A Tutorial:
Studying Human and Social Aspects in Software Engineering

(My Publish or Perish Keynote: The Uncut Version)

SBES 2019, Salvador, Brazil

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“all models are wrong, but some are useful”

– Box, 1976

Motivation

Paradigms (activity)

Methods (activity)

Contributions (activity)

Motivation

Paradigms (activity)

Methods (activity)

Contributions (activity)

Adds to our knowledge of tools, processes and practices

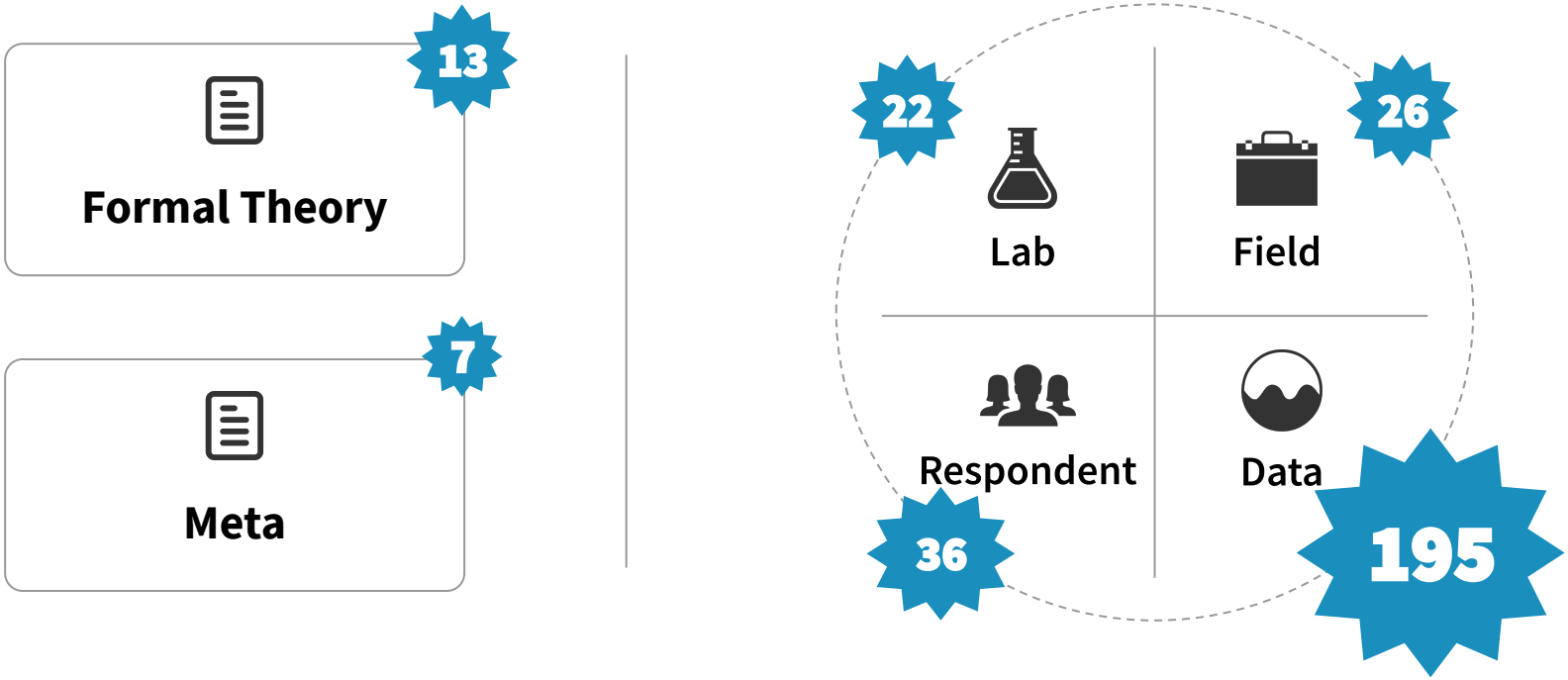
Addresses **gaps** in knowledge

Replicates knowledge by testing old knowledge with new participants or new research sites

Expands knowledge by extending research to new ideas or practices

Broadens our perspectives – e.g. add voices of individuals to the body of knowledge
Inform practice by developing new ideas

What is research?


13
Formal Theory
7
Meta
22
Lab
26
Field
Respondent
Data
36
195

“Measurement is the empirical, objective assignment of numbers, according to a rule derived from a model or theory, to attributes of objects or events with the intent of describing them.”

– Kaner, 2004

Product Metrics:
KLOC, Complexity measures (cyclomatic complexity, function points), OO metrics, #defects

Field metrics:
User engagement, user sentiment

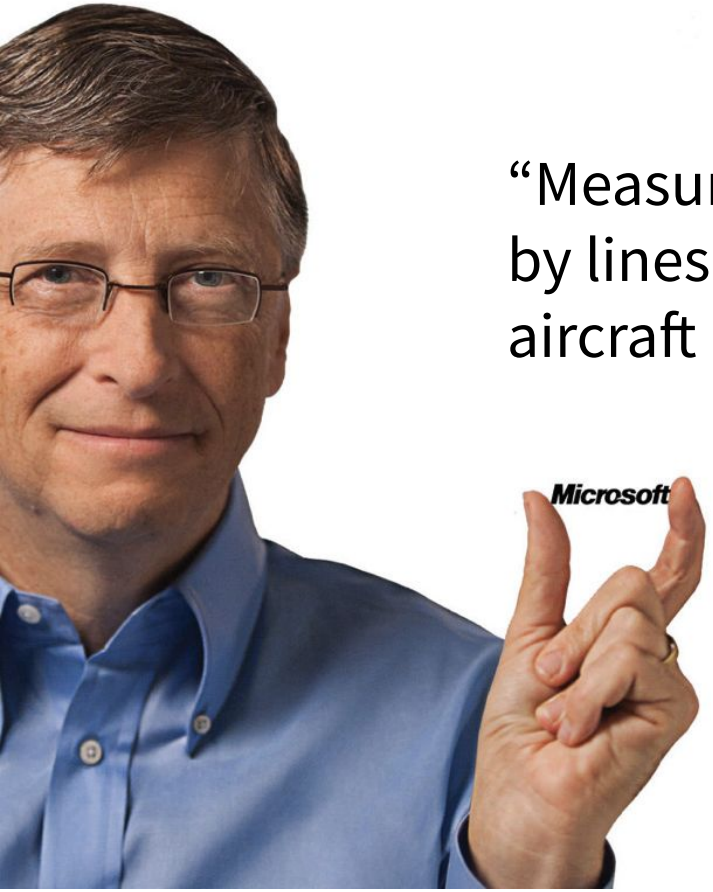
Process metrics:
Testing, code review, deployment, agile practices (e.g., #sprints, burndown rate)

Productivity:
KLOC, Mean time to repair, #commits, team sprint velocity

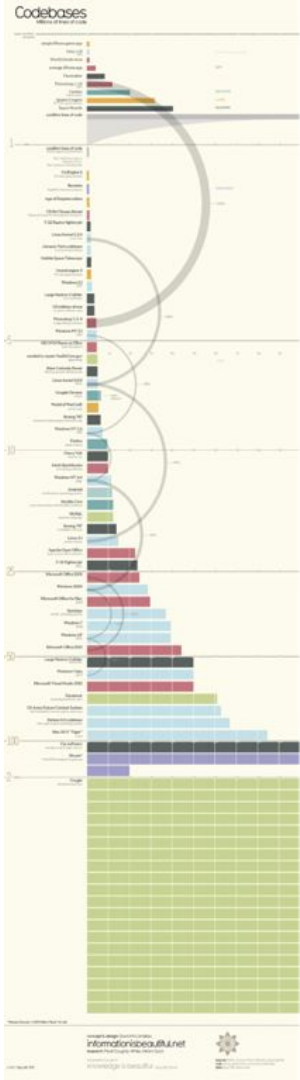
Developer metrics:
Skills, followers, biometrics

Estimation:
cost metrics and models

Types of metrics



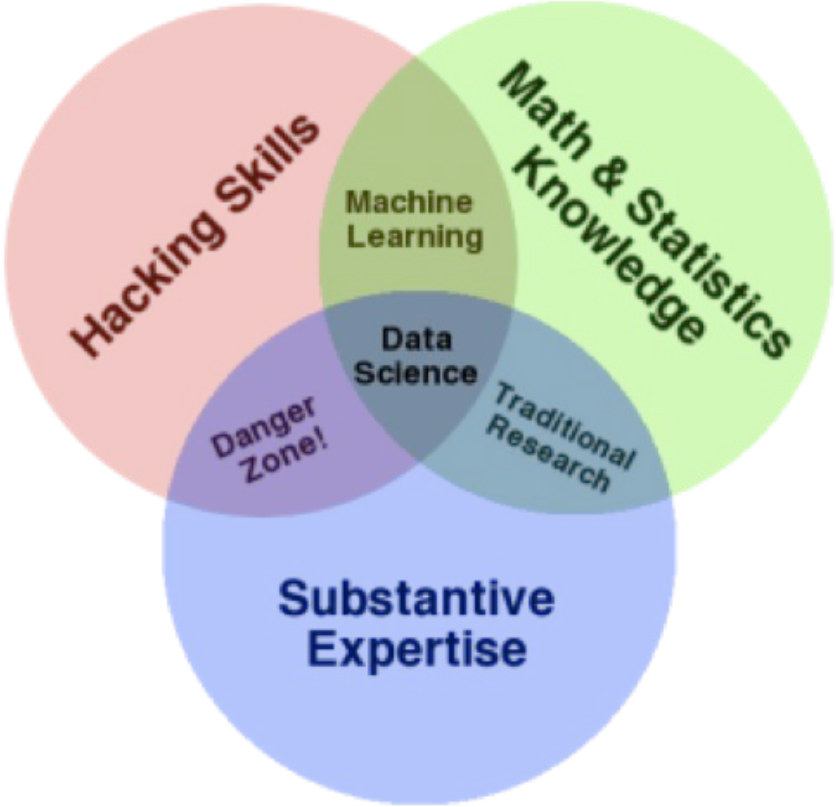
“Measuring programming progress by lines of code is like measuring aircraft building progress by weight.”



Program data:
runtime traces, program logs, system events, failure logs, performance logs, continuous deployment,…

User data:
usage logs, user surveys, user forums, A/B testing, Twitter, blogs, …

Development data:
source code versions, bug data, check-in information, test cases and results, communication between developers, social media


Hacking Skills
Math & Statistics Knowledge
Machine Learning
Data Science
Danger Zone!
Traditional Research
Substantive Expertise

Ownership
Churn
Tangled code changes

Poor replication
Poor actionability
“Secret life of bugs”

Data

Data may have low construct validity

Data assumes humans are “rational animals”

Data does not tell you why

Risks from data only studies

Perils from using GitHub data:

A repository is not necessarily a (development) project

Most projects are inactive or have few commits

Most projects are for personal use only

Only 10% of projects use pull requests

History can be rewritten on GitHub

A lot happens outside of GitHub

The Promises and Perils of Mining GitHub, Eirini Kalliamvakou et al., MSR 2014.

Data	Analysis
Data may have low construct validity	Correlations are not cause and effect
Data assumes humans are “rational animals”	Big data and small effects
Data does not tell you why	Researcher bias

Risks from data only studies

Martin Shepherd's meta analysis of 24 studies defect prediction:

Technique used had a small effect

but

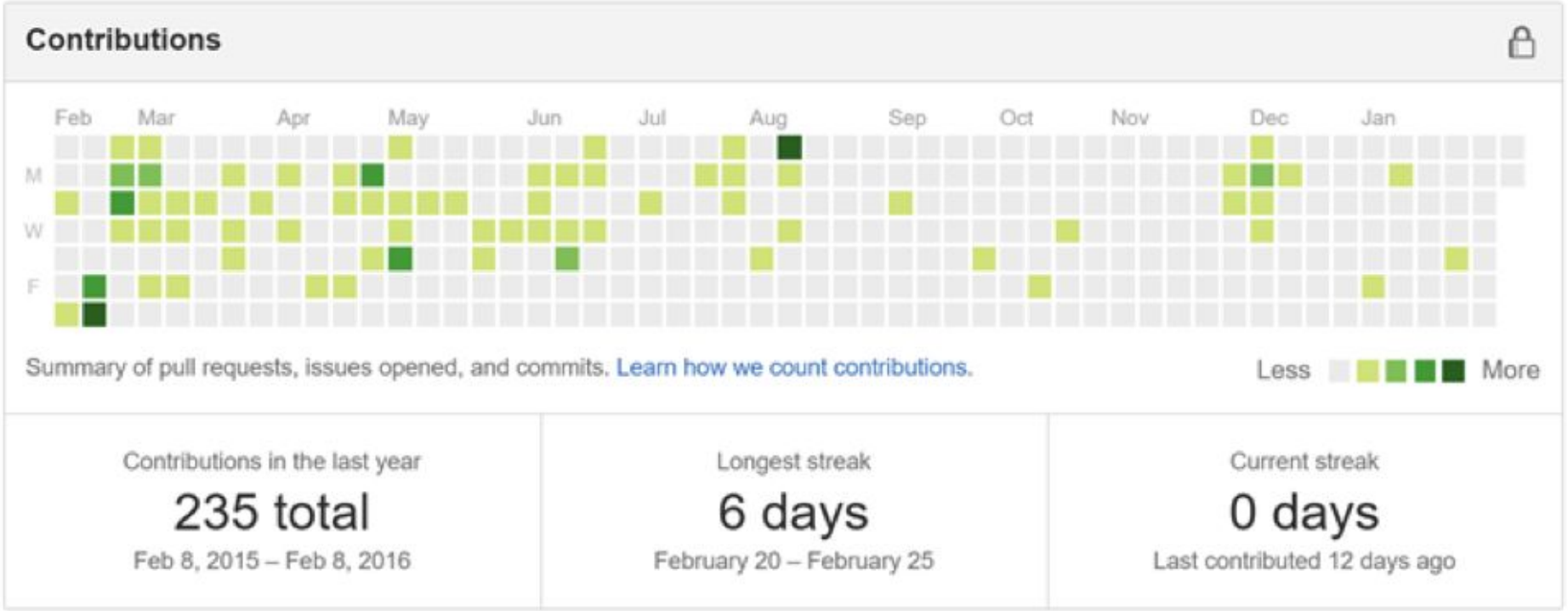
Research group that did the study had a bigger effect

Data	Analysis	Aftermath
Data may have low construct validity	Correlations are not cause and effect	Low actionability
Data assumes humans are “rational animals”	Big data and small effects	Ethics of using data
Data does not tell you why	Researcher bias	Unexpected consequences
		Biases in algorithms (feedback loops)

Risks from data only studies

“Defect prediction approaches are evaluated on the past history of a system’s bugs, where that history is treated as the future. A real prediction perturbs the space–time continuum. Without real world adoption, you simply can’t measure the predictor’s effect. A real prediction perturbs the space–time continuum.”

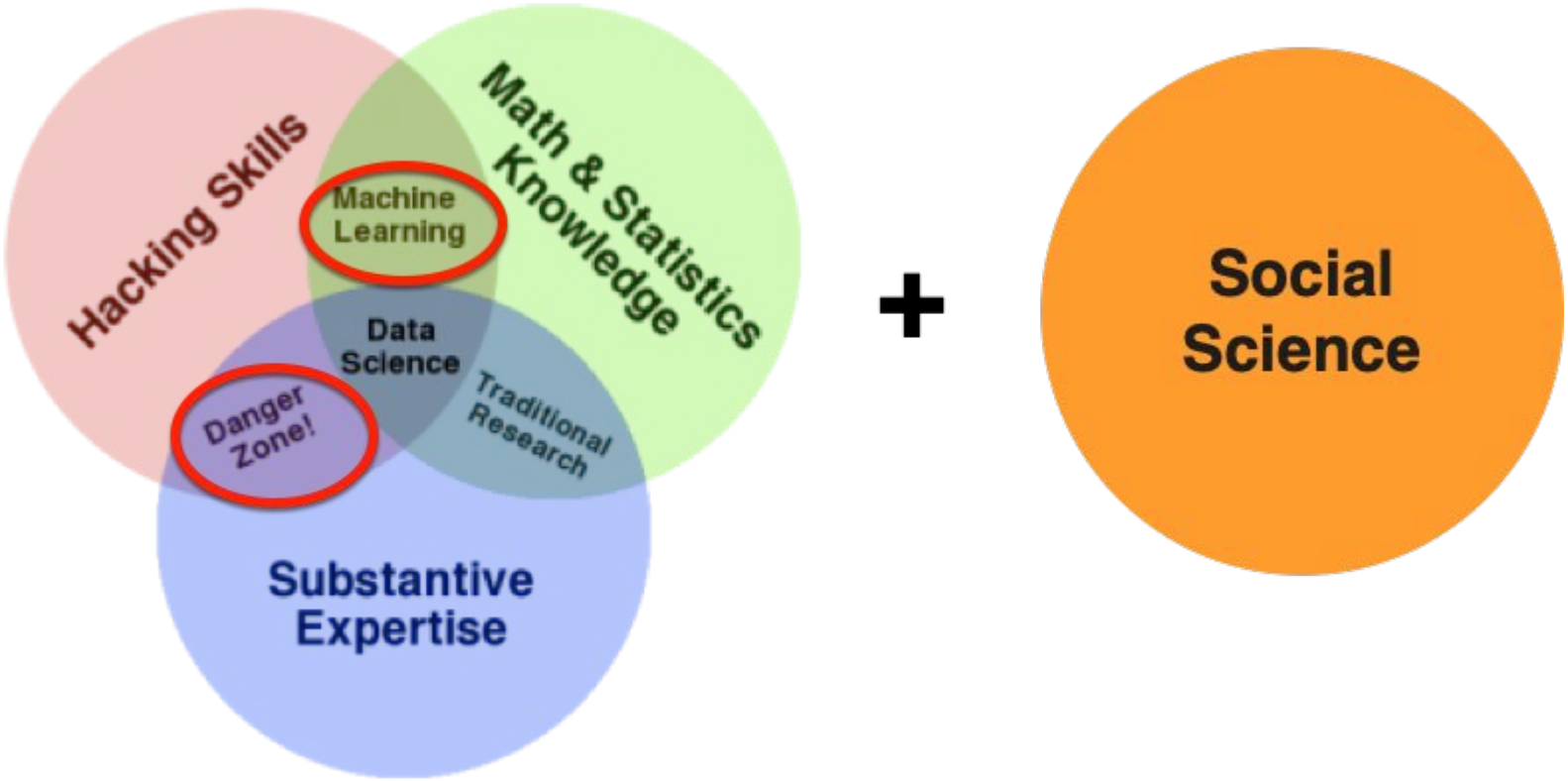
– Lanza et al., 2016



 | “Contributing graphs considered harmful”, Scott Hanselman

20 | Biases in algorithms and diversity

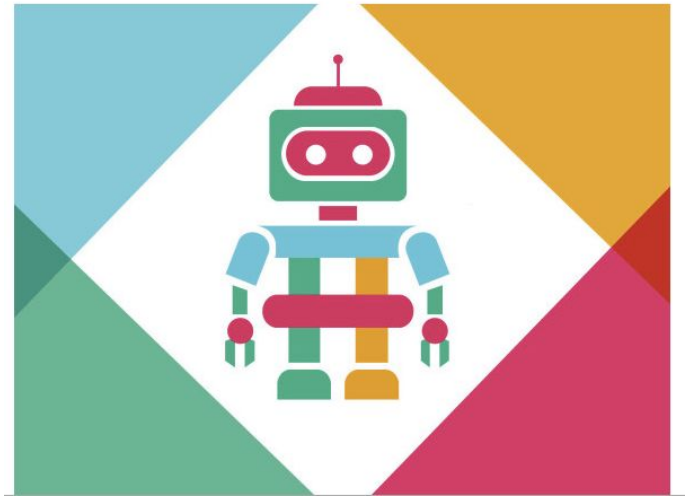
https://www.sciencemag.org/news/2017/04/even-artificial-intelligence-can-acquire-biases-against-race-and-gender



"Most big data is social data – the analytics need serious interrogation"

http://blogs.lse.ac.uk/impactofsocialsciences/2015/02/12/philosophy-of-data-science-emma-uprichard/

SLACK IS OVERRUN WITH BOTS. FRIENDLY, WONDERFUL BOTS



“You’ll be paid in the future based on how well you work with robots.”

