

Systematic Reviews with ReLiS

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Outline

1. Background on systematic reviews
2. Tool support: ReLiS
3. Challenges of conducting systematic reviews
4. Discussion: systematic review RL4SE

Secondary research

- **Narrative review**

- Overview of current knowledge in a topic
- *Informal survey*

- **Systematic review**

- More detailed and rigorous
- Review a research question
- Reproducible methodology for searching papers and analyzing results

- **Meta-analysis**

- Systematic review with statistical analysis to compare papers and derive new interpretations or new findings

Systematic review (SR)

(Kitchenham, 2004)

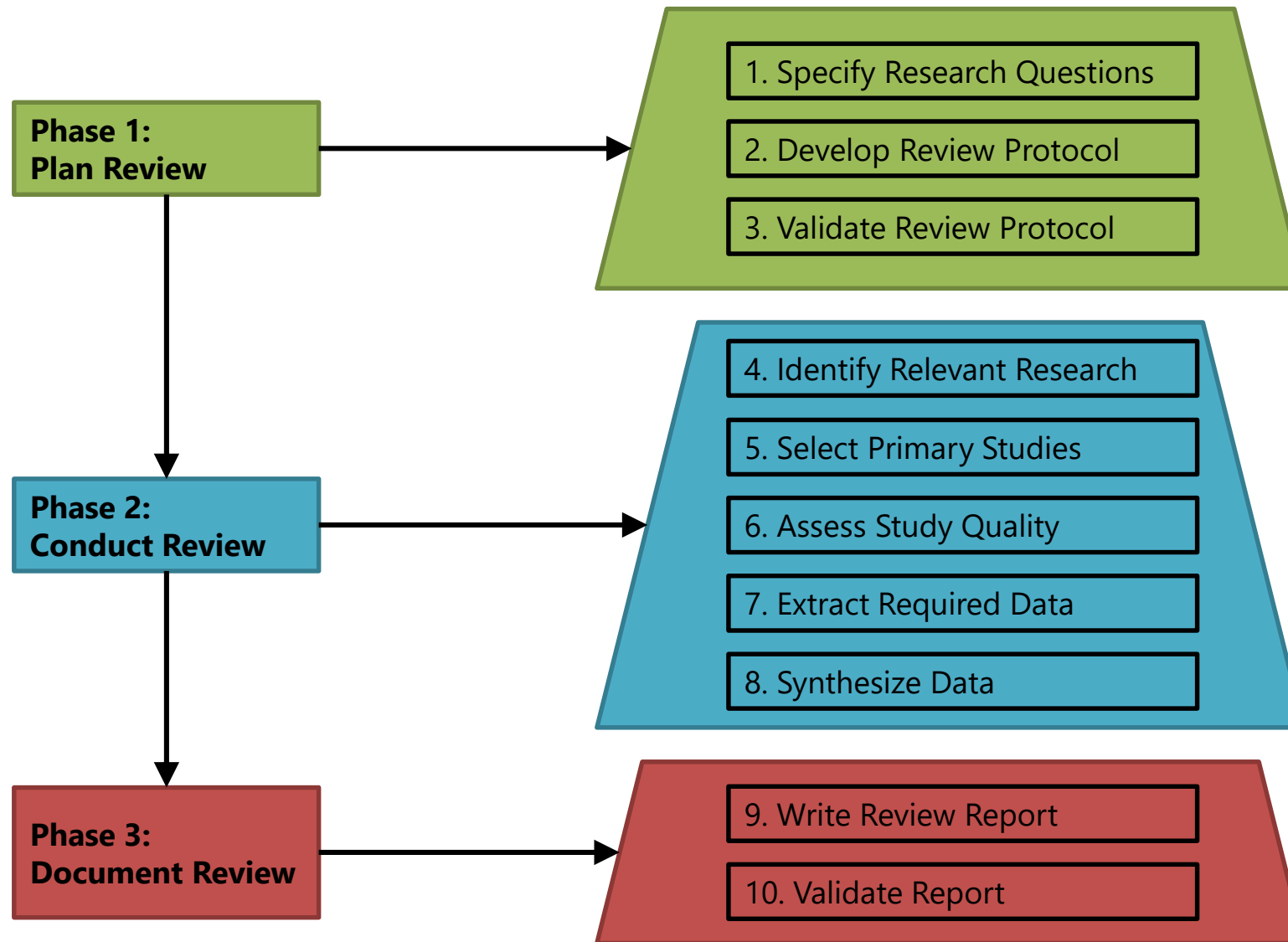
Research strategy used to extract new knowledge from existing studies

- Collect empirical proofs from existing studies corresponding to eligibility criteria to answer a specific research question
- Systematic \Rightarrow methodological, repeatable, low bias

Systematic reviews in software engineering (SE)

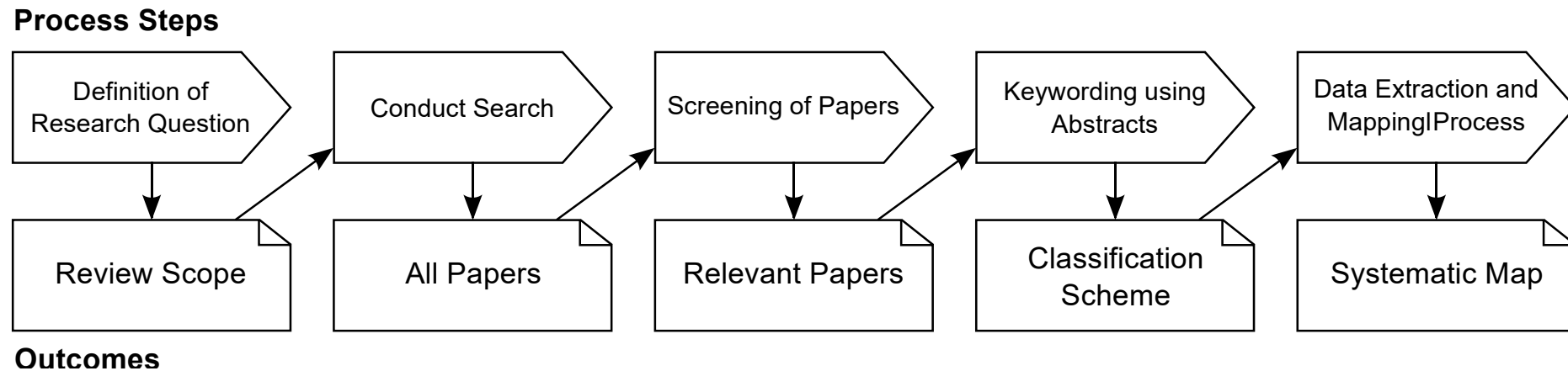
- **Systematic Literature Review (SLR)** (Kitchenham, 2007)
 - Collects, synthesizes, and analyzes results of primary studies
 - Studies them in detail to answer precise questions empirically
 - Quality of primary studies is important
- **Systematic Mapping Studies (SMS)** (Petersen, 2015)
 - A.k.a. **Scoping review**
 - Classifies primary studies into categories to demonstrate research trends in a domain
 - Overview of a research domain and on quantity of available research
 - Analyzes a larger corpus than SLR

Process of Systematic Literature Reviews



(Brereton et al., 2007)

