

# Decision Processes for Trustworthy Software

Günther Ruhe  
University of Calgary

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ICSP 2009, Vancouver, Canada  
May 16-17, 2009



# Agenda



- Trustworthiness – What it is?
- (Software) Decisions
- Decision processes
- Trustworthy decision processes
- Trustworthy release planning
- Empirical evaluation
- Summary and outlook

# What means trustworthiness (1/2)?

Findings of the PITAC Report (1999):



- Current Software has too many surprises. The sources of the surprises are poorly understood
- Key sources of software surprise include poorly integrated software domain sciences, construction (product) principles, and engineering processes.
- Key components of software surprises include scalability, evolvability, dependability, usability, performance, and predictability of cost and schedule.
- Software technology is hard to transition into practice and feedback is needed on its effectiveness.

# What means trustworthiness (2/2)?

- Trustworthiness = Level of confidence that the software satisfies its requirements (Amoroso et al. 1994)
- Trustworthy (software) product = product, which fulfills stakeholder's set of expectation (functional and non-functional)
- Trustworthy processes = Processes you can trust  
= Processes enabling trustworthy products

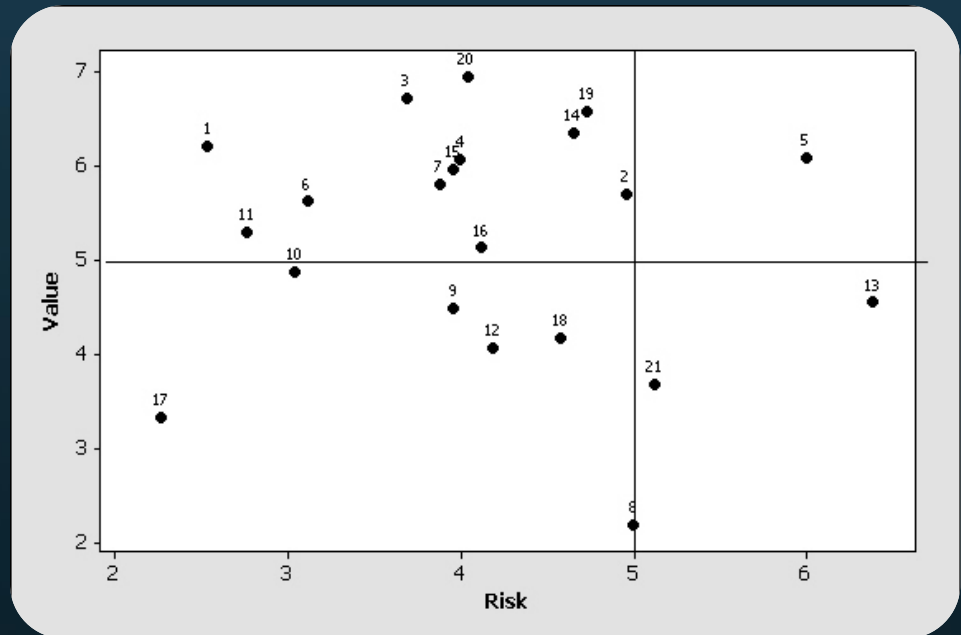


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# (Software) Decisions

- Set  $A = \{a_1, a_2, \dots\}$  of alternatives (these alternatives are not necessarily described explicitly)
- Set  $G = \{g_1, g_2, \dots, g_n\}$  of criteria to evaluate each alternative  $a$  of  $A$  from different perspectives
- Preference structure



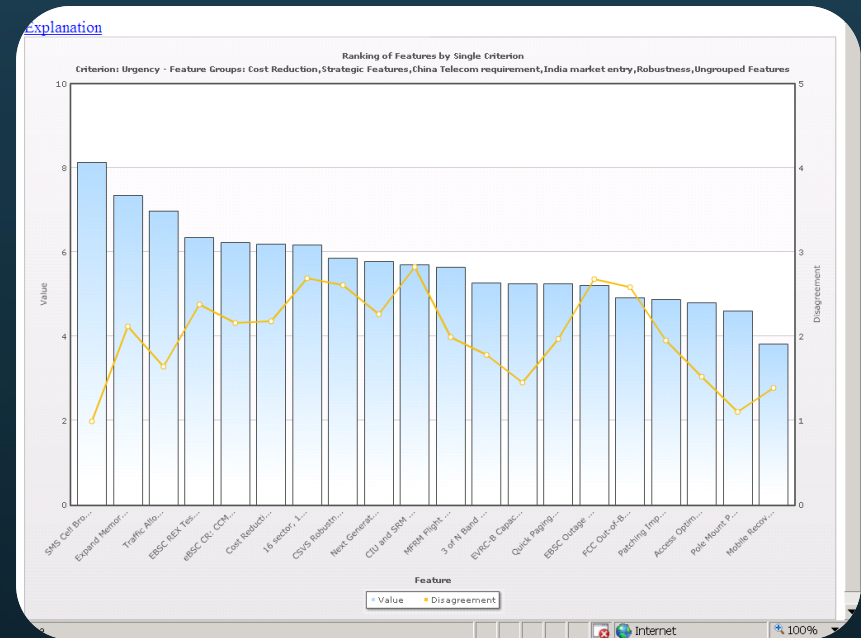
# Decision problems: Main categories

- Selection: Select one alternative  $a^* \in A$  or a subset  $A^* \subset A$   
*Example: Selection of COTS*
- Triage: Assign each alternative  $a \in A$  to one of the classes  $C_1, C_2, \dots, C_k$

*Example: Release planning*

- Ranking: Arrange all alternatives in  $A$  according to an order  $a_1 \geq a_2 \geq \dots$   
(  $a \geq b$  means “alternative  $a$  is at least as good as  $b$ ”)

*Example: Prioritization of requirements*



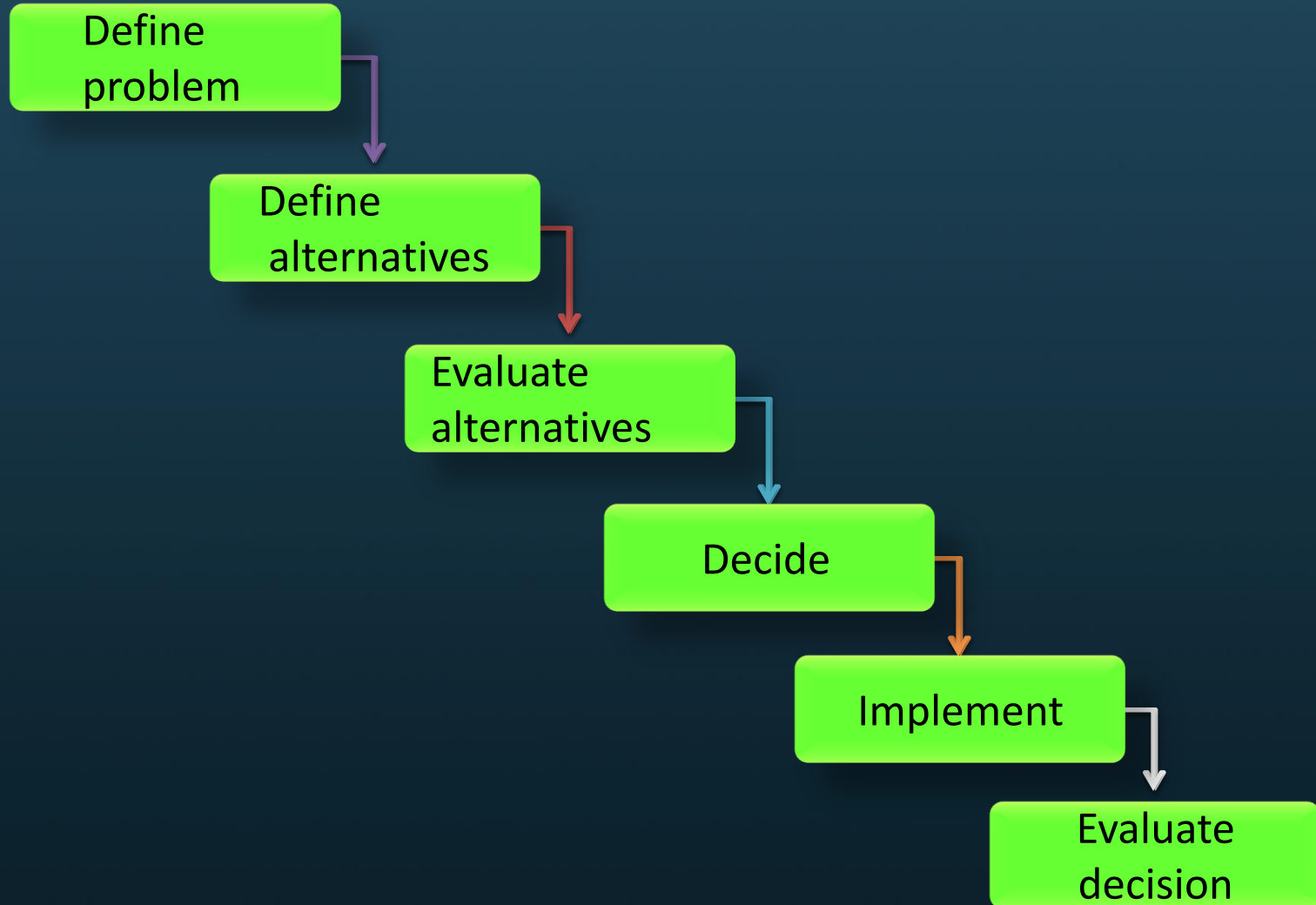
# Decision problems and their complexity