– Kevin Kelly, Futurist

References

Lies, damned lies and software analytics, why big data needs thick data, Storey, 2016

Mad about Measurement, De Marco

The Emerging Role of Data Scientists on Software Development Team, Miryung Kim, Thomas Zimmermann, Robert DeLine, and Andrew Begel, ICSE 2016.

Analyze This! 145 Questions for Data Scientists in Software Engineering, Andrew Begel & Thomas Zimmermann, ICSE 2014

Software Analytics Tutorial, Dongmei Zhang & Tao Xie, ICSE 2012

Rules of Data Science in SE, Tim Menzies

Researcher bias: The use of machine learning in software defect prediction, Sheppherd et al., IEEE TSE 2014.

Eight (No, Nine!) Problems with Big Data", Gary Marcus and Ernest Davis, New York Times, April 6, 2014.

Dwelling in Software: Aspects of the felt-life of engineers in large software projects, Harper et al., ECSCW 2013. Springer.

The secret life of bugs: Going past the errors and omissions in software repositories. Jorge Aranda & Gina Venolia, ICSE 2009.

Algorithms in our Midst: Information, Power and Choice when Software is Everywhere, Zeynep Tufekci, CSCW 2015. , ACM..

Test coverage and post-verification defects: A multiple case study, Audris Mockus, Nachiappan Nagappan, Trung T. Dinh-Trong, ESEM 2009

Paradigms Activity: Name badge

Name

Research area

Research paradigm
(if you know)

Postpositivist

Constructivist

Pragmatist

Advocate


Peggy
"Constructivist"
CTP © 2016

Motivation

Paradigms (activity)

Methods (activity)

Contributions (activity)

Actors:

human systems, individuals, groups, organizations, communities

Behavior:

all aspects of the states and actions of those human systems

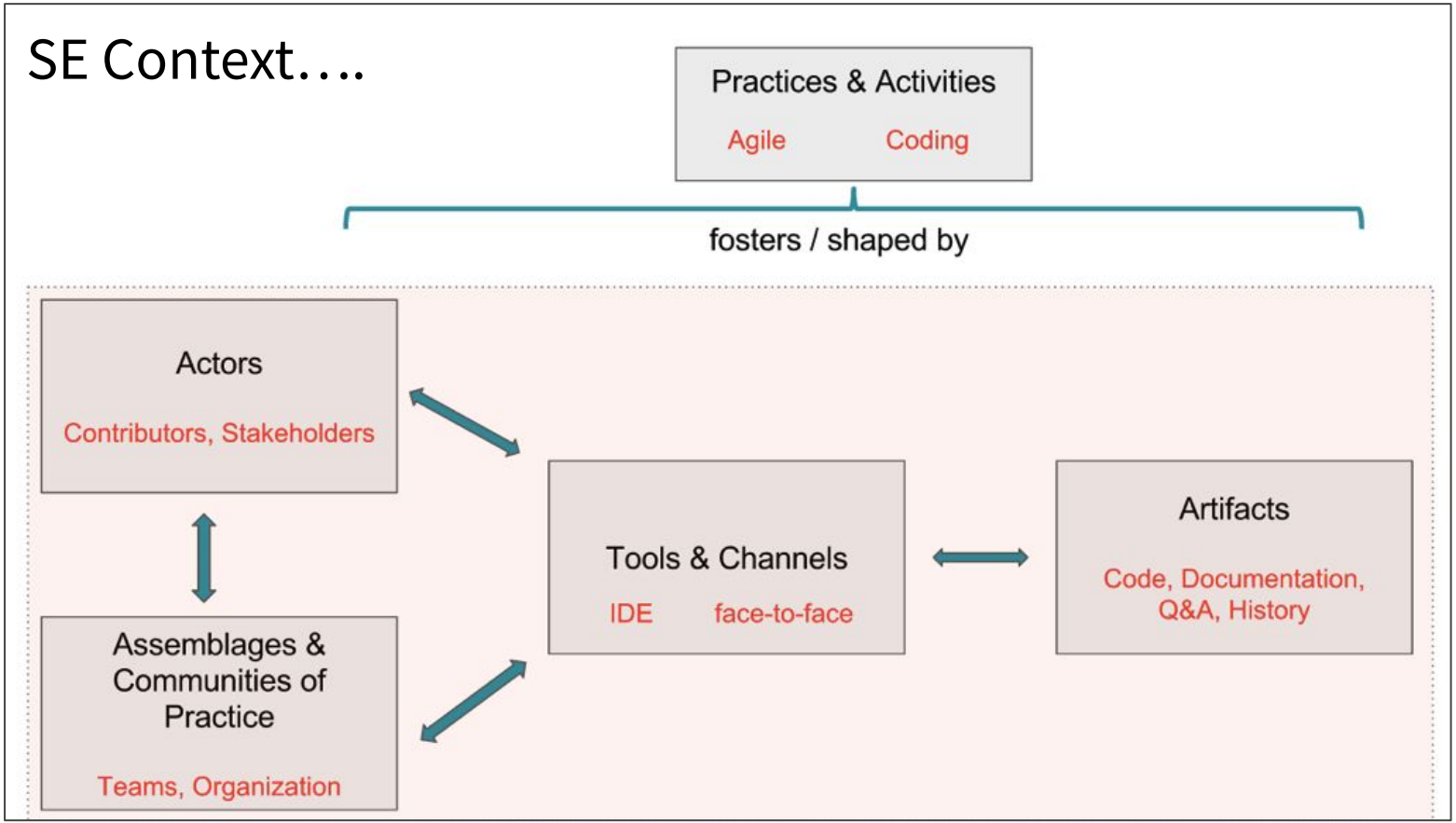
Context:

temporal, locational and situational features in which the human system is embedded

Who, what, where?

Joseph. E. McGrath.
Methodology matters: Doing research in the behavioral and social sciences. 1972

SE Context….

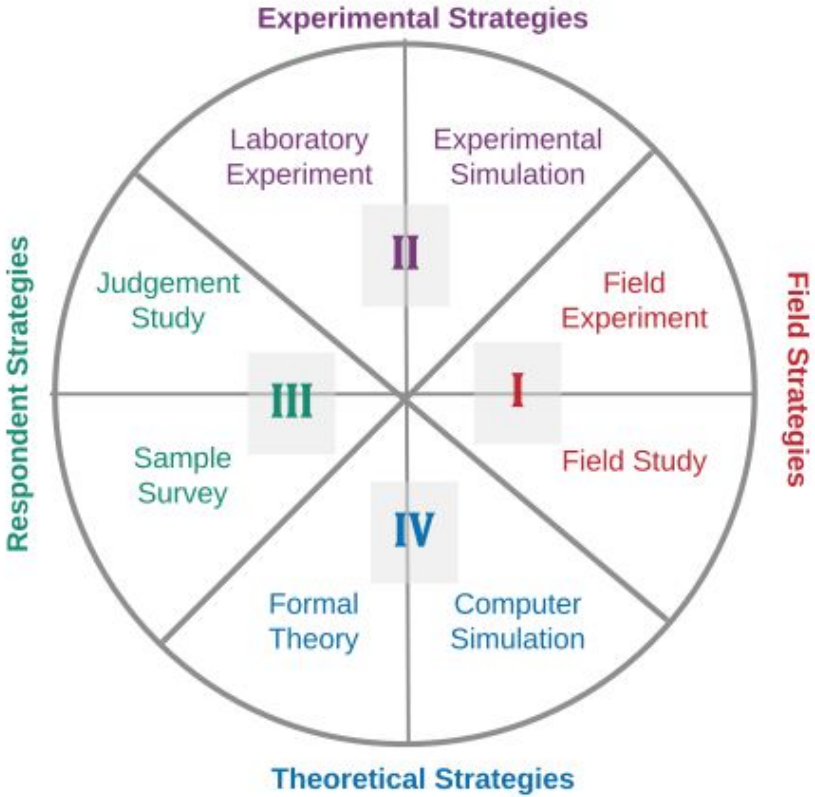

Practices & Activities
Agile
Coding
fosters / shaped by
Actors
Contributors, Stakeholders
Assemblages & Communities of Practice
Teams, Organization
Tools & Channels
IDE
face-to-face
Artifacts
Code, Documentation, Q&A, History

Some **content** that is of interest

Some **ideas** that give meaning to that content

Some **techniques** or procedures for studying the content and ideas

Joseph. E. McGrath.
Methodology matters: Doing research in the behavioral and social sciences. 1972



31 | McGrath's Circumflex

Joseph. E. McGrath.
Methodology matters: Doing research in the behavioral and social sciences. 1972

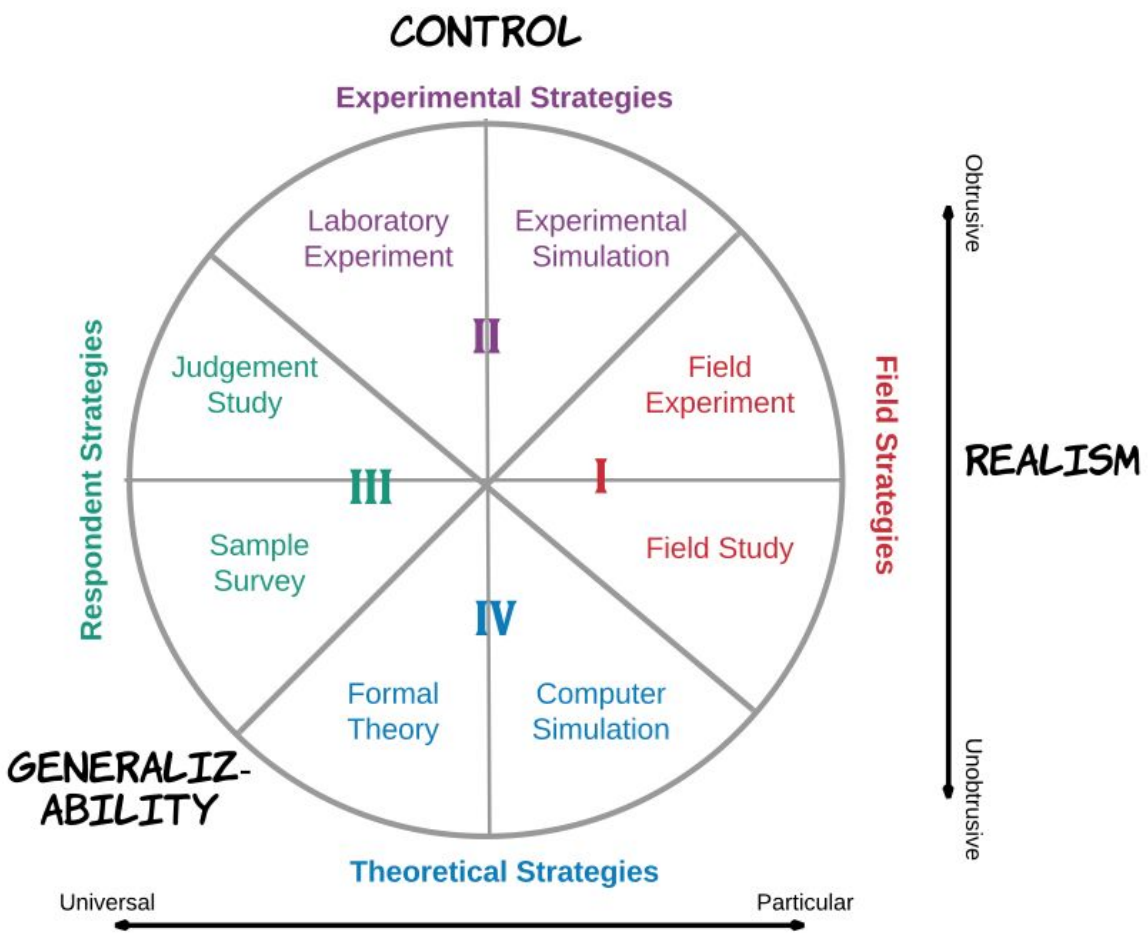
Generalizability
of the evidence over the populations of actors

Precision (control)
of measurement of the human behaviours being studied

Realism
of the situation or context where the evidence is gathered

Desirable features of research evidence

Joseph. E. McGrath.
Methodology matters: Doing research in the behavioral and social sciences. 1972



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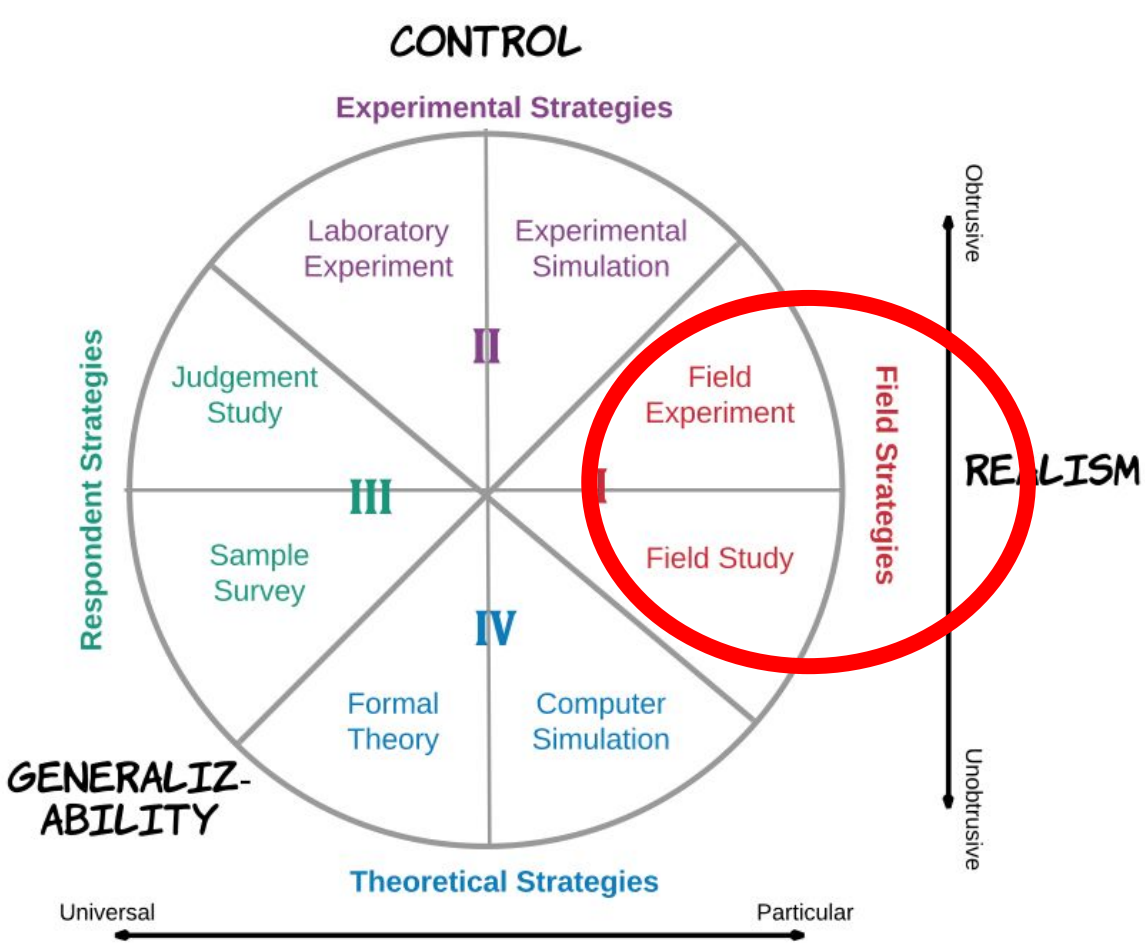


Joseph. E. McGrath.
Methodology matters: Doing research in the behavioral and social sciences. 1972

Field studies:

Ethnography

Case studies of organizations

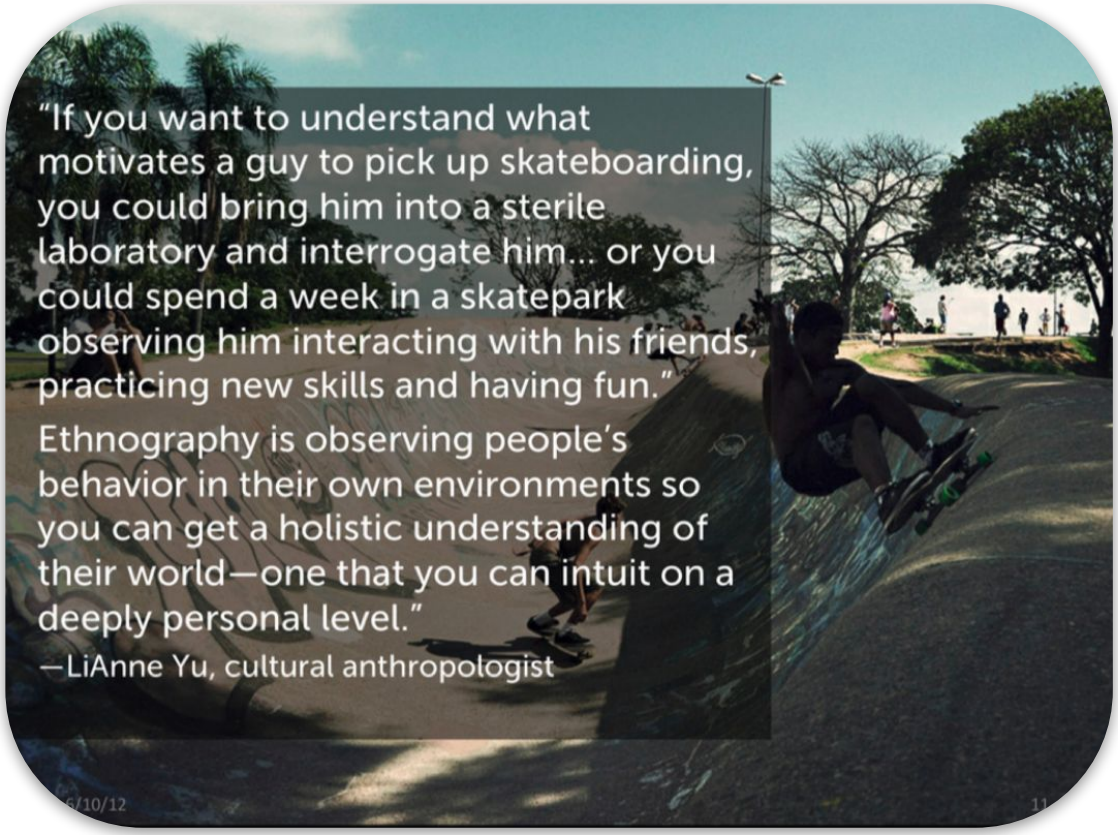
Field experiments:

Naturalness is given up for increased measurement precision

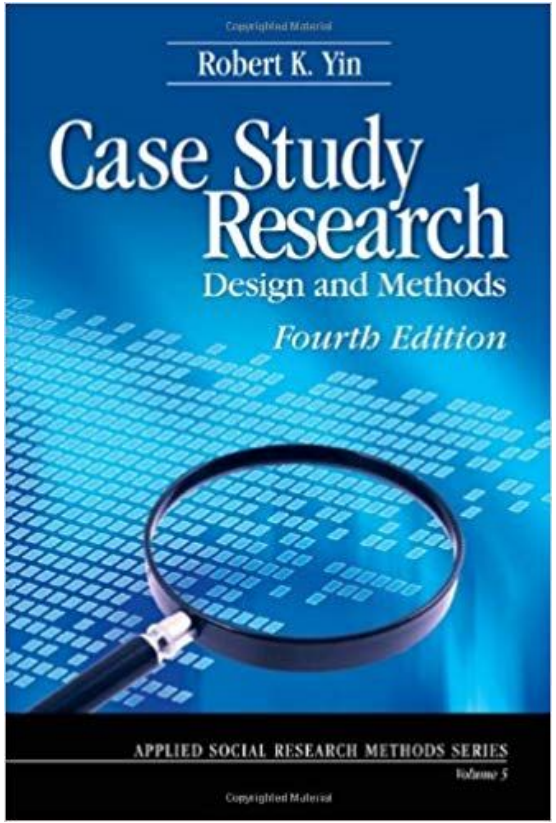
Some variable may be manipulated (e.g. tool used or process)

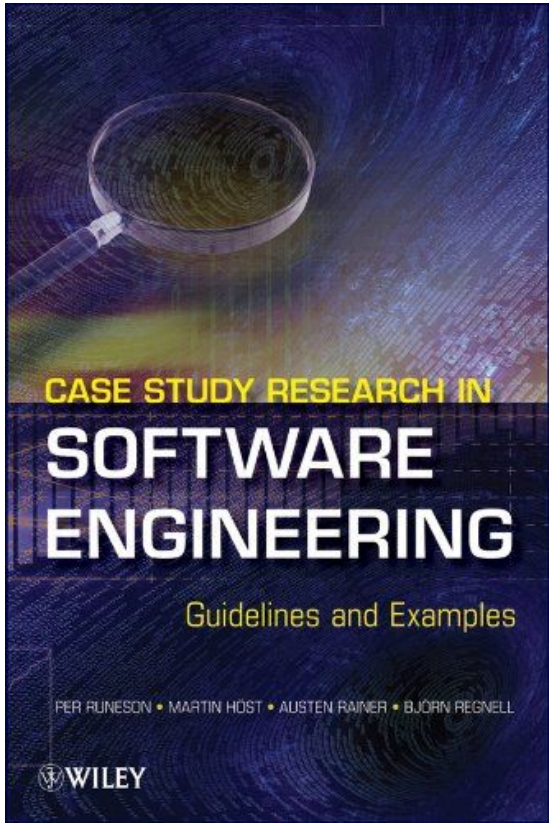
Highly obtrusive

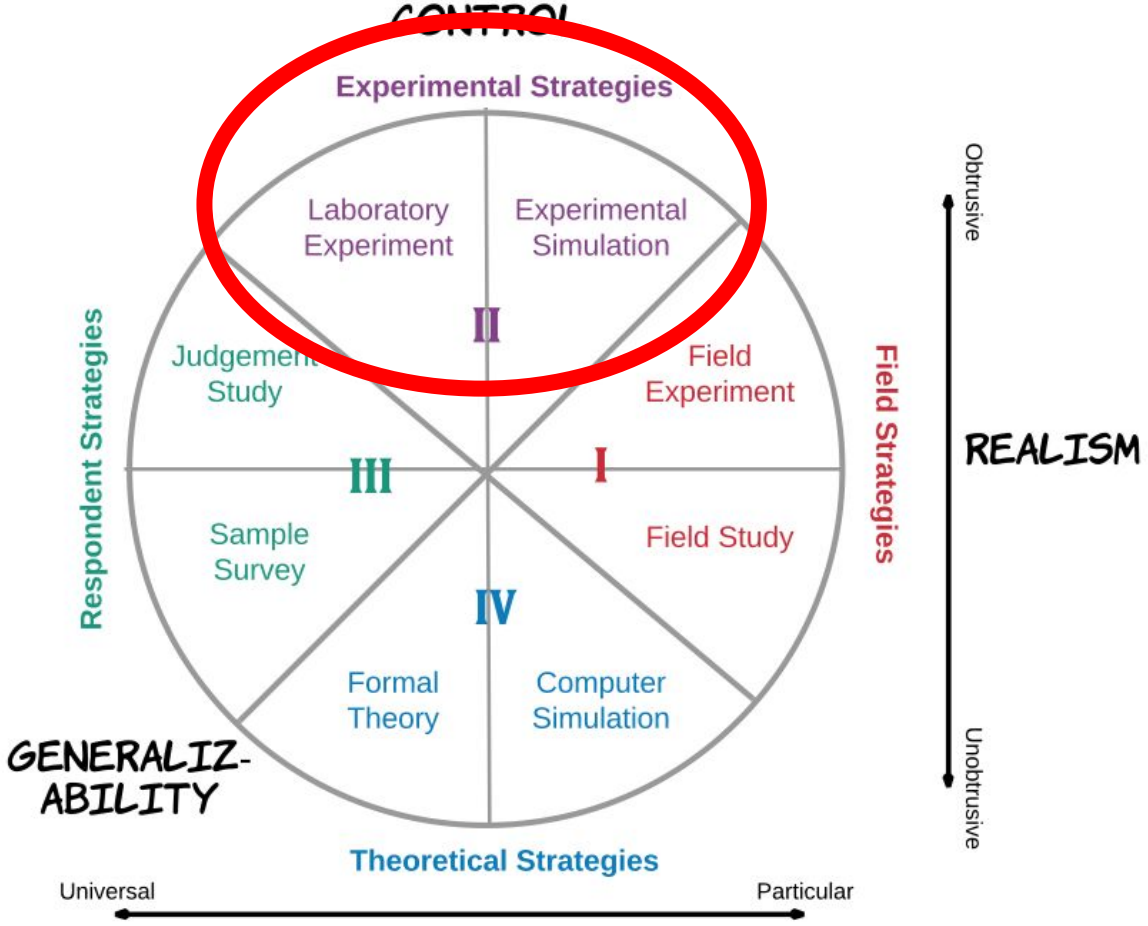
Quadrant I: Natural field setting



Ethnography


Robert K. Yin
Case Study Research
Design and Methods
Fourth Edition
APPLIED SOCIAL RESEARCH METHODS SERIES


CASE STUDY RESEARCH IN
SOFTWARE ENGINEERING
Guidelines and Examples
PER RUNESON • MARTIN HÖST • AUSTEN RAINER • BJÖRN REGNELL
WILEY



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Laboratory experiment:

Investigator created setting, defined rules for its operation, induces human actors to participate

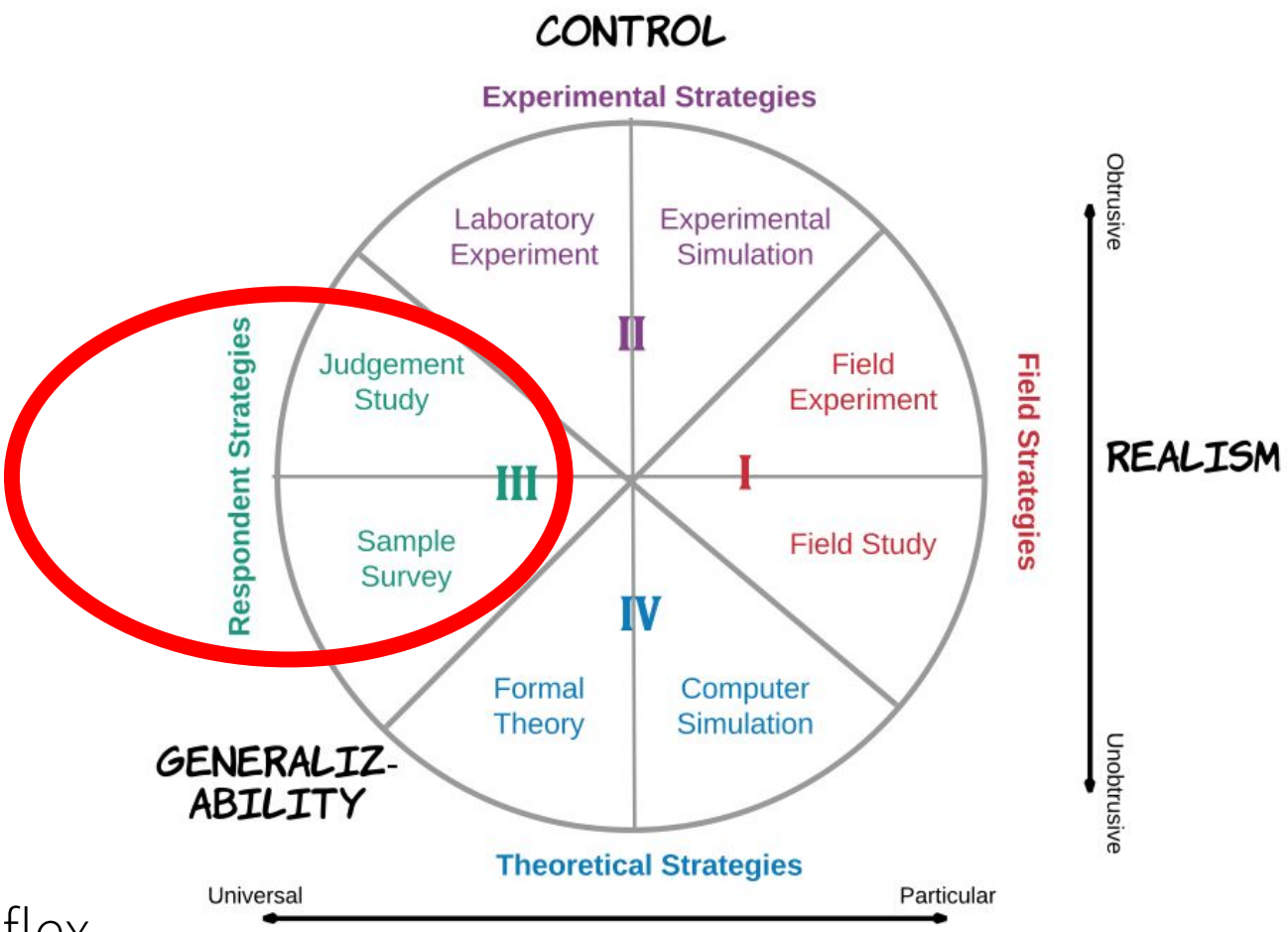
Increased precision of measurement over human behaviour

Increased obtrusiveness, unrealistic setting and reduced generalizability

Experimental simulation:

Experimenter has control over the setting and conditions – but feels more like the real setting
e.g. flight simulators

Quadrant II: Experimental strategies in an artificial setting



Joseph. E. McGrath.
Methodology matters: Doing research in the behavioral and social sciences. 1972

Sample survey:

Collects evidence across a distribution of some variables or relationships among them, within a specific human actor population

Careful sampling must be done to maximize generalizability

Little opportunity for much precision of measurements

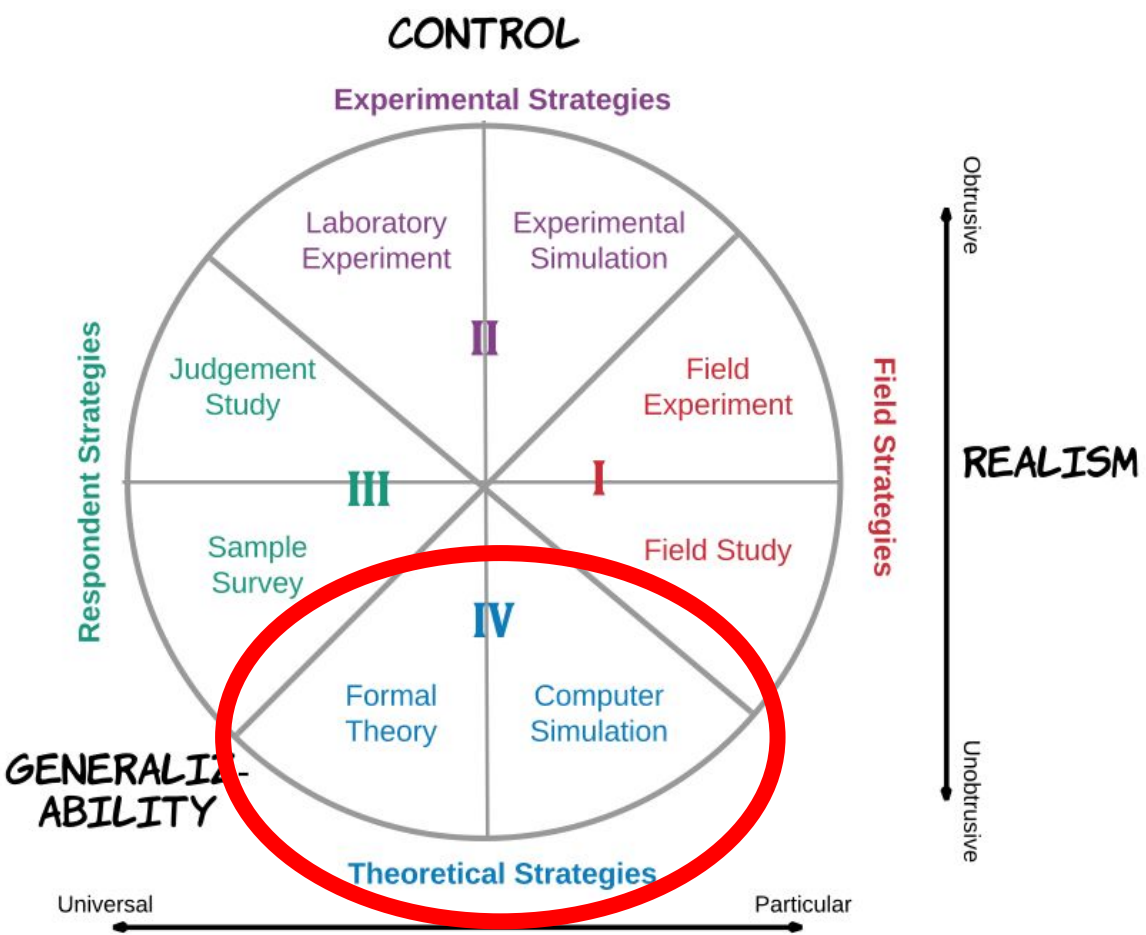
Judgment study:

Obtaining information about a set of stimulus materials

Usually done with actors of convenience

More precise measurements, but low generalizability

Quadrant III: Respondent strategies, setting not relevant



Joseph. E. McGrath.
Methodology matters: Doing research in the behavioral and social sciences. 1972

Formal theory:

Theories based on previous empirical evidence or theories

No gathering of empirical observations – relations among variables of interest are formulated

Relations (hypotheses, propositions) should hold over a broad range of populations

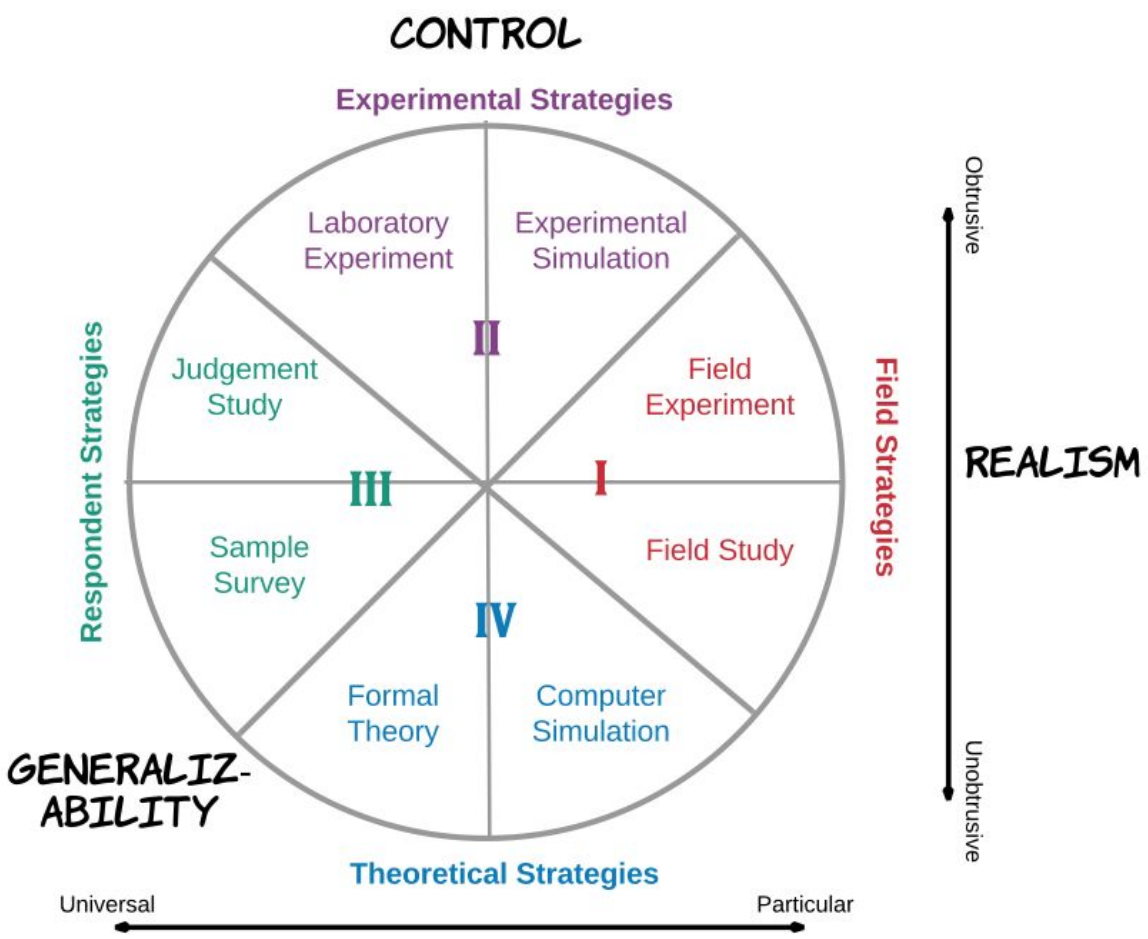
Computer simulation:

Contrived setting

A closed system that models the operation of the concrete system but without participants

Behaviour must also be modeled, so all behavioural parameters must be known in advance – based on previous empirical evidence

Quadrant IV: Theoretical strategies



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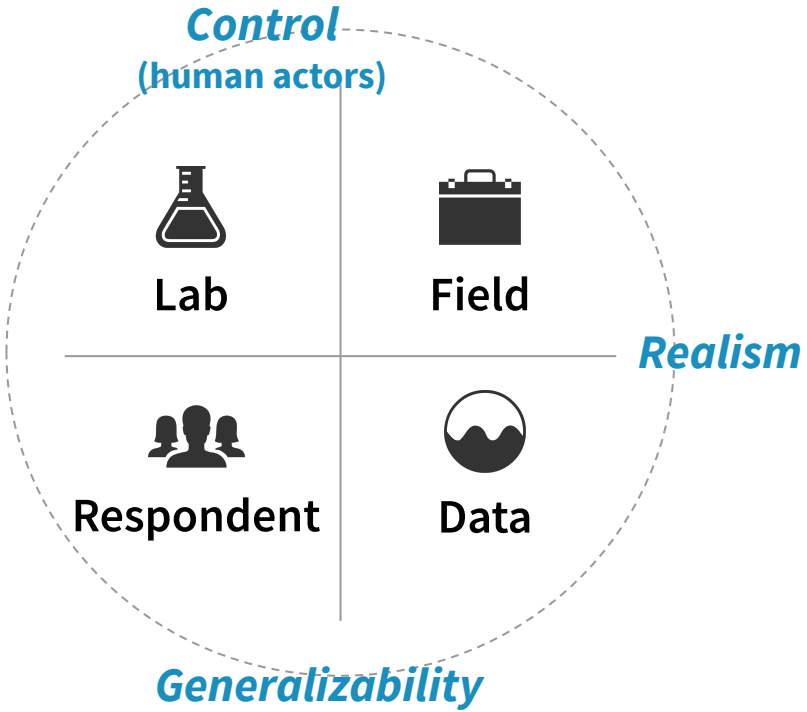
Non-Empirical

Formal Theory

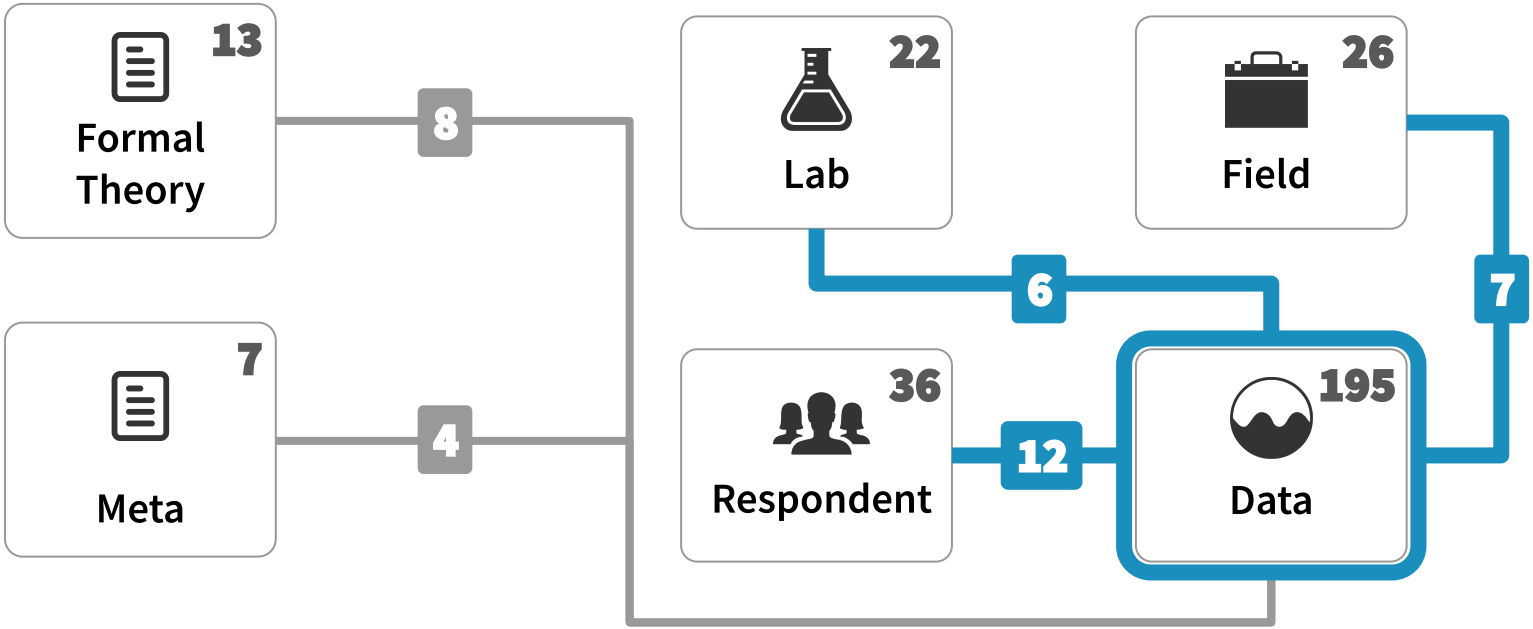
Meta

Empirical



Socio-Technical Research Framework

Extending: Runkel & McGrath:
Research on Human Behavior: A Systematic Guide to Method, 1972



 | 37 Data Papers Used **Triangulation**

Triangulation: “The basic idea underpinning the concept of triangulation is that the phenomena under study can be understood best when approached with a variety or a combination of research methods. Triangulation is most commonly used in data collection and analysis techniques, but it also applies to sources of data. It can also be a rationale for multiple investigators in team research.”

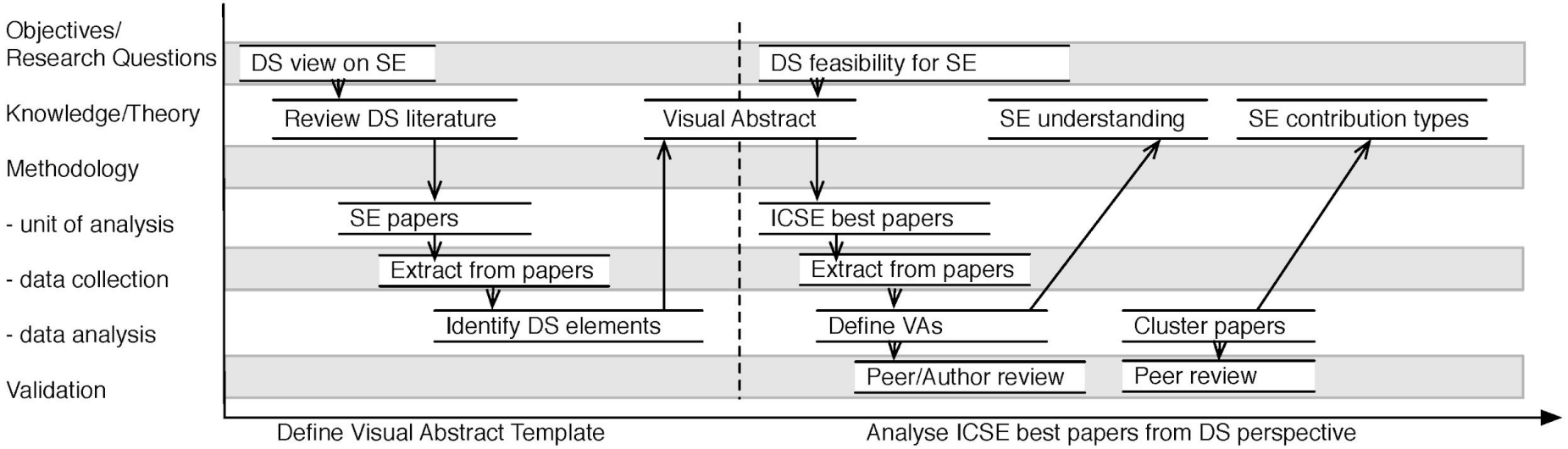
http://methods.sagepub.com/reference/sage-encyc-qualitative-research-methods/n468.xml

But 17/60 authors that responded to our survey did not understand the concept “triangulation”

Sequential explanatory strategy: e.g., quantitative analysis of trace data followed by qualitative analysis of interview data (latter helps explain the former)

Sequential exploratory strategy: e.g., analysis of qualitative data from surveys followed by analysis of quantitative trace data (for testing emerging theory, explain early exploratory findings)

Concurrent triangulation strategy: different methods used concurrently, improve validity



Research process map (Zagalsky, Runeson, Murphy, Storey)

Easterbrook, Singer, Storey & Damian, "Selecting empirical methods for software engineering research," 2008

Research Design, by John W. Cresswell

Educational Research, by John W. Cresswell

Joseph. E. McGrath. Methodology matters: Doing research in the behavioral and social sciences. In Readings in Human-Computer Interaction: Toward the Year 2000, Ronald M. Baecker (Ed.). Morgan Kaufmann, 152–169.

Philip J. Runkel and Joseph E. McGrath: "Research on Human Behavior: A Systematic Guide to Method" (1972)

Stol, Ralph & Fitzgerald, "Grounded theory in software engineering research: A critical review and guidelines," 2016

Runeson & Höst, "Guidelines for conducting and reporting case study research in software engineering," 2008

Zelkowitz & Wallace, 1998 "Experimental Models for Validating Technology"

Shaw, 2002 "Writing good software engineering research papers"

Vessey, Ramesh and Glass 2005, "A unified classification system for research in the computing disciplines"

Smite, Wohlin, Gorschek, and Feldt, 2010 "Empirical evidence in global software engineering: a systematic review"

Wohlin and Aurum, 2015 "Towards a decision-making structure for selectinga research design in empirical software engineering"

Siegmund , Siegmund and Apel, 2015 "Views on internal and externalvalidity in empirical software engineering"

Stol and Fitzgerald, 2018 "The ABC of Software Engineering Research"

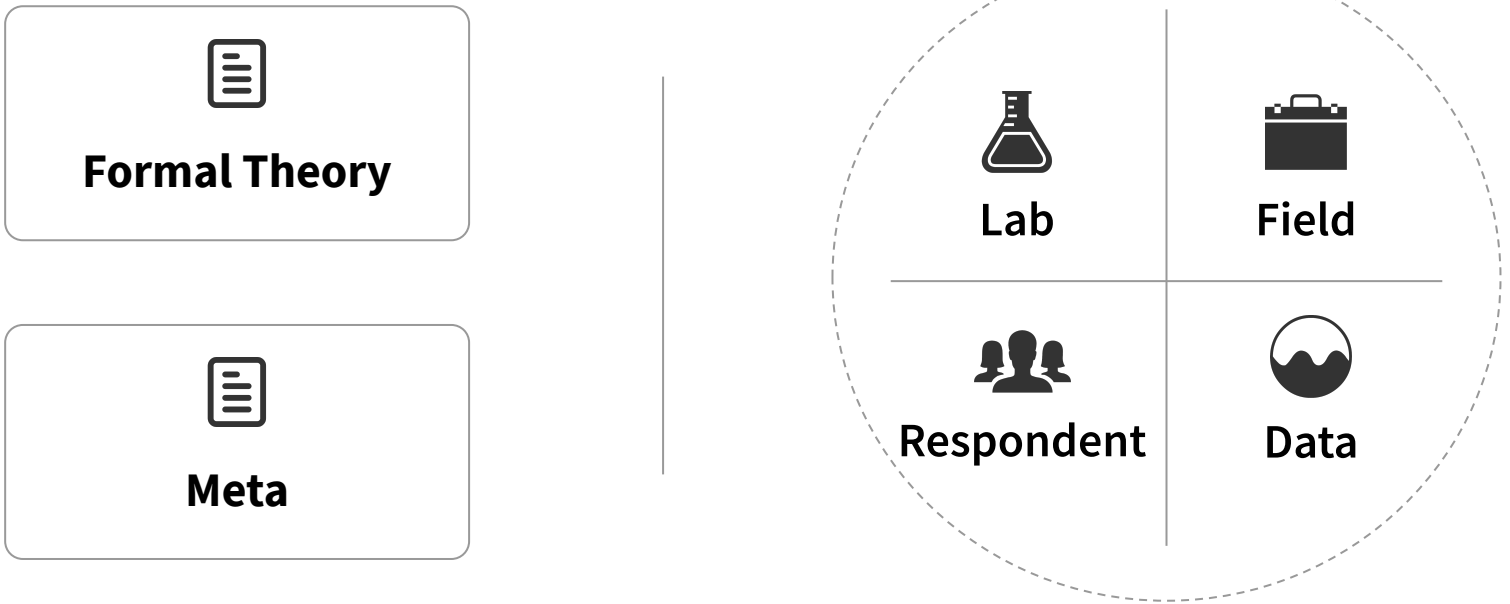
Additional reading

Methods Activity: Categorizing Papers Using the Socio-Technical Research Strategy Framework

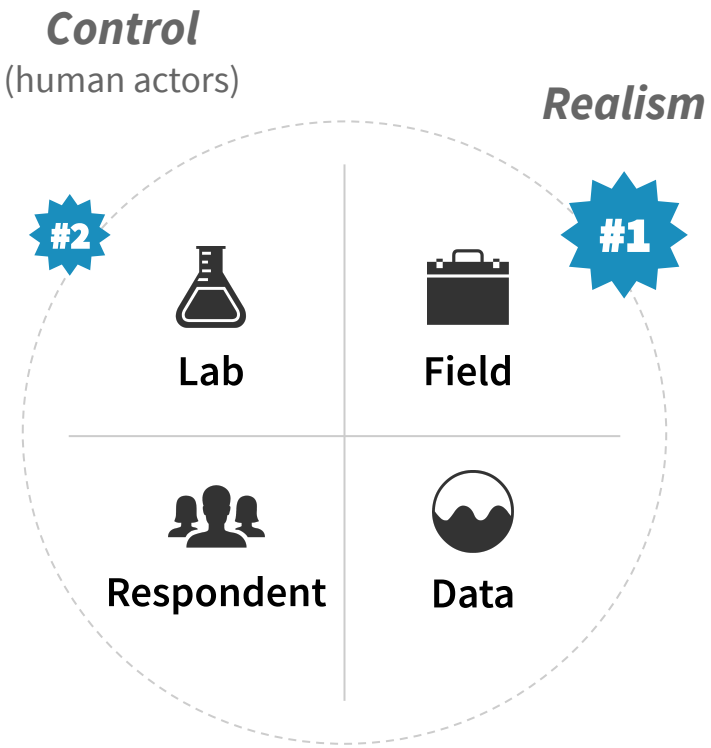
For the SBES 2019 Best Papers, which strategies do they use?

Non-Empirical

Empirical



CloudBuild



The Methods We Chose

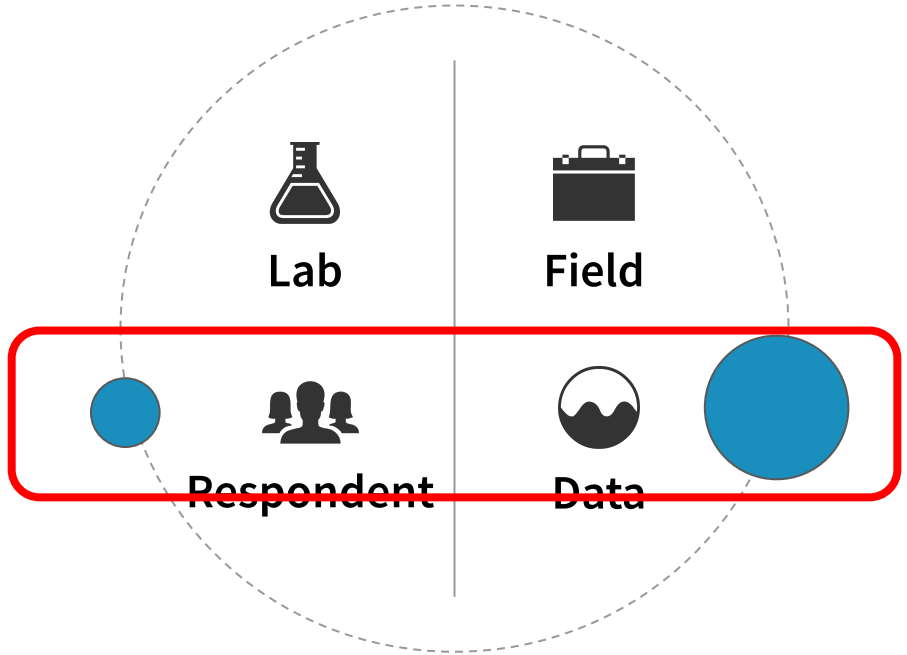
Lebeuf, Voyloshnikova, Herzig & Storey:
"Debugging, and Optimizing Distributed Software Builds: A Design Study", ICMSE 2018

Non-Empirical

Empirical

Formal Theory

Meta



Which primary and secondary strategies do the authors report (use size to indicate if one study is more of a focus)?

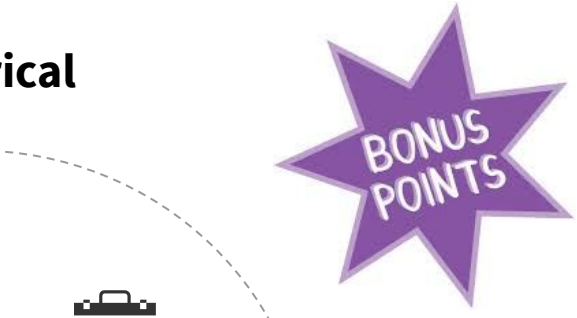
Sequential explanatory strategy: e.g., quantitative analysis of trace data followed by qualitative analysis of interview data (latter helps explain the former)

Sequential exploratory strategy: e.g., analysis of qualitative data from surveys followed by analysis of quantitative trace data (for testing emerging theory, explain early exploratory findings)

Concurrent triangulation strategy: different methods used concurrently, improve validity

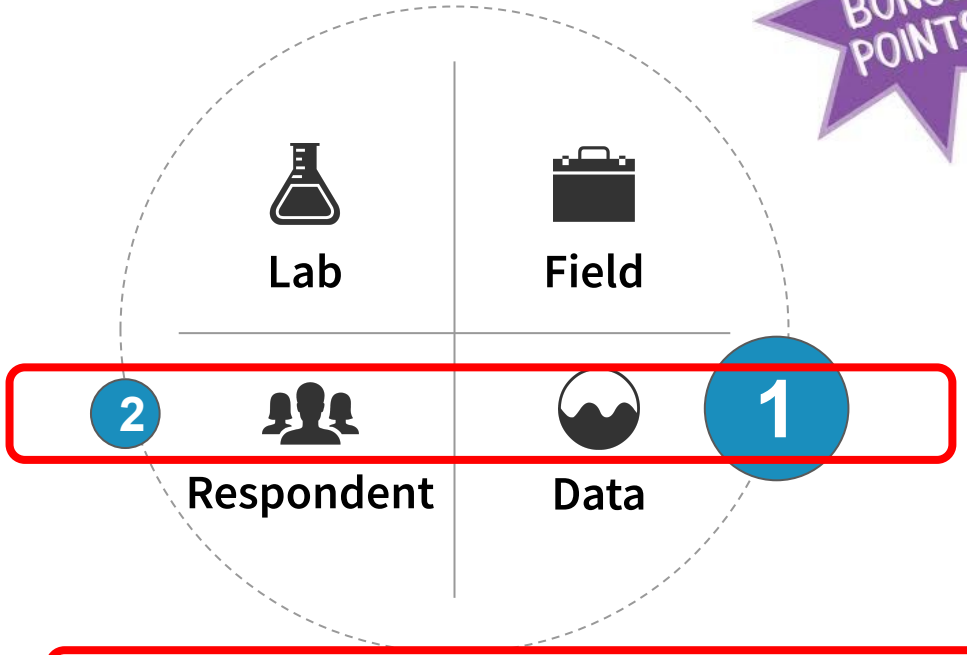
Non-Empirical

Empirical



Formal Theory

Meta



Sequential explanatory strategy!

 | If mixed methods, which design strategy do they use?

