LITERATURE, USE OF THEORY AND RESEARCH METHODS

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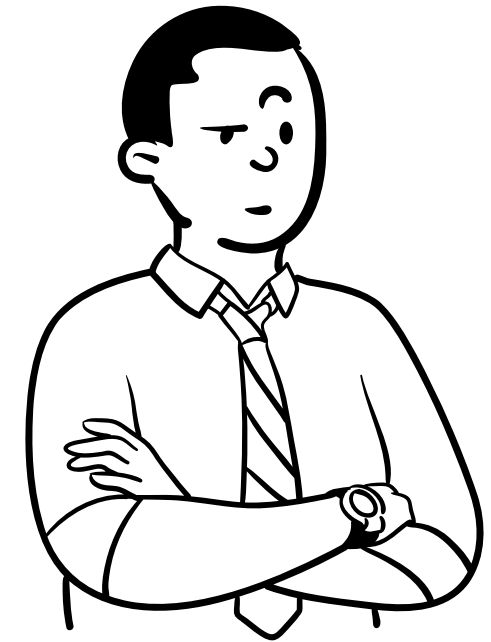
RECAP

- Definition of research

- Research Process

- Framework of Research

    - Philosophical views

    - Overview of research design

    - Overview of research methods

AGENDA

- ▸ Literature Review

- ▸ The use of theory

- ▸ Research problem

- ▸ Research question

- ▸ Selection of a research method

- ▸ Mandatory Exercise # 2 (Deadline: 27th September)

LITERATURE REVIEW

LITERATURE REVIEW- WHY DO IT?

LITERATURE REVIEW- WHY DO IT?

- **Provides the readers the results of other related studies.**

  - Demonstrate your knowledge of the topic.

- **Position your own work with respect to others' works.**

  - Are you doing some new? Are you adding a contribution?

- **Motivates the importance of your own work.**

  - There is a gap that current literature missing and you want to address that.

LITERATURE REVIEW- HOW TO USE IT? (CRESWELL & CRESWELL, 2018)

- In qualitative studies:

  - Literature tends to be used to point out that there is a gap in the results or findings of existing work.

- In quantitative studies:

  - Introduce a theory to be examined.

  - To provide direction for the research questions and hypothesis.

LITERATURE REVIEW- HOW TO USE IT? (CRESWELL & CRESWELL, 2018)

▸ In qualitative studies:

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▸ In quantitative studies:

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  ▸ To provide direction for the research questions and hypotheses.

A SUGGESTION NOT A RULE

LITERATURE REVIEW – SOME CAUTION

▸ You need to separate the following:

  ▸ Literature review to provide motivation for your study in "Background" or "Related Work" section, <u>Link</u>

  ▸ Literature review as a research method to gather and synthesise evidence, e.g., systematic literature review.

    ▸ This is a different topic to be discussed.

LITERATURE REVIEW AS A RESEARCH METHOD

▸ More on Systematic Literature review and secondary studies in Week 40 and 41.

THE USE OF THEORY

WHAT IS THEORY?

WHAT IS THEORY?

▸ "A supposition or a system of ideas intended to explain something, especially one based on general principles independent of the thing to be explained." (Oxford Dictionary).

Examples:

   ▸ Einstein's general relativity

   ▸ Darwin's theory of evolution

THE ROLE OF THEORY

▸ Meaning could vary depending on your philosophical stance (-_-')

▸ Could vary depending on the research design.

QUANTITATIVE RESEARCH

"An approach for testing objective theories by examining relationships between variables" (Creswell and Creswell, 2018)

