeholders

Conflicting objectives
(Multiple criteria)

Participation

Procedural

Substantial

Rationality

Decision Analytic Support System

Transparency

Many decision makers

Large scale, long term,
difficult, decision problems

Democratic values

Risks and uncertainties

# Decision Analysis

"[…] most analyses of important decision problems have left the incorporation of jugdments and values to informal procedures […] and to the intuition of the decision makers. What has been lacking is not information but a framework to articulate and integrate the values and professional judgments of decision makers and experts." Keeney, 1999

"MCDA is an aid to decision making, a process which seeks to:
- Integrate objective measurement with value judgment
- Make explicit and manage subjectivity"
Stewart and Belton, 2002

"[…] we find it remarkably troublesome that investments [in roads] of this magnitude appear to have been initiated without a more qualified decision apparatus where priorities, weights, and values are already openly expressed in the evaluation phase. "Ekenberg et al., 2009

# Research Focus

Applications of risk and decision analysis methods and on development of methods facilitating for practical decision analysis and decision support.

Decision process development

Development of software tools

Handling of imprecise information

Elicitation of decision data

Decision evaluation and computational aspects

Applications of risk and decision analytic methods in business and society

# Hmm...DA Applicability Issues

"[...] laypersons as well as expert decision makers can find it challenging to provide the required judgments, to understand the underlying methods, and to accept the entic suggested by the analysis for them." Katsiko

Benefitor resistance

Pursue the design of an effective and efficient decision process utilising methods and tools in support of this process.
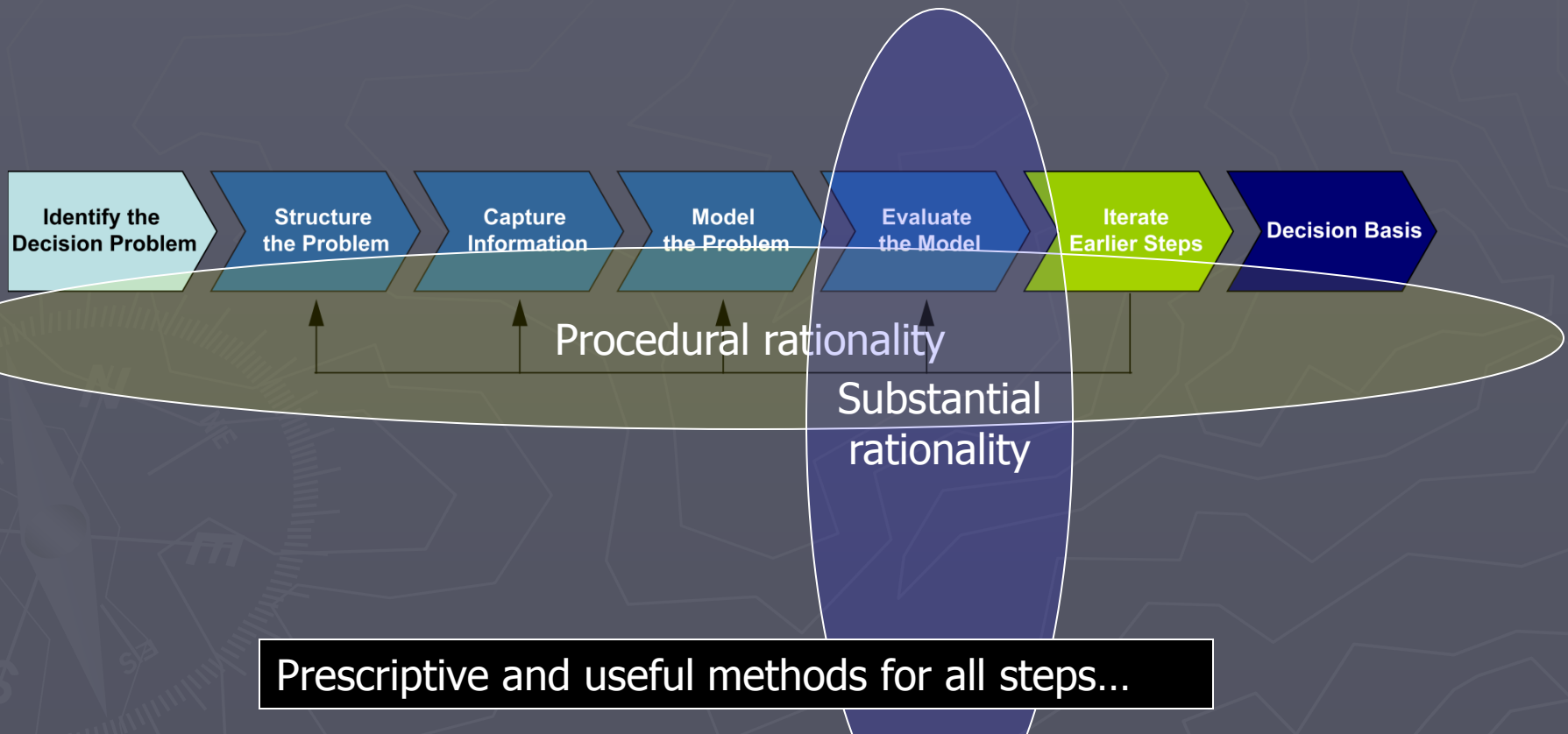
...cations, [...],
...alistic to assume that decision makers can provide precise input" Corner and Corner, 1995