Of the
Data Only Papers...

How many authors mention

Developers

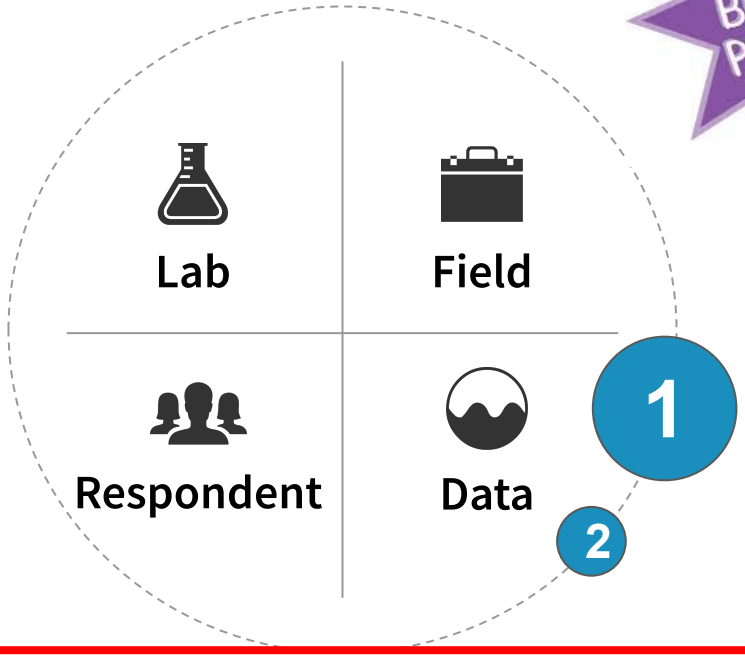
(But don't study human research subjects)

Non-Empirical

Empirical

Formal Theory

Meta



Yes, aim to improve dev productivity

 | If data strategies only, do they mention human stakeholders?

Which **research quality criteria** did the authors achieve in their choice of strategies (i.e., generalizability, control, realism)?

Could they have used **different strategies** in their research design to answer their research questions?

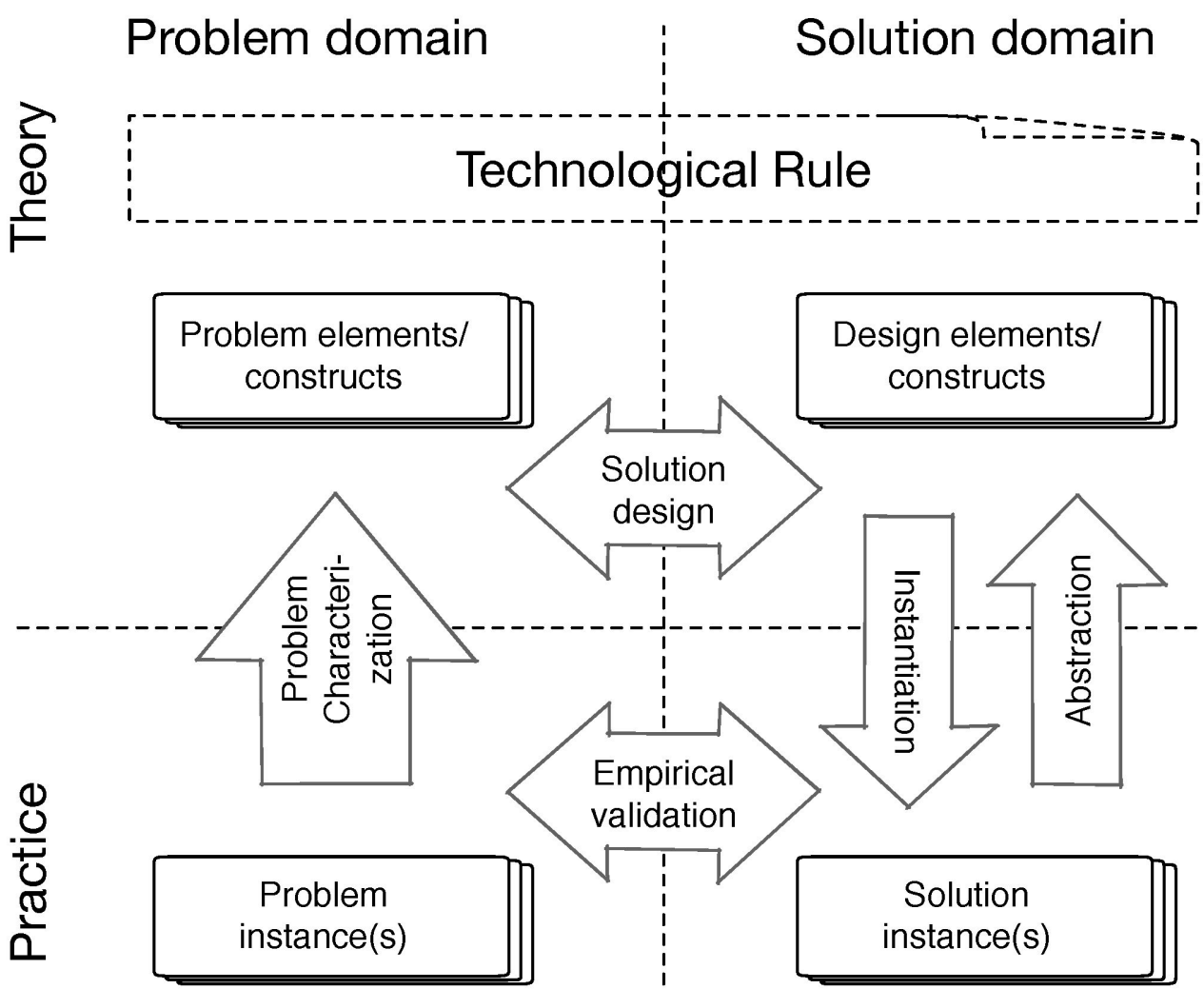
What else could we have asked about the choice of methods?

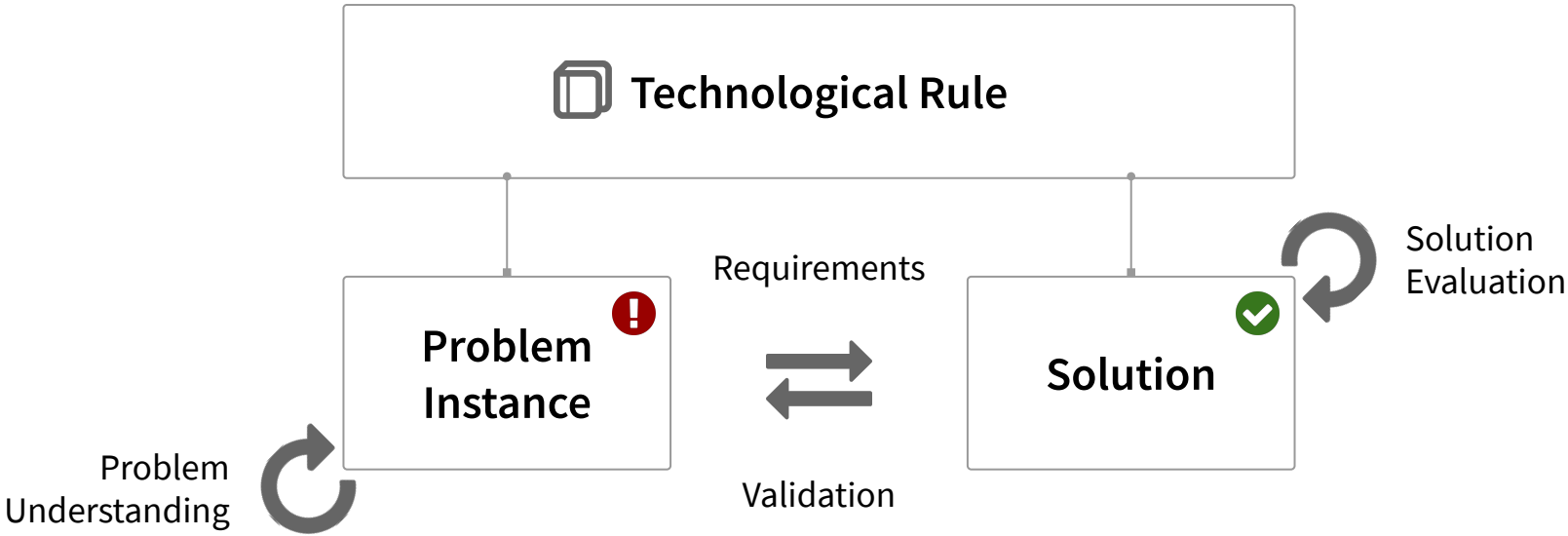
Motivation

Paradigms (activity)

Methods (activity)

Contributions (activity)


Problem domain
Solution domain
Theory
Technological Rule
Problem elements/ constructs
Design elements/ constructs
Solution design
Problem Characteri- zation
Instantiation
Abstraction
Empirical validation
Practice
Problem instance(s)
Solution instance(s)



63 | Design Science — Our View (Simplified)

van Aken, 2004

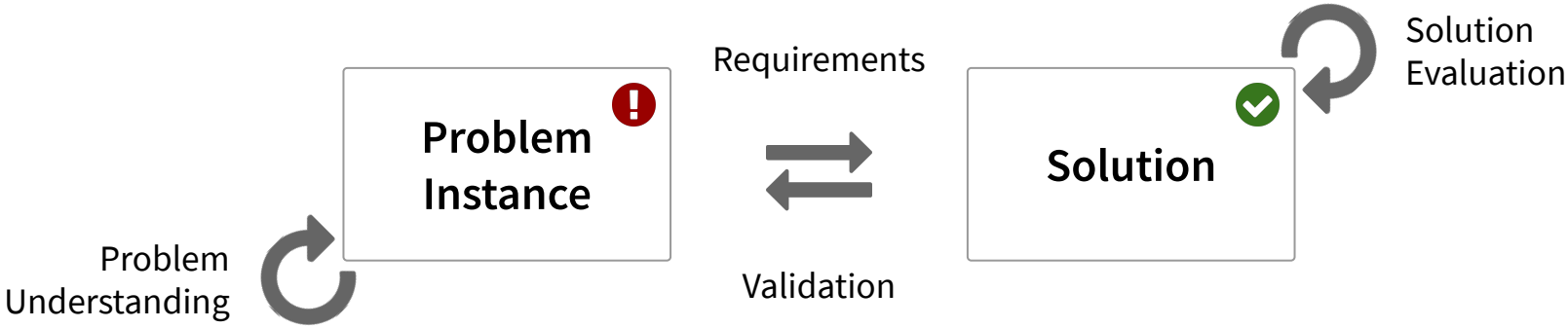
Technological Rule
(Theory Fragment)

To reduce errors in open source projects
use continuous integration.

To achieve an effect in a given context **use / do intervention.**

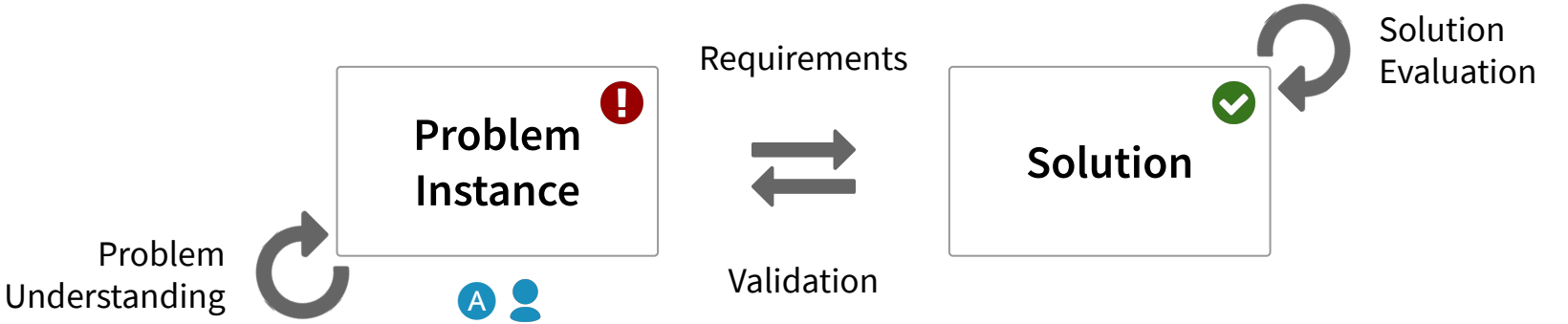
x y z

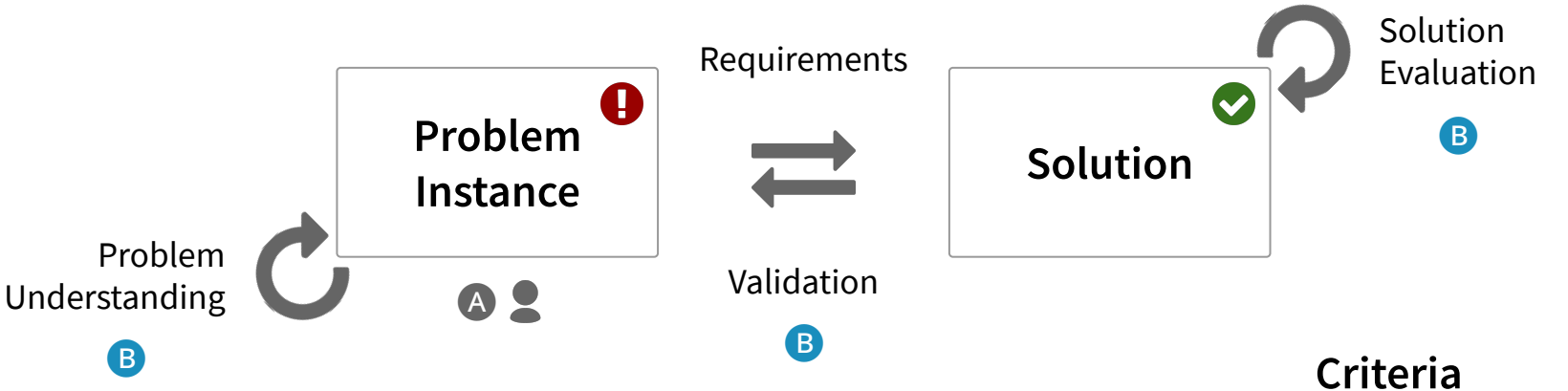
van Aken, 2004



Evaluation Criteria

Storey et al., 2017


Problem Instance
Requirements
Validation
Solution
Solution Evaluation
Problem Understanding
A
Criteria
A Relevance


Problem Instance
Requirements
Validation
Solution
Solution Evaluation
Problem Understanding
A
B
B
B
B
Criteria
A Relevance
B Rigor

Construct validity

Internal validity

External validity

Reliability: would the study yield the same results if done by different researchers?

Threats to Validity: Positivist stance

Triangulation

Member checking

Rich, thick descriptions

Clarify bias (report researcher bias)

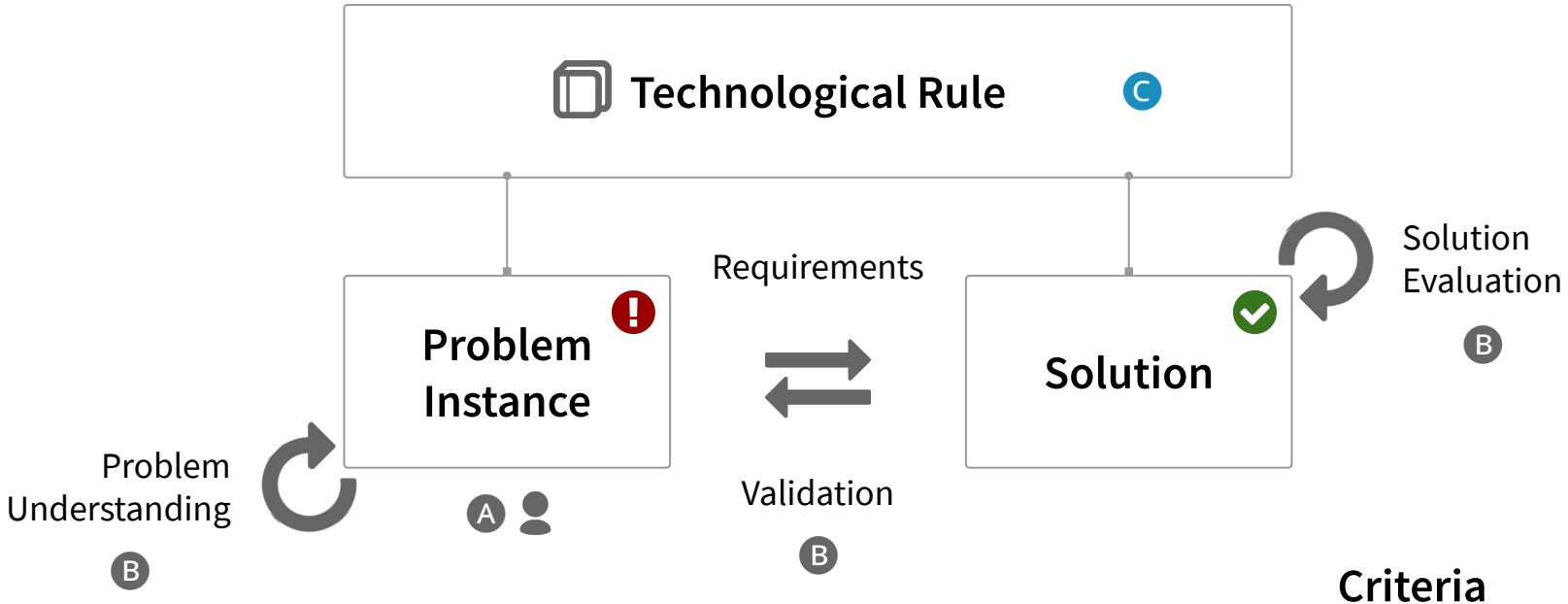
Report discrepant information

Prolonged contact with participants

Peer debriefing (plan ahead for this!)

