5th International Workshop on Quantitative Approaches to Software Quality (QuASoQ)
Nanjing, Dec 4, 2017

Pitfalls and Countermeasures in Software Quality Measurements and Evaluations

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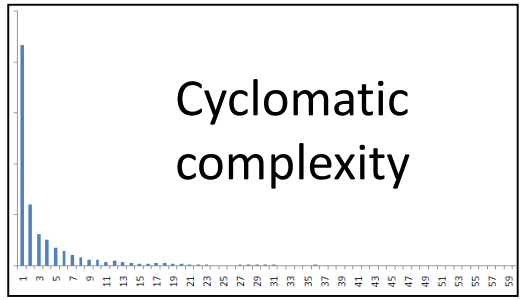
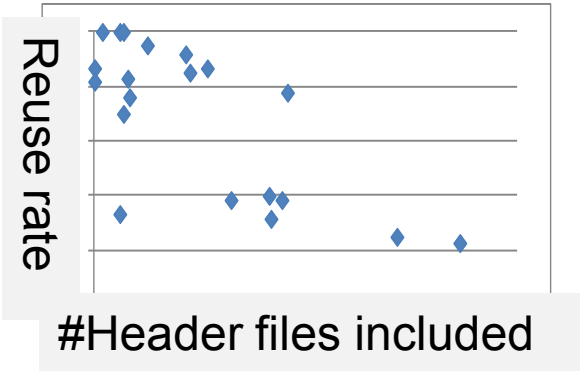
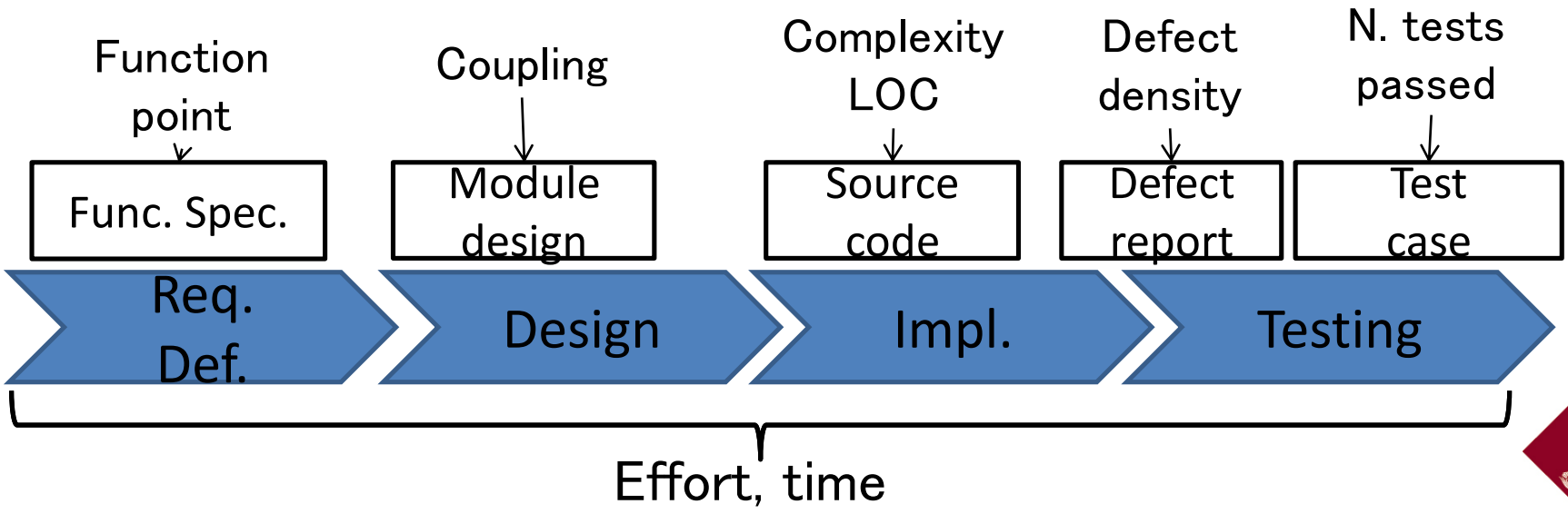
Chair, SEMAT Japan Chapter
Convenor, ISO/IEC/JTC1/SC7/WG20
PC Co-Chair, APSEC 2018 Nagoya!

Metric and Measurement

- Mapping attributes to values/names on scales
  - Quality control by single metric
  - Estimating metric values by other metrics
- You cannot control what you cannot measure!







Pitfalls and Countermeasures

Pitfall	Countermeasure
Negative Hawthorne effects	Goal-orientation
	Multidimensional measurements
Organization misalignment	Visualization of relationships among organizational goals, strategies, and measurements
	Exhaustive identification of rationales
Uncertain future	Prediction incorporating uncertainty
	Measurement program improvement by machine learning
Self-certified quality	Standard-based evaluation
	Pattern-based evaluation

H. Washizaki, Pitfalls and Countermeasures in Software Quality Measurements and Evaluations, Advances in Computers, 106, 2017

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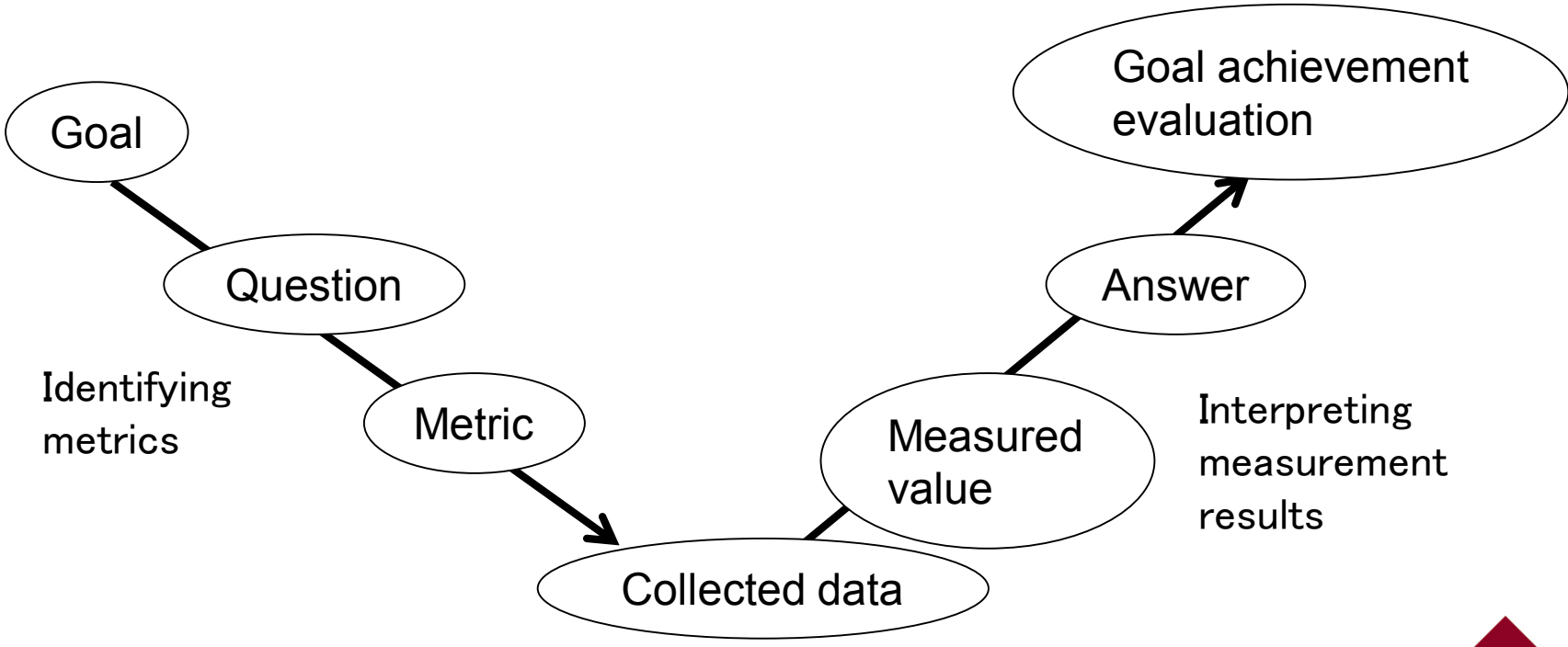
Hawthorne Effect

nicolasdsampson.com, Observe And Learn: The Magic Of Paying Attention
http://nicolasdsampson.com/wp-content/uploads/2012/10/2010_12_06_observe-learn-magic-paying-attention.jpg

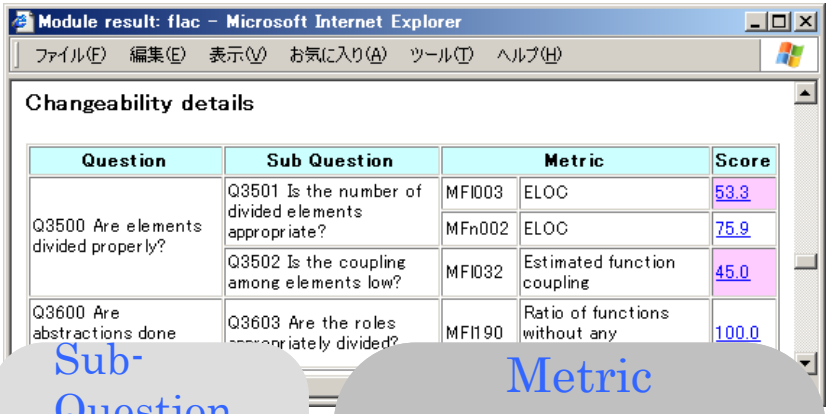
Goal-Question-Metric (GQM) Paradigm

- Goal-oriented framework for identifying goals and necessary corresponding metrics
- Goal: measurement goals
- Question: questions for evaluating goal achievement
- Metric: objective or subjective metrics for obtaining necessary quantitative data to answer questions



R. van Solingen, E. Berghout, “The Goal/Question/Metric Method” McGraw-Hill Education, 1999

GQM-based Multidimensional Measurements



Goal

- Reliability
- Efficiency
- Maintain-ability
  - Analysability
  - Changeability
  - Testability
- Portability
- Reusability

Question

- Are functions not complicated?
- Are entities named properly?

Independent

Sub-Question

- Is call-nesting not too deep?
- Is logic not too complex?

Specific

Metric

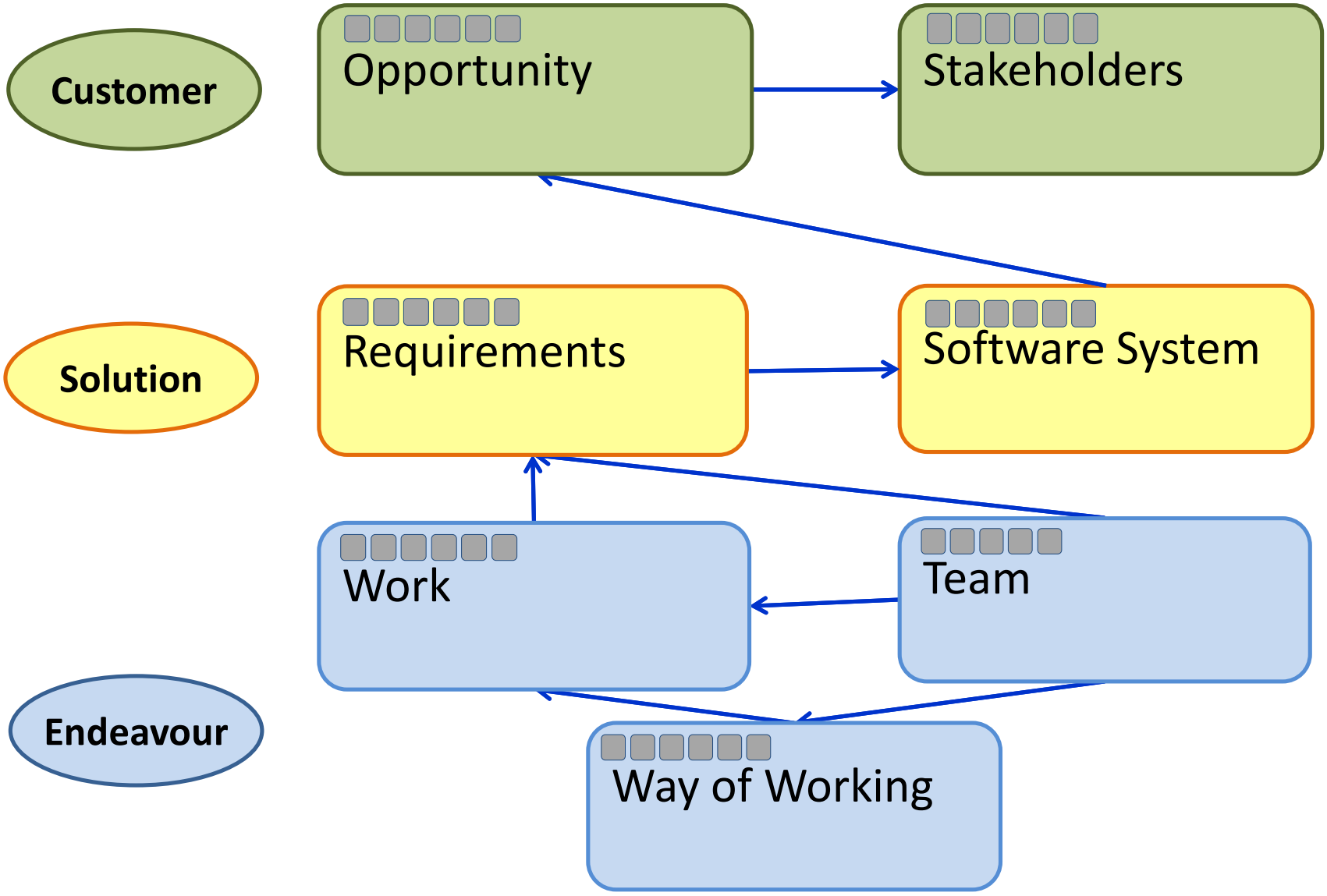
- Depth of call graph T
- Cyclomatic Number min
- Estimated static path length min