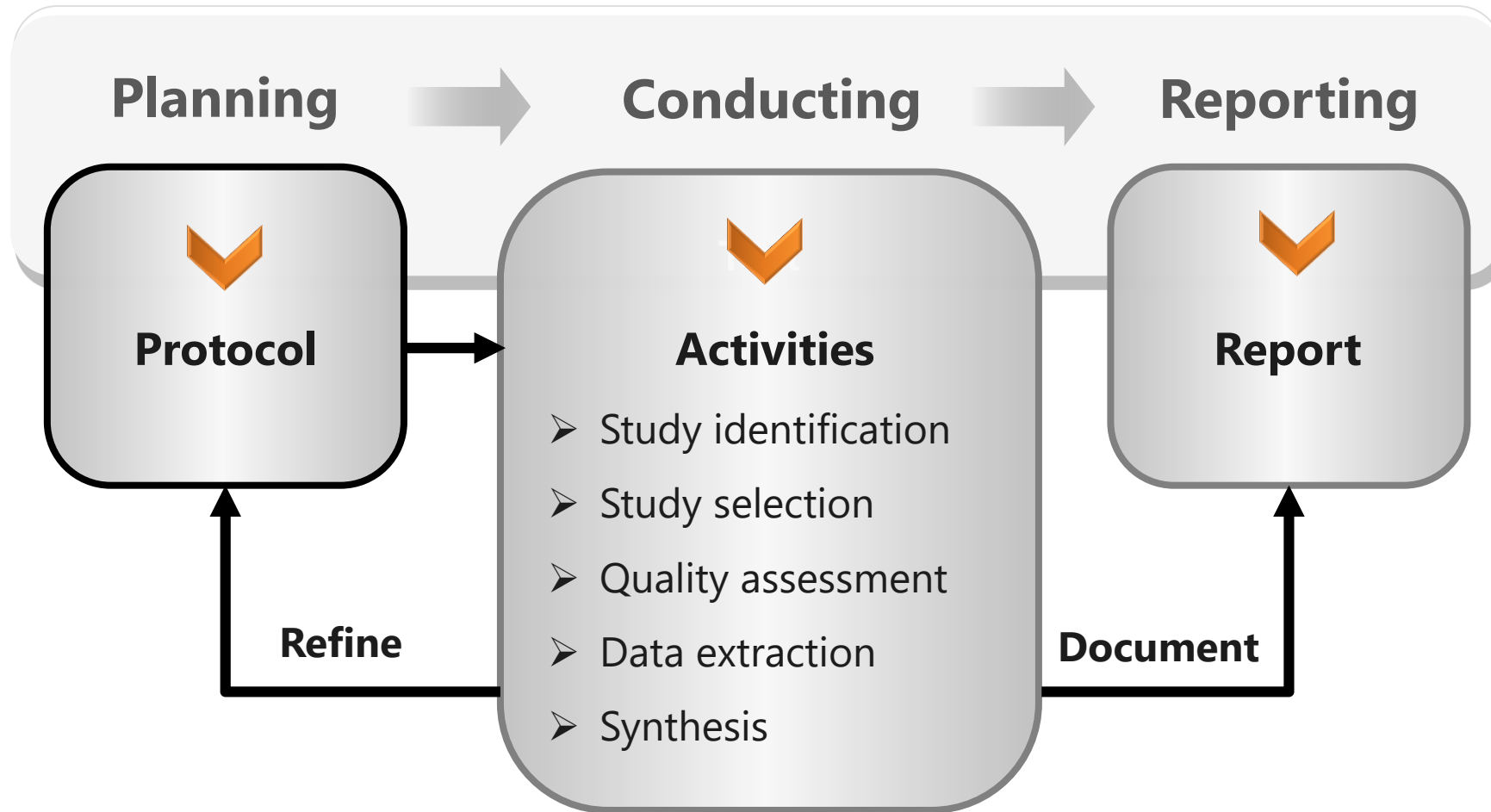
Process of Systematic Mapping Studies



(Petersen et al., 2015)

Systematic review process

Iterative process!



Planning

Need to perform SR

- Scientific, temporal reasons
- Number of primary studies available
- New review or update

Research questions

- Scope
- Objectives
- PICOTS format
- Time interval

Paper identification strategy

- Data sources
- Keywords
- Automatic search
- Manual search
- Snowballing
- Duplicate resolution
- Pilot studies

Study selection strategy

- Inclusion, exclusion criteria
- Phases: meta-data, entire text
- Number and role of reviewers
- Conflict resolution strategy

Evaluation of study quality

- Q&A check list
- Quality threshold
- Bias risk

Data extraction and synthesis strategy

- Classification scheme
- Data extraction form
- Quantitative and qualitative analysis techniques of the data

Dissemination strategy

- Report of protocol
- Publication of results
- Appendix for bibliography, extracted data, statistical analysis

Conducting

Identify candidate studies

- Execute search
- Collect meta-information and complete text
- Clean corpus, eliminate duplicates, correct references

Study selection

- Multiple phases
- Distribution of screening among reviewers
- Conflict detection
- Conflict resolution
- Validation by expert

Quality assessment

- Identify control list of studies
- Evaluate each study by answering to precise questions
- Decide to include/exclude study with low score

Data extraction and synthesis

- Fill data extraction form per retained study
- Collaboration among reviewers
- Conflict detection and resolution
- Validation by expert
- Synthesize to statistically analyze data