External auditor (also need to plan)

Validity of constructivist research



Criteria

- A Relevance
- B Rigor
- C Novelty

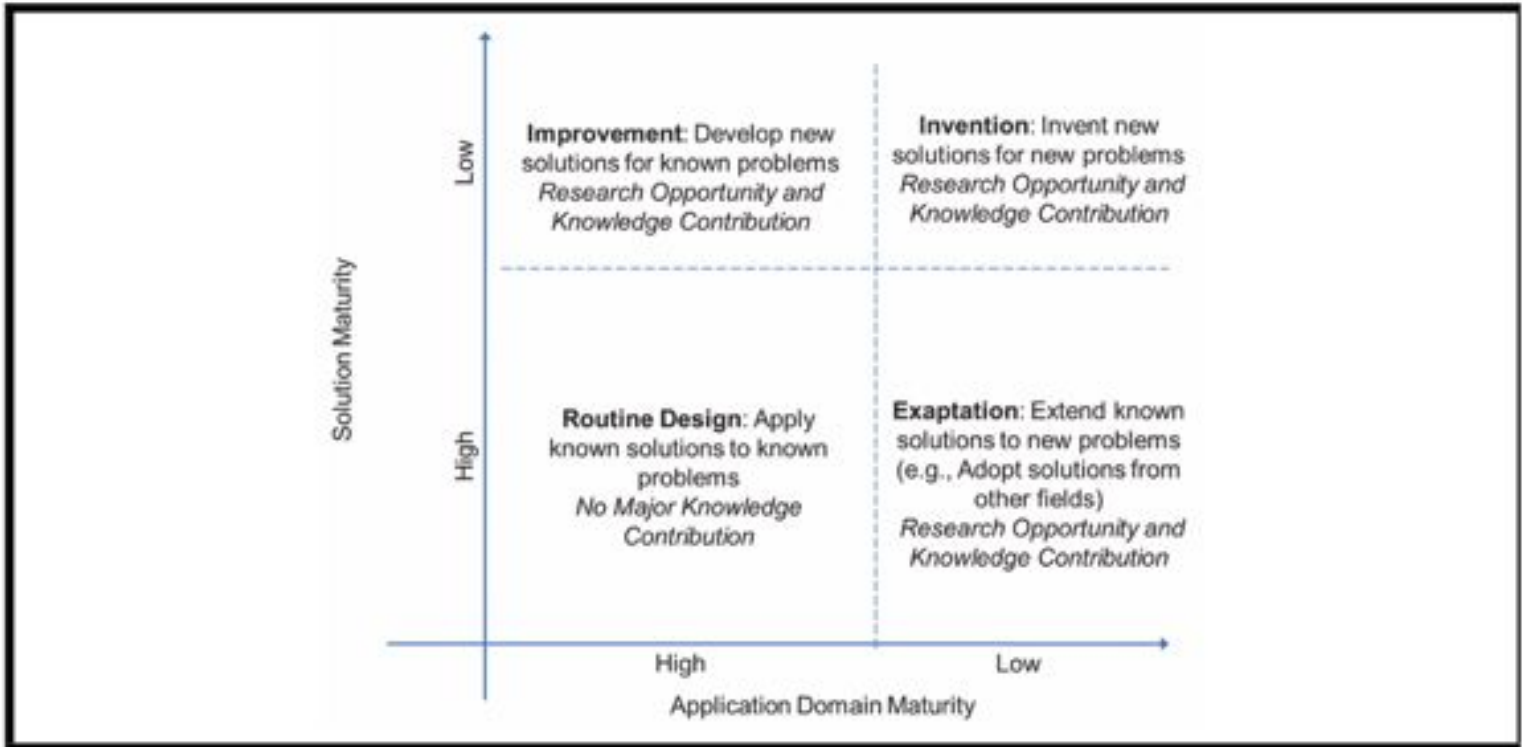


Figure 3. DSR Knowledge Contribution Framework

Categorizing design science knowledge contribution

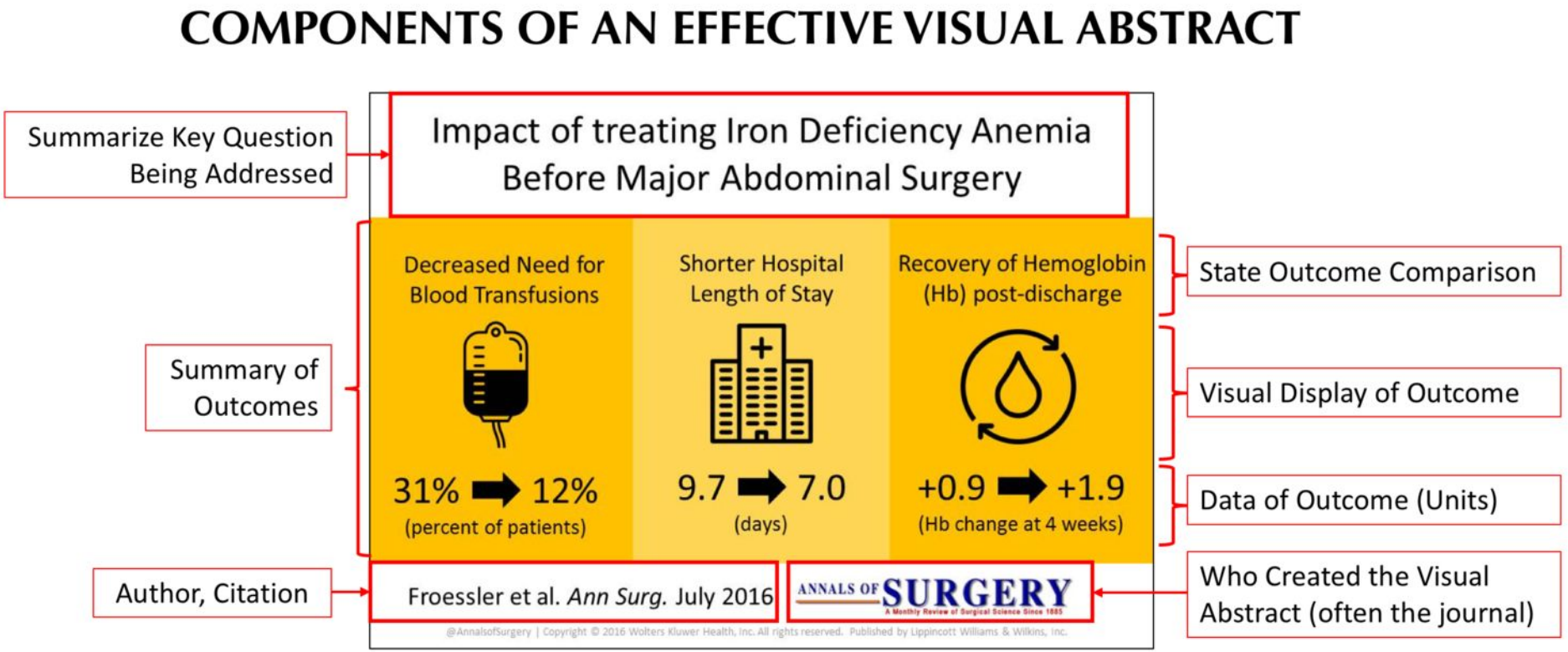
Refinement of an existing rule? (context, intervention)

Confirmation of an existing rule?

Refuting an existing rule?

New rule?

Novelty of the technological rule?

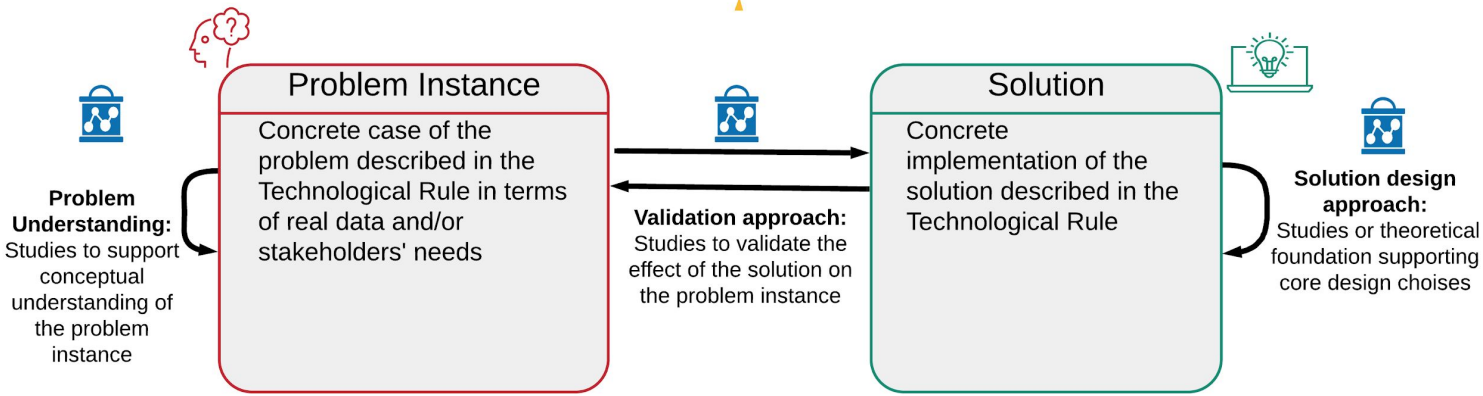


Visual Abstract Concept from Medicine

https://www.surgeryredesign.com/resources/

Generic Visual Abstract

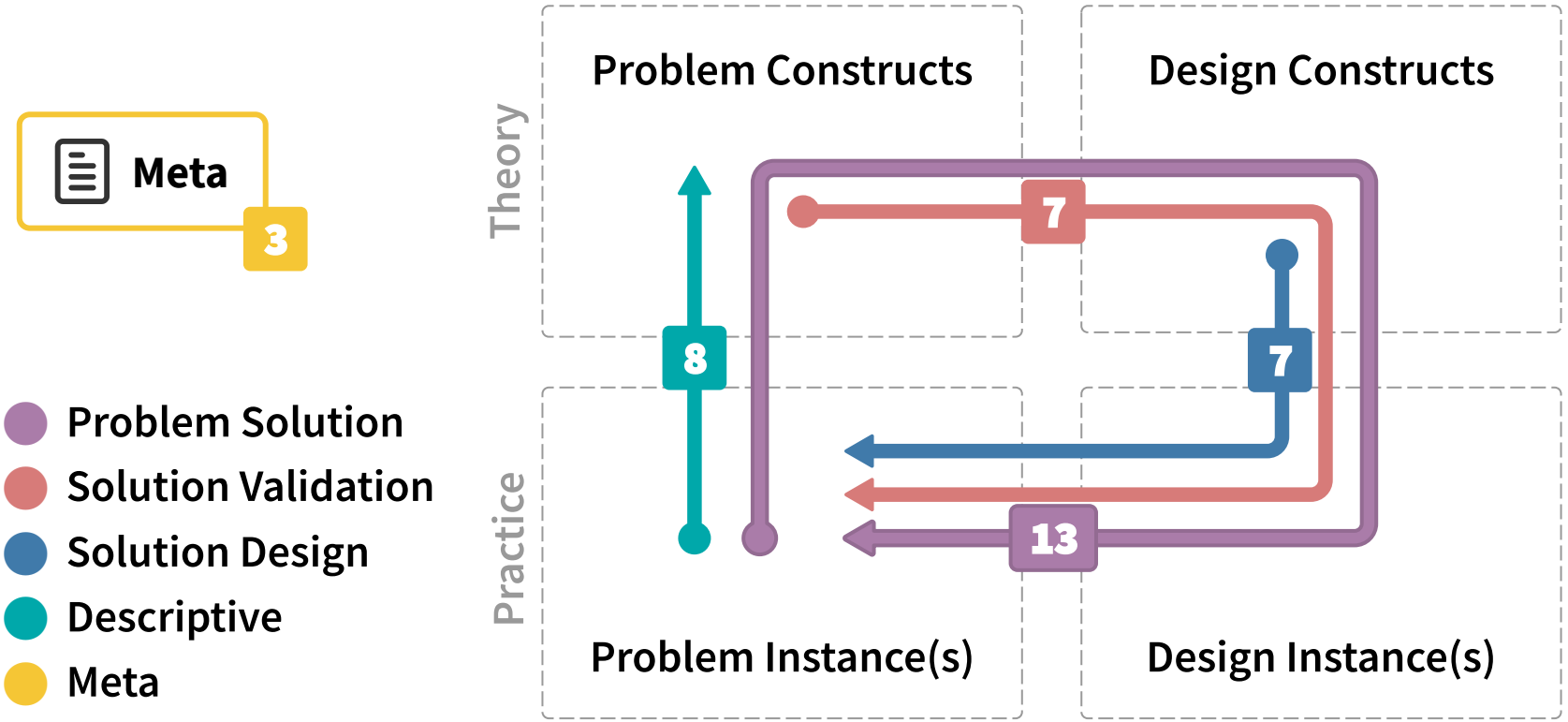
Technological rule: To achieve effect/change in situation/context apply solution/intervention



Relevance: Characteristics of the context that are likely to impact applicability and potential value of the proposed solution

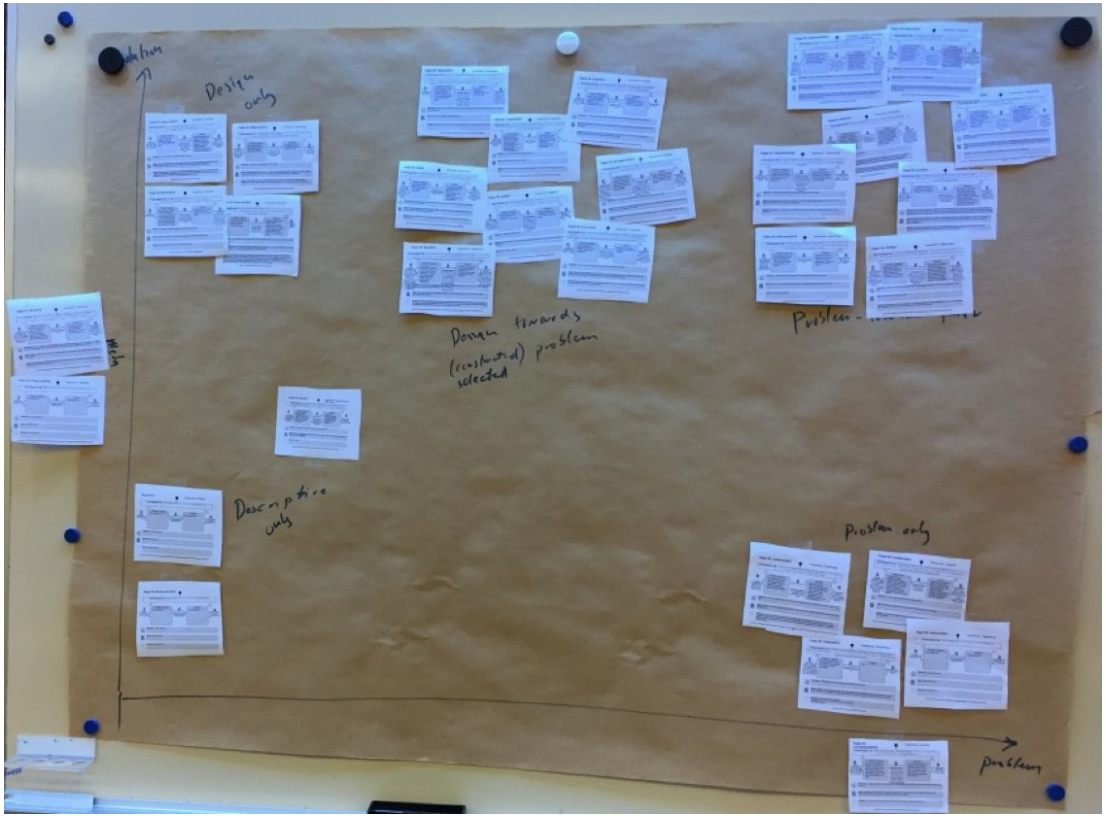
Rigor: Characteristics of the three knowledge creating activities (problem understanding, solution design and in context evaluation) that adds to the strength of the empirical support of the Technological Rule

Novelty: Positioning of the Technological Rule in terms of previous knowledge



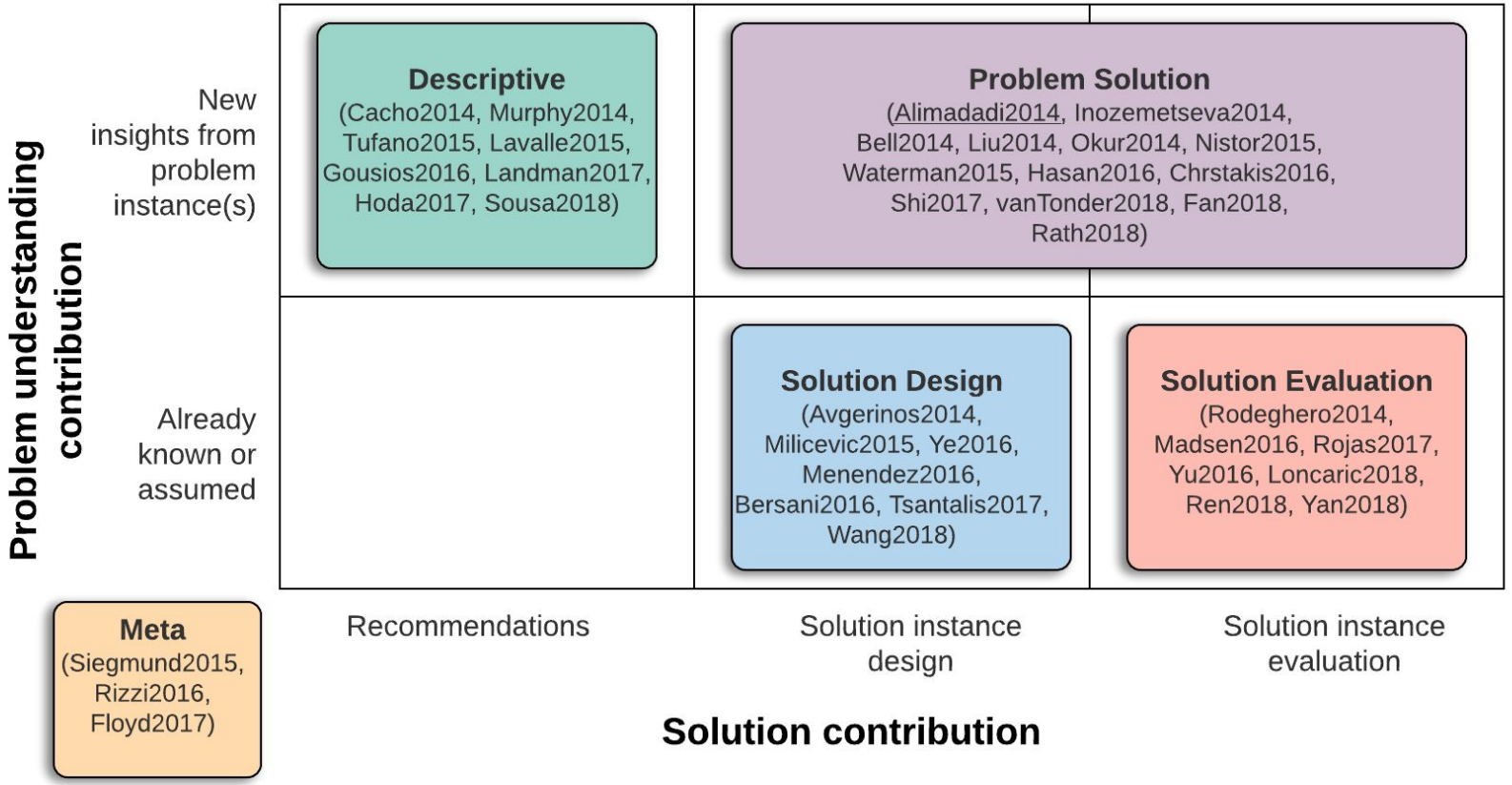
How were papers clustered?