Variables

Independent variables

Dependent variables
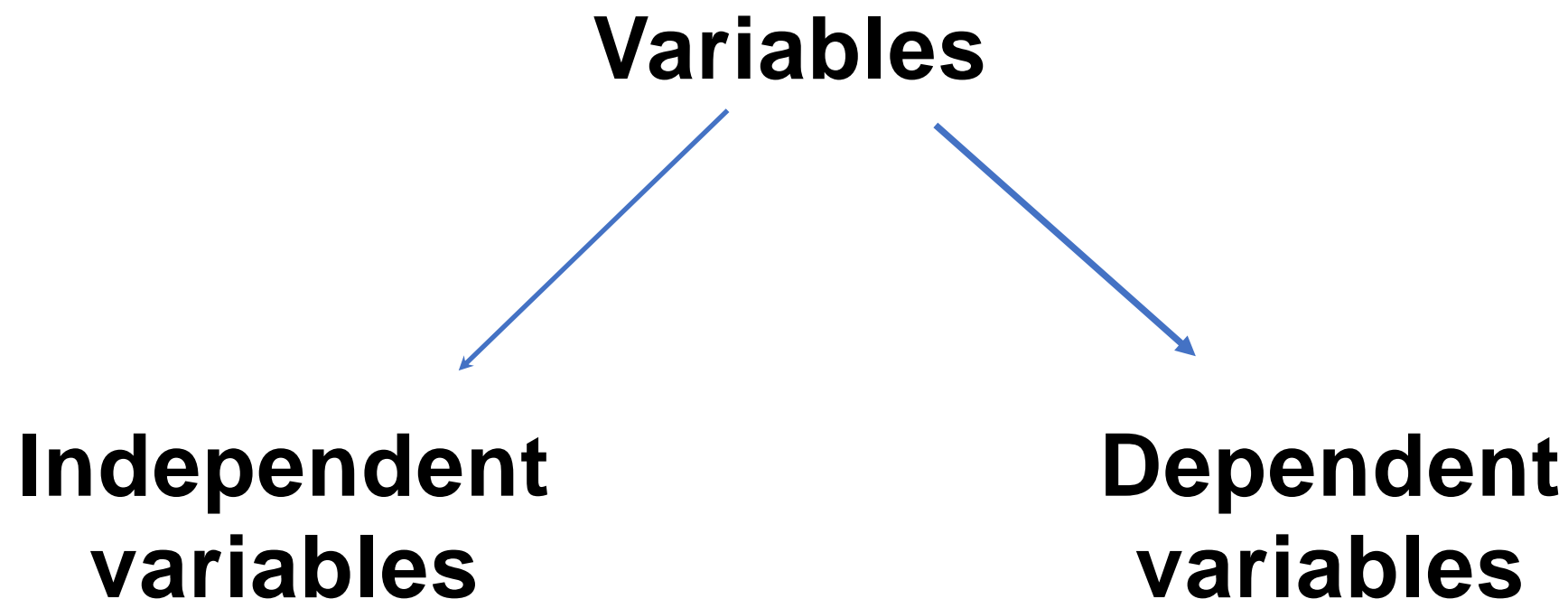
Does the type of software testing (independent variable) affect the number of post-release defects (dependent variable) in a software product?

QUANTITATIVE RESEARCH

Researcher tests or verifies a theory

Researcher tests hypotheses or research questions from theory

Researcher measures or observes variables derived from the theory

Researcher measures or observes variables using an instrument to obtain scores

QUANTITATIVE RESEARCH

DEDUCTIVE REASONING

Researcher tests or verifies a theory

⬇

Researcher tests hypotheses or research questions from theory

⬇

Researcher measures or observes variables derived from the theory

⬇

Researcher measures or observes variables using an instrument to obtain scores

Source: Creswell and Creswell (2018), p.58

QUALITATIVE RESEARCH

"An approach for exploring and understanding the meaning individuals ascribe to a social problem" (Creswell and Creswell, 2018)

QUALITATIVE RESEARCH

There is a variation, theory in qualitative research can be used as:

- ▸ A broad explanation of behaviour (similar to quantitative research)

- ▸ A perspective that shapes: types of questions being asked, data collection strategy, and data analysis.

- ▸ An end point, where theory is generated from the data into broad themes.

QUALITATIVE RESEARCH

Researcher poses generalisation or theories from past observations and literature

↑

Researcher looks for broad patterns, generalisations, or theories from themes and categories

↑

Researcher analyses data to form themes and categories

↑

Researcher asks open-ended questions of participants or records field notes

↑

Researcher gathers information (e.g., interviews, observations)

Source: Creswell and Creswell (2018), p.64

THE USE OF THEORY

QUALITATIVE
RESEARCH

INDUCTIVE
APPROACH

Researcher poses generalisation or theories from past observations and literature