<b>Complexity dimension</b>	<b>Parameters</b>
Computational complexity	P versus NP
Cognitive complexity	Tamed versus wicked problems
Decision-making complexity	Single versus group decisions
Information complexity	Deterministic versus stochastic
Process complexity	Static versus dynamic

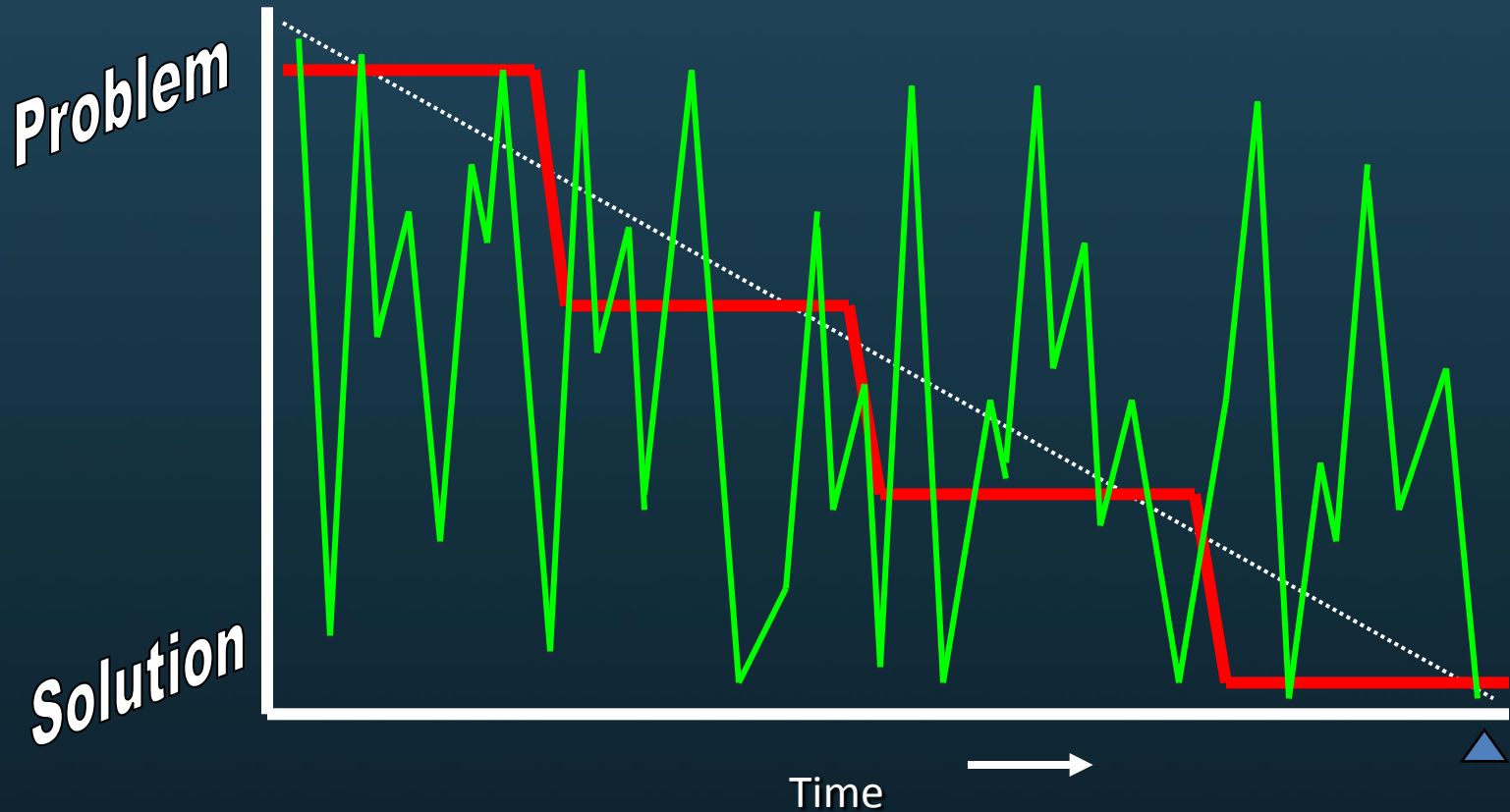
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# Decision process – Ideal view