Engström et al., 2019



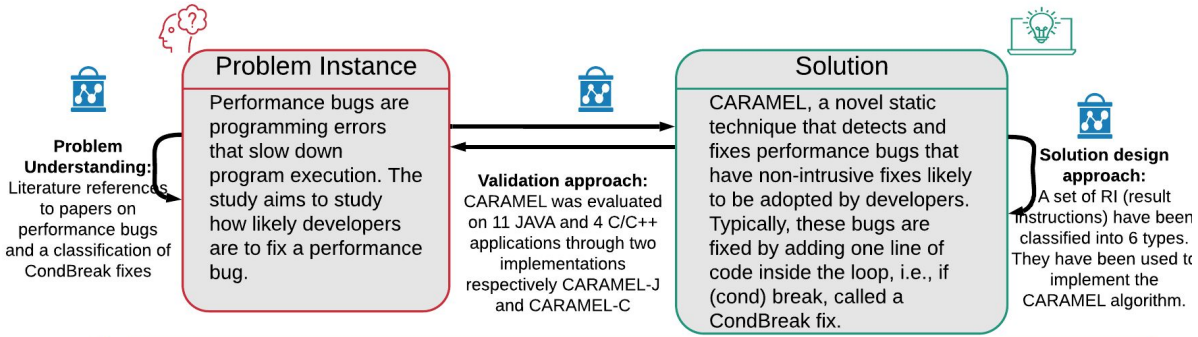
How we clustered

Clustered Papers by Design Science Contributions



Paper ID: Nistor2015

Technological rule: To fix performance bug problems caused by unnecessary loop execution use CARAMEL, which adds a break within loops

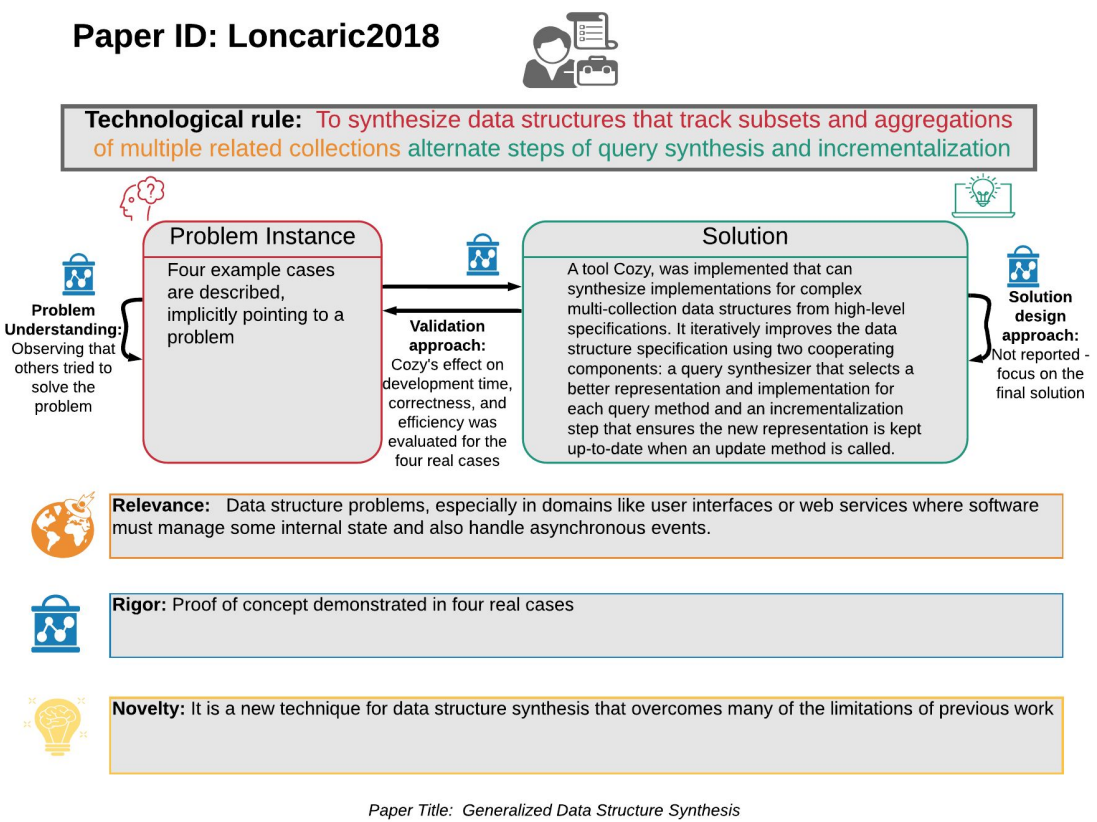


Relevance: Programming errors due to performance bugs. Relevant for programmers for which performance is an issue

Rigor: The validation pointed out that CARAMEL, used on 11 JAVA applications, and 4 C/C++ applications identified 61 performance bugs in the JAVA applications and 89 in C/C++ ones. Of these, 10+24 were not found before.

Novelty: (i) detect performance bugs whose fixes clearly offer more benefits than drawbacks to developers; (ii) identify a family of performance bugs; (iii) CARAMEL as tecnique for detecting performance bugs that have CondBreak fixes;

Paper Title: CARAMEL: Detecting and Fixing Performance Problems That Have Non-Intrusive Fixes



Solution Validation

Solution Design

Paper ID: Avgerino2014

Technological rule: To increase efficiency and effectiveness when using symbolic execution alternate between static and dynamic symbolic execution

Problem Understanding: The problem is well known and reported in several studies.

Problem Instance

How to increase bug detection in created benchmarks (using binaries from Debian Wheezy and Sid)

Validation approach: Use of benchmarks to compare with previous work, Applied MergePoint with veritesting to 33,248 binaries

Solution

Implement MergePoint with veritesting. Veritesting alternates between SSE and DSE. The alternation mitigates the difficulty of solving formulas, while alleviating the high overhead associated with a path-based DSE approach.

Solution design approach: It builds on and improves previous work (MergePoint) wrt the path explosion problem

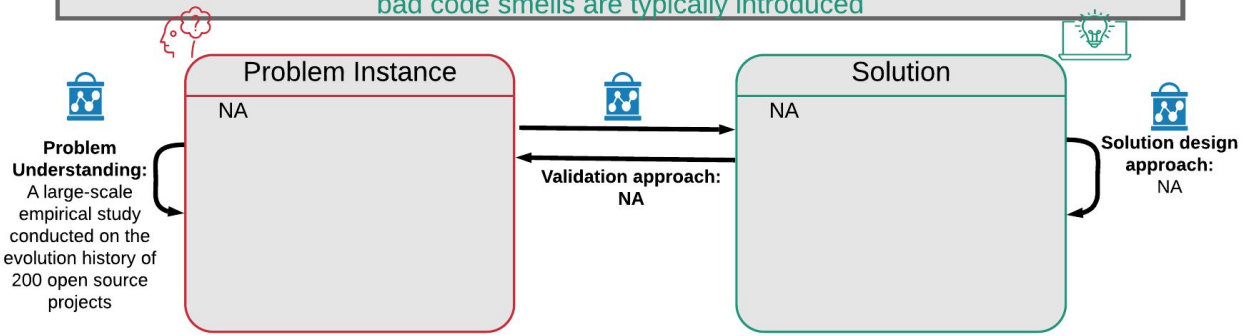
Relevance: Lack of efficiency when using symbolic execution

Rigor: Large-scale experiment on 33,248 programs from Debian Linux. MergePoint generated billions of SMT queries, hundreds of millions of test cases, millions of crashes, and found 11,687 distinct bugs

Novelty: Tested an order of magnitude more applications than have been tested by prior symbolic execution research. We analyzed each application for less than 15 minutes per experiment. We improve open source software by finding over 10,000 bugs and generating millions of test cases.

Paper ID: Tufano2015

Technological rule: To better plan activities for improving design and source code quality when developing software utilise the knowledge gained in this study about when and why bad code smells are typically introduced



Relevance: The study context is the change history of 200 projects belonging to three software ecosystems, namely Android, Apache, and Eclipse

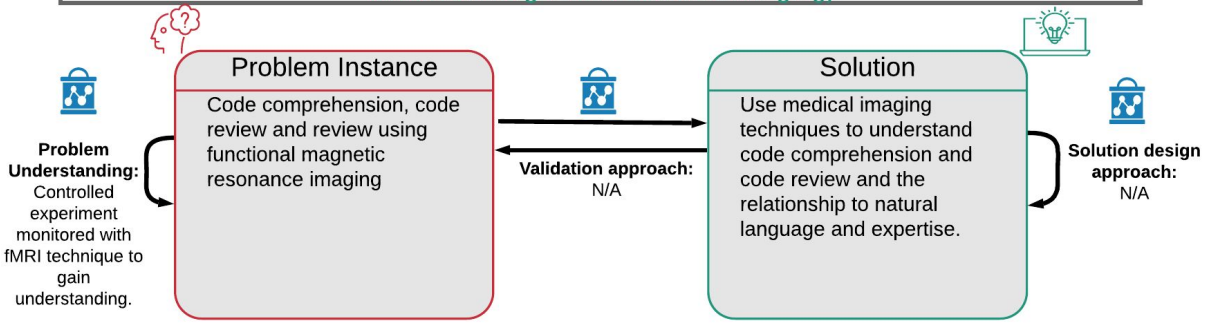
Rigor: Validity is ensured because a large set of 200 projects concerning the analysis of code smells and oftheir evolution has been investigated. Projects were extracted from three ecosystems: android, apache and eclips.

Novelty: First comprehensive empirical investigation into when and why code smells are introduced in software projects.

Paper Title: When and Why Your Code Starts to Smell Bad

Paper ID: Floyd 2017

Technological rule: To understand how human brain processes software engineering tasks when making subjective human judgments use medical imaging techniques (fMRI - functional magnetic resonance imaging)



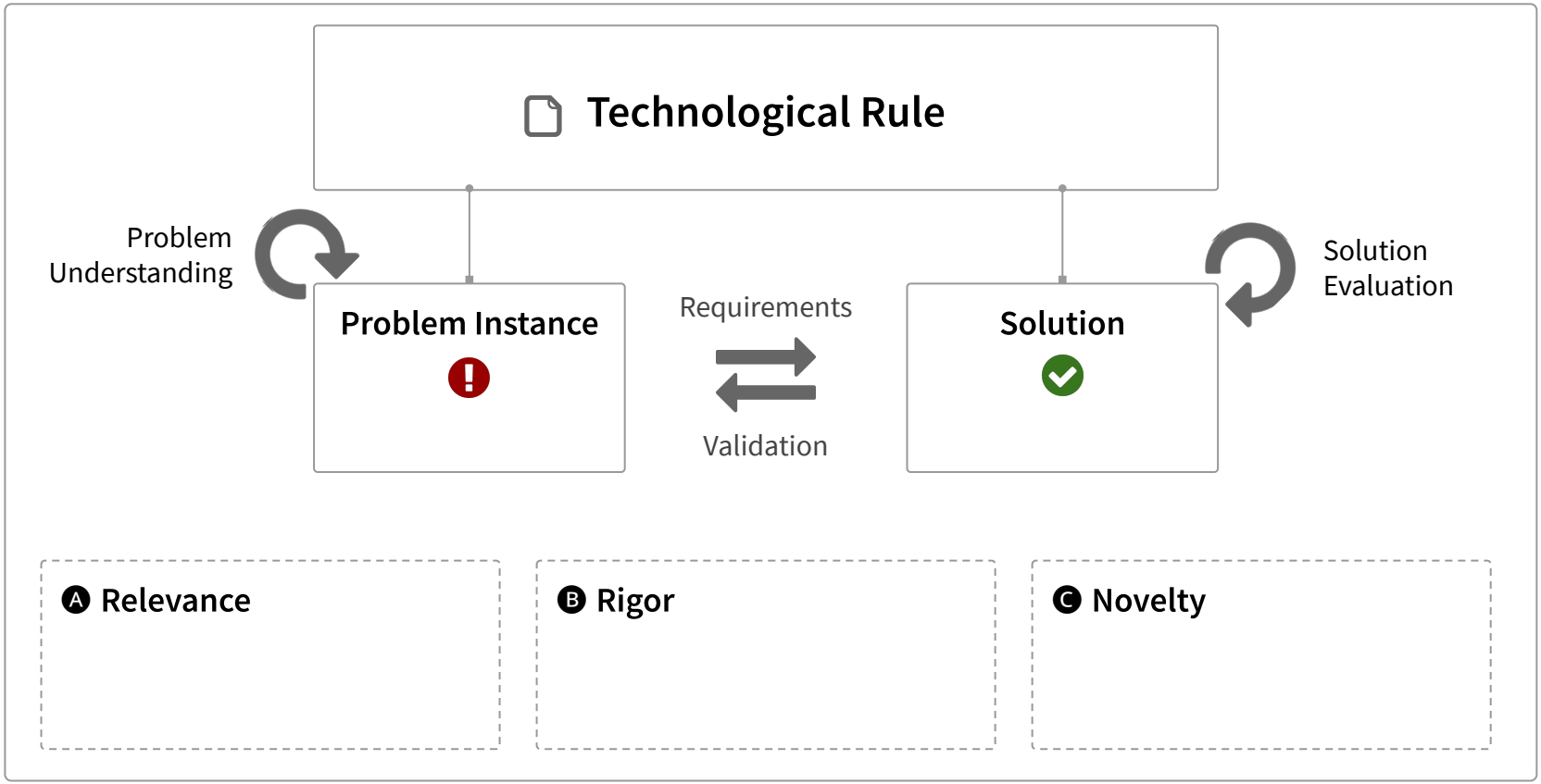
Relevance: Code review and comprehension vs prose review activities

Rigor: In a controlled experiment involving 29 participants, authors examine code comprehension, code review and prose review using functional magnetic resonance imaging.

Novelty: Measure brain activity for carrying out different tasks

Paper Title: Decoding the representation of code in the brain: An fMRI study of code review and expertise

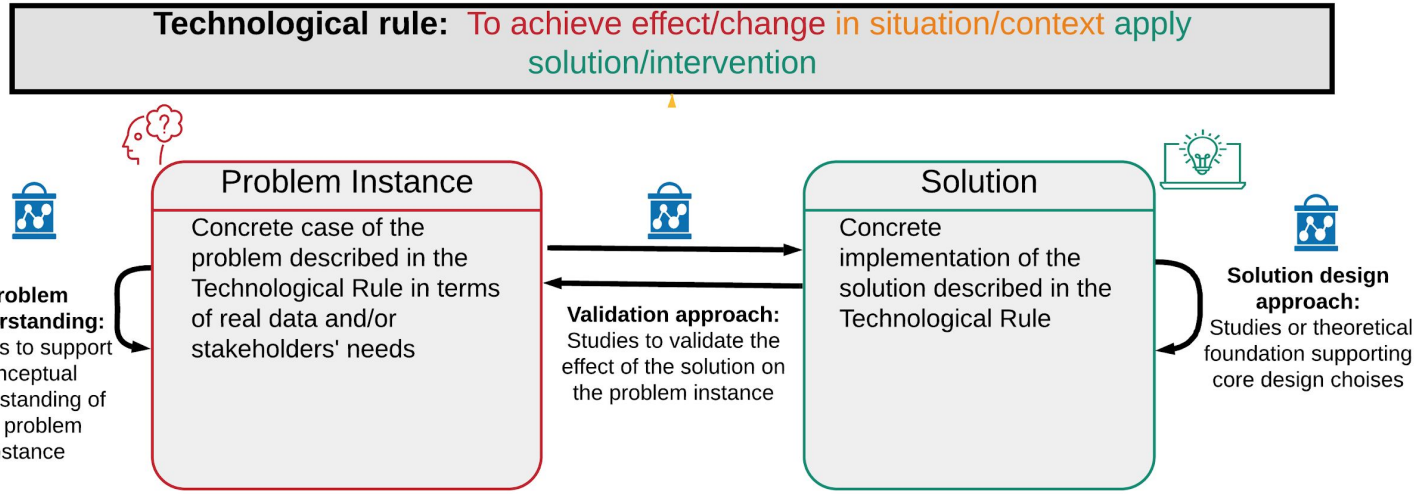
Activity: Applying the Design Science Lens



84 | Design Science Visual Abstract Template

Storey et al., 2017

Generic Visual Abstract



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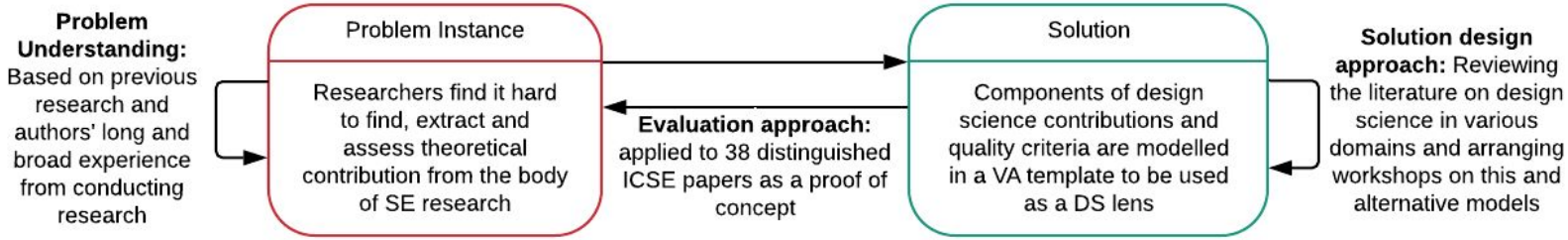
Rigor: Characteristics of the three knowledge creating activities (problem understanding, solution design and in context evaluation) that adds to the strength of the empirical support of the Technological Rule

Novelty: Positioning of the Technological Rule in terms of previous knowledge

Technological rule: To better assess and communicate research contributions within software engineering apply a design science lens