Measured by some tools

(Scale type: T threshold, min smaller is better, max larger is better)

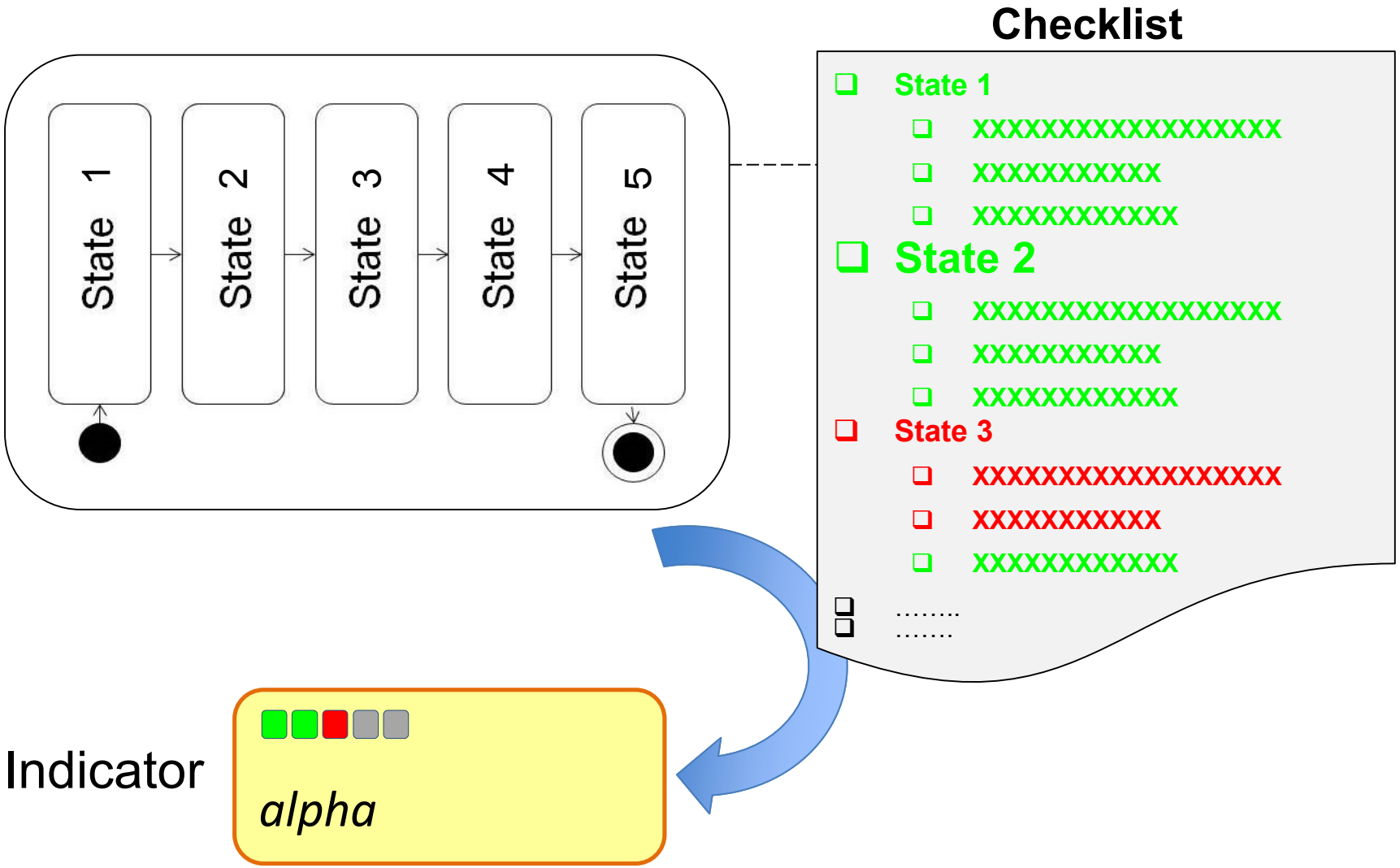
H. Washizaki, R. Namiki, T. Fukuoka, Y. Harada, H. Watanabe, "A Framework for Measuring and Evaluating Program Source Code Quality", 8th Int'l Conference on Product Focused Software Development and Process Improvement (Profes2007)

SEMAT-based Multidimensional measurements



Ivar Jacobson, Pan-Wei Ng, Paul E. McMahon, Ian Spence, Svante Lidman, “The Essence of Software Engineering: The SEMAT Kernel,” Communications of the ACM, vol.55, no.12, pp.42-49, December 2012.

alpha as Project Measurement

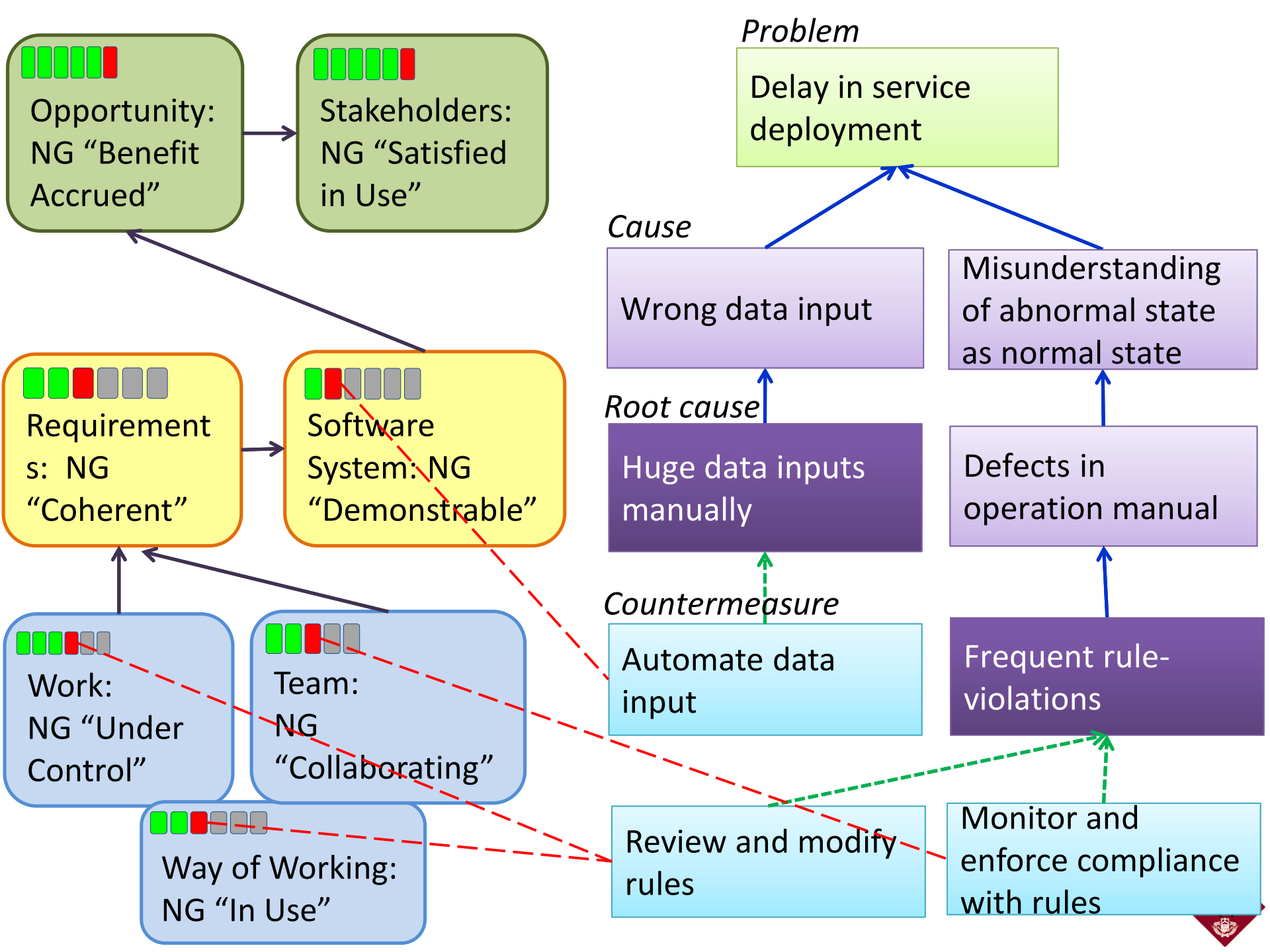


Adopted/modified from I. Jacobson, et al.: Tutorial: Essence - Kernel and Language for Software Engineering Practices, ICSE'13

Example from ITA WG on project failuers

- An employee in charge of Bank office inquires "registered customer information cannot be browsed from the terminal“.
- It was because a batch processing for the previous day has ended abnormally due to wrong data input.
- It took about two hours to recover the data, and employees at each office had to handle customer inquiry manually.
- For that reason, we had received plenty of complaints from customers who had been waiting for a long time!

H. Washizaki, “Analyzing and refining project failure cases from wider viewpoints by using SEMAT Essence,” Essence Conference in Seoul, 2017.


Opportunity: NG "Benefit Accrued"
Stakeholders: NG "Satisfied in Use"
Requirements: NG "Coherent"
Software System: NG "Demonstrable"
Work: NG "Under Control"
Team: NG "Collaborating"
Way of Working: NG "In Use"
Problem
Delay in service deployment
Cause
Wrong data input
Misunderstanding of abnormal state as normal state
Root cause
Huge data inputs manually
Defects in operation manual
Countermeasure
Automate data input
Frequent rule-violations
Review and modify rules
Monitor and enforce compliance with rules

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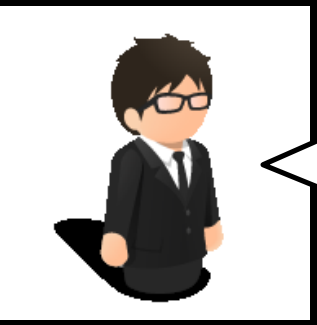
Organization misalignment

We increase customer satisfaction by quality and usability improvement!

Top management

We reduce customer-reported defects by improving testing process and product maintainability.