Reporting

Publish corpus

- References of included studies

Publish extracted data

- Tabular format
- Explanation of codes

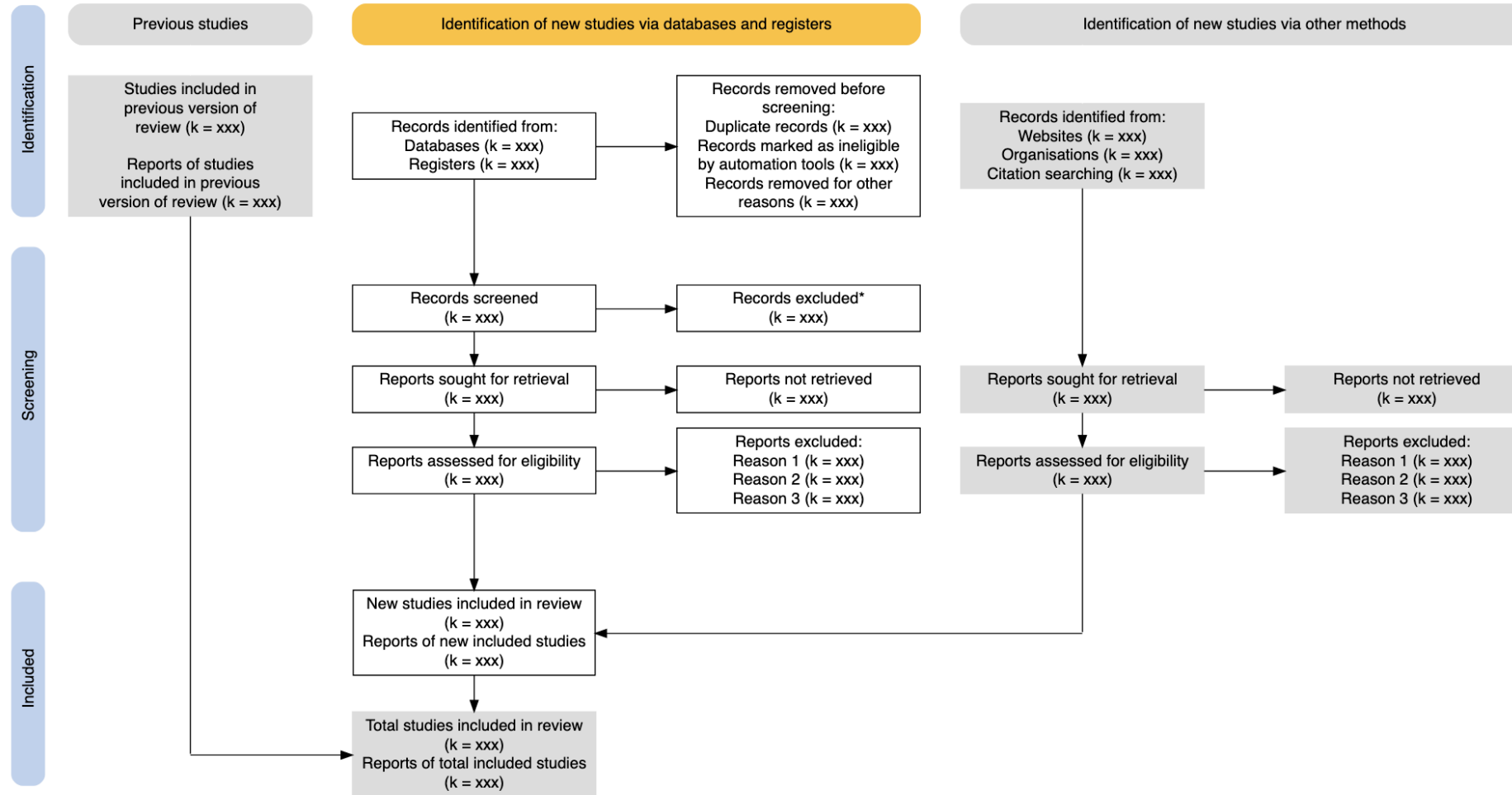
Publish protocol report

- Who, Where, How
- Pilot studies
- Manual corrections

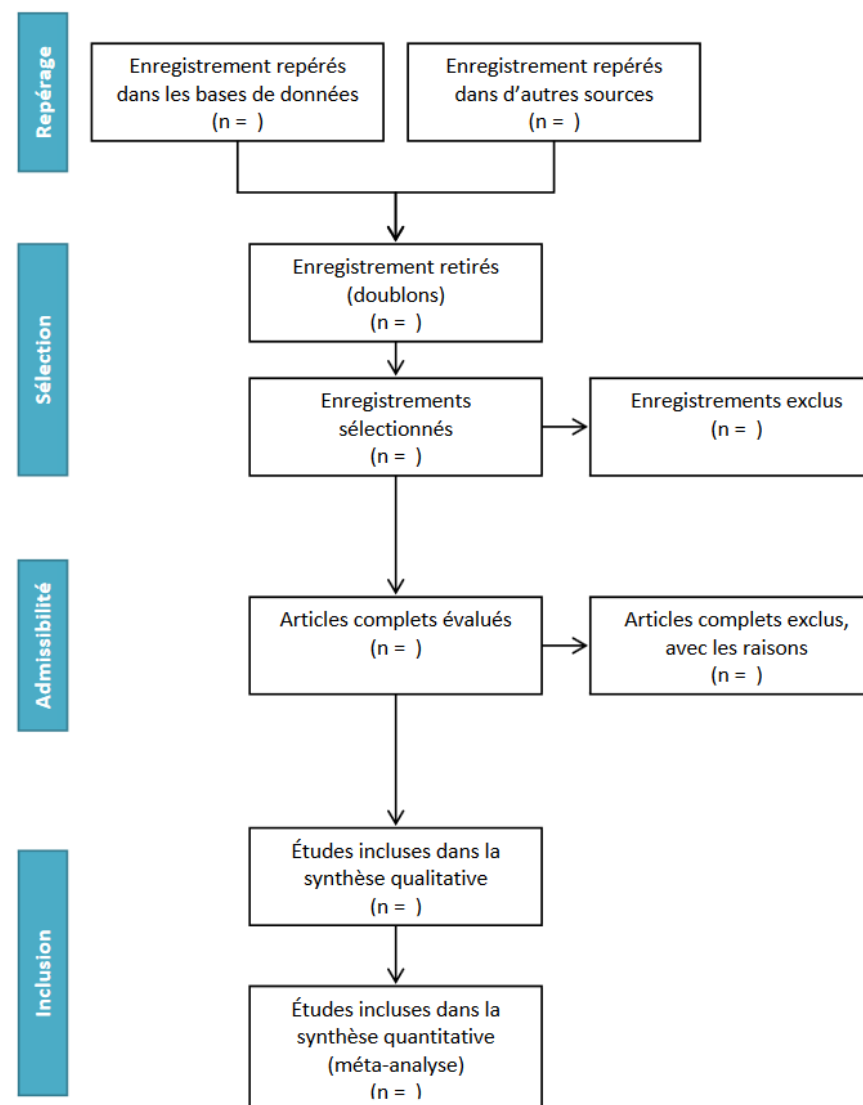
Publish results

- As a scientific contribution
- Good motivation
- Related work on topic and on methodology
- Interpret findings

PRISMA flow diagram



PRISMA flow diagram (simplified)



Notable standards

- **PRISMA** checklist <https://prisma.shinyapps.io/checklist/>
- **PICOTS** to formulate scope
- Methodology for **systematic literature reviews** ([Kitchenham et al., 2007](#))
- Methodology for **systematic mapping studies** ([Petersen et al., 2015](#))
- Guide to **snowballing** ([Wohlin, 2014](#))
- Systematic review **updates** ([Mendes et al., 2020](#))
- **Experimentation** in software engineering ([Wohlin et al., 2012](#))

Problem in conducting SR

Complex process

- A lot of activities
- Iterative process
- Collaboration

Time consuming
Error prone

SR tools

- Automate activities
- Generative approach
- On-the-fly installation
- Web based

Reduce time
Improve SR quality

Tool support for SR

- Reference management & text-mining
 - EndNote, RefWorks, Zotero, JabRef, **BiBler**
- Specific to software engineering
 - StArt, Parsifal, SESRA, SLuRP, SRLTOOL, **ReLiS**
- Used in other disciplines
 - Eppi Reviewer, Convidence, DistillerSR, RevMan

Cannot modify configuration of SR procedure on-the-fly

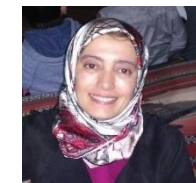
Cannot pilot reviews

ReLiS

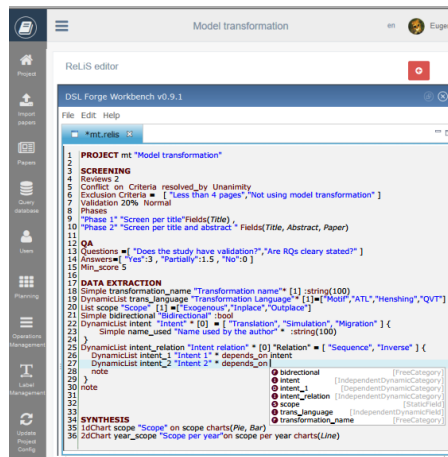
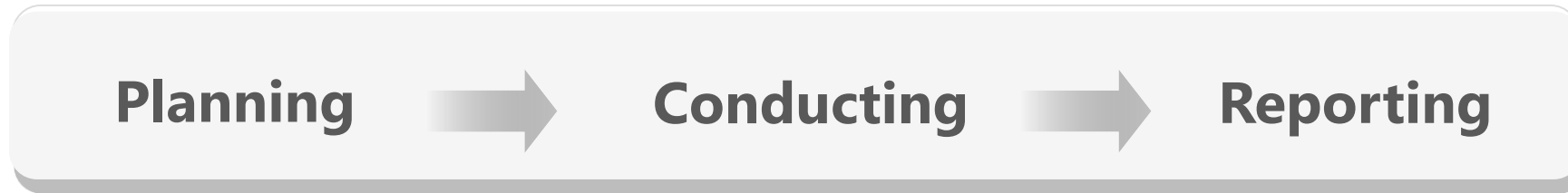
B. Bigendako and E. Syriani. **Modeling a Tool for Conducting Systematic Reviews Iteratively**. Model-Driven Engineering and Software Development. Scitepress: 1, pp. 552–559 (2018)

The team

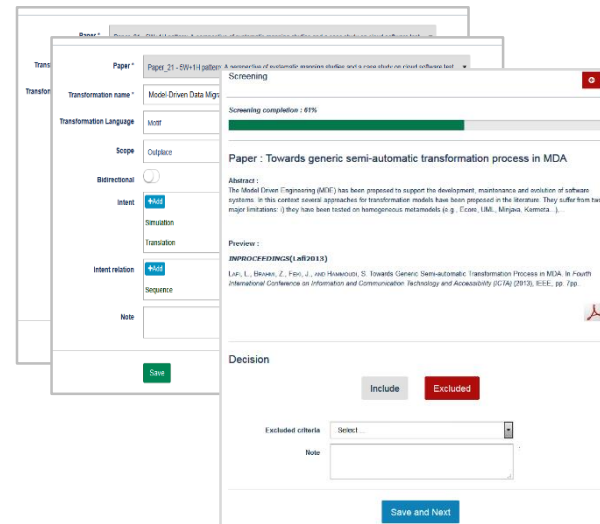
- **Brice Bigendako**'s M.Sc. thesis (main initial developer)
 - <https://papyrus.bib.umontreal.ca/xmlui/handle/1866/20187>
- Mitacs GlobalLink interns (improving functionalities)
 - **Naveen Kumar, Purboshi Das, Gauransh Kumar**
- Student projects
 - **Mahamat Youssouf Issa** (test automation),
Lucas Hornung (report generation)
- Research assistant: **Naima Essadi** (integration)
- Supervision: **Prof. Eugene Syriani**