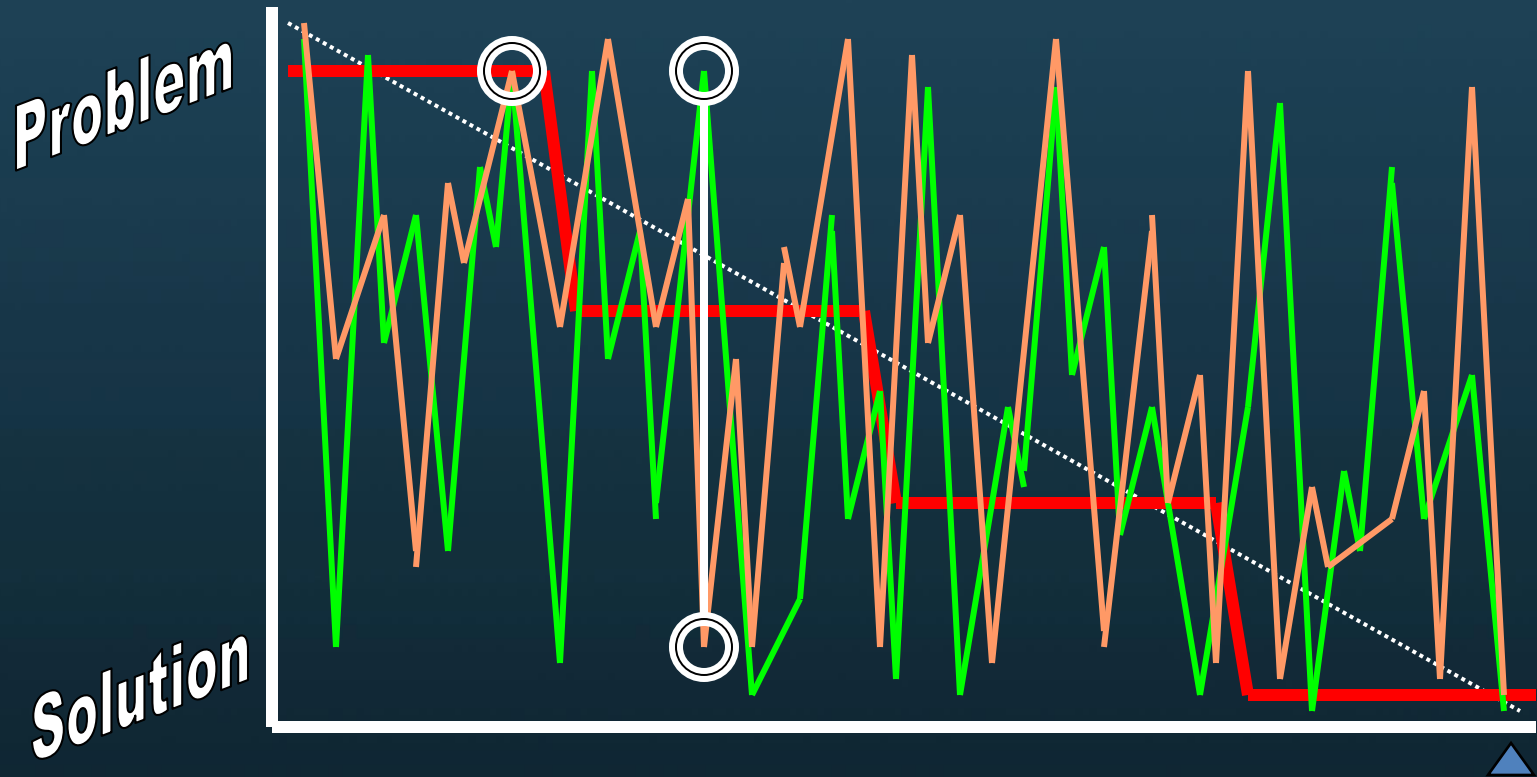


# An experiment about human problem solving (1/2)



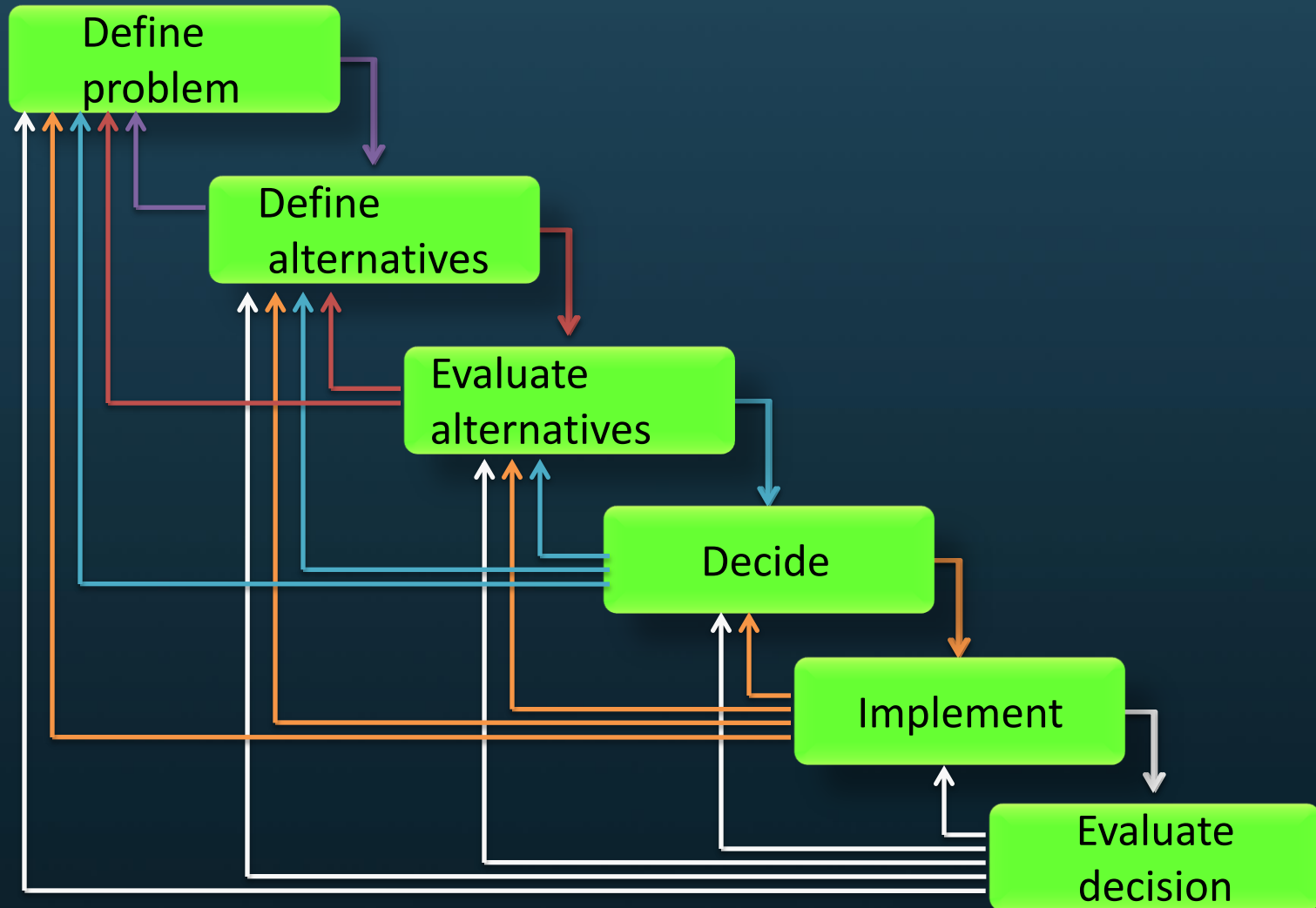
<sup>1)</sup> Jeff Conklin CogNexus Institute

# An Experiment about humans problem solving (2/2)



1) Jeff Conklin CogNexus Institute

# Decision process – Realistic view



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# Trustworthiness of decisions

- When to terminate testing?
- When and what to re-use?
- How to re-allocate resources?
- Which features should be implemented in the next release?

...

? Transparent

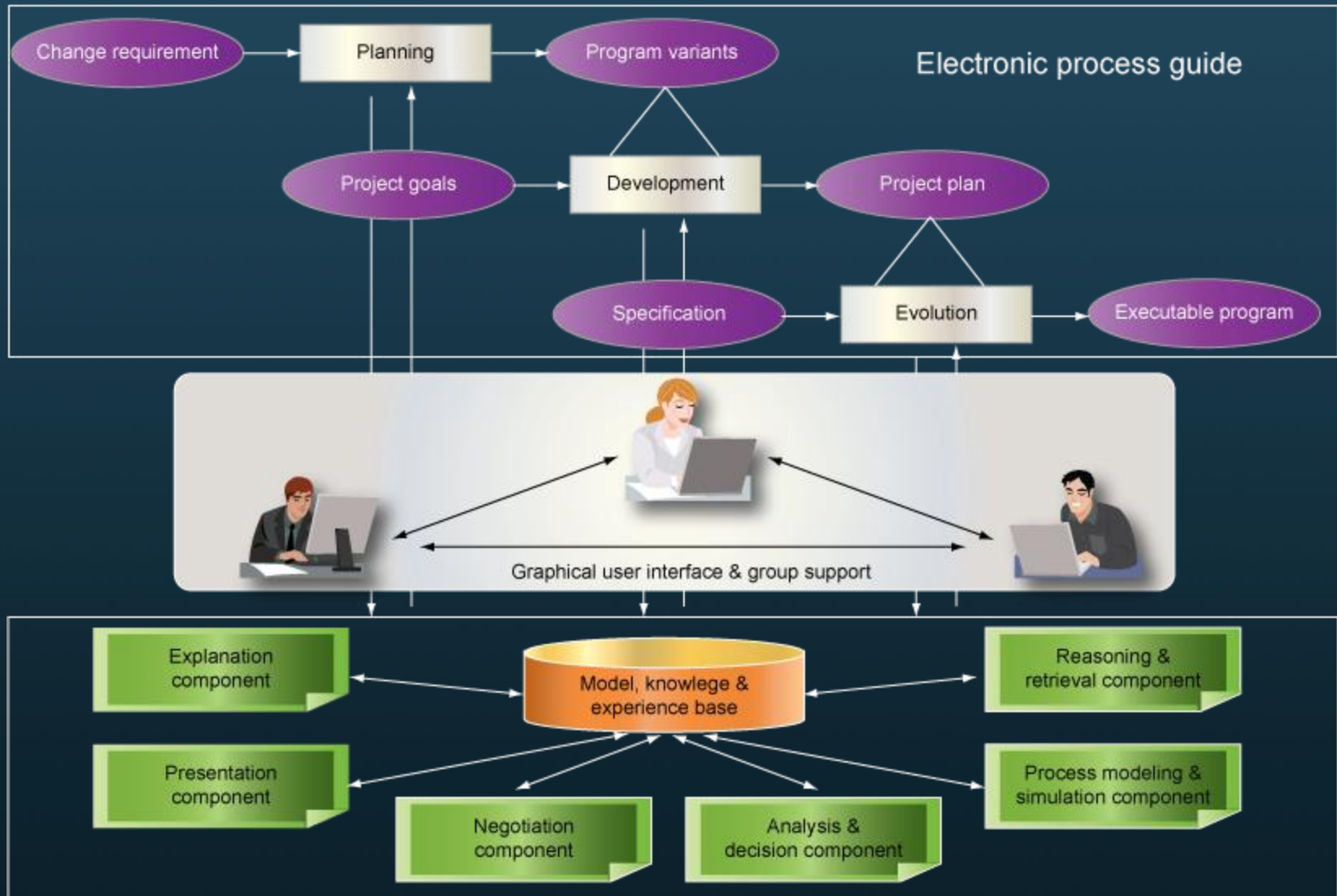
? Systematic

? Repeatable?