↑

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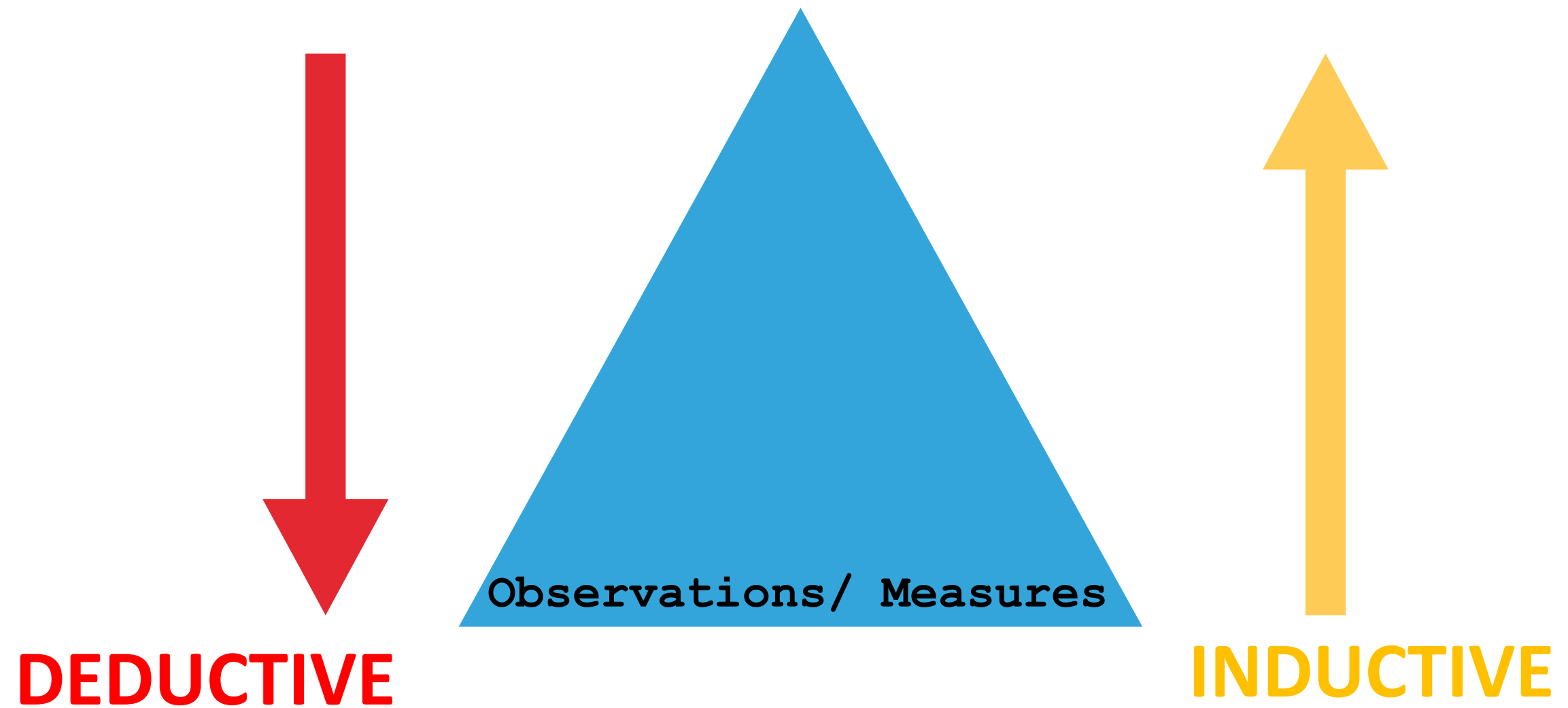Researcher analyses data to form themes and categories

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Source: Creswell and Creswell (2018), p.64

DEDUCTIVE

Observations/ Measures

INDUCTIVE

MIXED METHOD

▸ May include using theory deductively and inductively.

▸ Example:

  ▸ Start with a theory to guide the study

  ▸ Collect both quantitative and qualitative data

RESEARCH PROBLEM

WHAT IS A RESEARCH PROBLEM?

Bryman, Alan. "The Research Question in Social Research: What is its Role?" International Journal of Social Research Methodology 10 (2007):5-20.

WHAT IS RESEARCH PROBLEM?

- A clear expression about an area of concern,

- A condition to be improved upon,

- A difficulty to be eliminated or,

- A troubling question that exists in literature

- Does not state how to do something, offers a vague
  or broad proposition, or presents a value question
  (Bryman, 2007)

Bryman, Alan. "The Research Question in Social Research: What is its Role?" International Journal of Social Research Methodology 10 (2007):5-20.