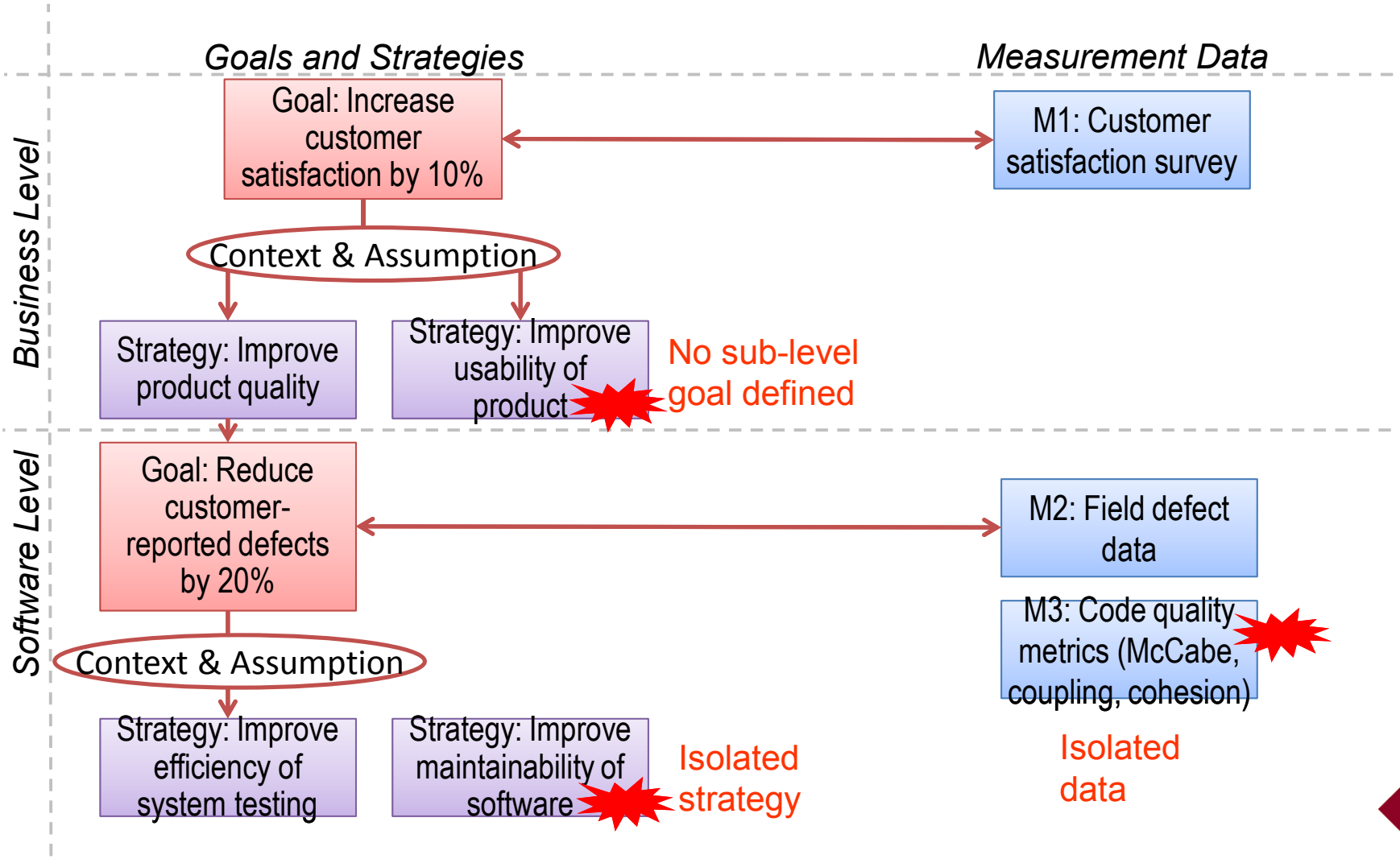
Development team

We track defect data and code quality metrics.

Quality assurance team

GQM+Strategies

- Alignment and tracing among goal, strategy and data

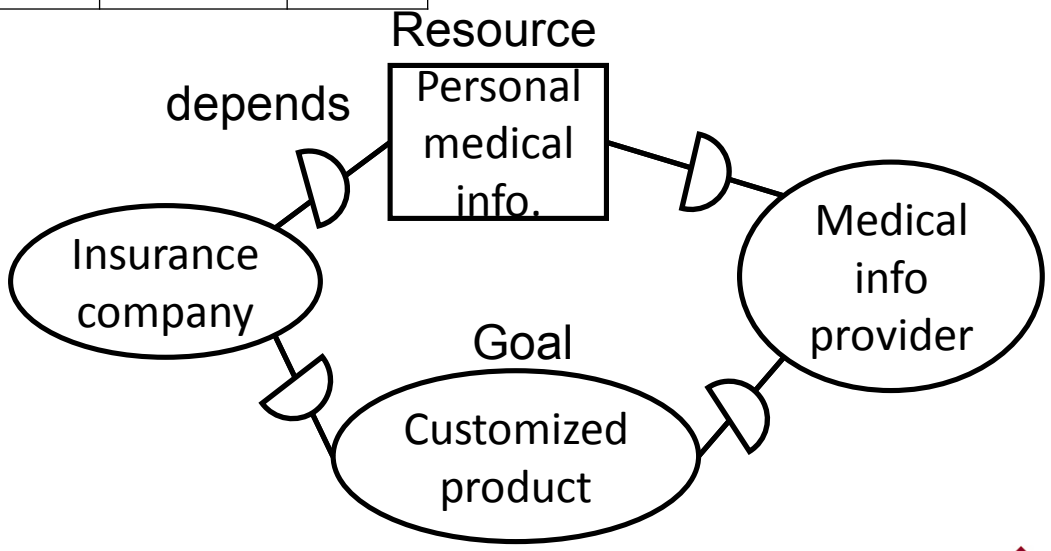


Context-Assumption-Matrix [IEICE'16]

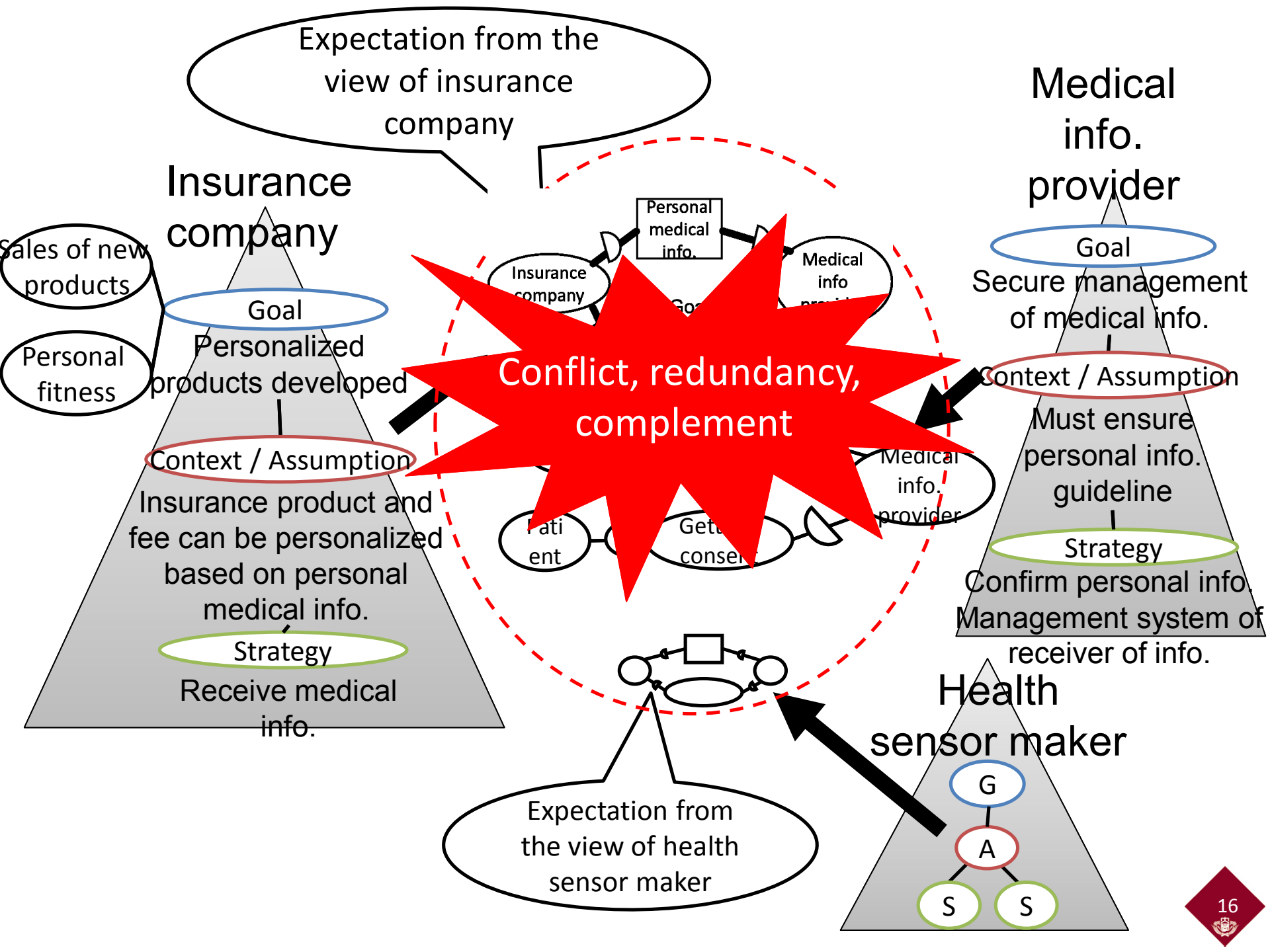
Target / View	Hospital	Insurance company	Health sensor maker	…
Hospital				
Insurance company				
Health sensor maker				
…				

Context / Assumption

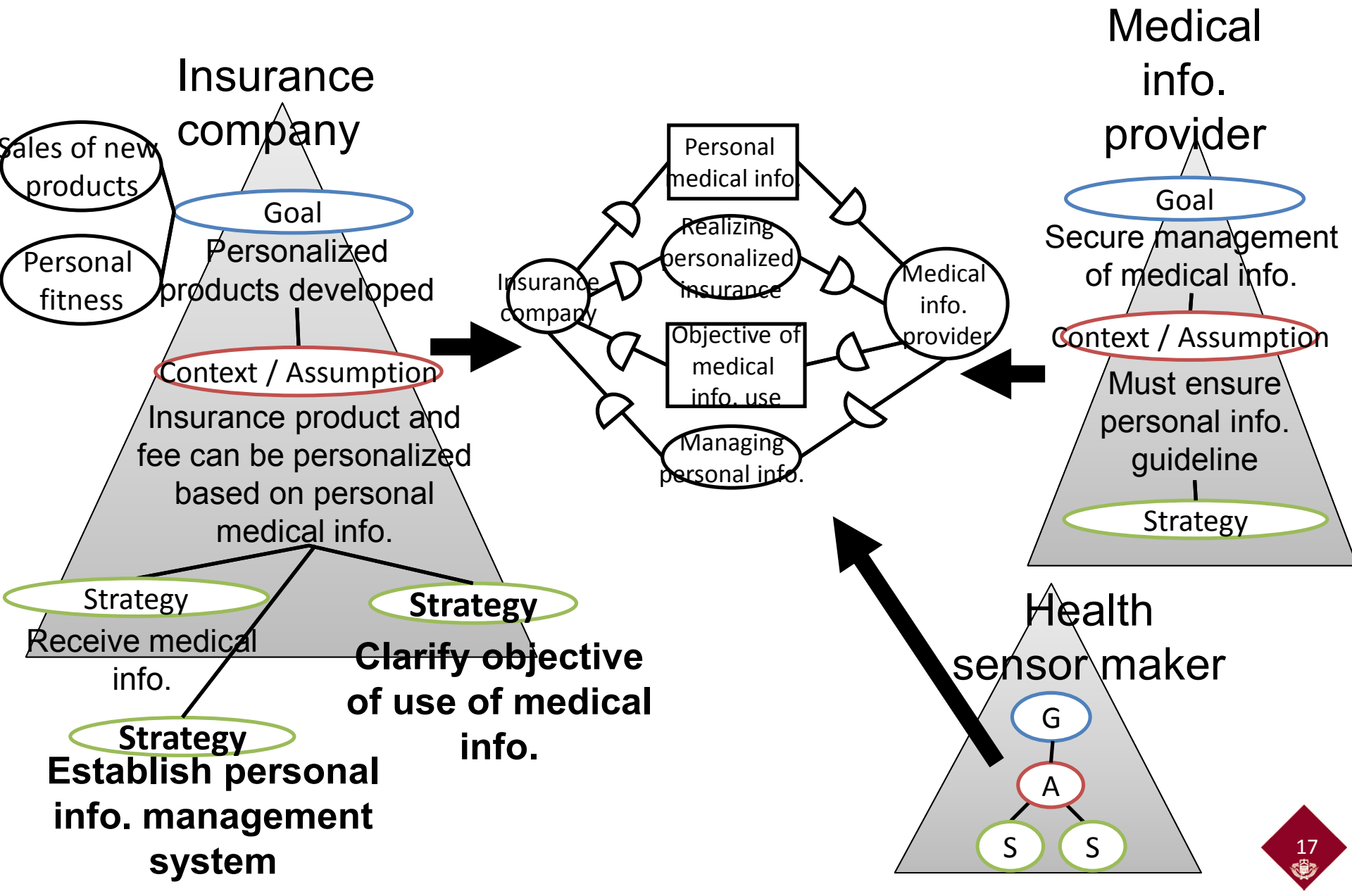
Insurance company can offer personalized products by having medical info…



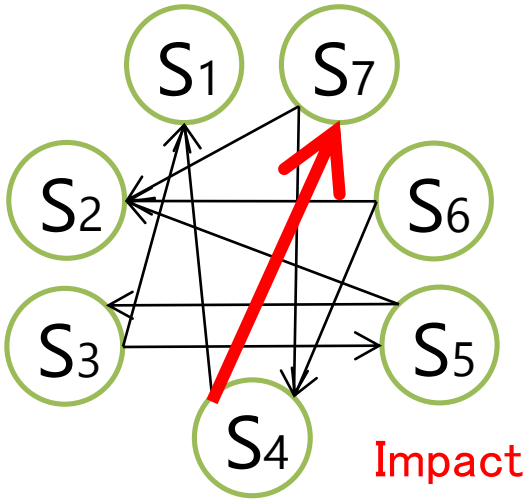
Takanobu Kobori, Hironori Washizaki, et al., "Exhaustive and efficient identification of rationales using GQM+Strategies with stakeholder relationship analysis," IEICE Transactions on Information and Systems, Vol.E99-D, No.9, pp.2219-2228, 2016.