Flexible tool for conducting SR collaboratively and iteratively



DSL for configuration

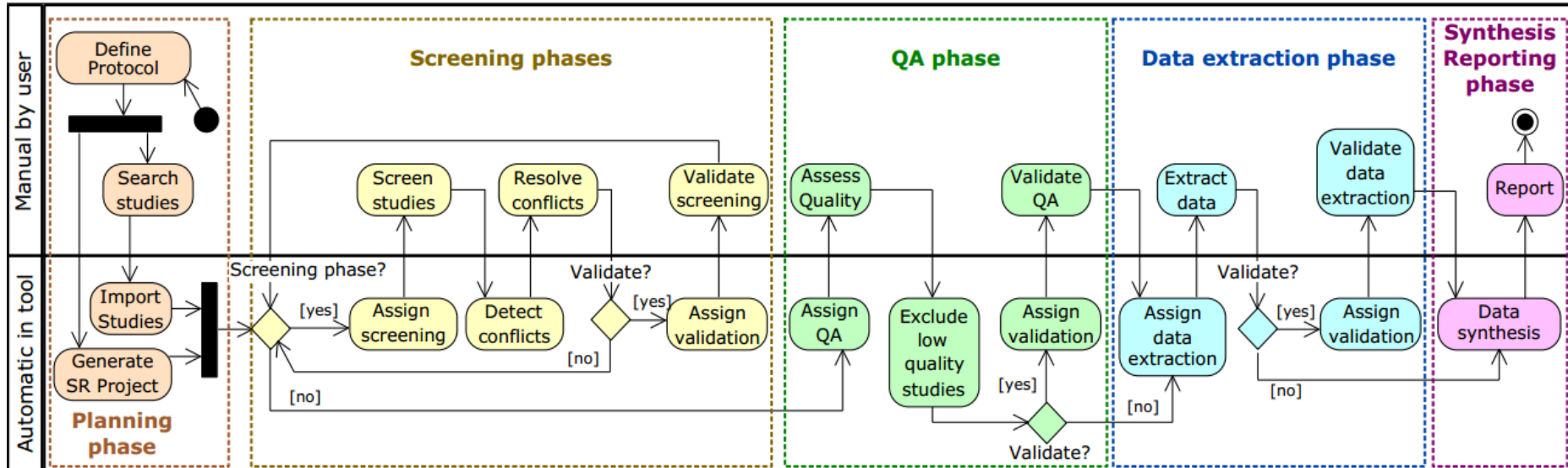


Generated web application

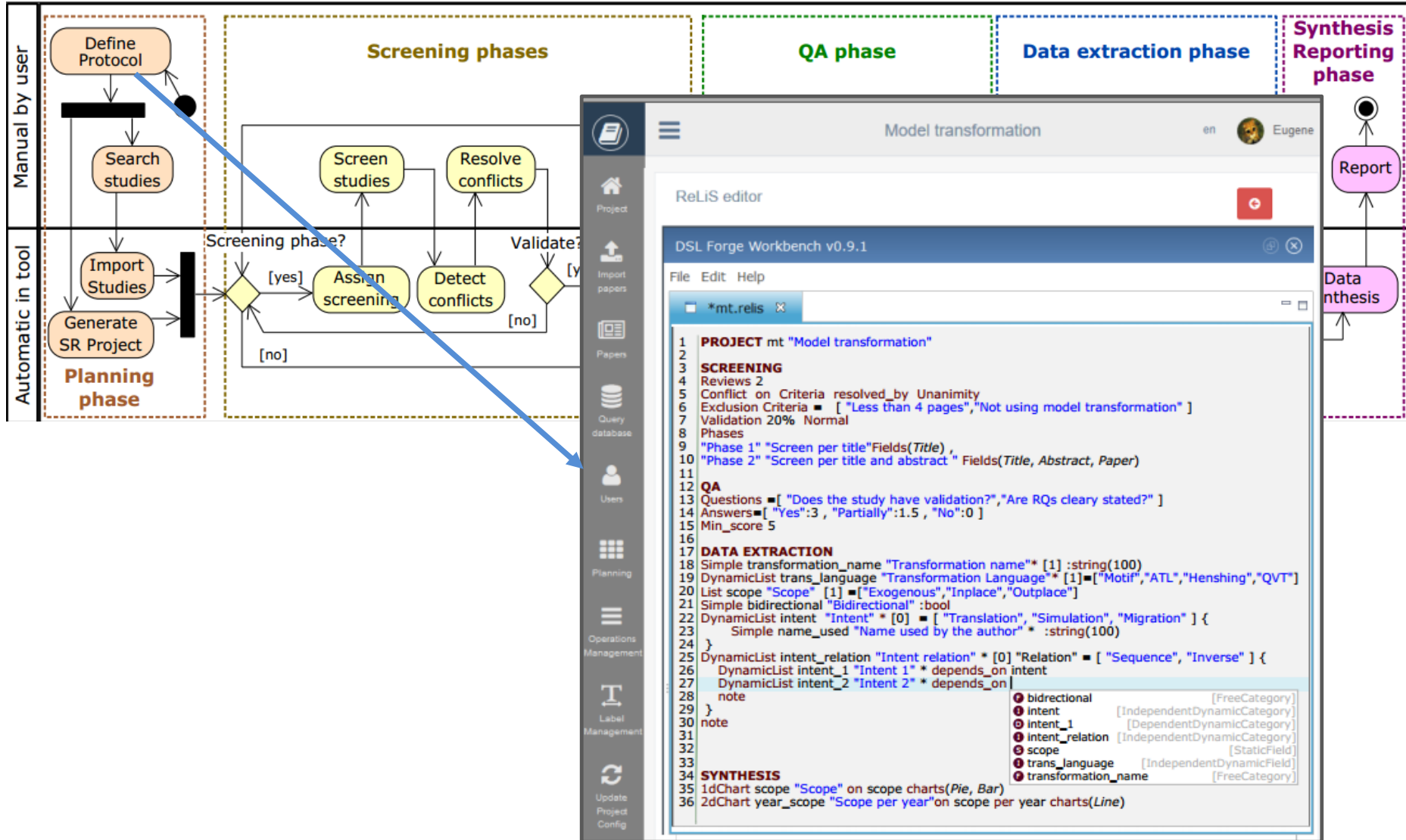


Synthesize data

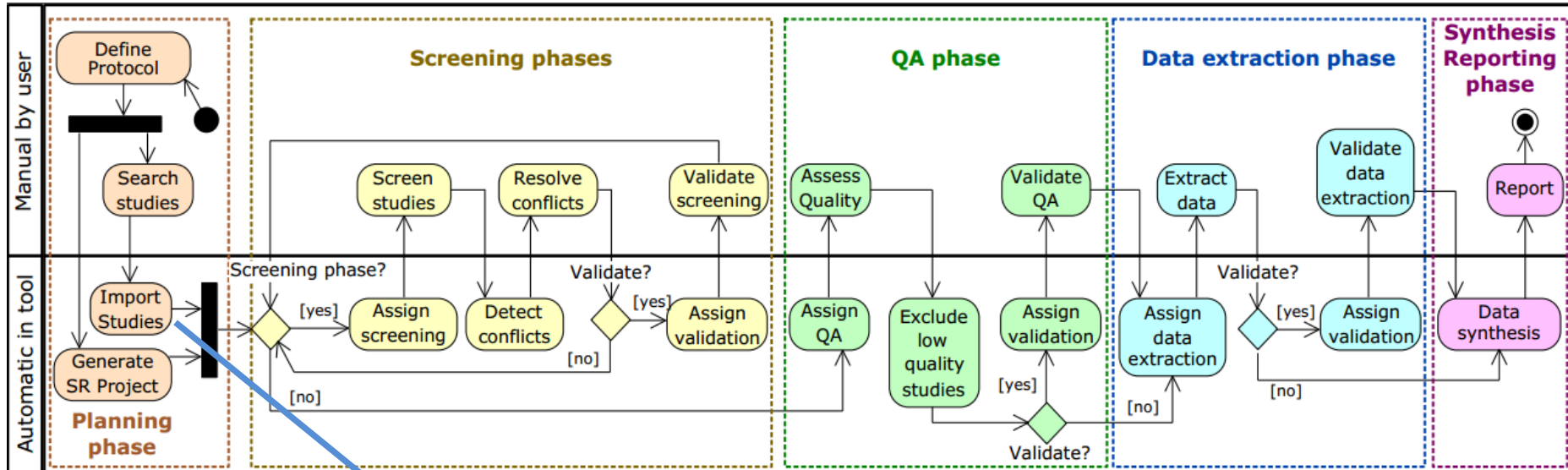