HOW TO IDENTIFY?

- ▸ Source:

  - ▸ Literature

  - ▸ Personal or collective observations

- ▸ A research problem could be, but limited to:

  - ▸ A gap in the literature

  - ▸ A conflicting result in the literature

  - ▸ A need to put attention to a (under-studied) topic

WHERE TO START?

- Ask yourselves what really interests you

- Find relevant literature and see what has been done.

    - Tip! Look into the "Future Work" section of a paper that interests you.

- Ask around!

RSEARCH QUESTIONS

WHERE DO THEY COME FROM?
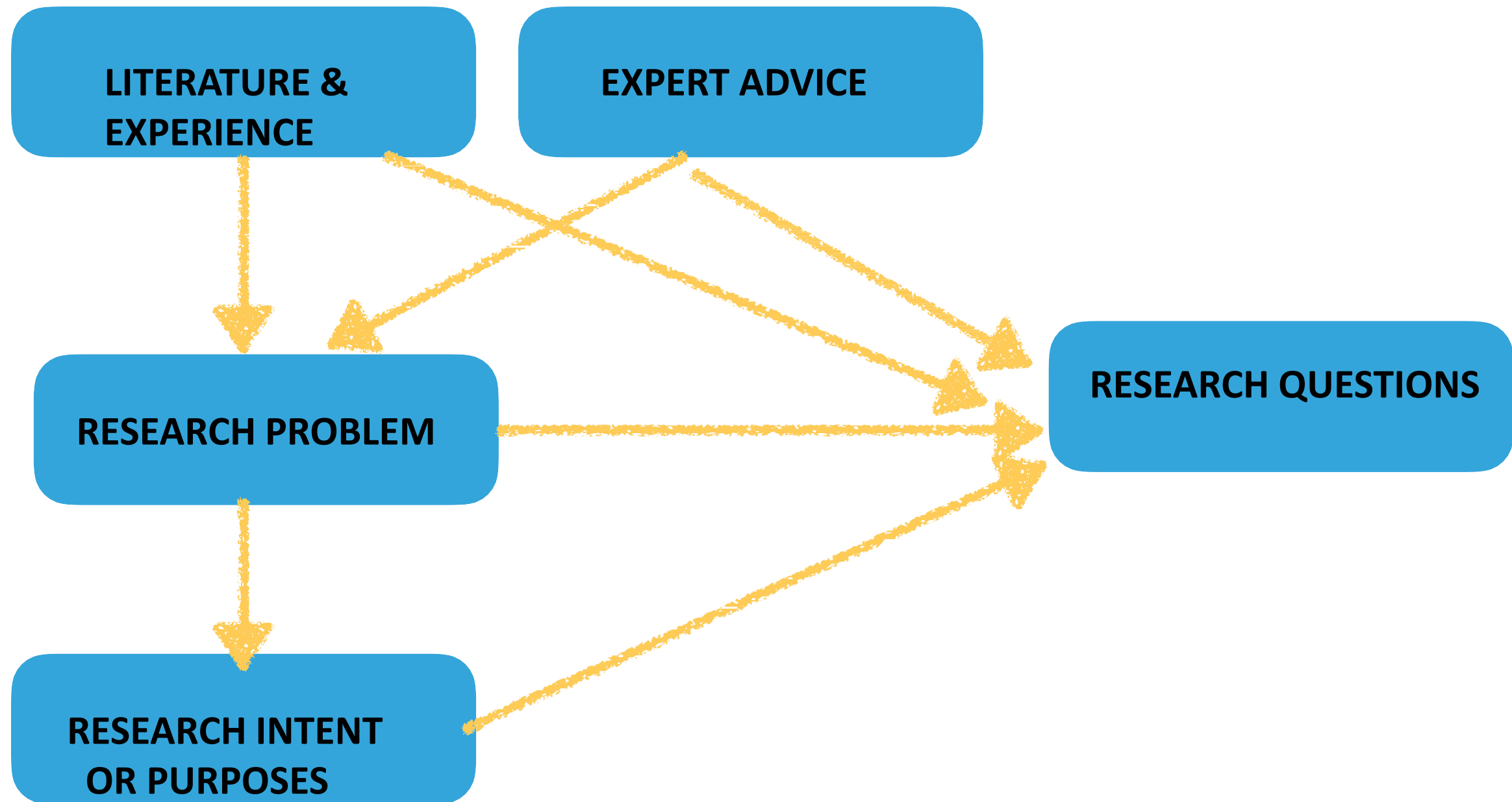
CHARACTERISTICS OF GOOD RESEARCH QUESTIONS (Robson,2011)

▸ Clear and unambiguous.