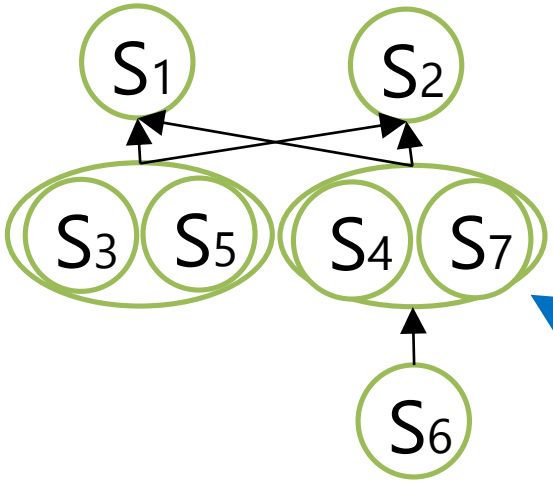

Expectation from the view of insurance company
Insurance company
Sales of new products
Personal fitness
Goal
Personalized products developed
Context / Assumption
Insurance product and fee can be personalized based on personal medical info.
Strategy
Receive medical info.
Personal medical info.
Insurance company
Medical info provider
Patient
Medical info. provider
Conflict, redundancy, complement
Medical info. provider
Goal
Secure management of medical info.
Context / Assumption
Must ensure personal info. guideline
Strategy
Confirm personal info. Management system of receiver of info.
Health sensor maker
G
A
S
S
Expectation from the view of health sensor maker

Towards clear dependency and alignment



Interpretive Structural Modeling (ISM)





Hierarchical structuring

Relation matrix

	S1	S2	S3	S4	S5	S6	S7
S1	1	0	0	0	0	0	0
S2	1	1	0	0	0	0	0
S3	1	0	1	0	1	0	0
S4	1	0	0	1	0	0	1
S5	0	1	1	0	1	0	0
S6	0	1	0	1	0	1	0
S7	0	1	0	1	0	0	1

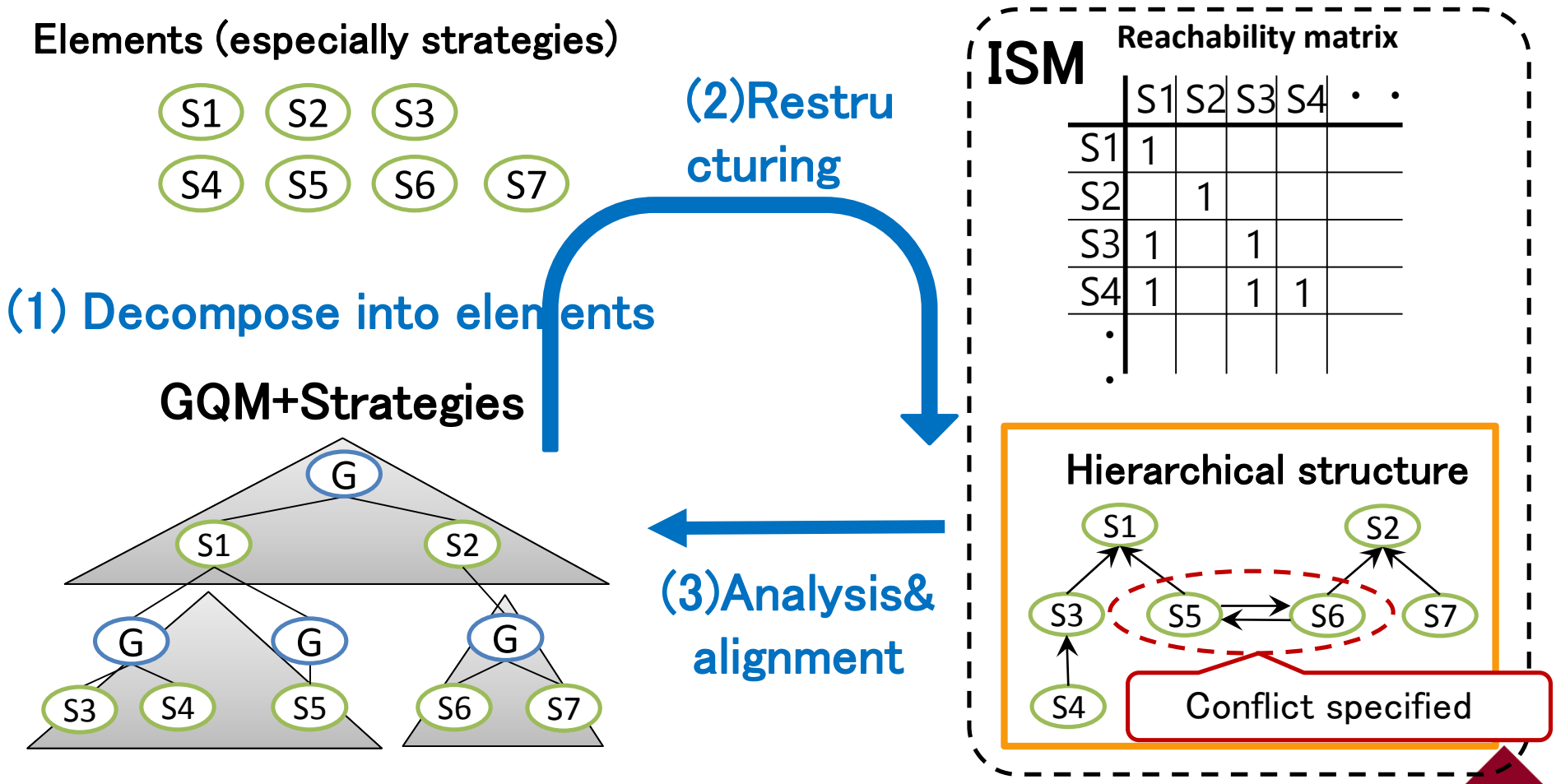
Power.

Reachability matrix

	S1	S2	S3	S4	S5	S6	S7
S1	1	0	0	0	0	0	0
S2	0	1	0	0	0	0	0
S3	1	1*	1	0	1	0	0
S4	1	1*	0	1	0	0	1
S5	1*	1	1	0	1	0	0
S6	1*	1	0	1	0	1	1*
S7	1*	1	0	1	0	0	1

ISM-based Alignment [HICSS'16]

- Alignment for single GQM+Strategies model
- Future: alignment over areas and stakeholders



Yohei Aoki, Takanobu Kobori, Hironori Washizaki, et al., "Identifying Misalignment of Goals and Strategies across Organizational Units by Interpretive Structural Modeling," 49th Hawaii International Conference on System Sciences (HICSS), 2016

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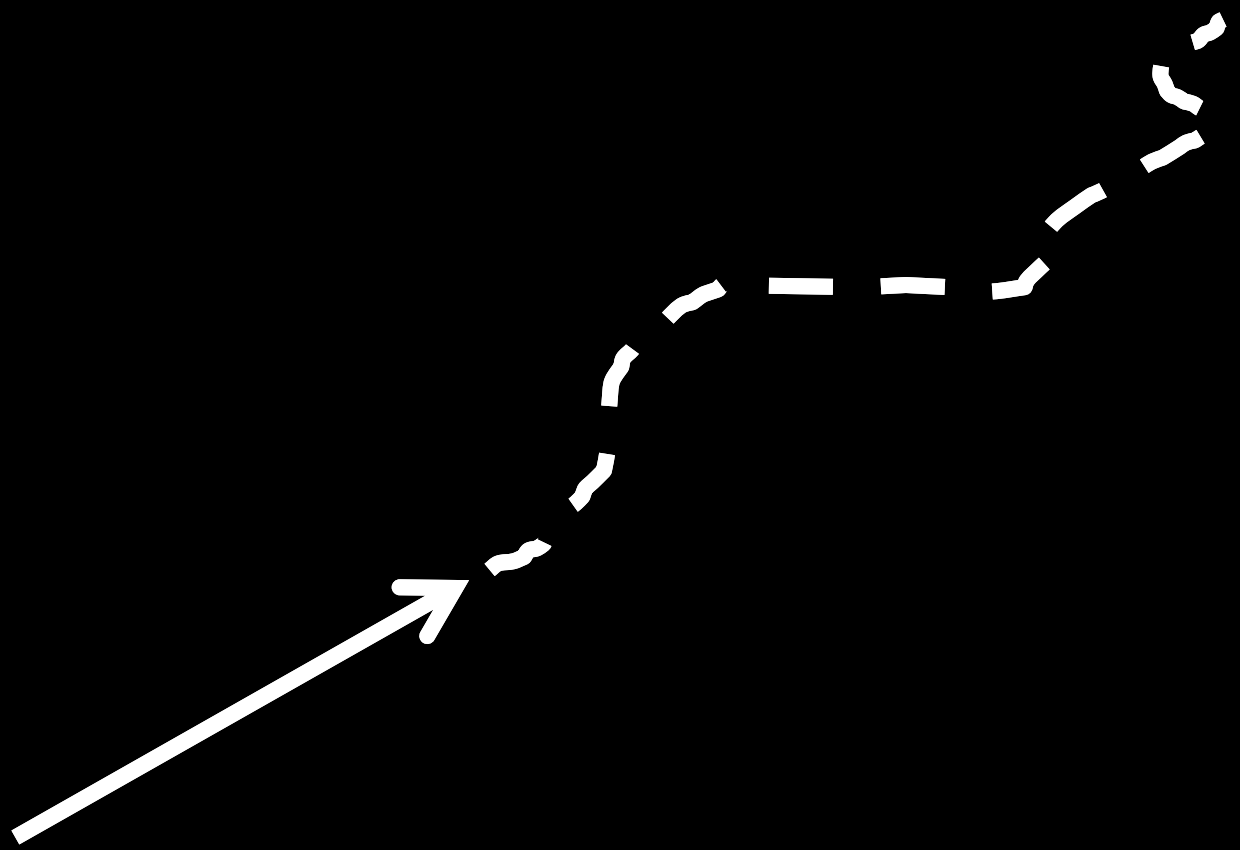
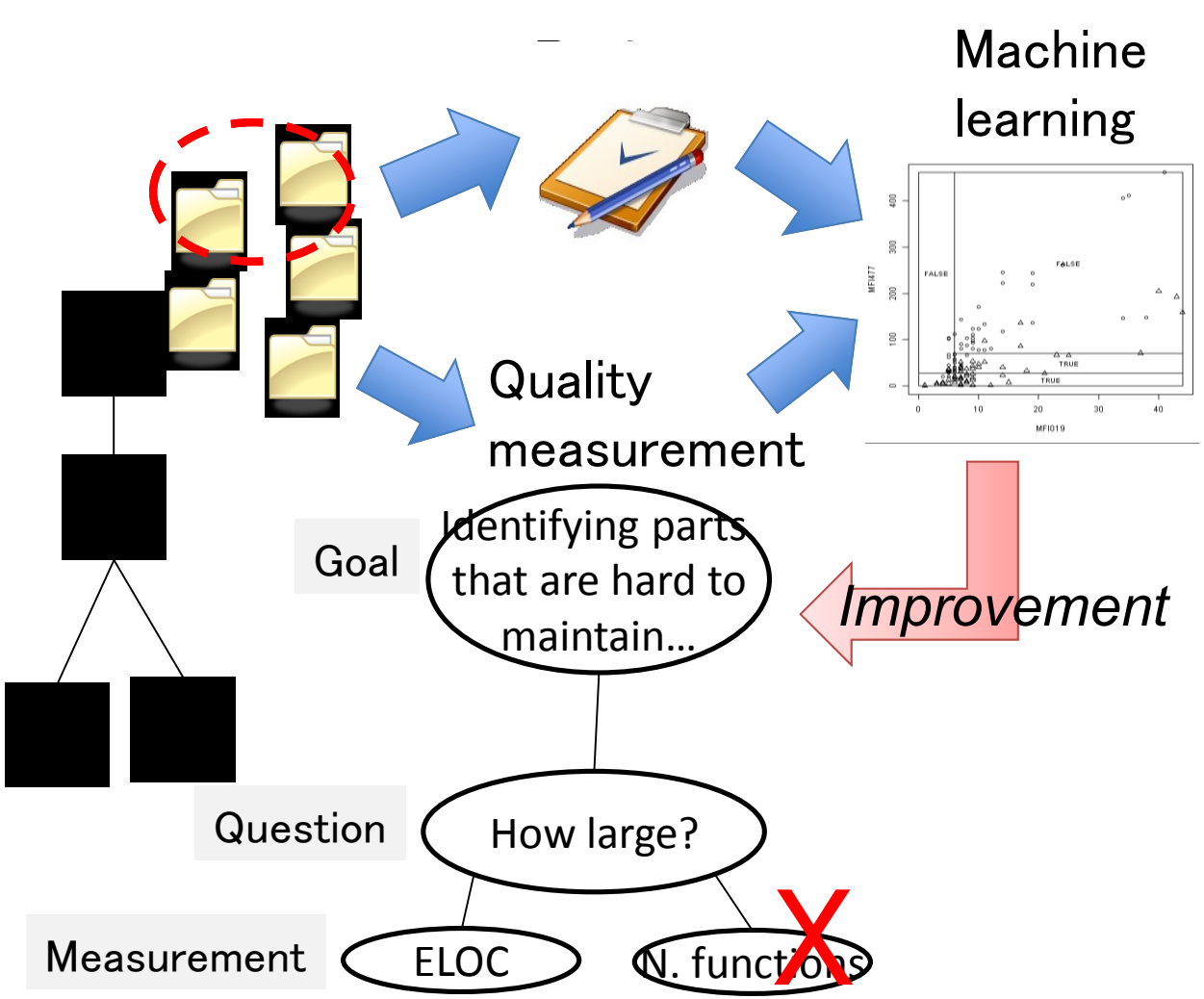
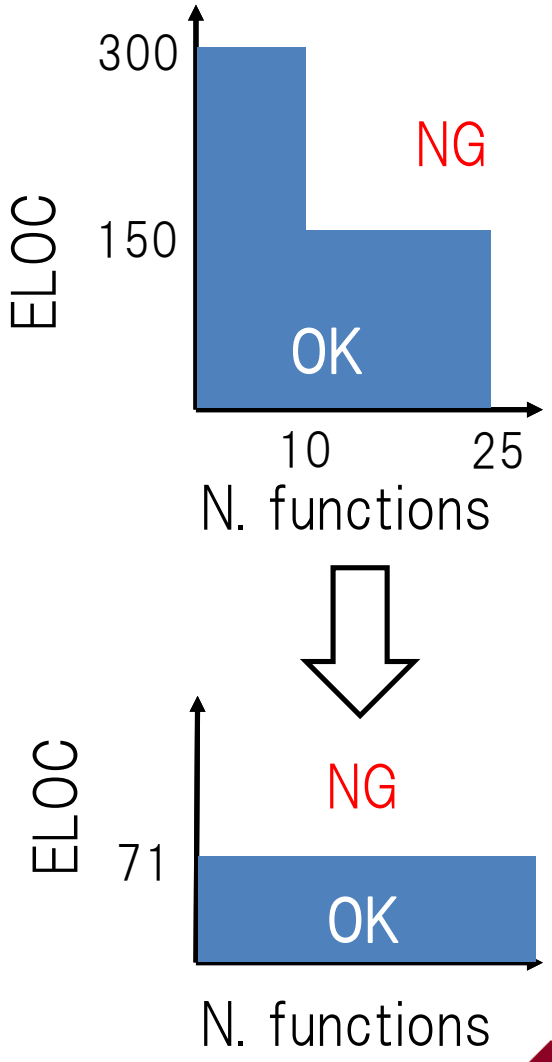
Uncertain Future