"[...] in order to improve the use of computer-based decision tools, it is of great concern to develop better techniques and methods for the elicitation of utility and probability measures" Riabacke, 2006
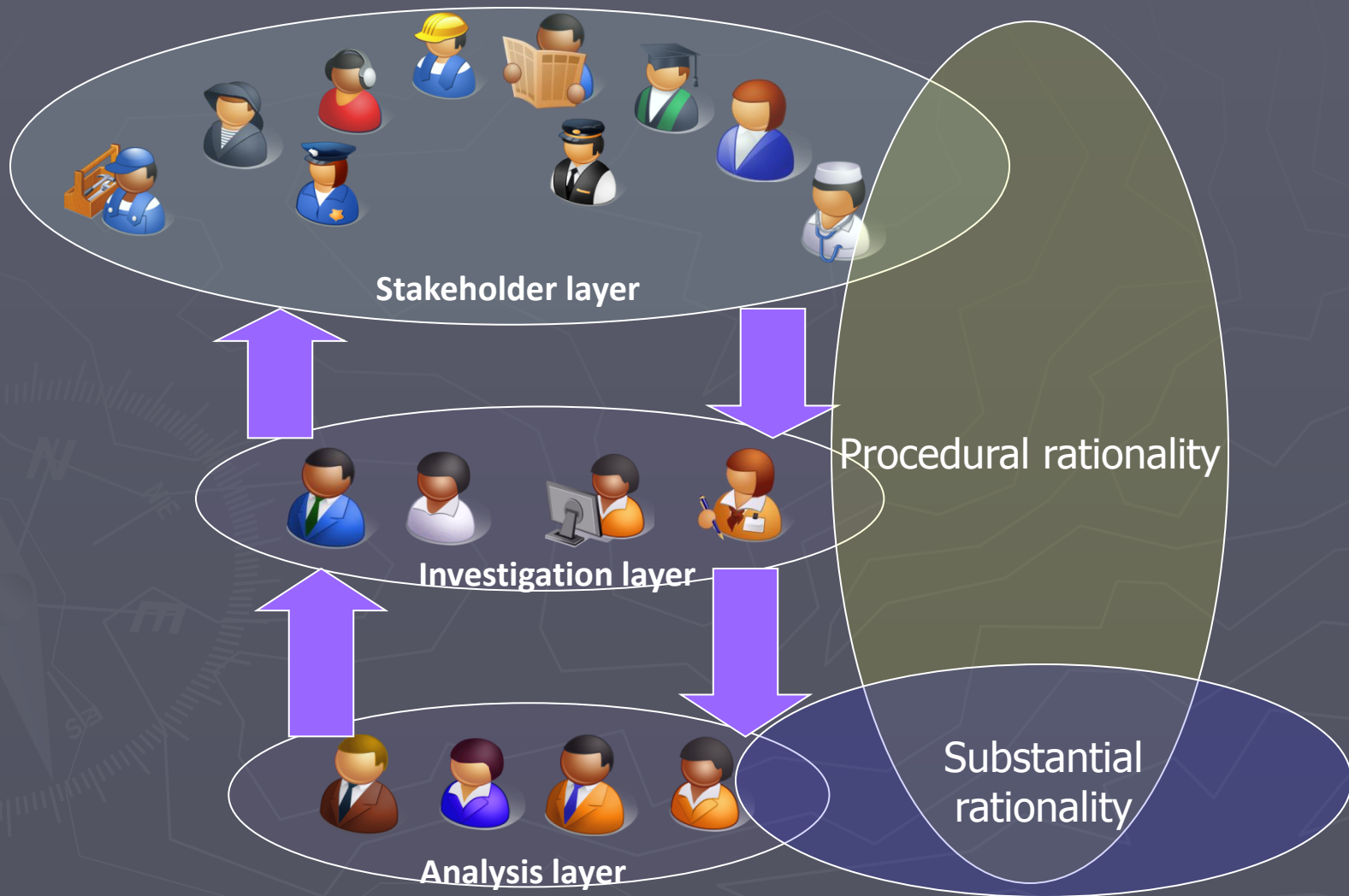
Lack of usable methods