▸ Show the purpose of your research.

▸ Answerable.

  ▸ "What is dark matter?" Nobody knows

▸ Not trivial

  ▸ "How do doctors treat Type-1 Diabetes"? - Insulin

Source: Robson (2011), *Real World Research*, Third Ed., John Wiley & Sons.

Break (10 min)

Jane: A fictional SE researcher

Jane is a new PhD student interested in the effectiveness of a novel **"fisheye-view"** file navigator. Her research is motivated by the fact that navigation is a primary activity of software developers requiring a lot of scrolling and many clicks to find files. "fisheye-view" display information in a compact format that could potentially reduce the amount of scrolling required. Jane's intuition is that the "fisheye-view" file navigator is more efficient for file navigation, but critics argue that the more compact information is difficult to read and that developers will not adopt it over the traditional file navigator. Her research goal, therefore, is to find evidence that supports or refutes her intuition that fisheye-view file navigators are more efficient than traditional file navigators for navigation.

Joe: A fictional SE researcher

Joe is a researcher in an industrial lab. His current interests are in understanding how developers in industry use (or not) UML diagrams during software design. This is because, as a student, his professors recommended UML diagrams be used during software design, but his recent exposure to industrial practices indicates that UML is rarely used. His research goal is to explore how widely UML diagrams are used in industry, and more specifically how these diagrams are used as collaborative shared artefacts during design.

Joy: A fictional LE & GD researcher

Joy is a new PhD student interested in the effectiveness of utilising gamification to teach agile methods. Her research is motivated by the fact that gamification can enhance teaching and learning in general. The agile methodology is an important manifesto that describes how projects should be managed and emphasizes collaboration between stakeholders. Joy's intuition is that If gamification is successfully applied to teaching the values of agile development, it may lead to higher gain from using agile principles., but critics have a different perspective on gamification of agile methodologies, i.e., such as encouraging unhealthy competition, fostering a focus on short-term goals over long-term success, or distracting from the actual work being done etc... Her research goal, therefore, is to find evidence that supports or refutes her intuition that gamification is more effective than traditional approach for teaching agile methods.

Emma: A fictional LE & GD researcher

Emma is a researcher in a game development lab. Her current research interests are contributing knowledge to future development of match-three games and enable developers to target different age groups. Her research goal is to explore what makes people keep playing match-three games, and more specifically how it varies across different age groups.

RESEARCH PURPOSE – RESEARCH QUESTIONS

Design	Purpose	Question
Qualitative	Existence	"Does X exist?" *Do collaborative shared artefacts (UML Diagram, code) actually exist?*
	Description and Classification	"What is X like?", "What are its properties?", "How can it be categorised?", "How can we measure it?","What is its purpose?", "Why do you choose X? *1. How can we measure efficiency for file navigation?* *2. What are all the types of shared collaborative artefacts?* *3. What are the different game-based tools used in teaching agile methods?*
	Descriptive - Comparative	"How does X differ from Y?" *1. How do UML diagrams differ from other representations of design information?* *2. How does gamified agile training differ from traditional/conventional training?* *3. How does motivation to play match three games differ across different age groups?*
	Descriptive - Process	"How does X normally work?", "What is the process by which X happens?" *1. How do programmers navigate files using existing tools?*

RESEARCH PURPOSE – RESEARCH QUESTIONS

Design	Purpose	Question
Quantitative	Frequency and distribution	"How often does X occur?", "What is an average amount of X?" *How many distinct UML diagrams are created in software development projects in large software companies?*
	Correlation	"Do occurrences of X correlate with the occurrences of Y?" *1. Does programmers' productivity correlate with their experience?* *2. Does participants' learning correlate with gamification?*
	Causality - Comparative	"Does X cause more Y than does Z?" or, "Is X better at preventing Y than is Z?" *1. Does exploratory testing better at identifying defects than scripted testing?* *2. Does gamified agile training better at improving learning than traditional approach?*