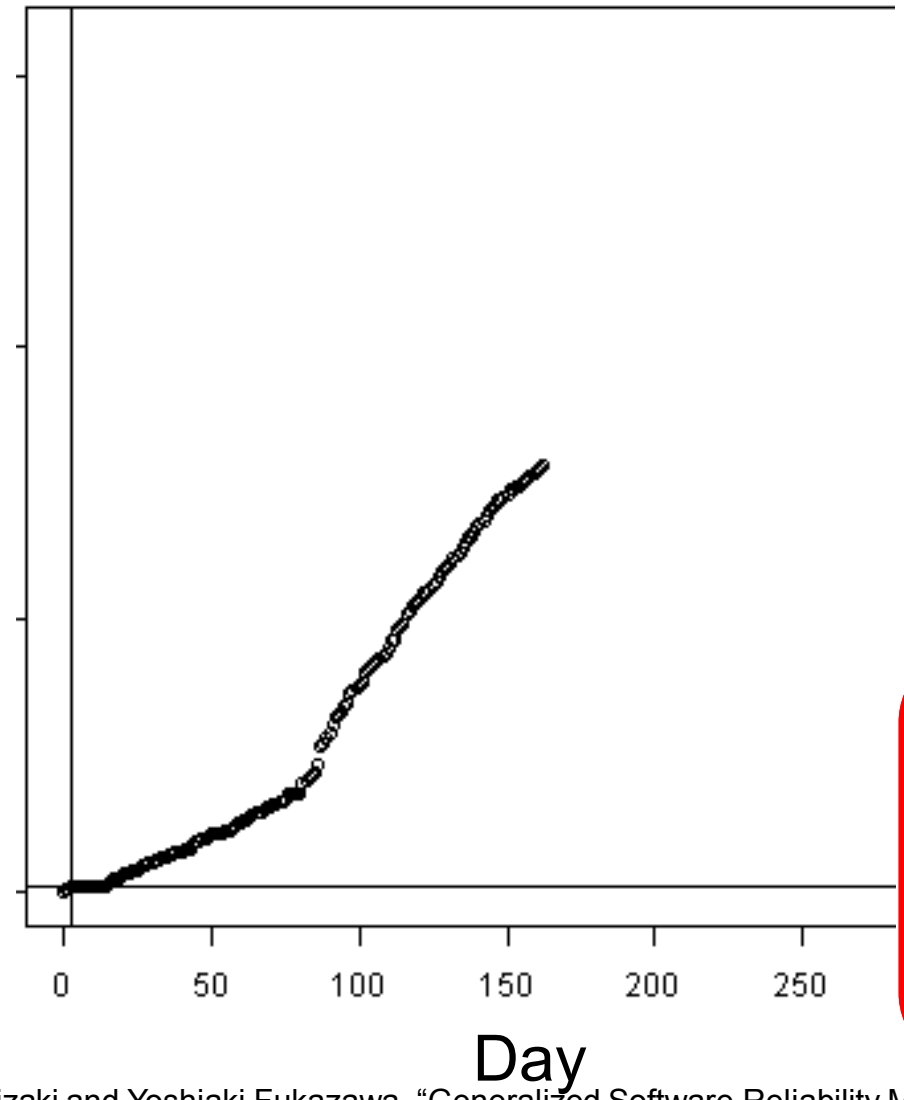
Measurement System Improvement by ML



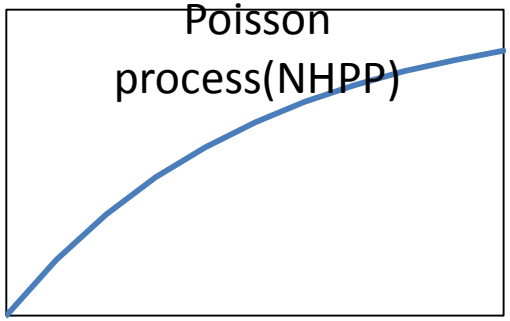


N. Tsuda, et al. Iterative Process to Improve GQM Models with Metrics Thresholds to Detect High-risk Files, SANER 2015

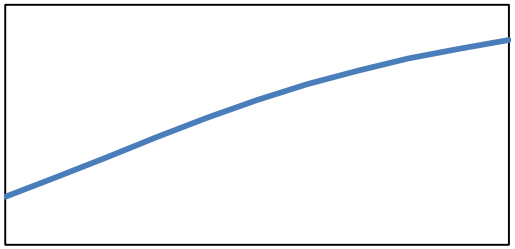
Software reliability model (SRM) as actionable metric



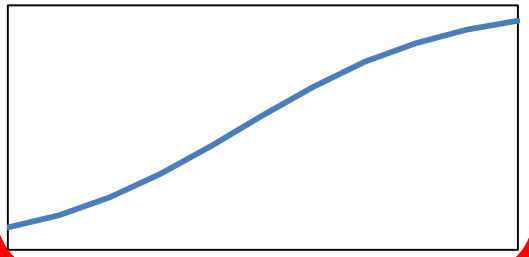
Non-homogeneous Poisson process(NHPP)



Gompertz

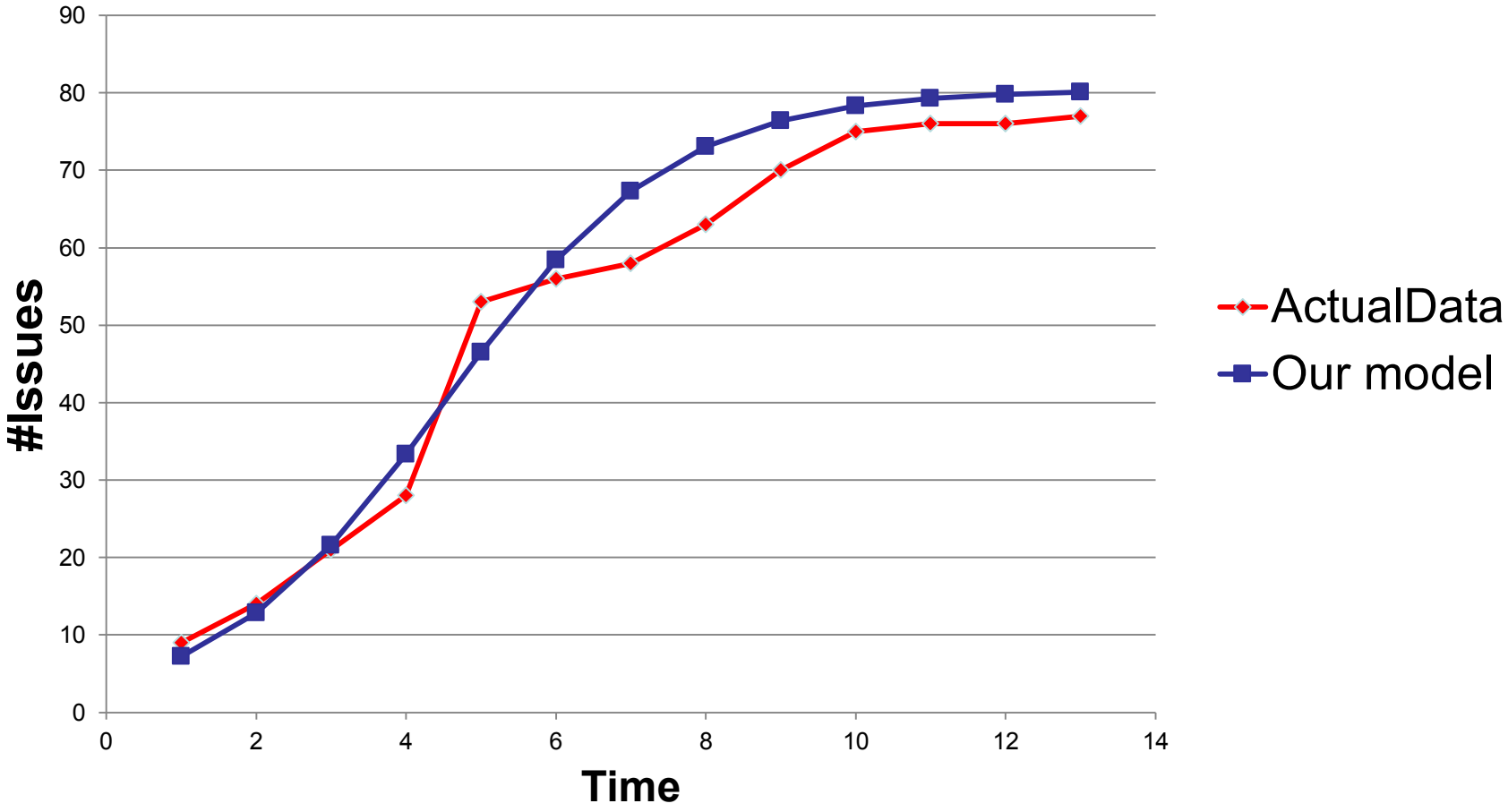


Logistic



Kiyoshi Honda, Hironori Washizaki and Yoshiaki Fukazawa, “Generalized Software Reliability Model Considering Uncertainty and Dynamics: Model and Applications”, International Journal of Software Engineering and Knowledge Engineering (IJSEKE), 2016.