# Decision Process Model Development

In order to utilise decision analysis in organisations a process model is needed. We search for and develop such processes.
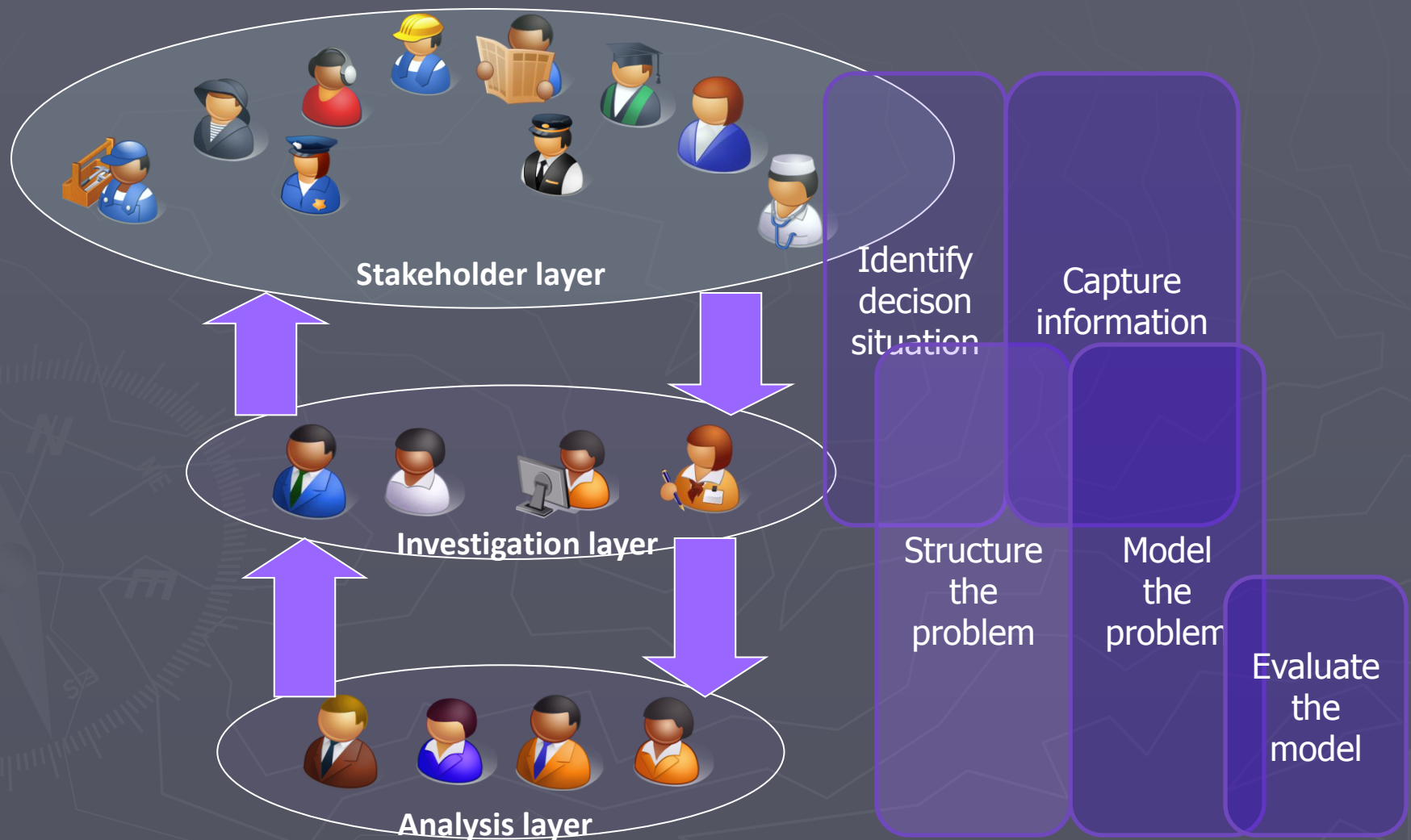


Identify the Decision Problem → Structure the Problem → Capture Information → Model the Problem → Evaluate the Model → Iterate Earlier Steps → Decision Basis

Procedural rationality

Substantial rationality

Prescriptive and useful methods for all steps...

