

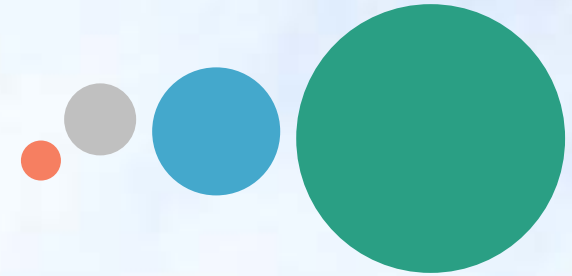
What Is the Further Evidence about UML?

- A Systematic Literature Review

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2017/12/4

Layout



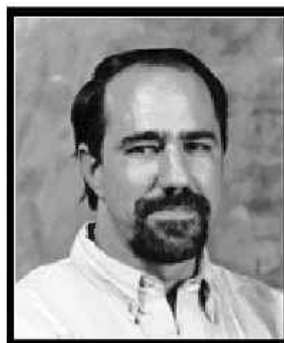
- 1 Background**
- 2 Conducting The Review**
- 3 Reporting Results**
- 4 Discussions**
- 5 Conclusions**

Background(1/5)—What is UML?

- Visual modelling language that enables builders to create blueprints that capture their visions in a standard, easy-to-understand way.
- Provides a mechanism to specify, share and communicate the vision.
- UML is just the name for 14 different types of diagrams.