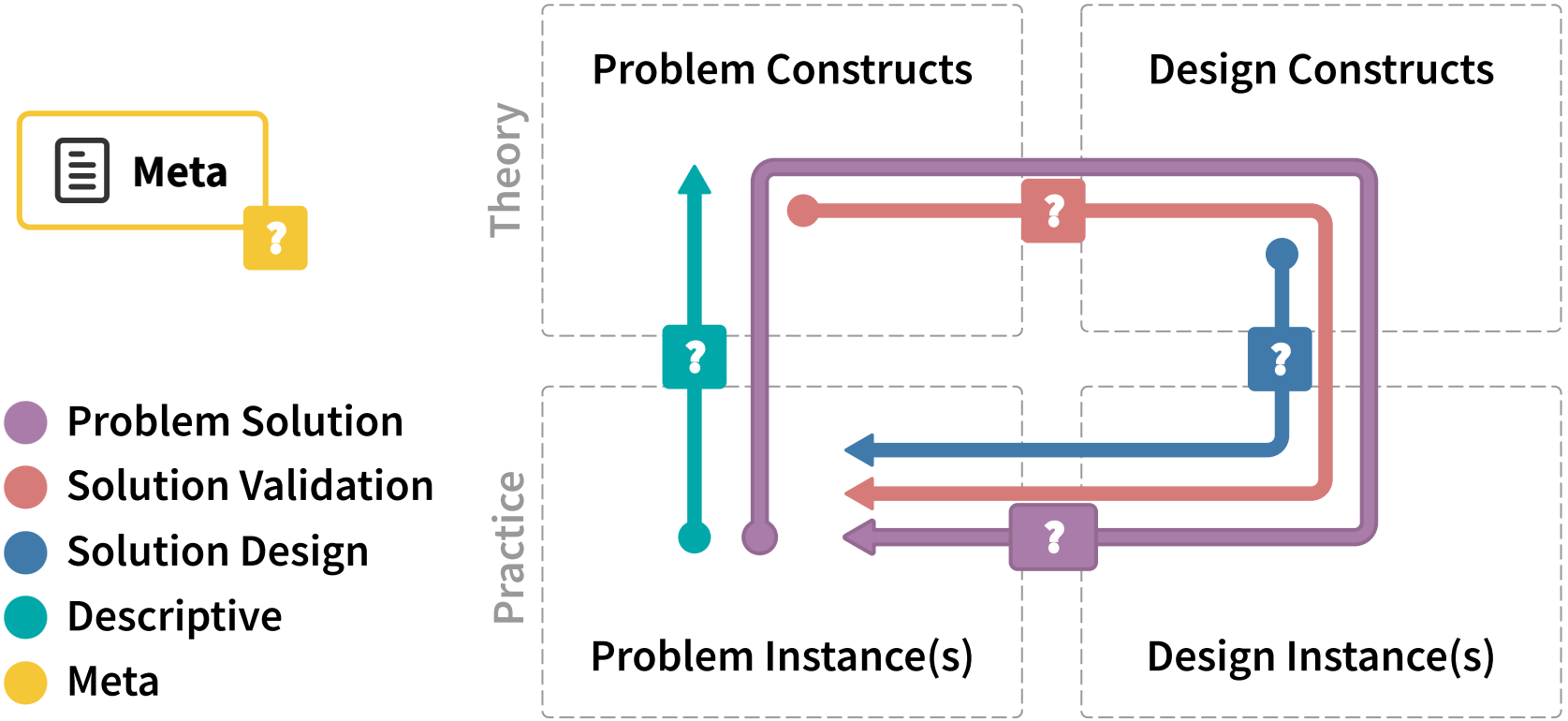
Relevance: Researchers aiming at conducting and disseminating industry-relevant SE research

Rigor: The problem is well known and the proposal is based on thorough review of design science litterature, no validation of the effects on communication and quality assessment was made

Novelty: The conceptualization of design science for software engineering and the VA model is novel, although it builds on previous discussions on the topic (Wieringa, Hevner, vanAken)

5

SBES Best Papers

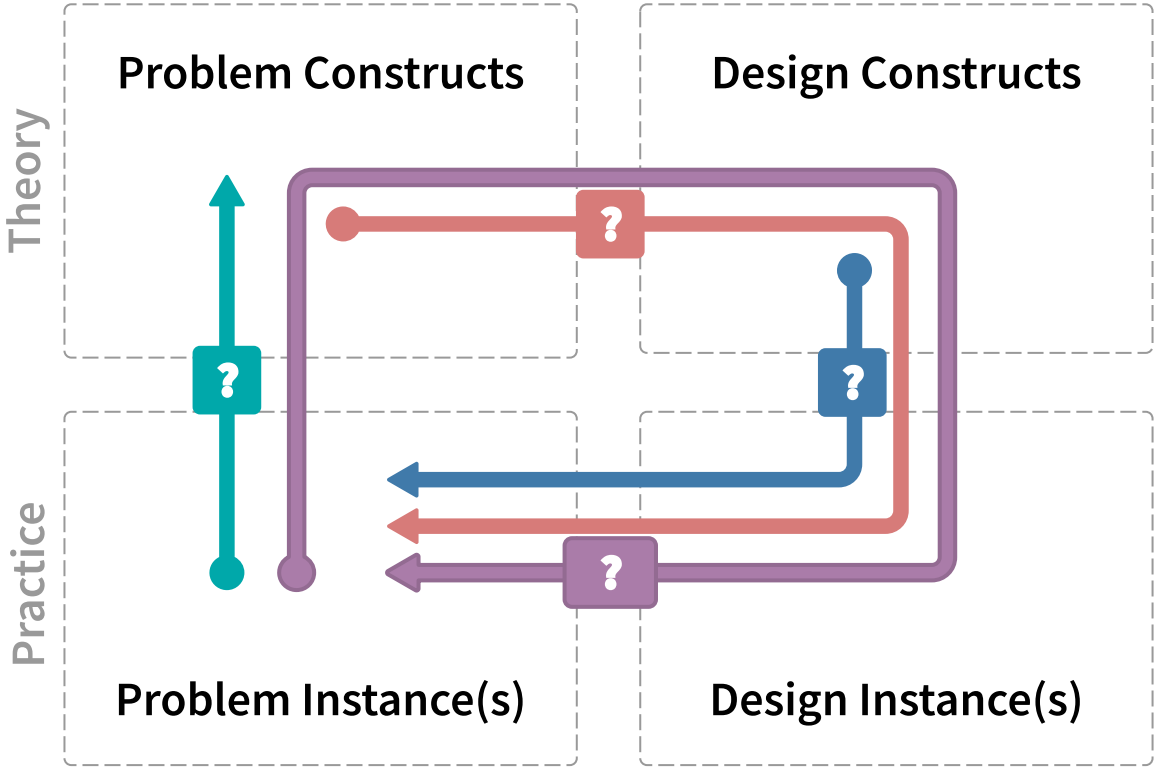


88 | Which contribution type is produced by this research?

Engström et al., 2019

Consider Stakeholders

- Problem Solution
- Solution Validation
- Solution Design
- Descriptive
- Meta



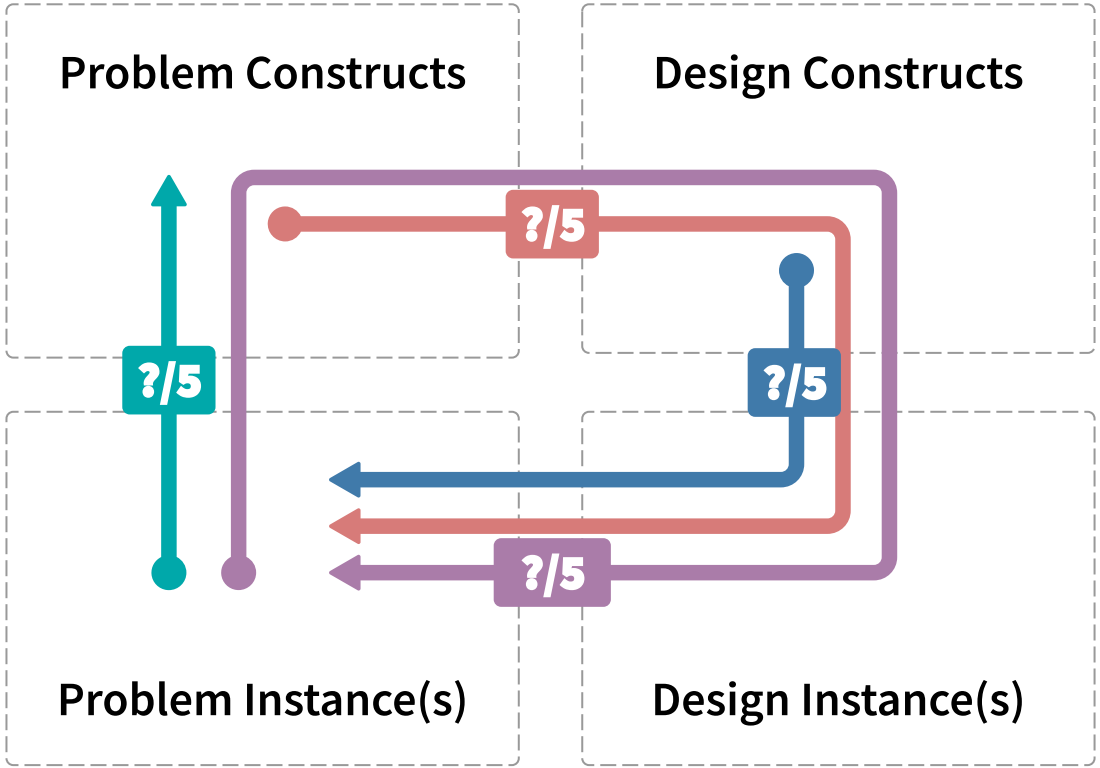
 | Relevance to stakeholders?

Engström et al., 2019

?/5

Consider Stakeholders

- Problem Solution
- Solution Validation
- Solution Design
- Descriptive



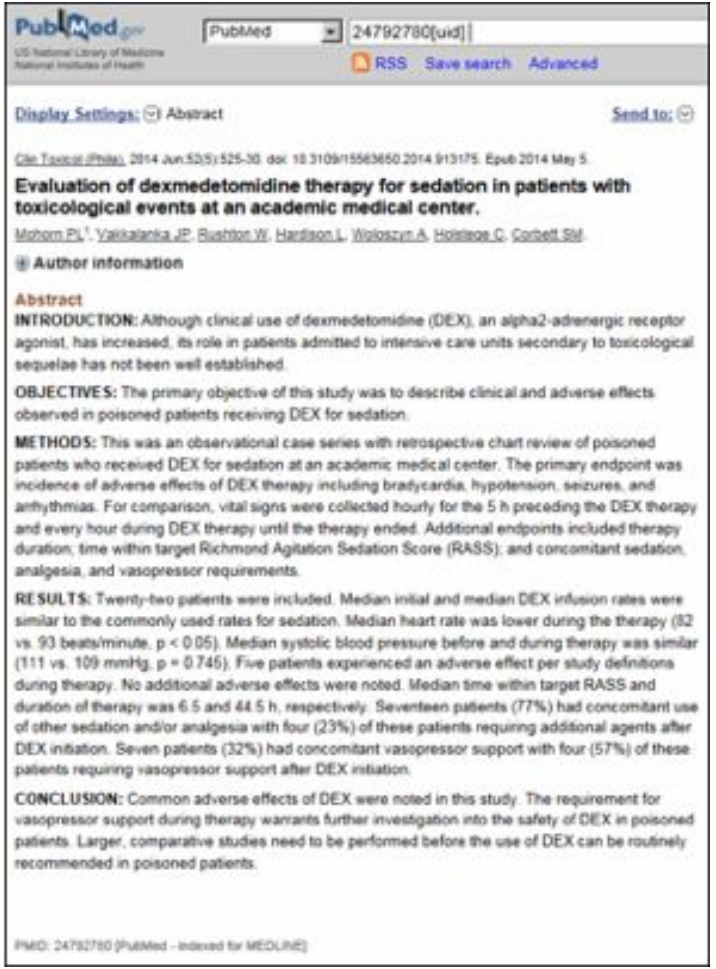
What **challenges** did you face filling out the visual abstract?

How does it compare to other types of **structured abstracts**?

Do you think this would be useful in a **systematic literature review** for linking hierarchically technological rules?

A **structured abstract** is an **abstract** with distinct, labeled sections (e.g., Introduction, Methods, Results, Discussion) for rapid comprehension.

In comparison, visual abstracts provide additional insights with a more flexible reading order



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Clin Toxicol (Phila). 2014 Jun;52(5):525-30. doi: 10.3109/15563650.2014.913175. Epub 2014 May 5.

Evaluation of dexmedetomidine therapy for sedation in patients with toxicological events at an academic medical center.

Mohorn PL[1], Vaikalanka JP, Rushton W, Hardison L, Woloszyn A, Holstege C, Corbett SW.

Author information

Abstract

INTRODUCTION: Although clinical use of dexmedetomidine (DEX), an alpha2-adrenergic receptor agonist, has increased, its role in patients admitted to intensive care units secondary to toxicological sequelae has not been well established.

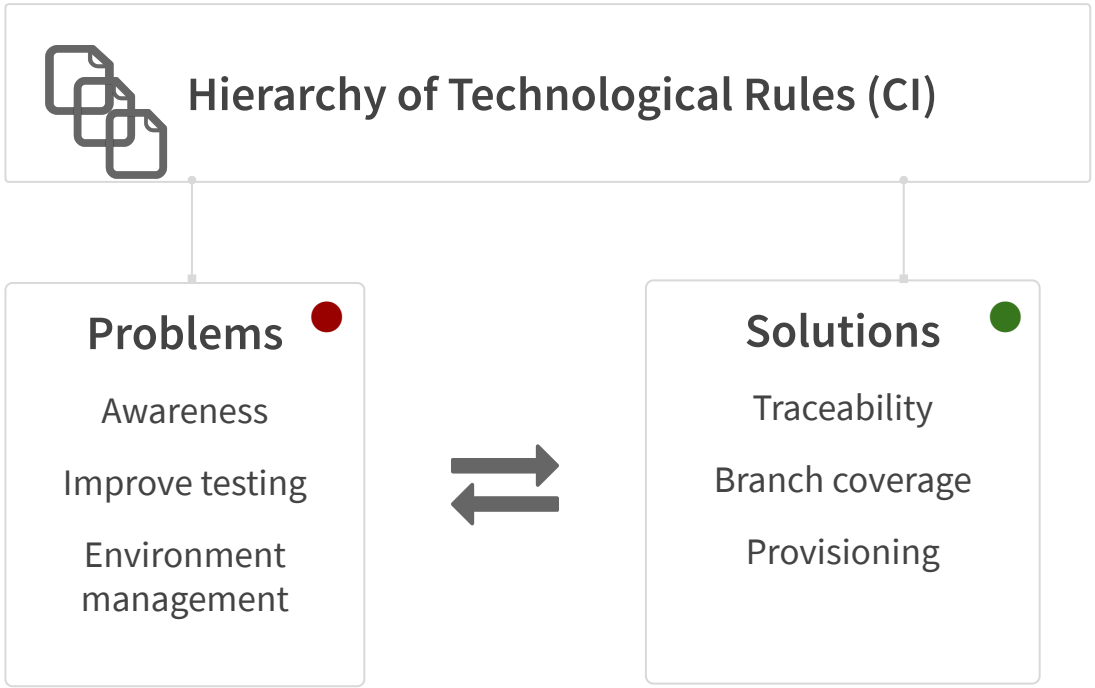
OBJECTIVES: The primary objective of this study was to describe clinical and adverse effects observed in poisoned patients receiving DEX for sedation.

METHODS: This was an observational case series with retrospective chart review of poisoned patients who received DEX for sedation at an academic medical center. The primary endpoint was incidence of adverse effects of DEX therapy including bradycardia, hypotension, seizures, and arrhythmias. For comparison, vital signs were collected hourly for the 5 h preceding the DEX therapy and every hour during DEX therapy until the therapy ended. Additional endpoints included therapy duration; time within target Richmond Agitation Sedation Score (RASS); and concomitant sedation, analgesia, and vasopressor requirements.

RESULTS: Twenty-two patients were included. Median initial and median DEX infusion rates were similar to the commonly used rates for sedation. Median heart rate was lower during the therapy (82 vs. 93 beats/minute, $p < 0.05$). Median systolic blood pressure before and during therapy was similar (111 vs. 109 mmHg, $p = 0.745$). Five patients experienced an adverse effect per study definitions during therapy. No additional adverse effects were noted. Median time within target RASS and duration of therapy was 6.5 and 44.5 h, respectively. Seventeen patients (77%) had concomitant use of other sedation and/or analgesia with four (23%) of these patients requiring additional agents after DEX initiation. Seven patients (32%) had concomitant vasopressor support with four (57%) of these patients requiring vasopressor support after DEX initiation.

CONCLUSION: Common adverse effects of DEX were noted in this study. The requirement for vasopressor support during therapy warrants further investigation into the safety of DEX in poisoned patients. Larger, comparative studies need to be performed before the use of DEX can be routinely recommended in poisoned patients.

PMID: 24792780 [PubMed - indexed for MEDLINE]



Design Science Prescriptive Contributions

Additional reading

Feldt & Magazinius, "Validity Threats in Empirical Software Engineering Research-An Initial Survey," 2010

Siegmund, Siegmund & Apel, “Views on internal and external validity in empirical software engineering,” 2015

Shneiderman, "Twin-Win Model: A human-centered approach to research success," 2018

Sjøberg et al., "Building theories in software engineering," 2008

Stol & Fitzgerald, "Uncovering theories in software engineering," 2013

Ralph, "Possible core theories for software engineering," 2013

Hevner, "A three cycle view of design science research," 2007

Van Aken, "Management Research Based on the Paradigm of the Design Sciences: The Quest for Field-Tested and Grounded Technological Rules,” 2004

"Using a visual abstract as a lens for communicating and promoting design science research in software engineering", Storey, Engström, Höst, Runeson, Bjarnason, ESEM 2017. http://chisel.cs.uvic.ca/pubs/storey-ESEM2017.pdf

"A review of software engineering research from a design science Perspective", Engström, Storey, Runeson, Höst, Baldassarre, Arxiv 2019. http://arxiv.org/abs/1904.12742

"Methodology Matters: How We Study Socio-Technical Aspects in Software Engineering.", Margaret-Anne Storey, Courtney Williams,, Neil A. Ernst, Alexey Zagalsky and Eirini Kalliamvakou. 2019. Arxiv. https://arxiv.org/abs/1905.12841

Twitter: @margaretstorey

Key references

Concluding remarks

Supplementary slides

“A paradigm is a shared world view that represents the beliefs and values in a discipline and that guides how problems are solved.”

– Schwandt, 2001

Scientific method

Evidence-based reality

Theory verification and falsification

Quantitative over qualitative

Creswell, 2014

Reality is subjective and experiential

Theory generation

Biases are expected and made explicit

Qualitative over quantitative

Creswell, 2014

Change oriented

Collaborative

Shaped by political and social lenses

Qualitative and quantitative

Creswell, 2014

Pragmatism

Problem centered • Real-world practice oriented

Creswell, 2014