...supported by a tool for multi-criteria decision analysis.

# Process for Societal Decision Making



**Stakeholder layer**

Procedural rationality

**Investigation layer**

Substantial rationality

**Analysis layer**

# Process for Societal Decision Making

# Decision Tool Developments

Structuring and modelling of decision problems and means for decision evaluation are supported by software. We develop such software for modelling and analysis of decisions under risk and with conflicting objectives.

# Decision Tool Developments

**Representations**
- Interval-valued probabilities, utilities, criteria weights.
- Decision rules
- (Second-order probabilities)

Reason and correctness.

**Computational Aspects**
- Optimisation methods
- Simulation methods

Complexity and usability (good enough)

**Graph Decision Models**
- Decision trees
- (Influence diagrams)
- Multi-criteria value trees

Usability (easy to use?) and appeal.

Usability, appeal, and expressibility

**Tool development**
- Software

**Tool/method dissemination**
- Decision projects/action research
- Tool availability

Perceived value

# Decision Process and Tool Development

**Supporting graph decision models**

**Multi-way sensitivity analyses**

**Risk profiles and security thresholds**

**Rankings and evaluations**

In support of:
- Complex decisions
- Conflicting objectives
- Multiple stakeholders
- Risks and uncertainties
- Imprecision

# Imprecise Information

The information, such as probabilities and values, available to decision makers is often vague and imprecise. We develop concepts, models, and evaluation methods extending the expressibility to represent and evaluate numerically imprecise information in decision situations. This includes evaluation algorithms and computational aspects.
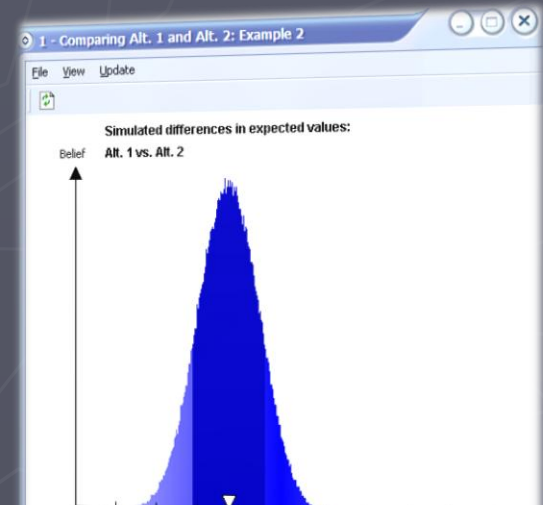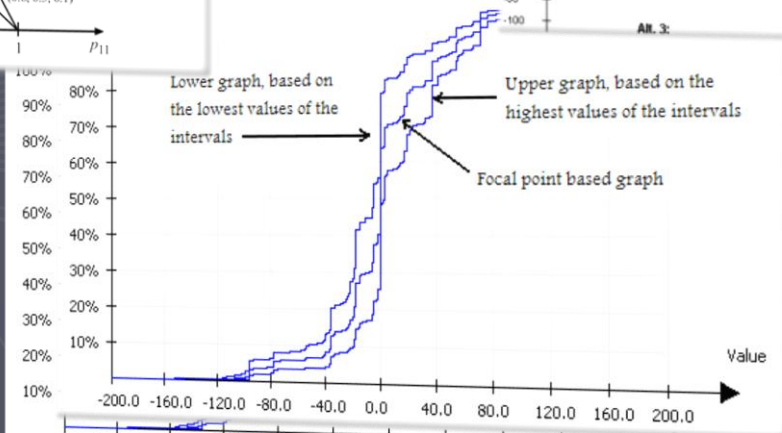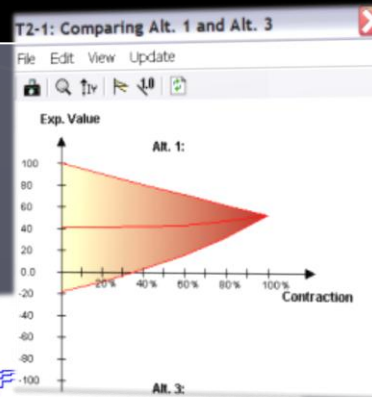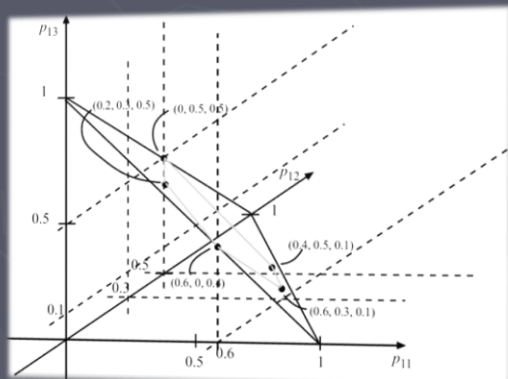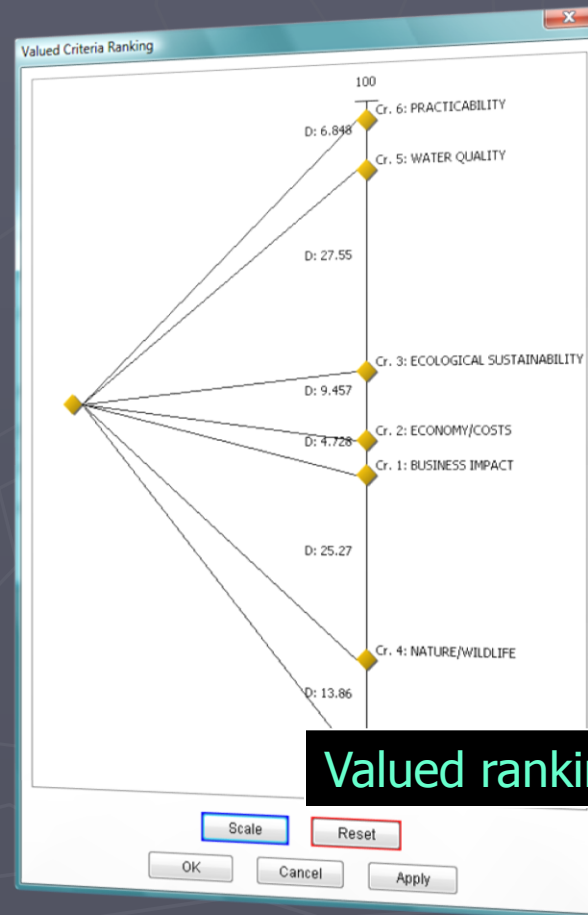