Jim Rumbaugh

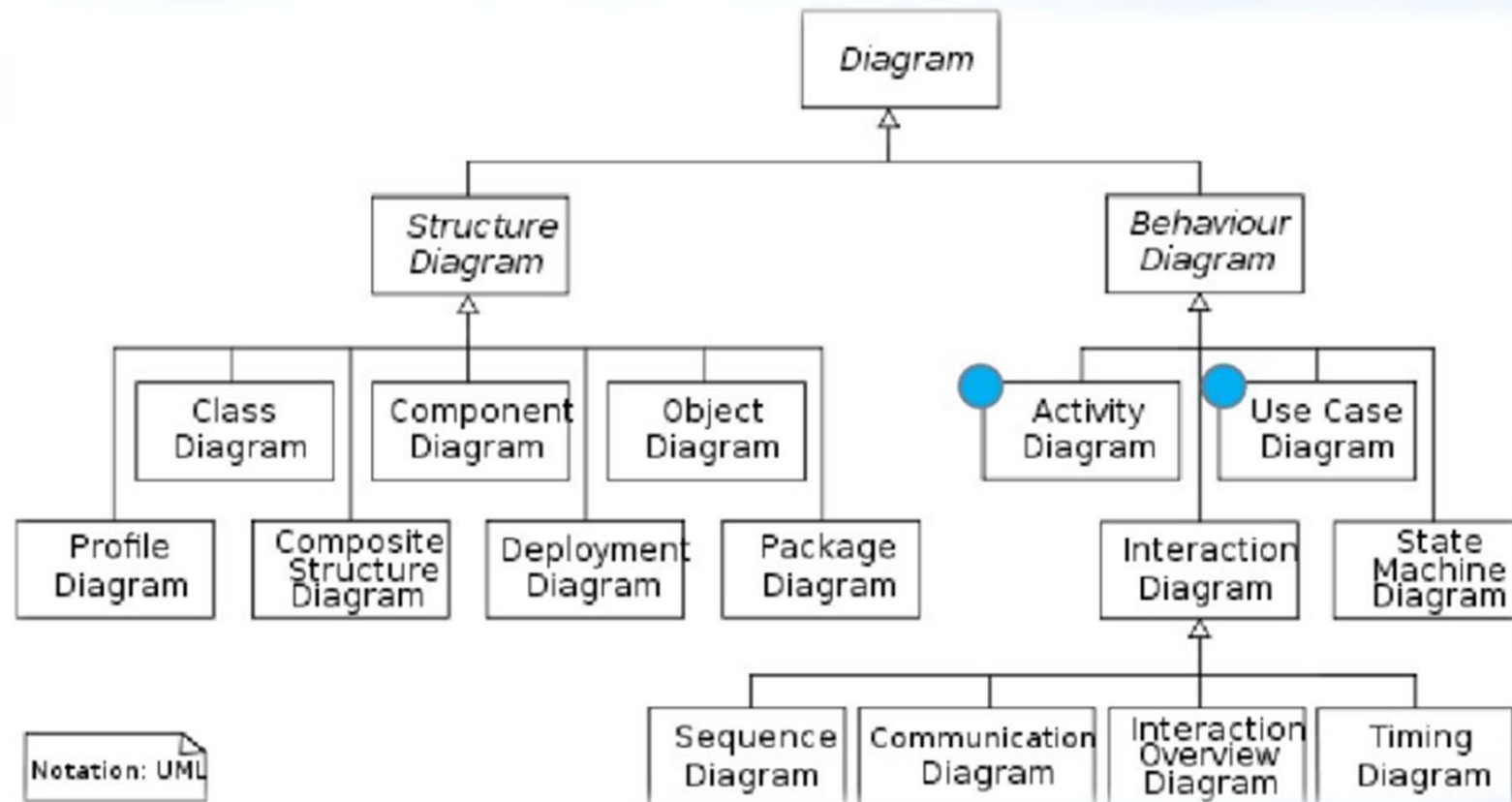


Grady Booth



Ivar Jacobson

Background(1/5)—What is UML?



The 14 diagrams of UML 2.X

Background(2/5) —Research Status

- ◆ Early in 2008, Pretorius *et al.* conducted a mapping study[1] to investigate the scope and scale of empirical studies about the UML.
- ◆ Three years later, Budgen *et al.* undertook the more in-depth study[2] to determine which the forms and characteristics of the UML have been studied empirically.
- ◆ Some related researches[3-5] that cover other aspect of the UML.

[2] D. Budgen, A.J. Burn, O.P. Brereton, B.A. Kitchenham and R. Pretorius. "Empirical evidence about the UML: a systematic literature review." *Software: Practice and Experience*. Vol. 41. pp.363-392, 2011.

Background(3/5) —Research Questions

- Which diagrams of the UML are most frequently used in empirical study?
- Which aspects of the UML could be recommended as the subject of further empirical research?
- What is the change in the research of UML in recent years?