Prediction with uncertainty



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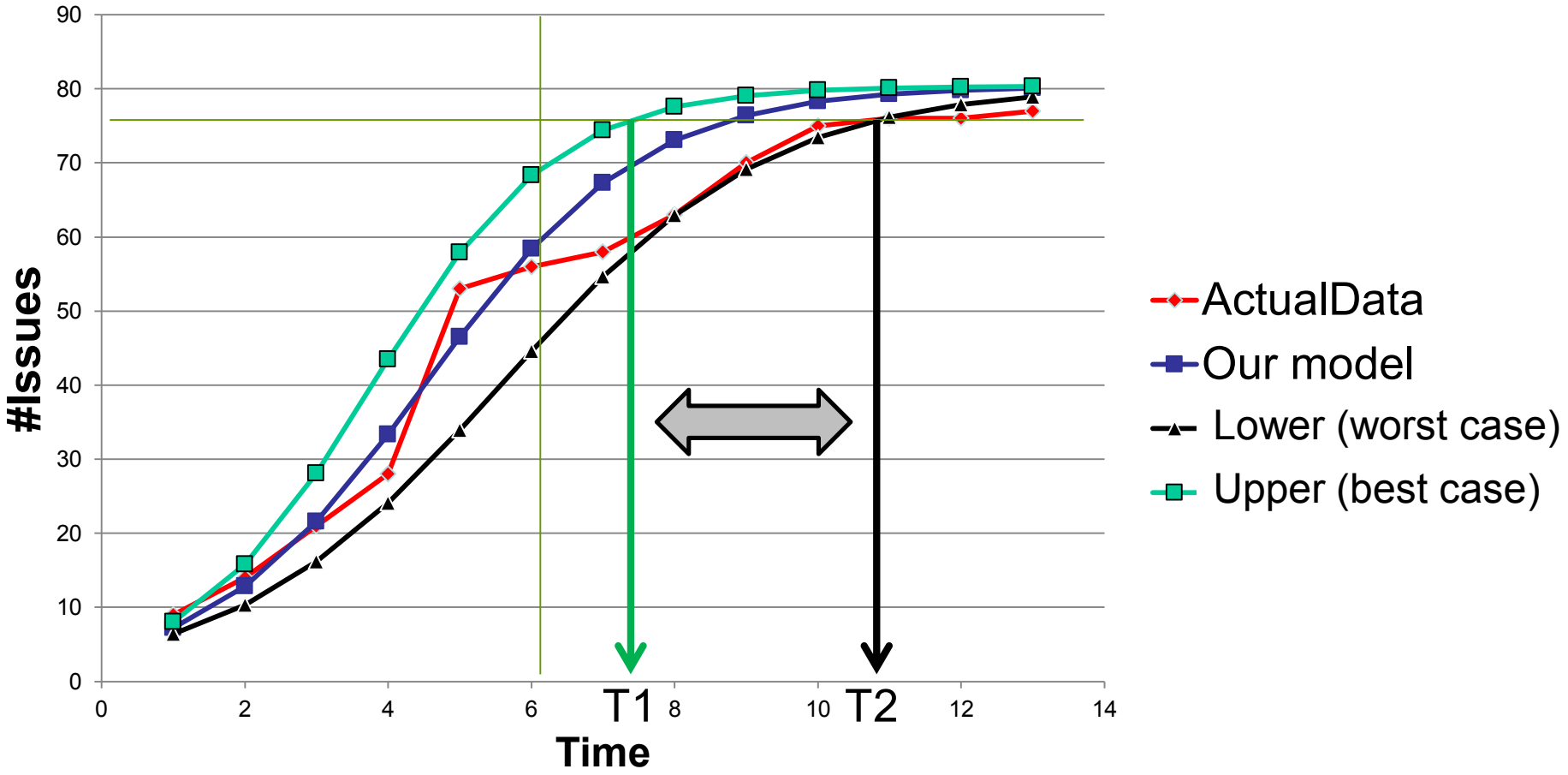

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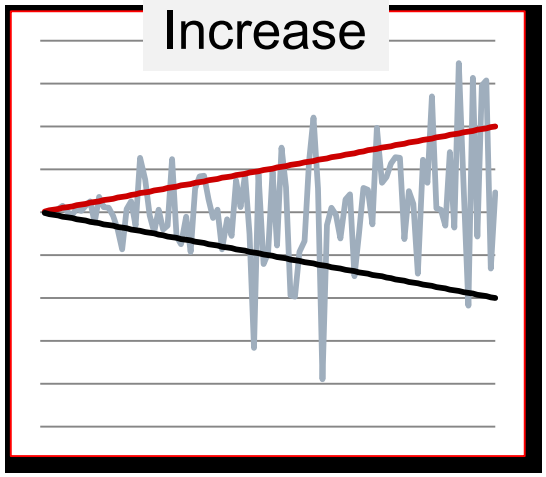
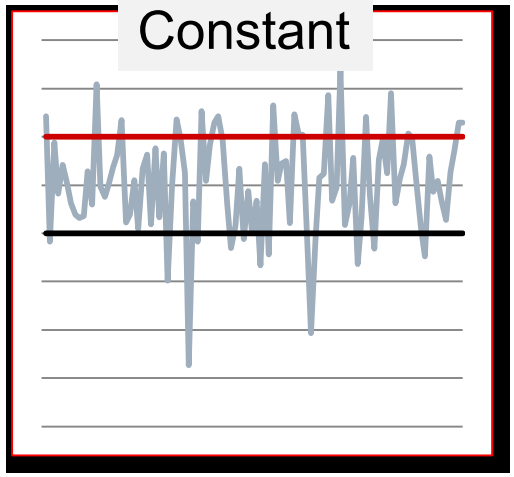
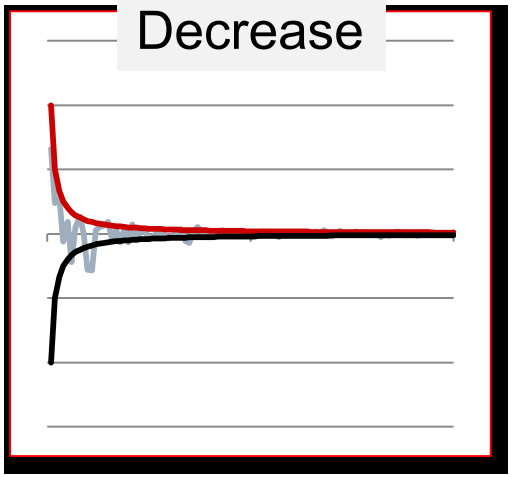
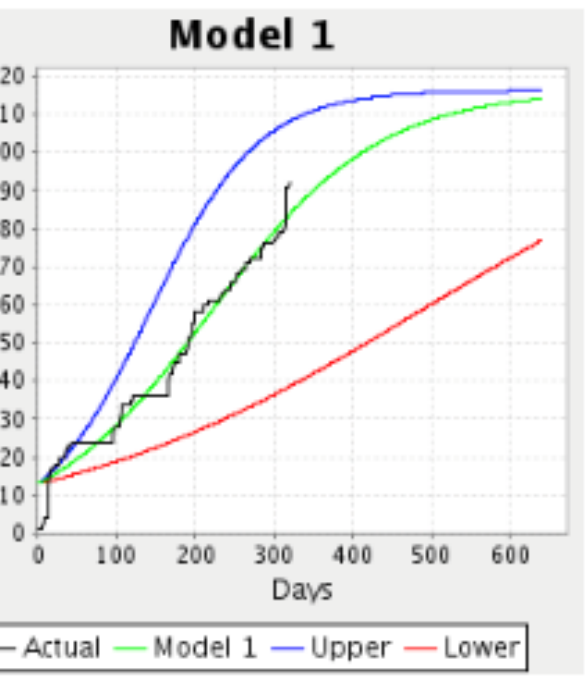
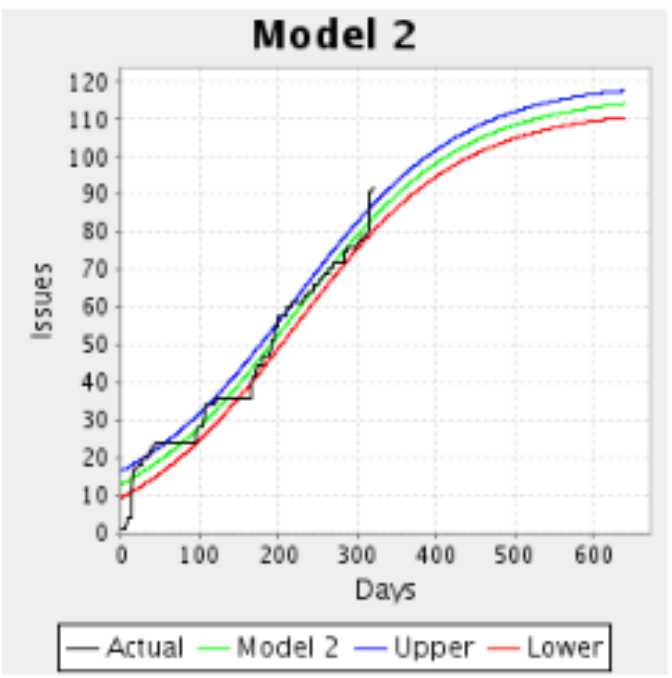
Uncertainty patterns and prediction

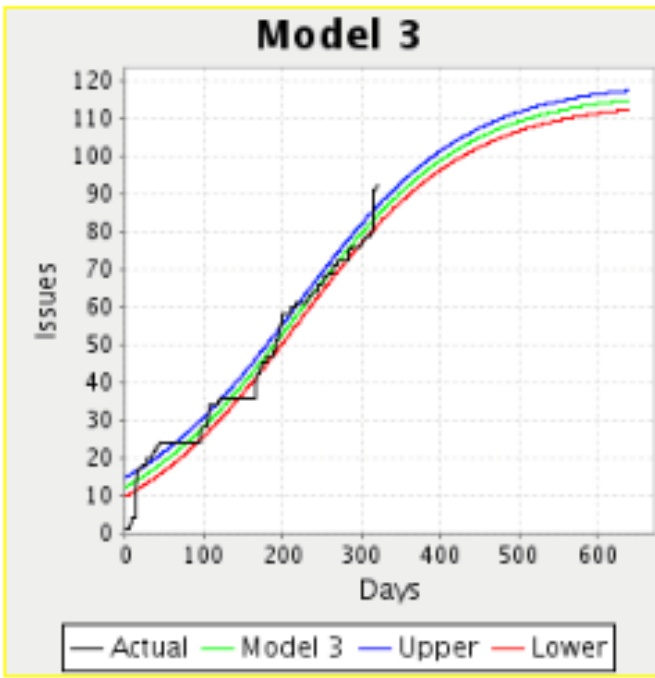












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Self-Certified Quality

Image: How to Spot a Fake: Avoiding Degree Mill Scams https://wenr.wes.org/2015/06/spot-fake-avoiding-degree-mill-scams

WSQB17

ISO/IEC 25000 SQuaRE-based Quality Measurement and Benchmark

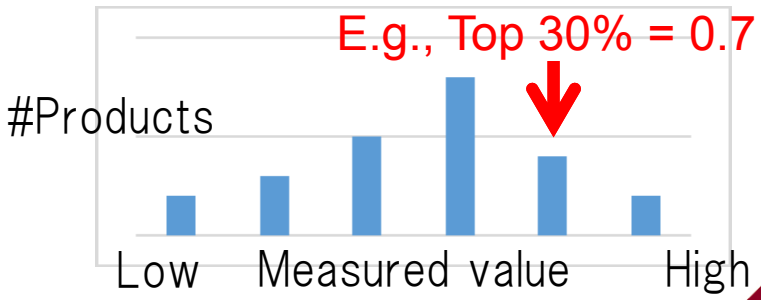
	Waseda U. Team	Vendor
1	Concretize SQuaRE measurements by GQM	
2	Prepare measurement methods: data forms, static analysis, questionnaire, user-testing	
3	Conduct code static analysis, user-testing	Fill data forms, questionnaire
4	Measure and evaluate quality	

E.g. Non-repudiation

G. The events or actions cannot be repudiated later through communication channels (paths).

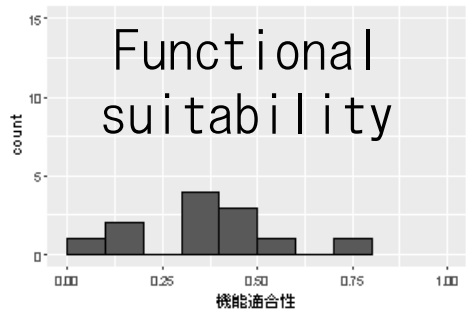
Q1. Any path going through internal servers only?
Q2. Any path going through outside servers?
Q3. Any P2P communications?
…
M. Signed communication path ratio
= #Signed_paths / #Total_paths

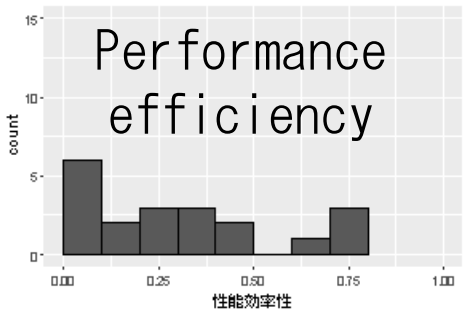
Scores by using percentile

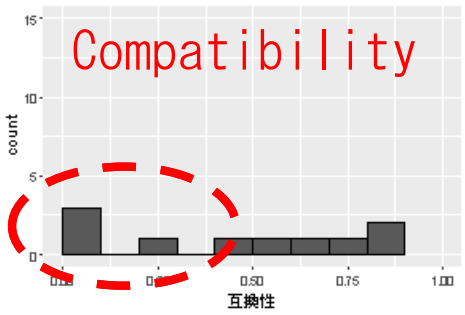


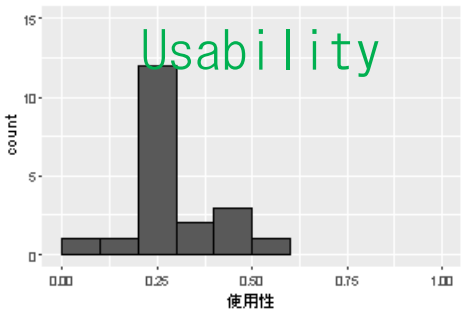
H. Nakai, N. Tsuda, K. Honda, H. Washizaki and Y. Fukazawa, Initial Framework for a Software Quality Evaluation based on ISO/IEC 25022 and ISO/IEC 25023, IEEE International Conference on Software Quality, Reliability & Security (QRS 2016)