SR workflow in ReLiS



SR workflow in ReLiS

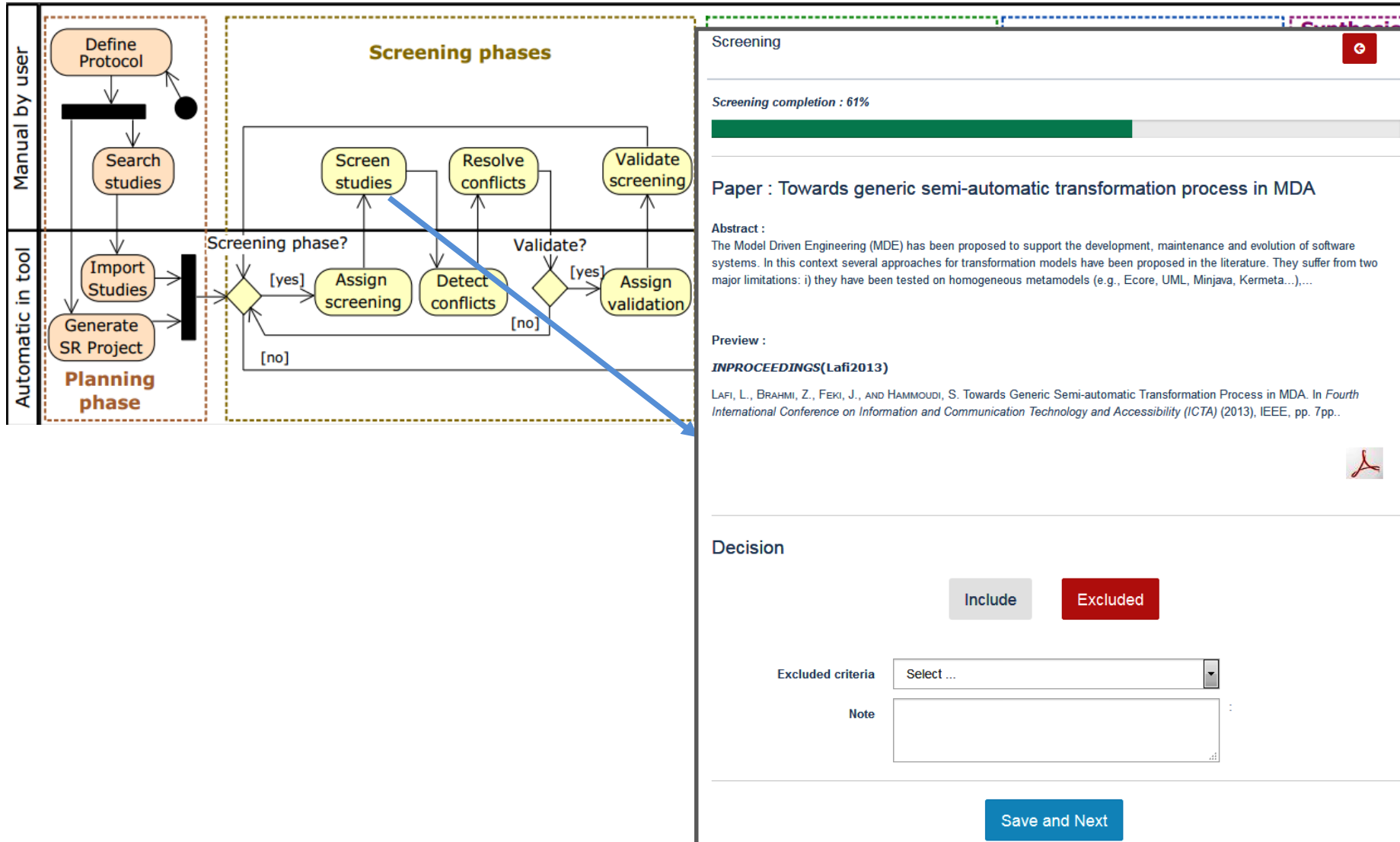


SR workflow in ReLiS

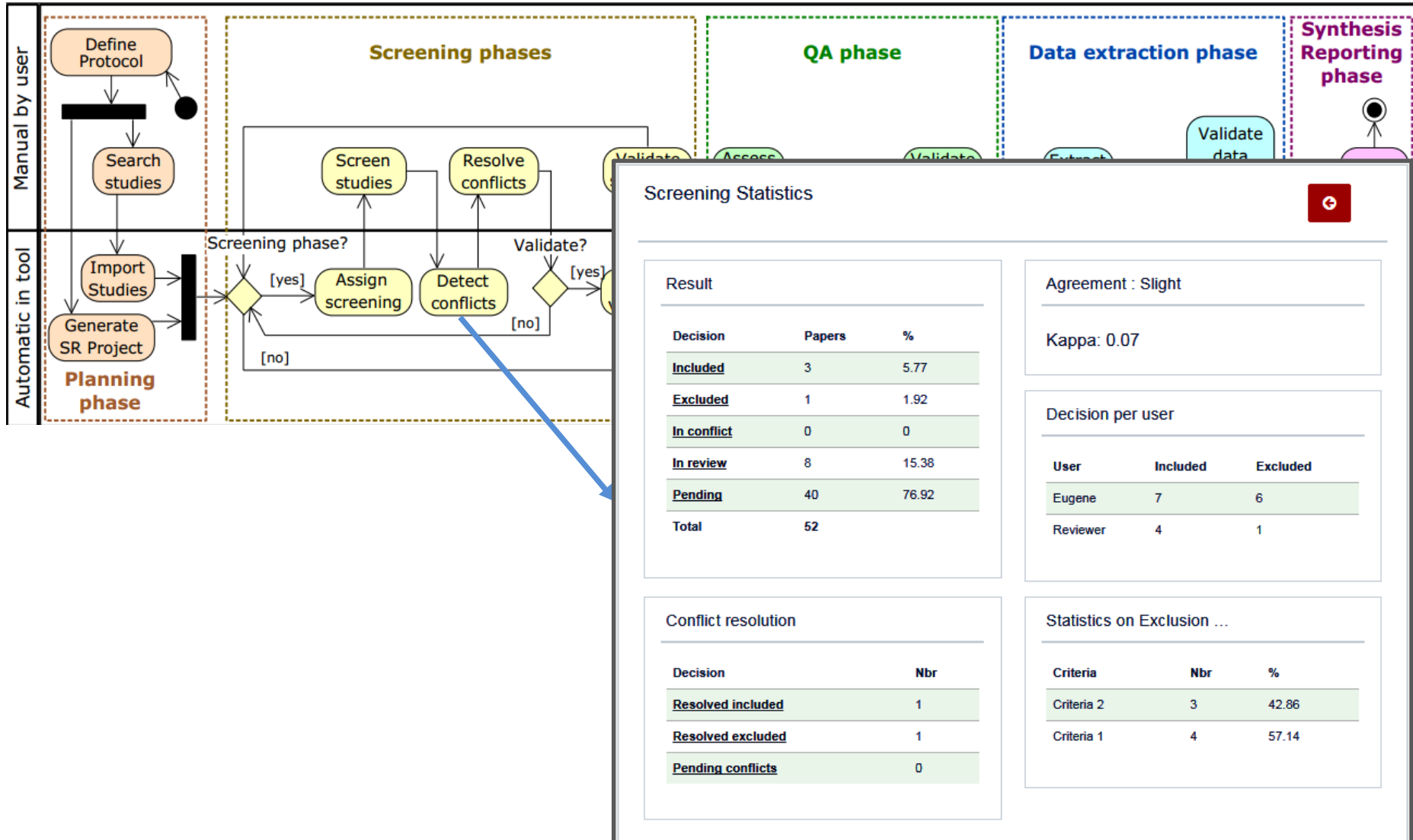


- Manual entry
- CSV
- BibTeX
- EndNote

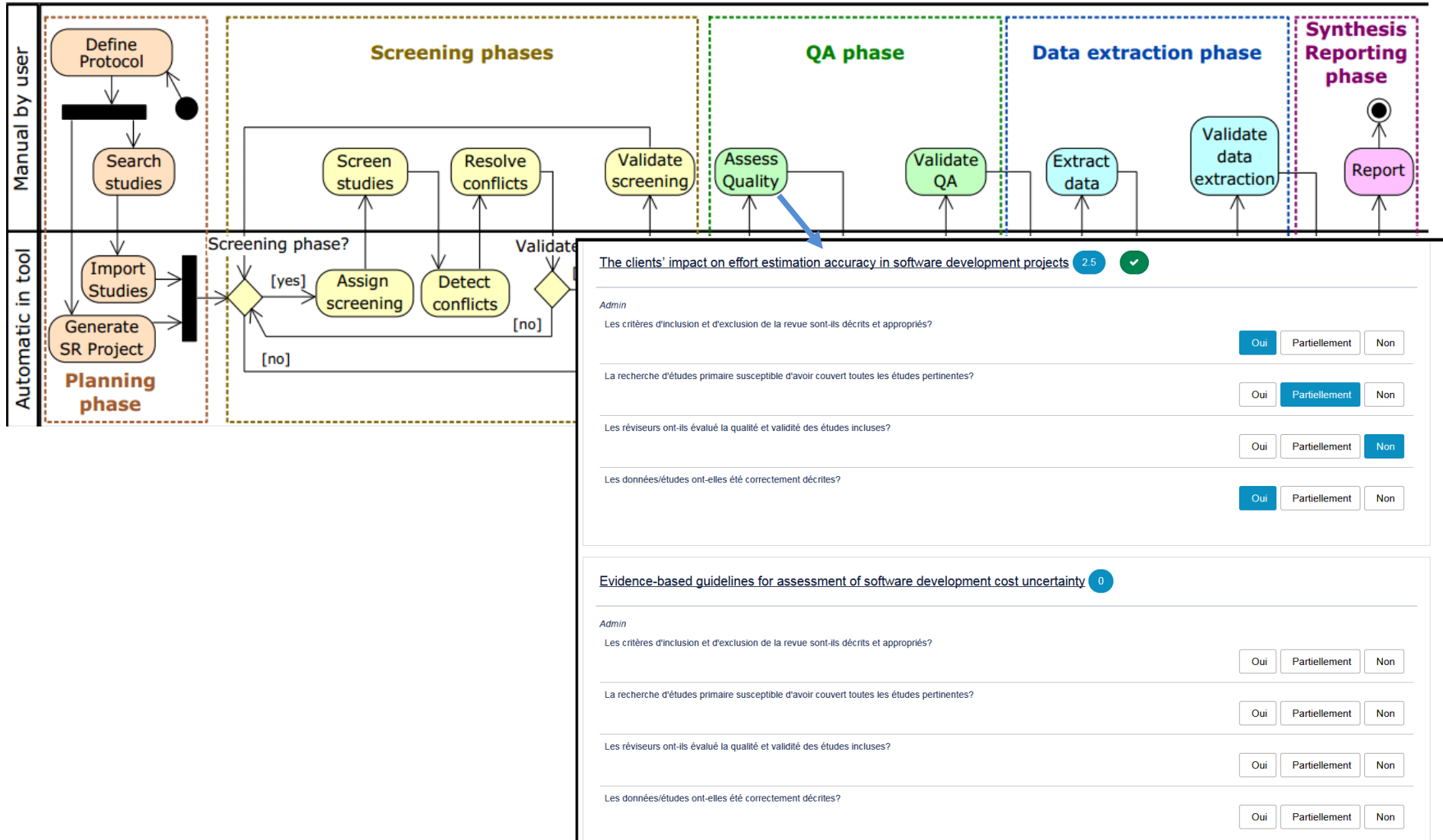