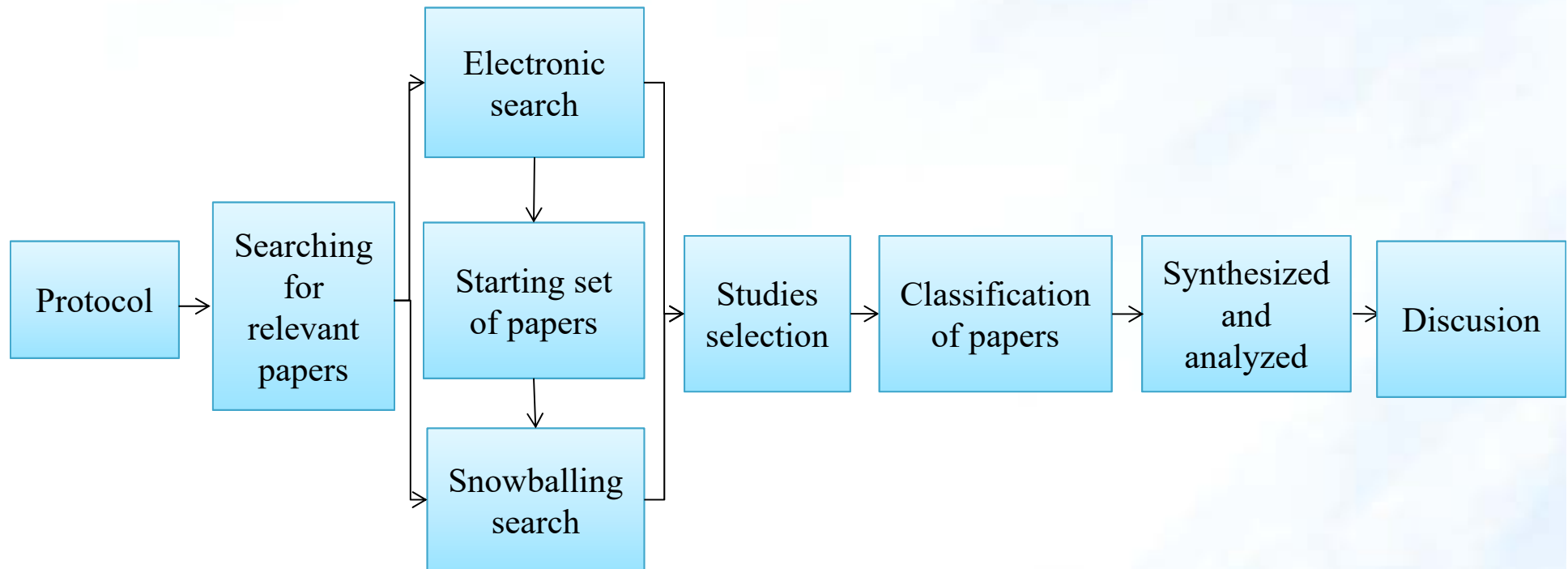
Background(4/5) —Research Approach

Systematic Literature Review(SLR)

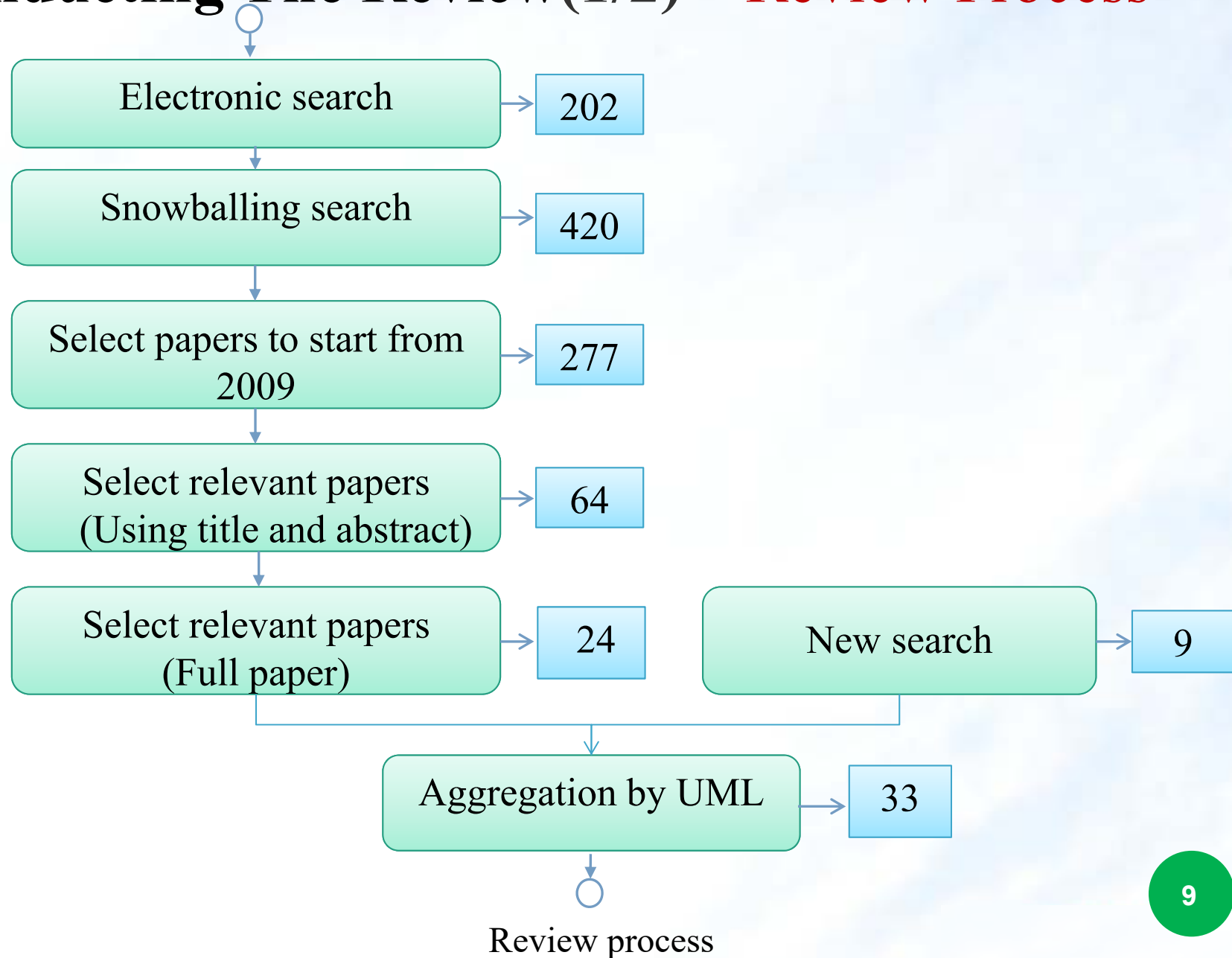
- A means of identifying, evaluating all available research relevant to a particular research question, or phenomenon of interest[6].
- Provides a key instrument to gather expert opinions and transfer them to evidence in software engineering.