? Qualified?



# Trustworthy decisions through decision support



## Trust into decision support solutions – Some practical experience

- ReleasePlanner™ is a web-based system to facilitate release decisions
- Able to optimize for several hundred of features, hundreds of stakeholders, and multiple criteria
- About 300 student and 30 industry projects so far
- Experience gained:
  - Users do not automatically trust solutions gained from theories they do not really understand
  - They disregard it in favor of past experience
  - Users think they get more support by talking to other people

# (Supposed) Factors to achieve trustworthiness of decision support

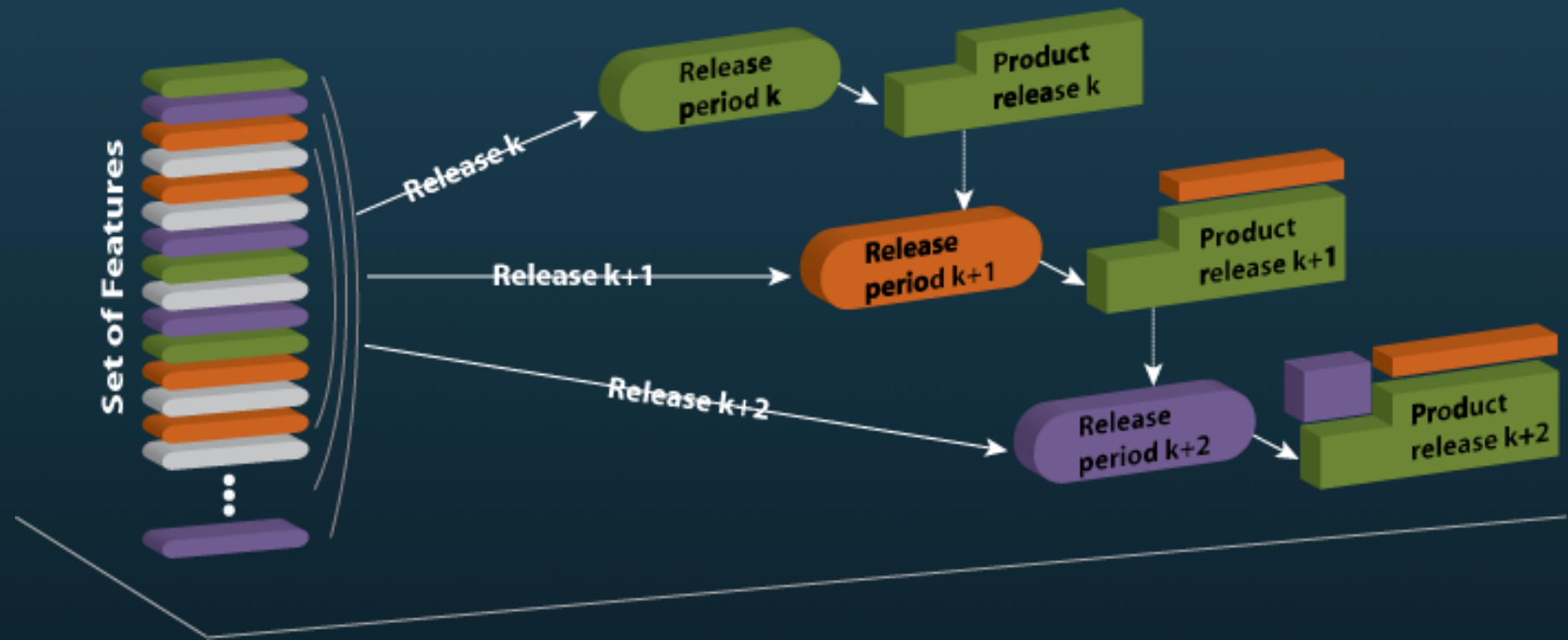
- User (decision-maker) understands proposed solutions
- User understands the solution process
- User is actively involved in the solution process
- Diversification of solution alternatives
- User is able to see the impact of different scenarios (what-if's)
- Trust by adjustment to change
- Trust by proven robustness of the solutions



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# What is release planning?



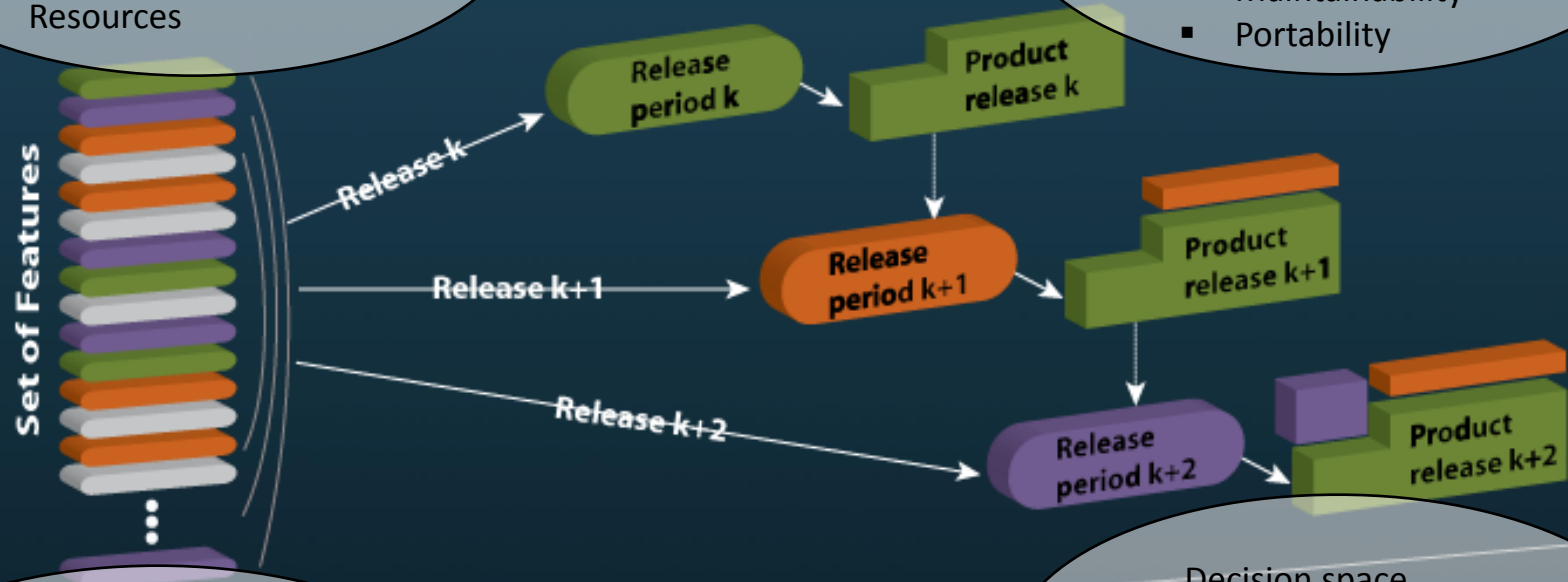
# Why release planning is difficult?