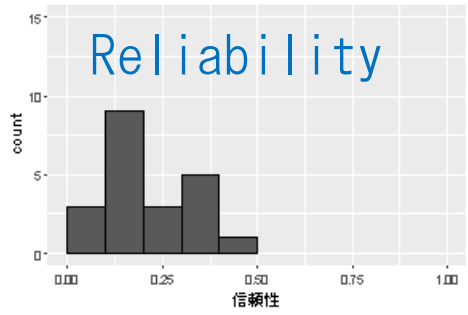
21 Japanese Products Measurement

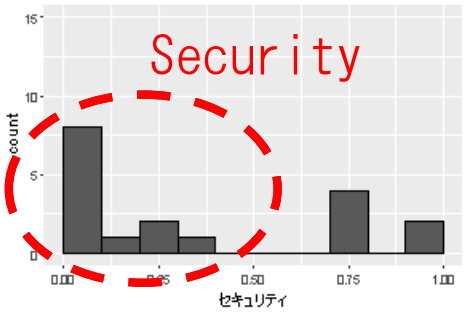


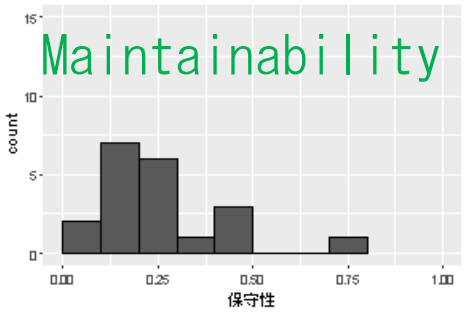


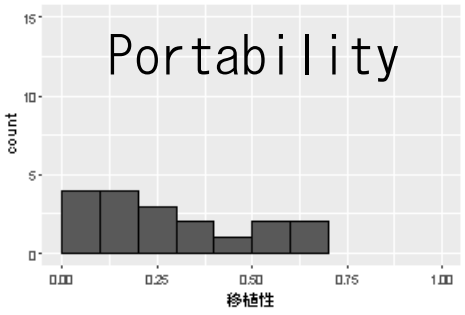


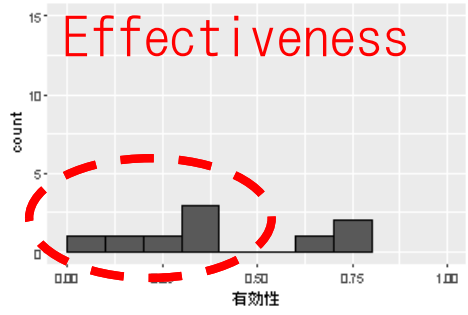


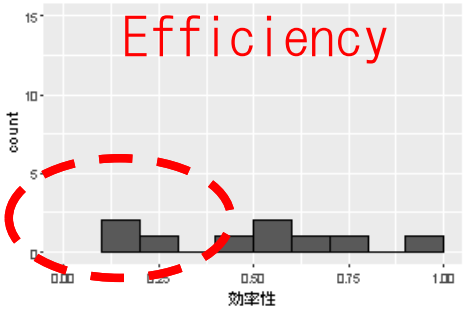


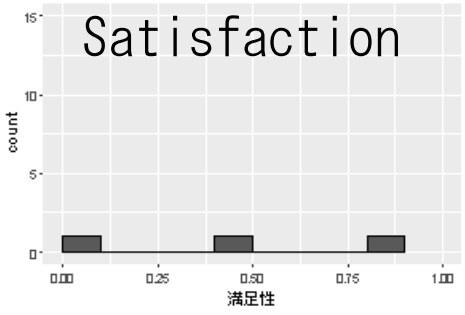


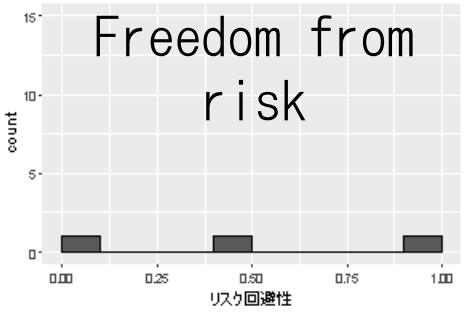












- Low security and compatibility in some products
- Necessary to address these in IoT era

H. Nakai, N. Tsuda, K. Honda, H. Washizaki and Y. Fukazawa, Initial Framework for a Software Quality Evaluation based on ISO/IEC 25022 and ISO/IEC 25023, IEEE International Conference on Software Quality, Reliability & Security (QRS 2016)

Relationships among characteristics

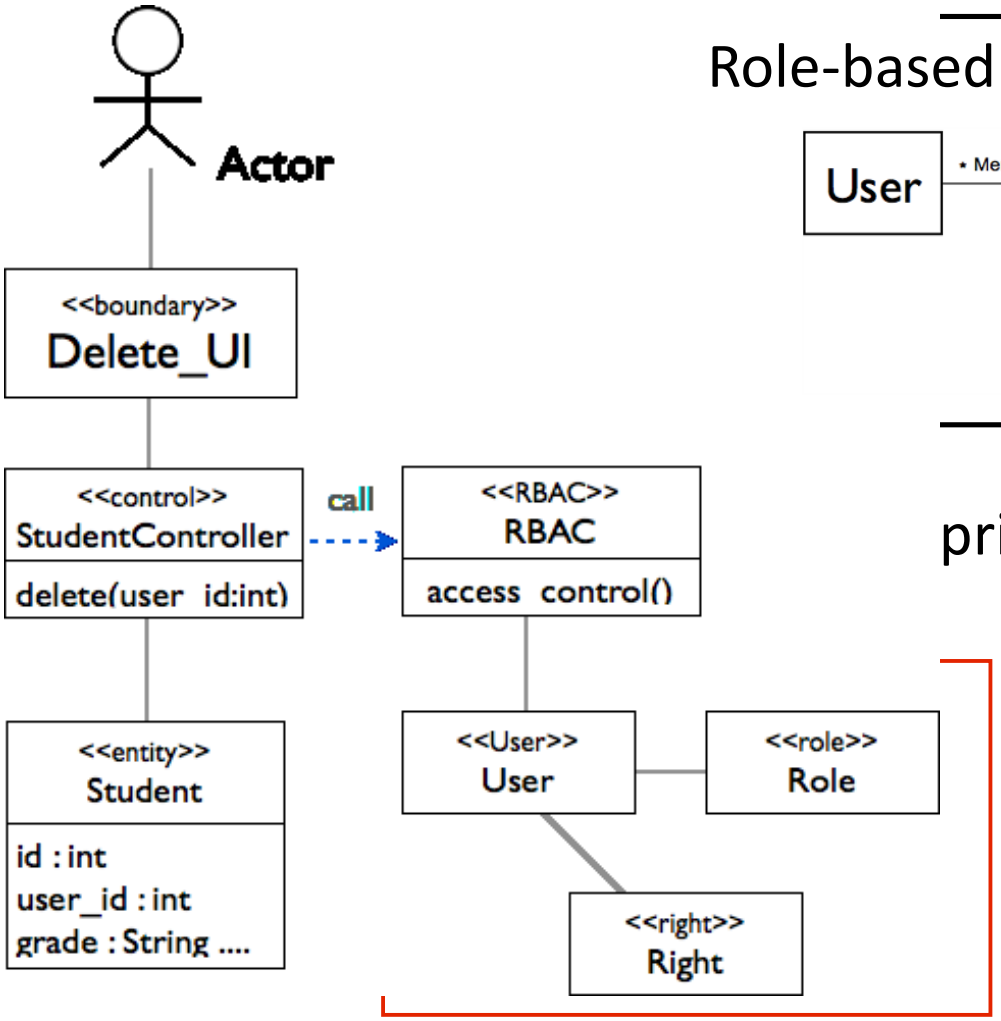
	Internal/External Quality							Quality in Use				
	Perf.	Comp.	Usa.	Relia.	Sec.	Main.	Port.	Effe.	Effic.	Sati.	Free.	Cont.
Func.	0.31	0.19	-0.72	0.37	-0.05	0.50	0.31	-0.14	0.52	1.00	1.00	1.00
Perf.		0.44	0.24	0.36	-0.17	0.37	0.32	0.32	-0.10	-0.50	-0.50	-0.50
Comp.			0.04	0.17	-0.06	0.36	-0.04	-0.14	0.05	-0.50	-0.50	-0.50
Usa.				0.17	-0.21	0.11	0.44	-0.09	-0.20	-1.00	-1.00	-1.00
Relia.					0.30	0.41	0.45	-0.08	0.11	1.00	1.00	1.00
Sec.						-0.06	0.19	0.64	-0.34	0.50	0.50	0.50
Main.							0.26	-0.29	0.01	1.00	1.00	1.00
Port.								-0.21	0.67	0.50	0.50	0.50
Effe.									0.03	-1.00	-1.00	-1.00
Effic.										1.00	1.00	1.00
Sati.											1.00	1.00
Free.												1.00

- Negative correlation between usability and functionality.
- Need to adopt user-centered development

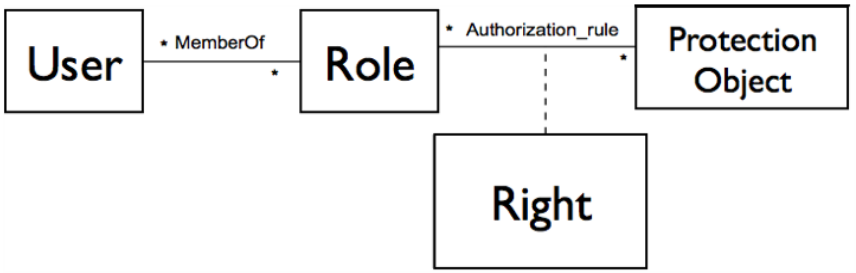
p-value < 0.1

H. Nakai, N. Tsuda, K. Honda, H. Washizaki and Y. Fukazawa, Initial Framework for a Software Quality Evaluation based on ISO/IEC 25022 and ISO/IEC 25023, IEEE International Conference on Software Quality, Reliability & Security (QRS 2016)