[6] B.A. Kitchenham, T. Dyba, and M. Jorgensen. "Evidence-Based Software Engineering." Proceedings of the 26th International Conference on Software Engineering. 2004, pp.273-281. Information and Software Technology. Vol. 55. pp.1119-1142, 2013.

Background(5/5) — Research Approach



Conducting The Review(1/2)—Review Process



Conducting The Review(2/2)

—Results of Classification

Table I. Classification of papers

	Interpretation	Electronic search	Snowballing search	New search	Total
Comprehension	The ability to understand UML model	3	6	3	12
Model quality	The properties of the model itself	2	4	3	9
Adoption	How exactly is UML used in practice	1	3	2	6
Metrics	A set of standards for measuring UML model	0	2	1	3
Methods and tools	Creating tools or using methods for detecting UML notation.	0	3	0	3
Total		6	18	9	33

Reporting Results(1/5)

—Summary of Comprehension Results

Studies in these category mainly concerned about the ability to understand UML model.

Table II. Characteristics of the studies investigating com

Study	comparison	Type(s) of participant	Sample size	Measure	conclusions
[7]	Different layout strategies	23 design experts, 22 design novices	45	Quantitative analysis (accuracy, speed, confidence level and preference)	The multi-cluster layout achieves a higher level of accuracy and takes less time than the orthogonal layout
[8]	Orthogonal vs Three-cluster vs Multi - cluster	Undergraduate students and graduate students	14/15	TSEC, The confidence level	Multi-cluster stereotyped layouts improve the comprehension.
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Reporting Results(2/5)

—Summary of Studies Addressing UML Quality

Table III. Characteristics of the studies

Study	Research question	Notations	Type of study	Sample size	Participants	Results
[9]	Which adapted notations (annotation or colour) are more efficient to capture the location /context of activities?	Activity Diagrams	1 Controlled experiment	46	Students	There is no significant difference, but the colour alternative comes out as slightly better.
[10]	How the effectiveness of complementing class diagrams with object diagrams in the understandability of software systems?	Class diagrams	1 Replicated experiment	24	Graduated students	There is a clear improvement in the understandability of software systems when used object diagrams.
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The group 'UML-use' is only focus on how effective the different UML notations are.