Hard and soft constraints on

- Time
- Effort
- Quality
- Resources

Multiple objectives

- Usability
- Security
- Reliability
- Maintainability
- Portability



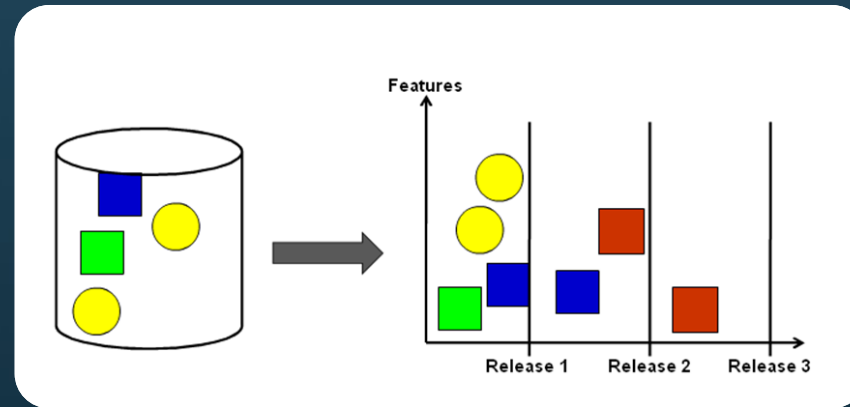
Information is

- uncertain
- inconsistent
- incomplete
- fuzzy

Decision space

- of large size
- of high complexity
- is dynamically changing

# Why is “on-the-fly” not creating trust?



- Informal process
- Criteria for decisions not transparent
- Stakeholders opinion is largely left out
- Resource and other information is left out

# Trust by synergy of art and science

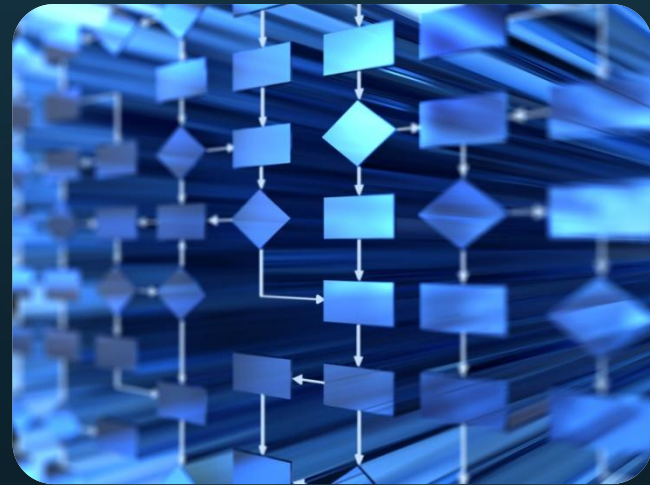
- **Art:**

Focus on the human intuition and communication

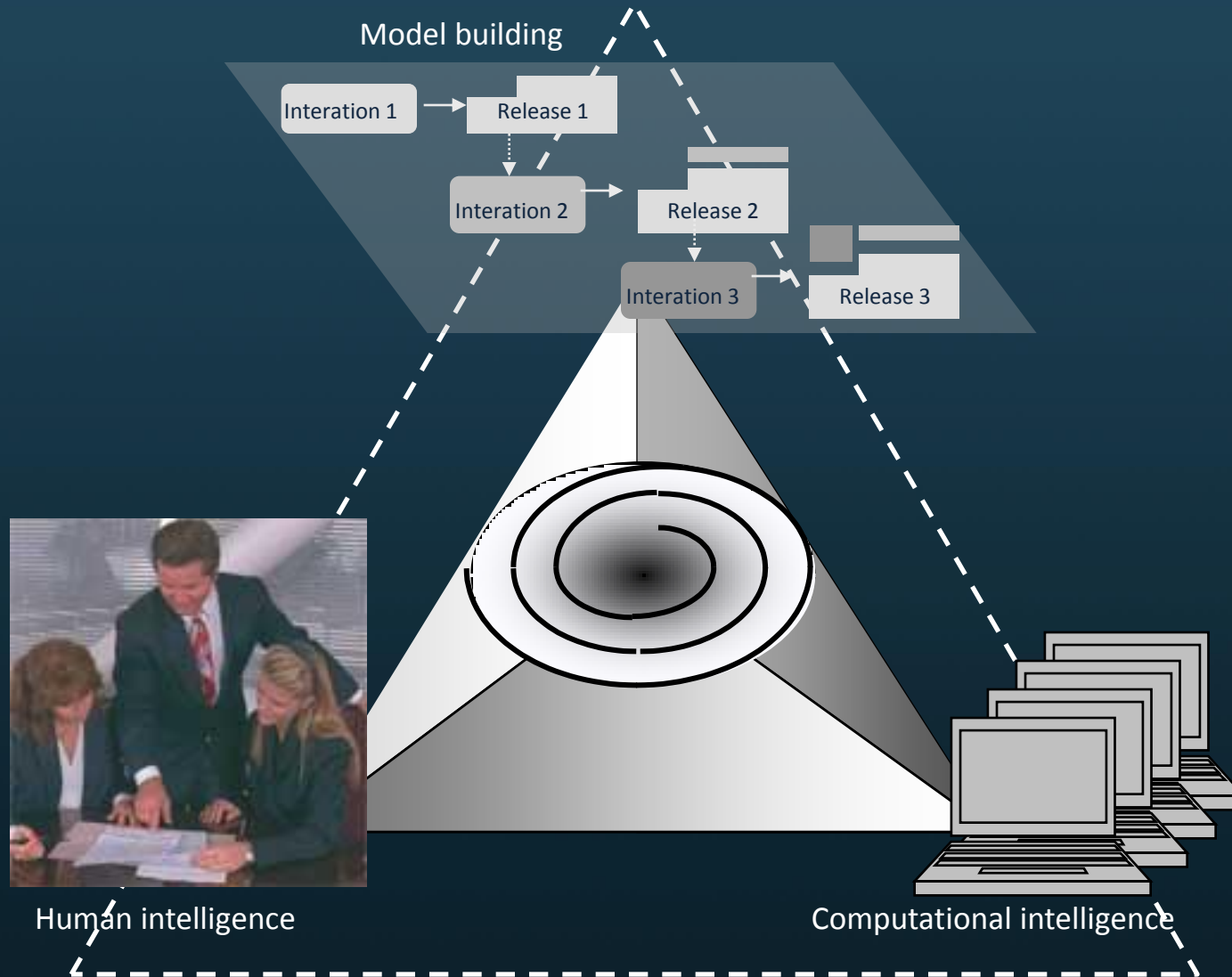


- **Science:**

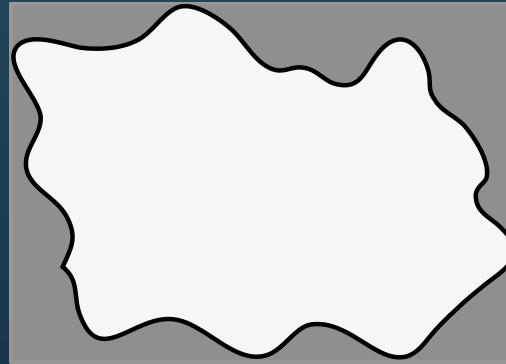
Focus on formalization of the problem and application of computational algorithms to generate best solutions.



# How to make synergy between art and science?



# Trust through diversification



Very large size of solutions

$10^{12}$



Mid size set of qualified solutions

$10^2$



Small set of qualified and diversified solutions

5



# Trust through diversification

*Hypothesis: Multiple semi-optimal and structurally different solutions are creating more trust than a single optimal solution.*

Solution Set		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
ID	Project					
A1	Hierarchical dependencies	1	1	1	1	1
A2	Grouping of features	2	3	4	1	3
A3	Pre-assignments	3	4	2	3	3
A4	Feature dependencies	3	4	2	3	3
A5	Feasibility analysis	3	4	2	3	3
B1	Flexible number of releases	1	1	1	1	1
B2	Flexible number and type of criteria	2	2	3	3	3
B3	Flexible number and type of resources	4	3	4	4	2
B4	Type 1: Stakeholder consensus driven planning	1	1	1	1	1
B5	Type 2: Financially driven planning	1	1	1	1	1
C1	Ranking of features based on different criteria	1	1	1	1	1
C2	Similarity analysis	3	3	3	3	3
C3	Dual charts combining ranking and disagreement analysis	4	3	3	2	3
C4	Comparison of priorities between groups of stakeholders	1	1	1	1	1
D1	Import manual plan	1	1	1	2	1
D2	Import of project data	1	1	1	1	1
D3	Re-import of updated project data	2	3	2	2	2
D4	Export of plans and project data	3	3	4	3	4
D5	Export of generated analysis charts	4	2	3	4	4
E1	Trade-off analysis	2	2	3	3	3
E2	Estimated stakeholder satisfaction analysis	3	2	3	2	3
E3	Consensus analysis between alternative plans	2	2	3	4	2
E4	Structure of alternative plans	1	1	1	1	1
E5	Quality evaluation of alternative plans	1	1	1	1	1
E6	Resource evaluation of alternative plans	2	2	2	2	4

# Trust by what-if's

*Hypothesis: Consistency of release decisions across varying assignments is creating more trust than a single optimal solution.*