MIXED METHOD – RESEARCH QUESTIONS

1. Method based

2. Content based

3. Method and Content based

MIXED METHOD – RESEARCH QUESTIONS

1. ## Method based

   Example: *Does the qualitative data help explain the results from the initial phase of the study?*

2. ## Content based

   Example: *What are the common software design patterns and coding practices (qualitative) employed by software development teams in agile environments, and how do these practices impact software quality metrics (quantitative) such as defect density and code maintainability?*

3. ## Method and Content based

   Example: *How do qualitative interviews with software development teams about software design patterns and coding practices serve to contribute to a more comprehensive understanding of predicting relationship between coding practices and software quality, via integrative mixed methods analysis?*

HYPOTHESIS

- Predictions, the researcher makes about the expected outcomes of relationships among variables

- have two forms:
  1. null = makes a prediction that no relationship or no significant difference exists between groups on a variable

     example:

RQ: Are teens better at math than adults?	Ho: Age has no effect on mathematical ability.

  2. Alternative/directional= makes a prediction (higher, more, lower, less etc...) about the expected outcome.

     example:

people with a high exposure to ultraviolet light will *have a **higher** frequency of skin cancer.*

Example 1:

A researcher randomly assigns college students to a prescribed amount of study time. She plans to examine the extent to which study time leads to improved test scores.

RQ: How does the amount of time spent studying influence test scores?

1. Can you identify variables? If yes, how many?

2. Can you identify independent variable?

3. Can you identify dependent variable?

4. Can you formulate a hypothesis?

   - Null Hypothesis

   - Directional Hypothesis

Example 2:

A researcher aims to investigate the relationship between the number of code reviews conducted during the software development process and the subsequent number of post-release defects scores.

RQ: **Does increasing the number of code reviews in a software development project have a significant effect on reducing the number of post-release defects?**

1. Can you identify variables? If yes, how many?

2. Can you identify independent variable?

3. Can you identify dependent variable?

4. Can you formulate a hypothesis?

   - Null Hypothesis

   - Directional Hypothesis

SELECTION OF RESEARCH METHODS
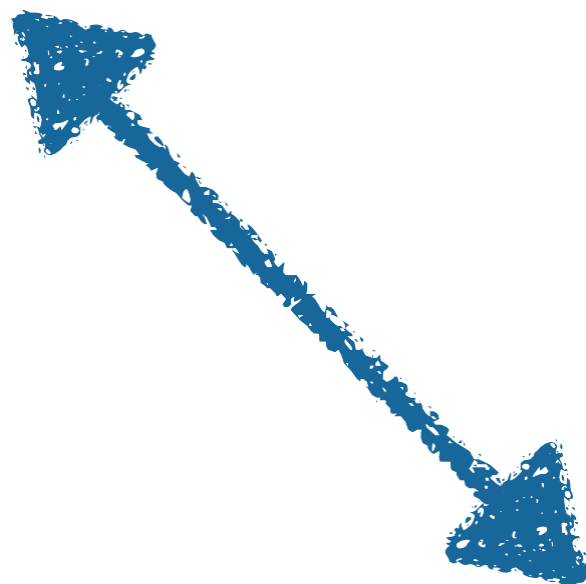
RESEARCH FRAMEWORK

Philosophical Worldviews

Positivism
Constructivism
Transformative
Pragmatic

Research Design

Quantitative
Qualitative
Mixed Methods

Research Methods

Questions/Hypotheses
Data Collection
Data Analysis
Interpretation
Validation

PHILOSOPHICAL VIEW, RESEARCH DESIGN, RESEARCH METHOD

	Qualitative	**Quantitative**	**Mixed**
Philosophical View	Constructivist/ transformative	Positivist	Pragmatic
Strategy of inquiry	ethnography, exploratory case study, (qualitative) survey, action research	Survey, experiments, confirmatory case study	Convergent parallel Explanatory sequential Exploratory sequential
Methods	Open-ended question, text or image data, flexible inquiry	Close-ended question, numeric data, pre-determined	Both open and close ended questions, text and numeric data

Modified from Table 1.4 in (Creswell and Creswell, 2018)

RESEARCH METHODS OVERVIEW

- ➢ Survey

- ➢ Ethnography

- ➢ Case study

- ➢ Experiment

- ➢ Design Science/Action research

- ➢ Mixed-methods

RESEARCH METHODS OVERVIEW

Survey

- Identify the characteristics of a broad population of individuals

- Could be qualitative (exploratory w/ open questions) or quantitative (confirmatory w/ closed questions).