Reporting Results(2/5)

—Summary of Studies Addressing UML Quality

Table IV. Characteristics of the studies us

Study	Research question	Notations	Experimental treatment	Sample size		
[11]	How does the use of UML modeling impact upon the quality of software projects?(case study)	Class diagrams	Case study	25	Participant from project's staff	Classified classes have significantly lower defect density than those that are not modeled.
[12]	Whether class or sequence diagrams are reflected in improved the quality of the implemented code (measured in defect density)?	Class diagrams and sequence diagrams	Post hoc analysis	25 (India)	Developers in India and the Netherlands	The productions of UML class and sequence diagrams reduce defect density in the code.
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The group 'UML-properties' is mainly focuses on the properties of the model itself rather than its form.

Reporting Results(3/5)

—Summary of Adoption Results

Adoption of the UML studied how exactly the UML used in practice, and participants had relevant programming experience.

Table V. Summary of studies focus on the

Study	Research question	Type of study	Sample size	Types of participant	Time duration	Result
[13]	How the extent to which design models is used before coding?	Survey	3785	Research programmers	About 15-20 one person	Design models are not used very extensively in industry, the use is informal and without tool support and the notation is often not UML.
[14]	What the benefits of using UML in software maintenance?	Survey	178	Professionals	15 minutes	No conclusion.
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Reporting Results(4/5)

—Summary of metrics papers

Studies on metrics is related to a set of standards for measuring UML model

Table VI. Summary of studies on UML met

Paper ID	Research question	Notations	Study type and number	Sample size	Types of participant and context	Dependent metric	Task duration
[15]	What the effect that structural complexity has on the understandability of the statechart diagram	Statechart diagrams	1 controlled experiment and 2 replications	18/24/49	Students and professionals (UCLM)	Understandability, complexity of UML statechart diagrams	1 week
.....							

Reporting Results(5/5)

—Summary of methods & tools results

Studies on this category is focus on creating some tools or using methods for detecting UML notation.

Table VII. Details of papers investigating methods & tools

Study	Research question	Notations	Study type and number	Sample size	Types of participant and context	Task duration	Main conclusion
[16]	How feasible is the CCUJ approach supports conformance checking between a UML design and a Java implementation.	class diagram	2 experiments	N	Developers in industrial-strength software systems	N/A	Using CCUJ technology to check the conformance between a UML class diagram and a Java implementation performed significantly reaction
.....							

Discussions(1/3)

—**For Research Question 1**, “Which diagrams of the UML are most frequently used in empirical study?”

Table VIII. Results per type of diagram

Available diagram	Number of studies	Percentage	List of papers
Class diagrams	19	47.5%	[8-14,16,20,22,23,26,30-33,35,39,40]
Sequence diagrams	6	15%	[11,14,23,26,28,34]
Use case diagrams	5	12.5%	[12,19,23,33,38]
UML diagrams	3	7.5%	[29-31]
Activity diagrams	4	10%	[12,21,27,35]
Startchart diagrams	2	5%	[16,36]
Component diagrams	1	2.5%	[27]

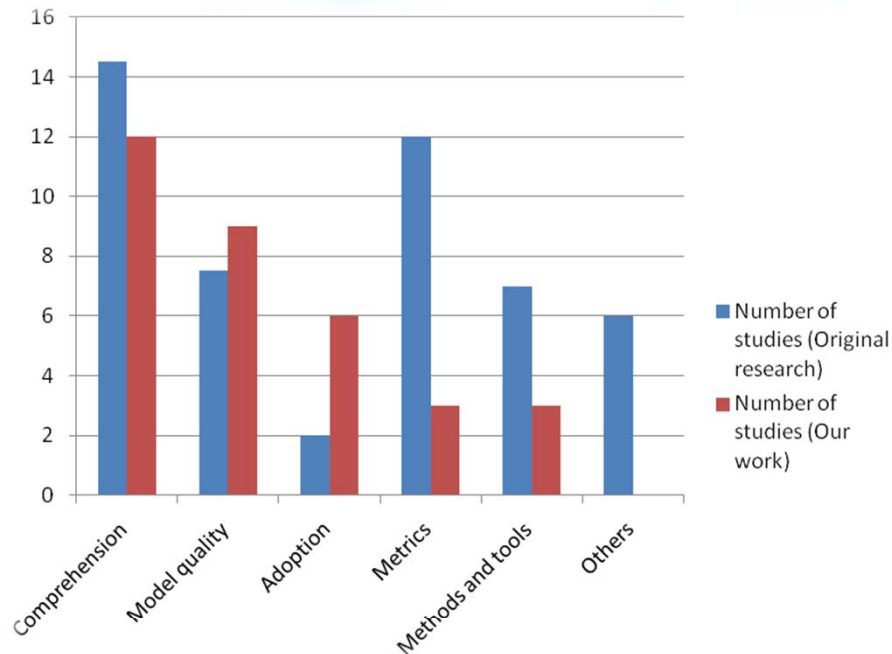
Discussions(2/3)