Feature	All criteria	CTO and value	Value	Frequency of use	Dissatisfaction	Volatility
Hierarchical dependencies	2.5	2.5	2.5	2.5	2.5	2.5
Grouping of features	2.6	2.7	2.6	2.7	2.6	2.6
Pre assignments	2.5	PP	2.5	2.5	2.5	2.5
Feature dependencies	PP	2.7	PP	2.7	PP	PP
Feasibility analysis	2.7	2.7	PP	2.6	2.7	2.7
Flexible number of releases	2.5	2.5	2.5	2.5	2.5	2.5
Flexible number and type of criteria	2.7	2.6	2.7	2.6	2.7	2.7
Flexible number and type of resources	2.6	2.6	2.6	2.7	2.6	2.6
Type 1: Stakeholder consensus driven planning	2.5	2.5	2.5	2.5	2.5	2.5
Type 2: Financially driven planning	2.5	2.5	2.5	2.5	2.5	2.5
Ranking of features based on different criteria	2.5	2.5	2.5	2.5	2.5	2.5
Similarity analysis	PP	2.7	2.7	2.7	2.7	PP
Dual charts combining ranking and disagreement ana...	2.6	PP	2.7	2.6	2.6	2.6
Comparison of priorities between groups of stakeho...	2.6	PP	2.5	2.7	2.6	2.6
Import manual plan	2.5	2.5	2.5	2.5	2.5	2.6
Import of project data	2.5	2.5	2.5	2.5	2.5	2.5
Re import of updated project data	2.5	2.5	2.5	2.5	2.5	2.5
Export of plans and project data	2.7	2.6	2.7	PP	PP	2.7
Export of generated analysis charts	2.7	2.5	2.7	2.6	2.7	2.6
Trade off analysis	2.6	PP	2.6	2.6	2.6	2.7
Estimated stakeholder satisfaction analysis	2.7	PP	2.6	2.7	2.7	2.7
Consensus analysis between alternative plans	2.6	PP	2.6	2.6	2.6	2.5
Structure of alternative plans	2.6	PP	2.6	2.5	2.6	2.5
Quality evaluation of alternative plans	2.5	2.5	2.5	2.5	2.5	2.5
Resource evaluation of alternative plans	2.5	PP	2.6	PP	2.5	2.6

# Trust through robustness (Al-Emran et al. 2009)

## *Hypothesis:*

*The more robust a solutions against parameter changes, the more trust does it create.*

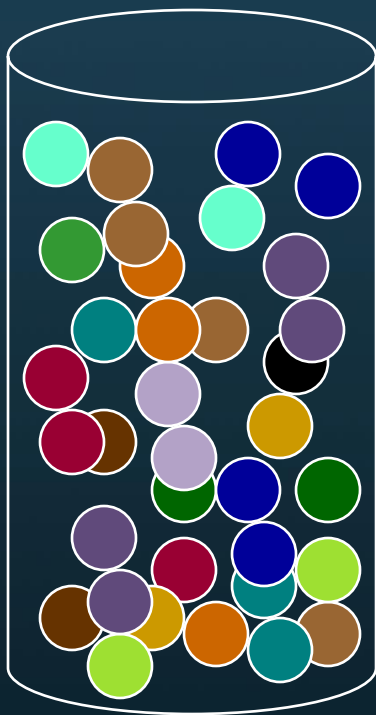
<b><i>Operational planning variation factors:</i></b>	<b><i>Robustness</i></b>
<ul style="list-style-type: none"><li><i>• Productivity of developers</i></li><li><i>• Effort per task</i></li><li><i>• Number of new features arriving</i></li><li><i>• Availability of developers</i></li></ul>	<ul style="list-style-type: none"><li><i>• Project duration/make-span</i></li><li><i>• Assignment of developers to tasks</i></li><li><i>• Schedule time of tasks</i></li></ul>



# Trust through re-planning (Jadallah et al. 2009)

*Hypothesis: The better you adjust to change by performing re-planning, the more trust you can expect.*