- Questionnaires (web-based, telephone, paper-based, interviews).

- Research question is about the nature of a particular target population (e.g., SW developers working with Agile in Denmark).

➢ Ethnography
➢ Case study
➢ Experiment
➢ Design Science/Action research
➢ Mixed-methods

RESEARCH METHODS OVERVIEW

➢ Survey

Ethnography

- ▪ Field Observation

- ▪ Research question focuses on the cultural practices of a particular community.

- ▪ Study how developers (and maybe other roles) work and make sense of their work in their natural settings.

➢ Case study
➢ Experiment
➢ Design Science/Action research
➢ Mixed-methods

RESEARCH METHODS OVERVIEW

➢ Survey

➢ Ethnography

Case study

- ▪ offer in-depth understanding of how and why certain phenomena occur, and can reveal the mechanisms by which cause–effect relationships occur (Flyvbjerg, 2006)

- ▪ Could be: exploratory (inductive) or confirmatory (deductive).

- ▪ Research question focuses on "how" or "why" something occurs.

➢ Experiment

➢ Design Science/Action research

➢ Mixed-methods

RESEARCH METHODS OVERVIEW

- ➢ Survey
- ➢ Ethnography
- ➢ Case study

Experiment

- A controlled investigation of two or more variables.
- Need to determine independent and dependent variables.
- Research questions formulated to understand correlation or causality.
- More often hypotheses are formulated (see chapter 7 creswell)

- ➢ Design Science/Action research
- ➢ Mixed-methods

RESEARCH METHODS OVERVIEW

- ➢ Survey
- ➢ Ethnography
- ➢ Case study
- ➢ Experiment

Design Science/Action Research

- ▪ Design science research is a methodology which we can place close to the engineering, technical areas of software engineering.

- ▪ Design science is the design and investigation of artifacts in context

- ▪ Research questions oscillate around the topics of how well the artifacts work in a given context

- ➢ Mixed-methods

RESEARCH METHODS OVERVIEW

➢ Survey

➢ Ethnography

➢ Case study

➢ Experiment

Action research

- A method for co-development of research results, where academia and industry can work together.

- requires action and action requires a context to be performed.

- requires an object that we will perform the action on,

- requires to define the specific action and its outcomes

- requires to define evaluation of the action

➢ Mixed-methods

When to Choose Which Methodology

Design Science	Action Research
- When we want to evaluate a specific method or tool in an industrial context.	- When we want to develop our understanding of the problem and focus on the impact of our work on the industrial practices.
- When our research problem is related to the technical aspects of software engineering, e.g., developing new tools.	- When our goal is to understand the context of the technology a bit more than the tooling.
- When our research team consists of academic researchers and is done primarily in an academic lab using the industrial context as validation.	- When our research team consists of both academic researchers and practitioners.
- When our research project is time-limited and the amount of time is less than 6 months.	- When our research project is long-term and the amount of time is greater than 6 months.

RESEARCH METHODS OVERVIEW

- Survey
- Ethnography
- Case study
- Experiment
- Action research

Mixed-methods

- Concurrent:
  - Qualitative and quantitative data collection and analysis done in parallel.

- Sequential:
  - Collect and analyse quantitative data ->collect and analyse qualitative data (Explanatory).
  - Collect and analyse qualitative data -> collect and analyse quantitative data (Exploratory)

RESEARCH PURPOSE – RESEARCH QUESTIONS

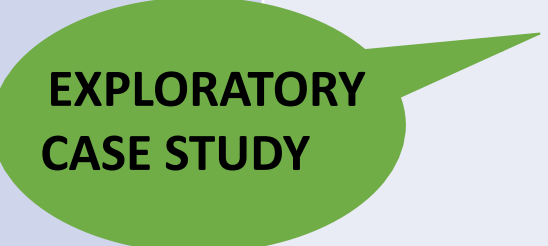| Design	Purpose	Question
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ETHNOGRAPHY