Security Patterns and Testing

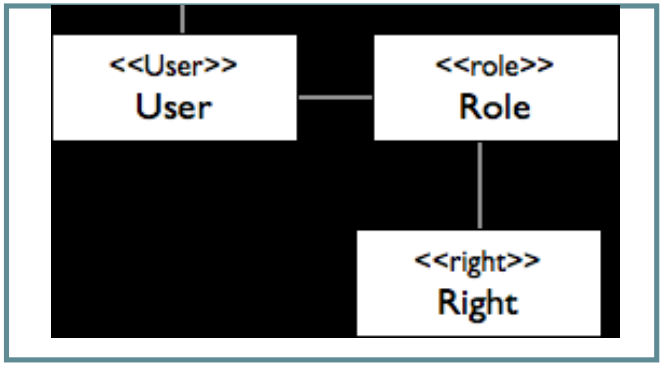


Role-based access control (RBAC) pattern



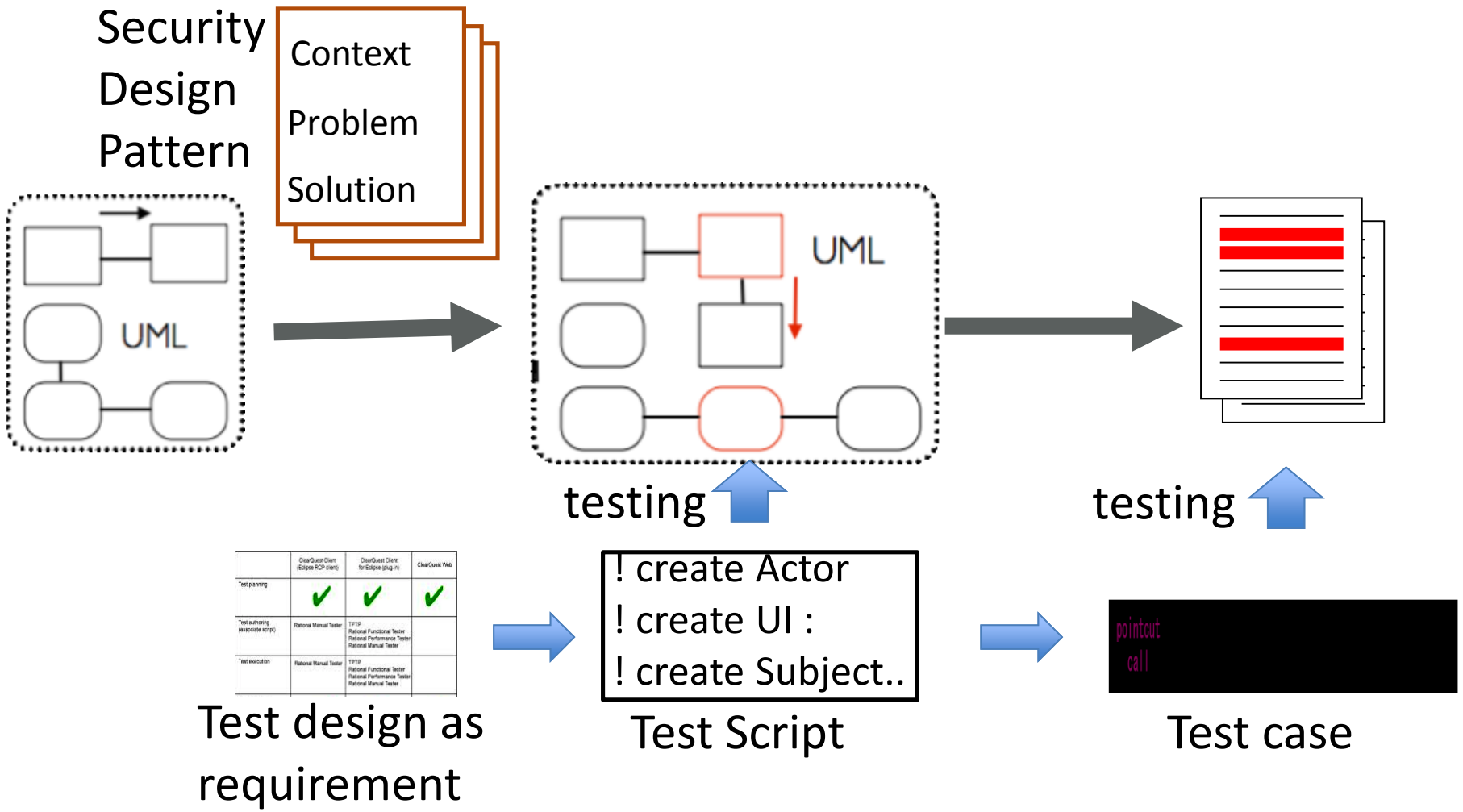
priate

Appropriate design



TESEM: Test Driven Secure Modeling Tool

[ARES'13][ARES'13][IJSSE'14][ICST'15][Information'16]



[ARES'13] Validating Security Design Pattern Applications Using Model Testing, Int'l Conf. Availability, Reliability and Security

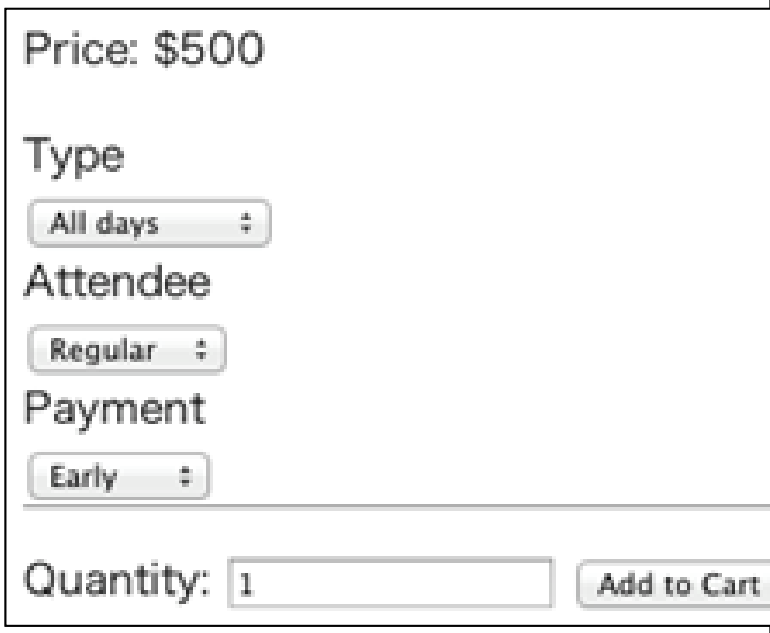
[ARES'14] Verification of Implementing Security Design Patterns Using a Test Template, Conf. Availability, Reliability and Security

[IJSSE'14] Validating Security Design Pattern Applications by Testing Design Models, Int'l J. Secure Software Engineering 5(4)

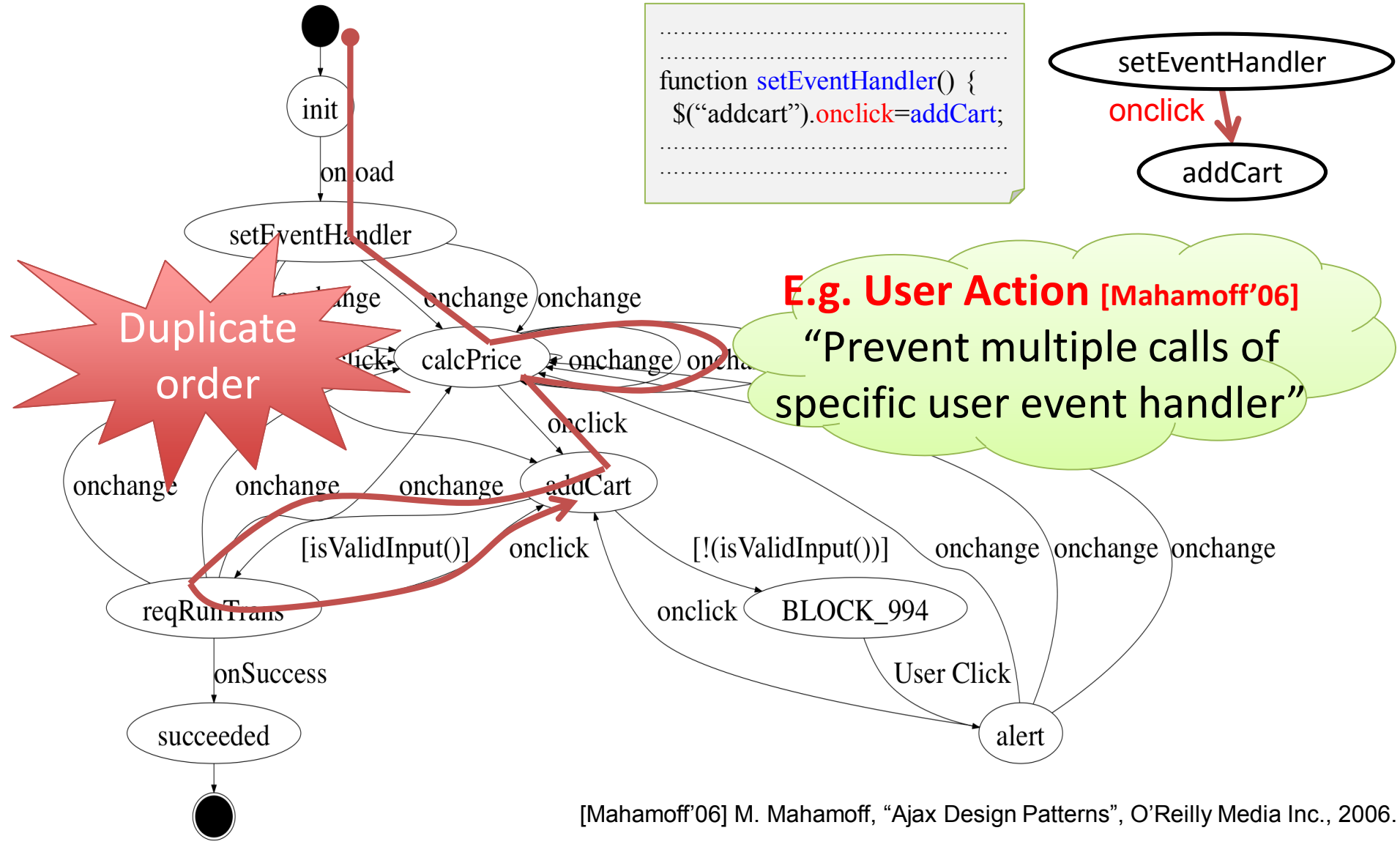
[ICST'15] TESEM: A Tool for Verifying Security Design Pattern Applications by Model Testing, IEEE ICST'15 Tools Track

[Information'16] Implementation Support of Security Design Patterns Using Test Templates, Information 7(2)

```
window.onload = setEventHandler;
function setEventHandler() {
  $("reg_type").onchange = calcPrice;
  ...
  $("reg_addcart").onclick = addCart;
};
function calcPrice() { ... };
function addCart() {
  if(isValidInput()) {
     reqRunTrans();
  } else {
     alert("Invalid user inputs");
  }
};
function reqRunTrans() {
  new Ajax.Request("runTrans.php", {
    method: "GET", parameters: getParams(),
    onSuccess: succeeded });
};
function succeeded() { disableAll();
  jumpToConfirm();
};
```



Finite State Machine Extraction

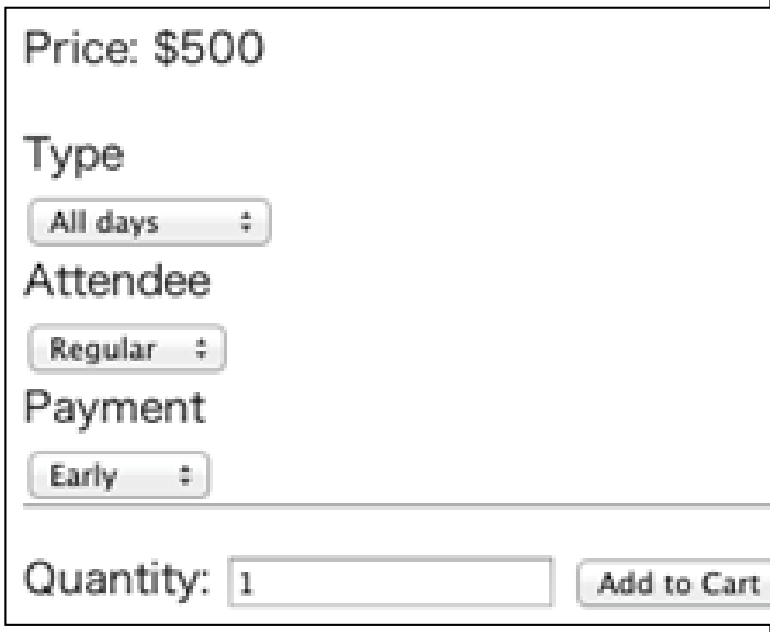


[Mahamoff'06] M. Mahamoff, "Ajax Design Patterns", O'Reilly Media Inc., 2006.

Y. Maezawa, K. Nishiura, H. Washizaki, S. Honiden, Validating Ajax Applications Using a Delay-Based Mutation Technique", 29th IEEE/ACM International Conference on Automated Software Engineering (ASE 2014)

Y. Maezawa, H. Washizaki, Y. Tanabe and S. Honiden , "Automated Verification of Pattern-based Interaction Invariants in Ajax Applications, 28th IEEE/ACM International Conference on Automated Software Engineering (ASE2013)

```
window.onload = setEventHandler;
function setEventHandler() {
  $("reg_type").onchange = calcPrice;
  ...
  $("reg_addcart").onclick = addCart;
};
function calcPrice() { ... };
function addCart() {
  if(isValidInput()) {
     $("addCart").disabled = true;
     reqRunTrans();
  } else {
     alert("Invalid user inputs");
     $("addCart").disabled = false;
  }
};
function reqRunTrans() {
  new Ajax.Request("runTrans.php", {
    method: "GET", parameters: getParams(),
    onSuccess: succeeded }); };
function succeeded() { disableAll();
  jumpToConfirm(); };
```



Pitfalls and Countermeasures

Pitfall	Countermeasure
Negative Hawthorne effects	Goal-orientation
	Multidimensional measurements
Organization misalignment	Visualization of relationships among organizational goals, strategies, and measurements
	Exhaustive identification of rationales
Uncertain future	Prediction incorporating uncertainty
	Measurement program improvement by machine learning
Self-certified quality	Standard-based evaluation
	Pattern-based evaluation

SamurAI Coding

IPSJ 6th International AI Programing Contest

World Final
March 14 2018 Tokyo
http://samuraicoding.info

COMPSAC 2018

42nd IEEE Computer Society Int'l Conf. Computers, Software & Applications

Tokyo
July 23-27 (due: Jan 15)

APSEC 2018

25th Asia-Pacific Software Engineering Conference

Nara
Dec 4-7 (due: June)
PC Chair: H. Washizaki

Int. Journal of Agile and Extreme Software Development (IJAESD)

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