Set of features/objects



Change



Basic Release Plan

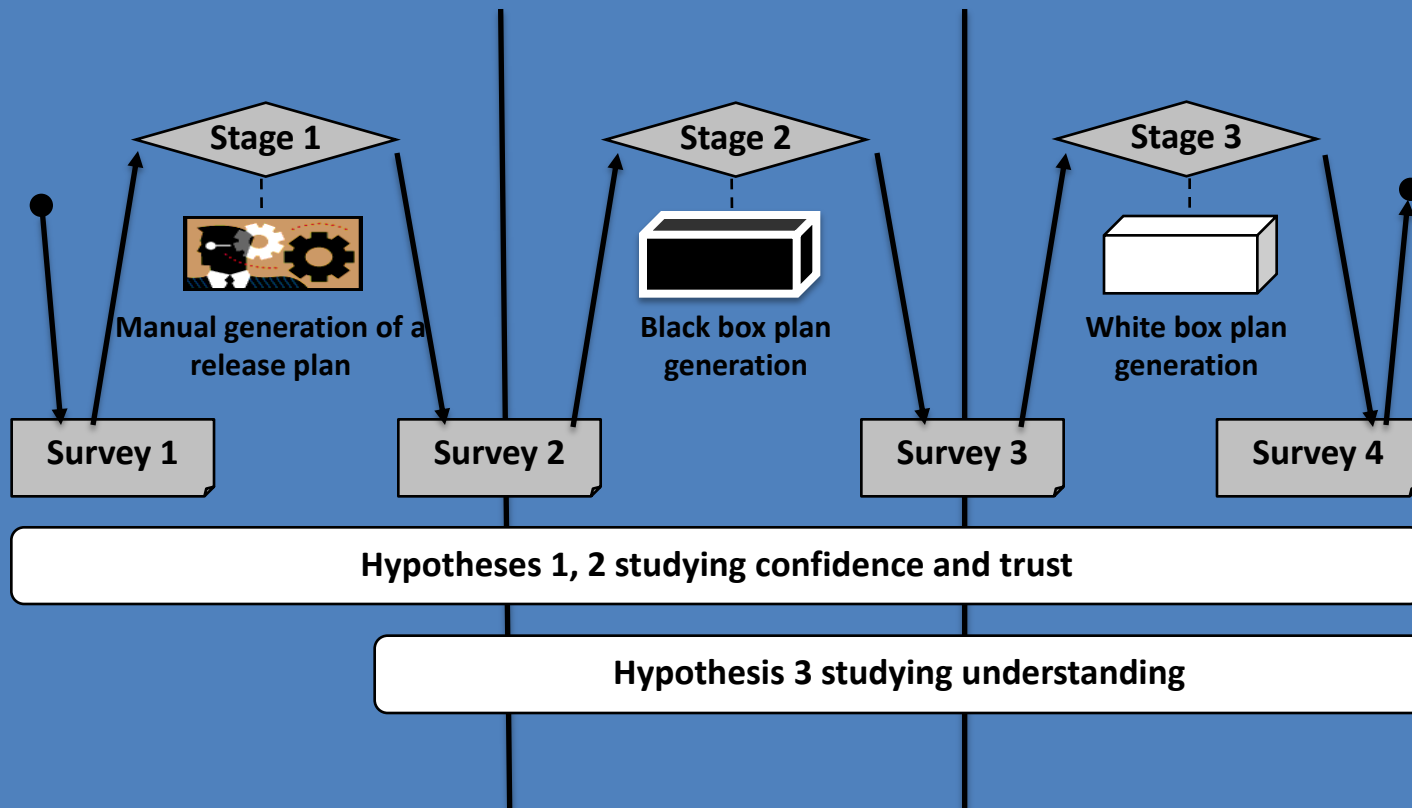


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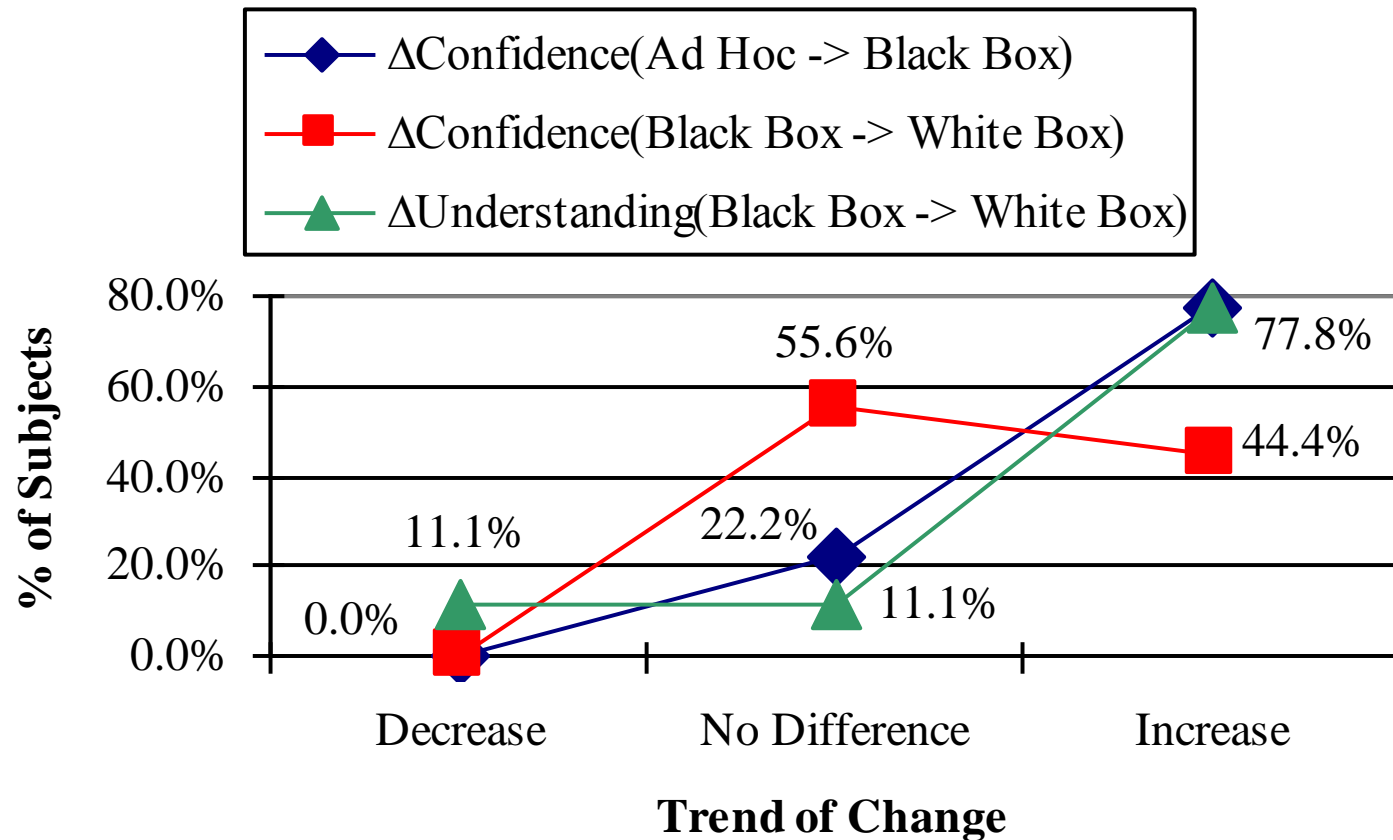


# Empirical evaluation 1: Trust through understanding



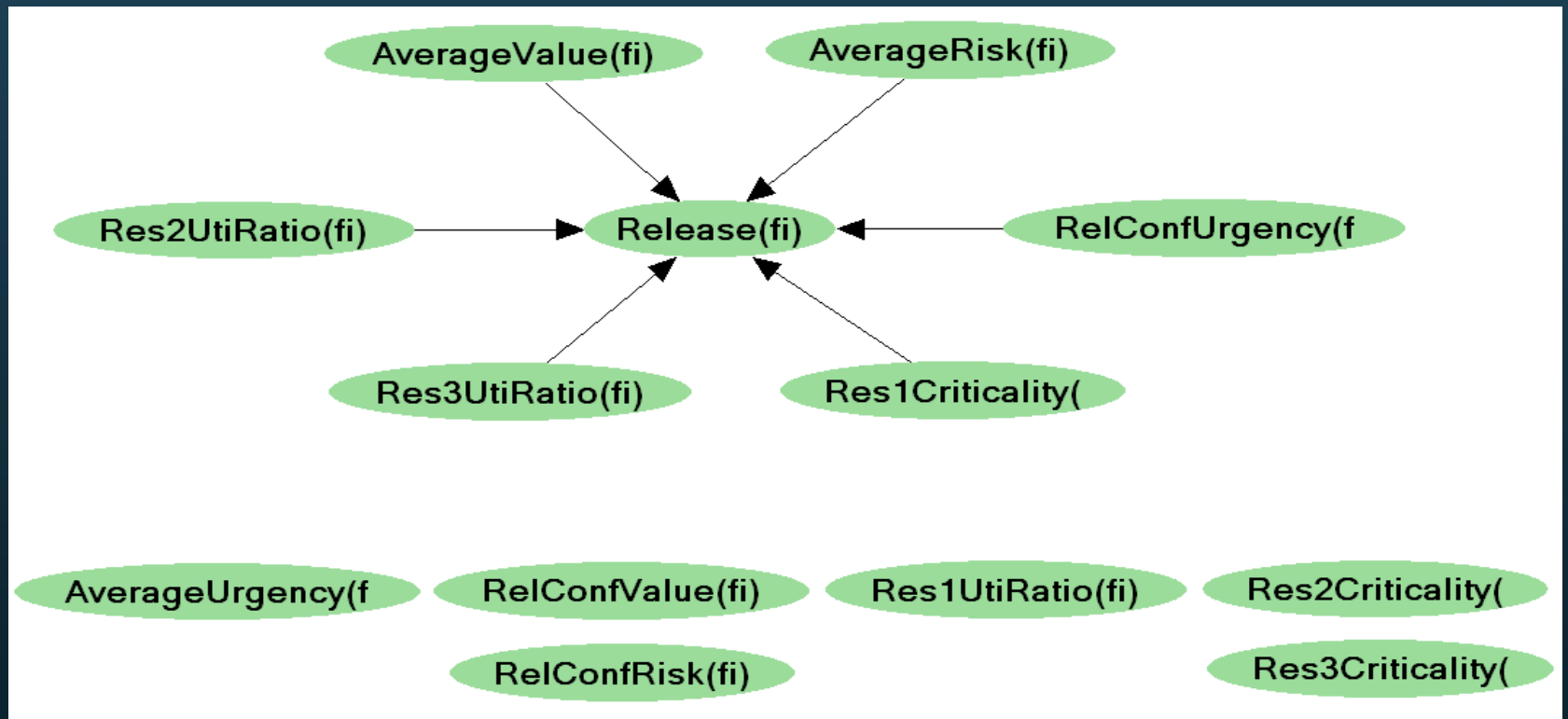
# Empirical evaluation 1: Results

## Subjects' $\Delta$ Confidence/ $\Delta$ Understanding in Release Plans



# Empirical evaluation 2: Trust through explanation


*Hypothesis: "Explanation of solutions offered by decision support is creating more trust than a non-robust solution."*