—**For Research Question 2**, “Which aspects of the UML could be recommended as the subject of further empirical research?”

- UML quality, adoption as well as comprehension could be present as a topic which needs further investigation.
- The task of comprehension had constantly been considered by the researchers.
- Also, more attention is paid to the quality of models, because it directly affects the quality of the understanding of the application domain.

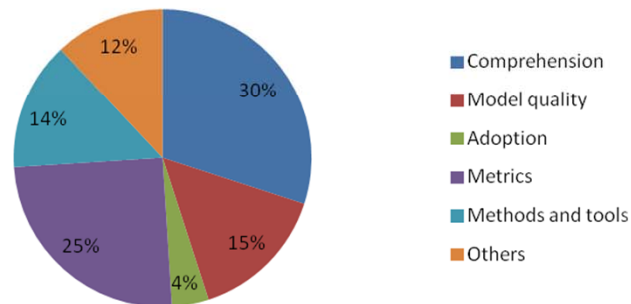
Discussions(3/3)

—For Research Question 3, “What is the change in the research of UML in recent years?”

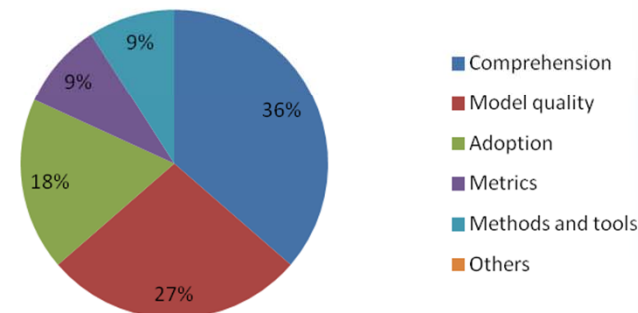


- UML metrics has presented a significant decreasing trend whereas the original study holds the opposite view.
- Adoption gradually into the line of sight of researchers regarding the use of UML in software development or maintenance.
- The subjects that performed the task are mostly students, most of the studies performed controlled experiments with laboratory context.

Percentage(Original research)



Percentage(Our work)



Conclusions

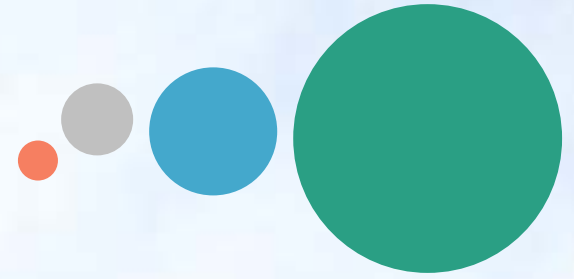
- ✓ Adoption of UML is being studied by researchers and will be more and more interested in industry practitioners. Study concentrates on comprehension had a tendency to continue for future studies .
- ✓ Beyond our expectations, several studies revealed the motivation essentially by situation of modeling is not widely adopted.
- ✓ More studies are also necessary conducted with professional software engineers or practitioners to raise the generalizability of the results.
- ✓ For the future work, we hope to focus on the specific diagrams and investigate what the effectiveness of the notation.

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Thank You