Interval probabilities, probability boxes, probabilities on probabilities, sensitivity analysis.

# Elicitation of Decision Data

Elicitation of decision data from experts, stakeholders, and decision makers is not trivial and surrounded by biases. We search for and develop robust and useful elicitation methods.
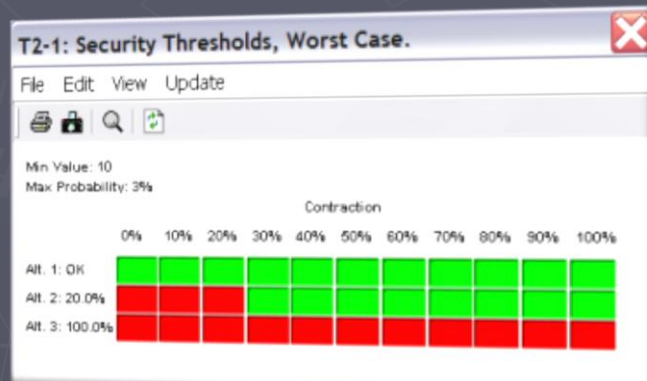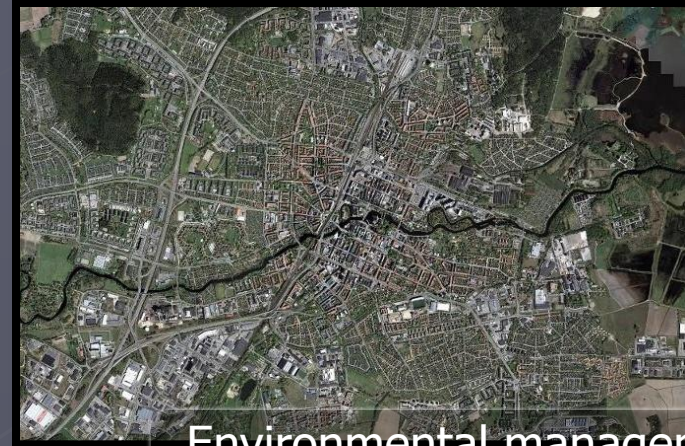


Risk constraints



Valued rankings

# Applications

Urban planning
*City of Stockholm*

Environmental management
*Municipality of Örebro*

Mine action
*Cambodian Mine Action Centre*

Flood management
*Hungarian Academy of Science*