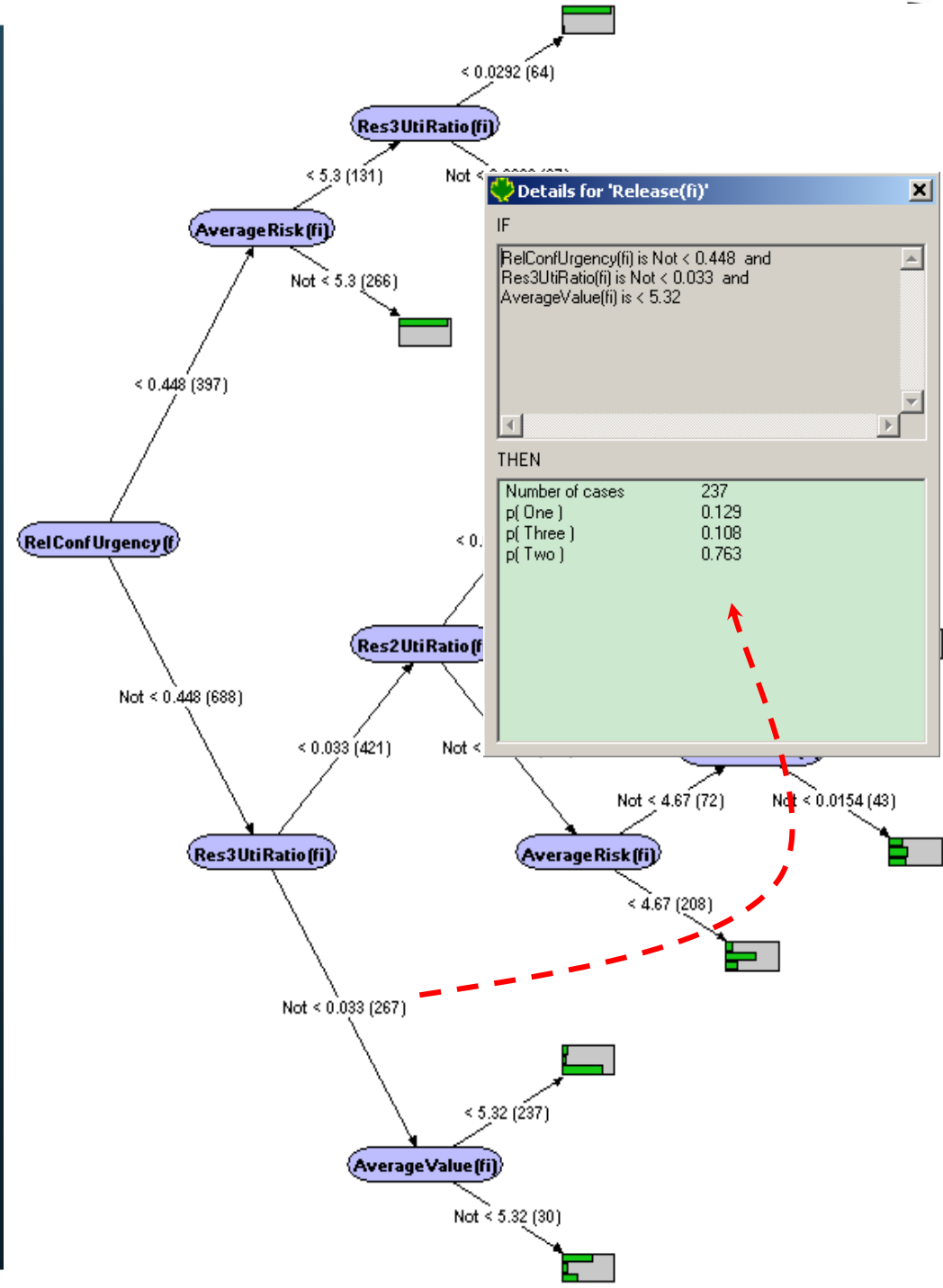


Degree of importance of inputs on ReleasePlanner™ solutions

# Empirical evaluation 2: Trust through explanation

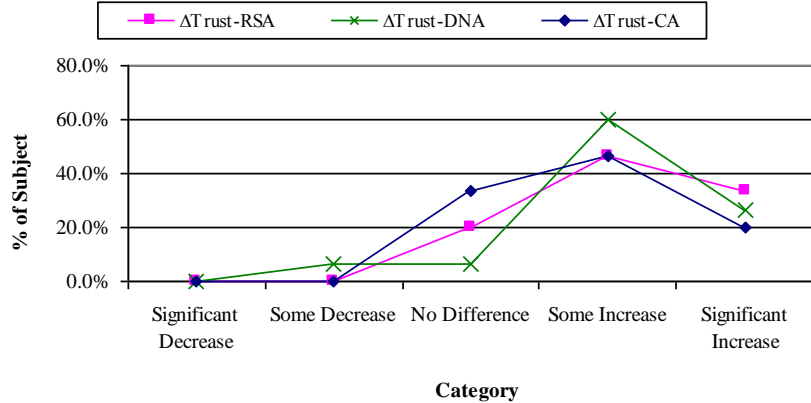
*Hypothesis: "Explanation of solutions offered by decision support is creating more trust than a non-robust solution."*

Relationships between inputs and solutions: 

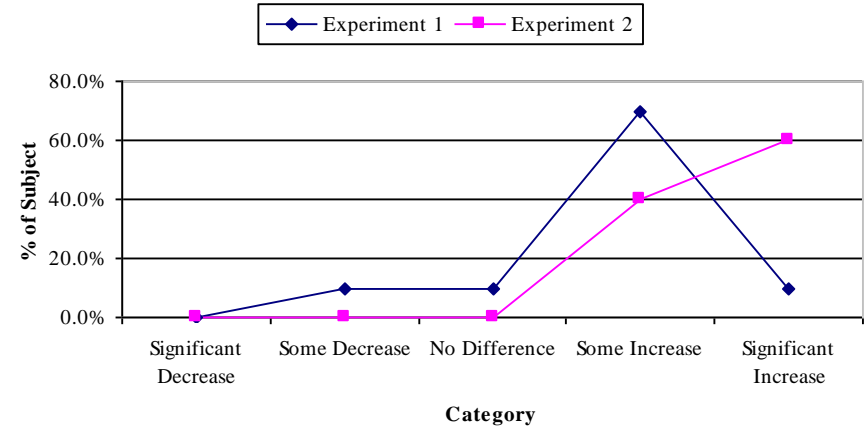


# Empirical evaluation 2: Results

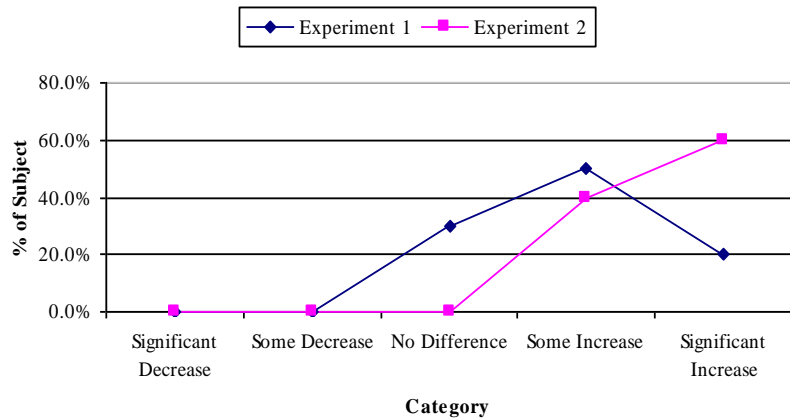
Subject's Evaluations on RSA, DNA, and CA Explanations - Trust in the Tool



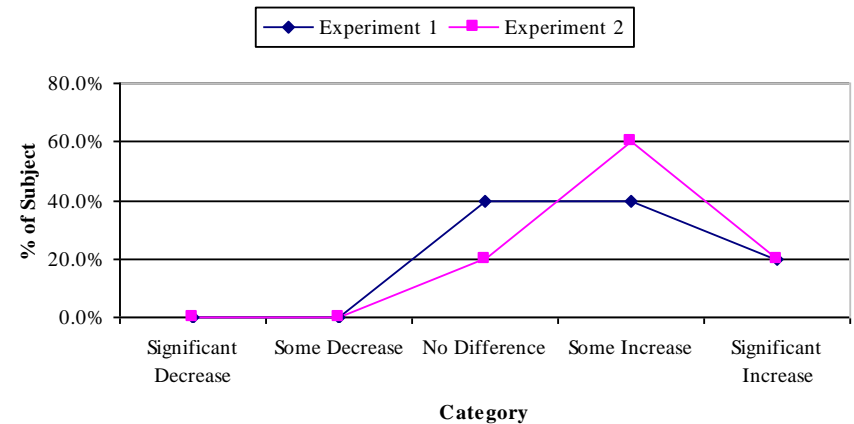
Subject's Evaluations on DNA Explanations - Trust in the Tool



Subject's Evaluations on RSA Explanations - Trust in the Tool



Subject's Evaluations on CA Explanations - Trust in the Tool



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# Summary and outlook

- Trustworthiness was studied in the context of decision-making
- Premise: Trustworthy decisions are integral part of the process to achieve trustworthy products
- Different strategies were studied to increase trust into decisions suggest by support systems
- Future research topics
  - Finding impacting factor on trustworthy processes and decisions
  - Industrial validation of impacting factors on trust
  - Explanation systems for decision support
  - Robustness of processes

# References

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*Du, G., Ruhe., G., "Does Explanation Improve the Acceptance of Decision Support for Product Release Planning?", submitted to ESEM 2009.*

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*Jadallah, A. et al., "The How? When? and What? for the Process of Re-Planning for Product Releases", ICSP 2009.*

# QUESTIONS ?