SR workflow in ReLiS



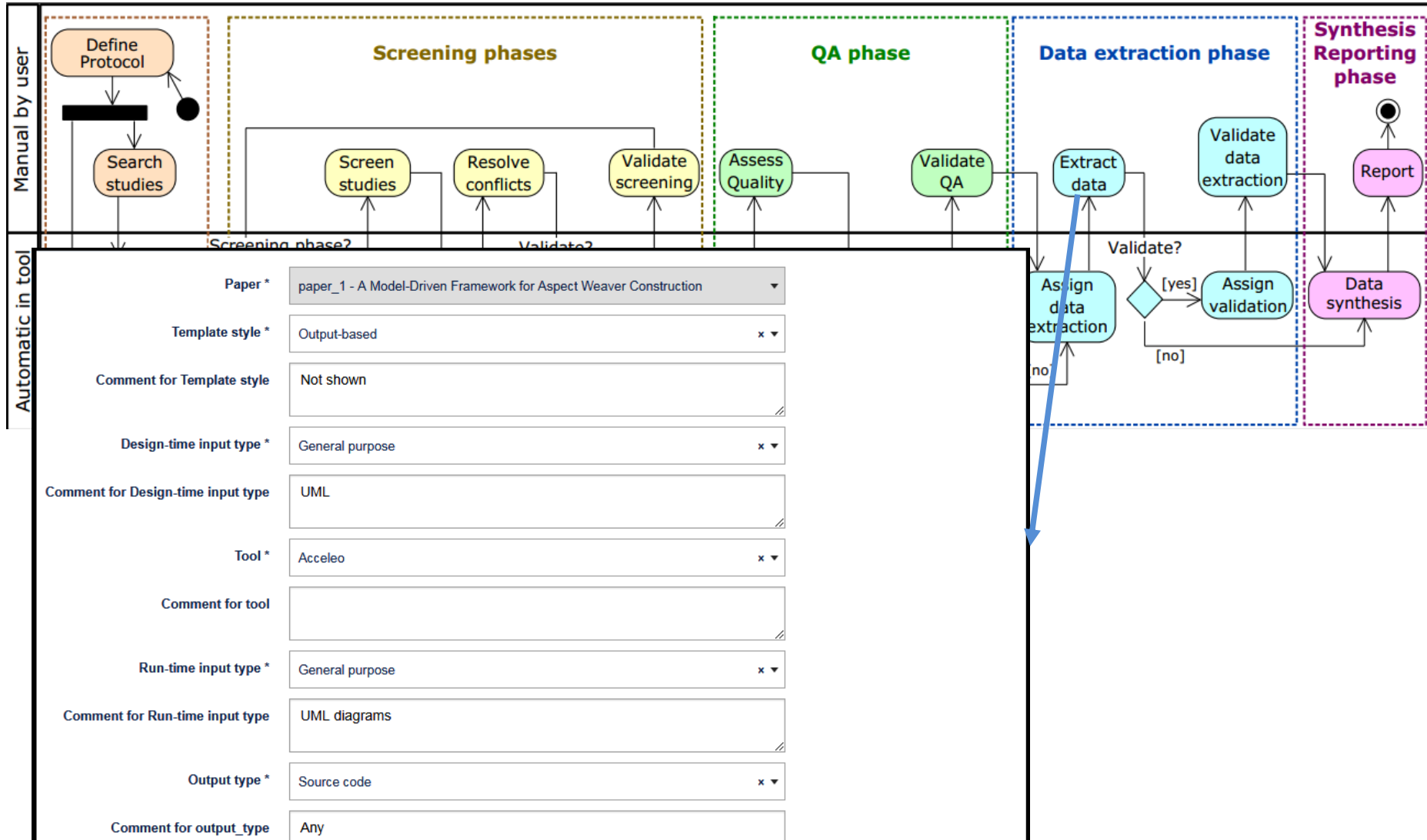
SR workflow in ReLiS



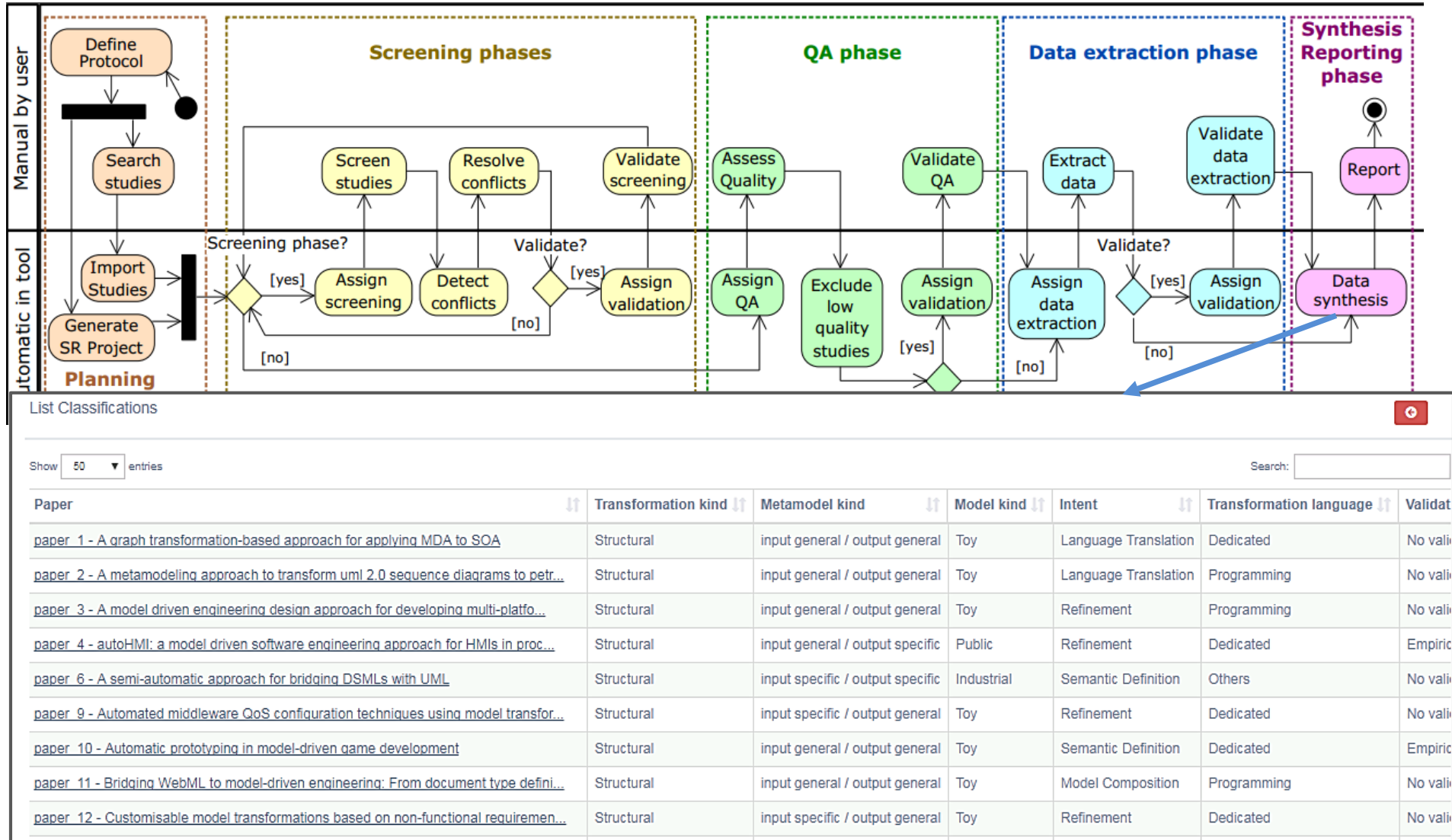
SR workflow in ReLiS



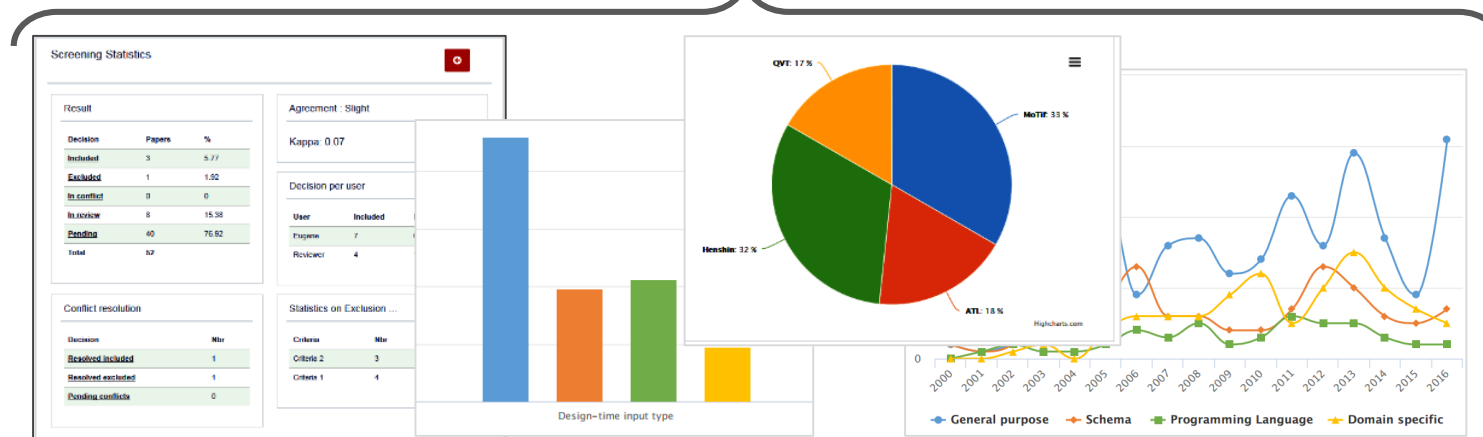
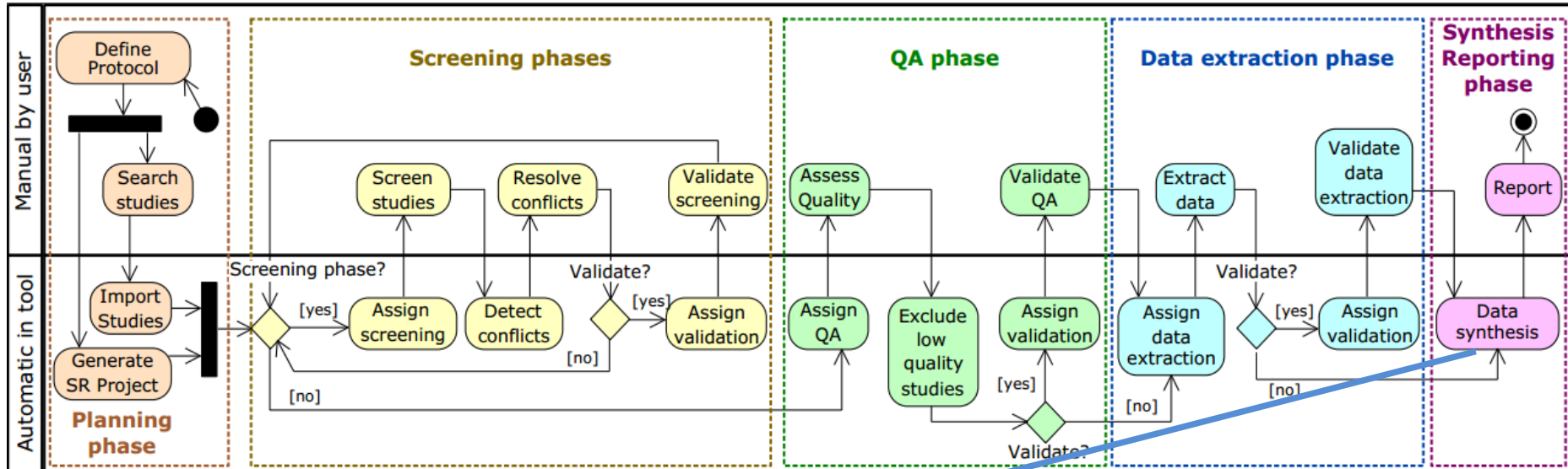
SR workflow in ReLiS



SR workflow in ReLiS



SR workflow in ReLiS

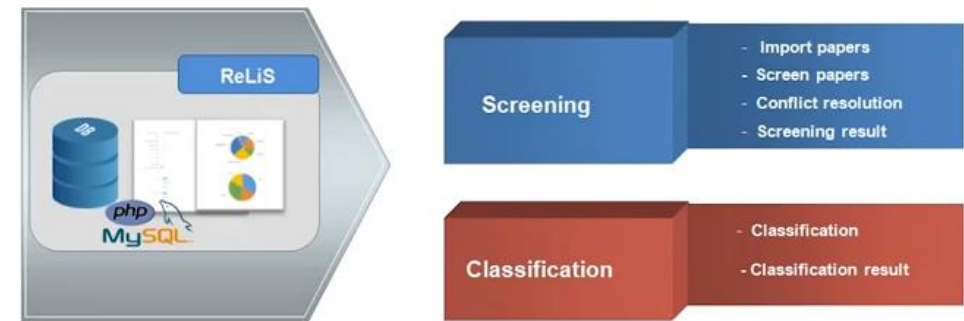


ReLiS in action



<https://youtu.be/EFkMGfwCBsM>

In this video we will show how to perform a systematic review following this process:



<https://youtu.be/U5zOmk2vWy8>

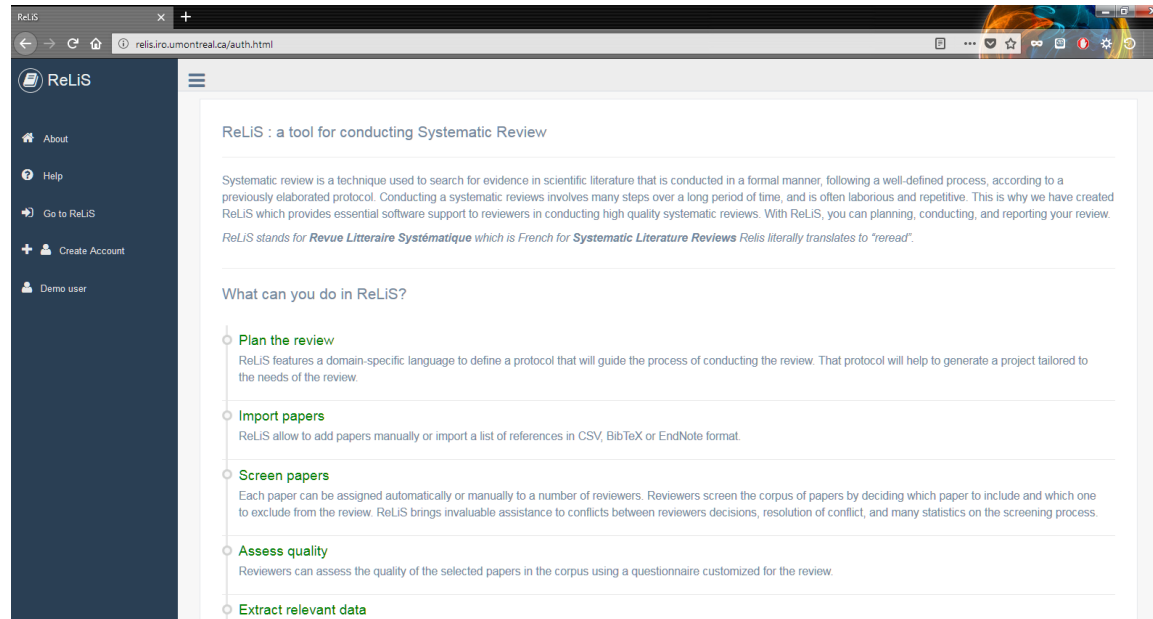
Feature coverage

Weight	Top ranked high-level features	StArt	Parsifal	SESRA	ReLiS	SLuRP	SLRTOOL	SLR-Tool
10	Collaboration Support	100%	100%	100%	100%	100%	66%	0%
9	Integrated Search	26%	62%	53%	9%	17%	17%	17%
8	Traceability	100%	75%	75%	75%	25%	50%	50%
7	Support Text Mining	23%	30%	7%	0%	14%	14%	14%
6	Support Inclusion and Exclusion	60%	30%	30%	40%	20%	30%	30%
5	Support Quality Assessment	100%	50%	50%	100%	50%	50%	50%
4	Data Maintenance	100%	100%	100%	50%	100%	100%	100%
3	Automated Analysis	50%	50%	50%	67%	66%	33%	33%
2	Visualization	60%	60%	60%	67%	90%	60%	60%
1	Coding of Methods and Data	14%	0%	0%	86%	14%	14%	0%
1	Storage of Studies	66%	66%	66%	67%	66%	66%	66%
	Total score	68%	63%	59%	55%	48%	44%	32%

Feature coverage evaluation using (Al-Zubidy et al., 2017)

- 4th place on high level requirement: 55%
- 2nd place with no Integrated search + Text mining: 76%
- **1st place on all requirements: 58%**

ReLiS tool availability



<http://relis.iro.umontreal.ca>



<https://github.com/geodes-sms/relis>



Tools to use with ReLiS

Bibliography curation



[BiBler](#): standard formatting for BibTeX



[EndNote](#): collects abstracts + keywords, efficient duplicate detection, collaboration



[JabRef](#)



[Zotero](#): grouping, extract directly from web

Analysis of extracted data



[Excel](#): cleaning data, clustering



[R](#)



[SPSS](#): statistical methods, graphs

Reporting

– LaTeX/MiKTeX  [Overleaf](#)  [TeXStudio](#)

Tips using ReLiS

Setup and import

- **Assign roles appropriately:** administrator, project manager, validator, reviewer
- You may need to **query the database** for more advanced manipulations
- Typical **workflow to import papers:**
 1. Download references from online databases in EndNote format (ensure abstract is available)
 2. Create groups for each source
 3. Eliminate duplicates
 4. Export them to BiBler Export format
 5. Import them into BiBler, clean, and save
 6. Import them into ReLiS

Tips using ReLiS

Screening

- Beware that **all statistics are updated continuously**
 - If you add new papers in a screening phase, all statistics are going to be updated
 - If you resolve conflicts they will not appear in the statistics and kappa anymore
- Take screenshots of the statistics page at key moments
- Project managers can **reassign papers** to other reviewers if needed

Tips using ReLiS

Data extraction

- Define your **classification schema before** producing data in the project
 - Every category should be properly defined
 - If you significantly change the classification scheme after screening, create a new project with classification only and import the included papers from the other project
- Use **DynamicList** fields as much as possible for better statistics and more flexibility
- **Maintain a log** of important milestones in a separate document, e.g.
 - Date and number of imported papers from a source, search string
 - Date of each activity and screenshot of their statistics

Challenges encountered in Systematic Reviews

Lessons learned from applying SLRs in SE
(Brereton et al., 2007) + mine

Challenges encountered in SR

1. Specify research questions

Expect to **revise RQs during protocol** development,
as your understanding of the problem increases

Not while conducting the review!

A **pre-review mapping study** may help in scoping RQs

Include an RQ about **publication trends** and
an RQ about **tool support** when appropriate

Challenges encountered in SR

2. Develop review protocol

All reviewers must **collaborate** to develop the review protocol

Piloting the protocol is essential to find mistakes in data collection, may indicate to change the methodology to address the RQs

Challenges encountered in SR

3. Validate review protocol

Specific **validation process** separate from the protocol

Ideally, **external reviewers** should undertake this validation process

Challenges encountered in SR

4. Identify relevant research

Explore **alternative search strategies** to achieve different sort of search completion criteria

Search many **different sources**: no single source indexes all studies in SE
ACM DL, IEEE Xplore, SpringerLink, Web of Science, Google Scholar, Scopus

Some excluded papers (especially secondary studies) can make up your **related work**

Challenges encountered in SR

5. Select primary studies

The standard of SE **abstracts** is too poor to rely on when selecting primary studies: also review the **conclusions**

Make sure all reviewers understand the **inclusion** and **exclusion criteria**: the scope must be well-defined

Decide when to resort to **snowballing**: missed articles, enlarge corpus

Challenges encountered in SR

6. Assess study quality

Some disciplines require a QA step, but in SE it depends:
Sometimes for SLR, not for SMS

Decide how **QA** is used in data aggregation and analysis

Challenges encountered in SR

7. Extract required data

For large corpus, have 2 reviewers for each paper:
one **data extractor** and one **data checker**

Make sure **everyone understands** the protocol
and data extraction process

Identify **clusters** of papers for repeated/similar studies

Challenges encountered in SR

8. Synthesize data

Systematic reviews in SE are likely to be **qualitative** in nature

Tabulating data is a useful aggregation, yet explain how the aggregated data actually **answers the RQs**

Explain or interpret unexpected observed phenomena from the results

Challenges encountered in SR

9+10. Write review report + Validate report

Keep a detailed **record of decisions** made throughout the review process

To validate it, publish a **technical report**, have it reviewed then write a scientific paper about the findings

Report **threats to validity** and how they have been mitigated

Read other systematic reviews

Examples of systematic reviews in SE

- [1] E. Syriani, L. Luhunu, and H. Sahraoui. **Systematic Mapping Study of Template-based Code Generation.** *Computer Languages, Systems & Structures*: 52(1), pp. 43–62 (2018)
- [2] T. Kosar, S. Bohra, and M. Mernik. **Domain-specific languages: A systematic mapping study.** *Information and Software Technology*: 71, pp. 77–91 (2016)
- [3] B. Kitchenham, O. P. Brereton, D. Budgen, M. Turner, J. Bailey, and S. Linkman. **Systematic literature reviews in software engineering - A systematic literature review.** *Information and Software Technology*: 51(1), pp. 7–15 (2009)
- [4] M. Franzago, D. D. Ruscio, I. Malavolta, and H. Muccini. **Protocol for a Systematic Mapping Study on Collaborative Model-Driven Software Engineering.** *arXiv*: abs/1611.02619 (2016)
- [5] M. Franzago, D. D. Ruscio, I. Malavolta, and H. Muccini. **Collaborative Model-Driven Software Engineering: A Classification Framework and a Research Map.** *Transactions on Software Engineering*: 44(12), pp. 1146–1175 (2018)
- [6] M. Lamothe, Y. Guéhéneuc, and W. Shang. **A Systematic Review of API Evolution Literature.** *ACM Computing Surveys*: 54(8), pp. 1–36 (2021)
- [7] Misbhauddin, M., Alshayeb, M. **UML model refactoring: a systematic literature review.** *Empirical Software Engineering*: 20, pp. 206–251 (2015)
- [8] E. Nascimento, A. Nguyen-Duc, I. Sundbø, and T. Conte. **Software engineering for artificial intelligence and machine learning software: A systematic literature review.** *arXiv*: 2011.03751 (2020)



Discussion

Systematic review on **The use of reinforcement learning in SE**

RQ1: What characteristics of SE problems RL has been used for?

- What SE problem? In what SE activity? How is the RL method presented?

RQ2: What characteristics of RL methods have been used in SE?

- What type of RL? What RL algorithm? How are state/policy/value function/reward signal represented? To what extent is the environment modeled? How are the results of the RL method presented/explainable?

RQ3: What RL tools are used and how they are integrated in the process?

- Tool popularity in RL and SE communities? Documentation? Appreciation by SE?

RQ4: What are the typical challenges and limitations of using RL in SE?

RQ5: What are the publication trends in RL in SE?