EXPLORATORY CASE STUDY

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QUALITATIVE SURVEY

EXPLORATORY CASE STUDY

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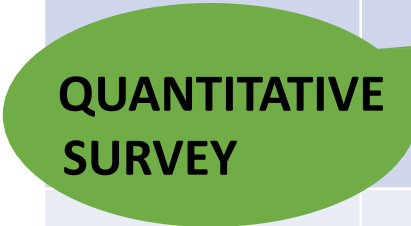
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ETHNOGRAPHY

RESEARCH PURPOSE – RESEARCH QUESTIONS

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CONTROLLED EXPERIMENT

EXPLANATORY CASE STUDY

RESEARCH PURPOSE – RESEARCH QUESTIONS

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CONTROLLED EXPERIMENT

Jan: A fictional researcher

Jan is a researcher, who is working on a "Defect Prediction" research project in order to evaluate a number of defect prediction models (constructed in the 1970s and 1980s) based on industrial data. There is a need to evaluate whether they are still applicable in the 2020s.

Research Objective:

To evaluate how well the models can predict the defect inflow from a number of industrial projects.

Sofie: A fictional researcher

Which research method, will be chosen to achieve Sofie's research objective???

Sofie has recently joined a research team, which set off to understand the dynamics of the defect inflow profiles in industry.

Research Objective:

To design and evaluate a method for predicting the number of defects reported per week.

EXAMPLE (<mark>For SE Students</mark>)

Helen is a master student in software engineering study program, and she has two supervisors. Her topic is related to understanding the efficiency of Test-driven Development (TDD). Supervisor A suggests that she should run an experiment, so she can conclusively (under controlled environment) measure the effect of TDD (compared to Test-last development) on the time to complete coding tasks and number of correct tasks. Supervisor B disagrees, he suggests that Helen should observe and interview developers in industry who are doing TDD. He thinks the efficiency of TDD has a lot to do with the individual developers experience and skills, and also the contexts that the developers work in (type of software being developed, organisation culture, tools, etc.).

EXAMPLE (<mark>For LE & GD Students</mark>)

Peter is a master student in Learning Experience and Game Development study program, and he has two supervisors. His topic is related to examining the effects of gamification in education. Supervisor A suggests that he should run an experiment, so he can conclusively (under controlled environment) measure the effect of gamification (compared to Traditional/Conventional approach) on students' learning (grades), and engagement (number of logins) etc. Supervisor B disagrees, he suggests that Peter should interview educators who are using gamification in their teaching and the students. He thinks, a big effort is required in the design and implementation of gamification for it to be fully motivating for the students. Therefore, the effectiveness of gamification is influenced by the individual educator's experience and skills, personality traits of the students, and also the educational contexts, the gamification is applied in (type of course, mode of teaching, tools, etc.).

Compulsory Exercise # 2

Considering the potential research problem that the thesis is trying to address:

➢ Which research design would you choose for the topic? and why?

➢ How would you formulate the research questions/ hypothesis

➢ Which research method would you choose to address the research question? And why?

Note: Please write Research Design, Purpose, Research Questions (Also hypothesis (Null/Directional) if its quantitative design), Research Method

Table 2.1: Evaluation of state of the art

Authors	Evaluation Criteria					
	1	2	3	4	5	6
SoS Coordination Strategies						
Fang and DeLaurentis [14]	×	×		×		
Barnes II et al. [15]						
CC	×	×	×	×		
HC	×	×		×		
PC	×	×	×	×		
DC	×	×		×		
Wenzel et al. [16]	×	×		×		
Cooperative Control Strategies						
Sugar and Kumar [19]	×	×	×			
Pasqualetti et al. [20]	×	×	×			×
Madhevan and Sreekumar [21]	×	×	×			×
Khazaei and Nguyen [22]	×	×	×	×		
Ren et al. [23]	×	×	×	×		
Negotiation Strategies						
Klein et al. [25]	×			×		
Aydoğan et al. [27]	×			×		
Fujita et al. [28, 29]	×			×		
Marsa-Maestre et al. [30]	×			×	×	
Clausen et al. [32]	×			×	×	

1. Support heterogeneity
2. Maintain operational independence
3. Provide conflict resolution
4. Exhibit complex nature
5. …
6. ….

Ref: Umair, Aisha. "An Agent Based Approach to Coordination of Resource Allocation and Process Performance." PhD diss., Syddansk Universitet. Det Tekniske Fakultet, 2017