Systematic Literature Reviews

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What is a Systematic Literature Review?

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- Conducted to "identify, analyze, and interpret all available evidence related to a specific research question"

- Aims to give a complete, comprehensive, and valid picture of existing evidence

- This must be done in a scientific and rigorous way, using the following 3-step process:
  1. Planning the review
  2. Conducting the review
  3. Reporting the review

Outcomes

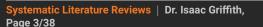At the end of today's lecture you should be able to

- Know and understand the steps to conduct a SLR
- Understand various analysis approaches used for an SLR
- Structure and produce a review report
- Know why and when to conduct a review

ROAR

Phase 1: Plan Review

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Planning the Review

Planning an SLR requires the following actions:

- Identification of the need for a review

ROAR

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- Specifying the review questions

- Developing a review protocol

Need for a Review

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This goes in the introduction section of your report

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- Additionally the experiment designs to include should be noted in the research question.

Population Examples

- A specific software engineering role
  - testers, managers

- A category of software engineer
  - novice or experienced

- An application area
  - IT systems, command and control systems

- An industry group
  - Telecomm companies or small IT companies

PICO Example

From Kitchenham et al.

- **Population:** software or web project
- **Intervention:** cross-company project effort estimation model
- **Comparison:** single-company project effort estimation model
- **Outcomes:** prediction or estimation accuracy

This led to the following questions:

1. What evidence is there that cross-company estimation models are not significantly different from within-company estimation models for predicting effort for software/web projects?
2. What characteristics of the study data sets and the data analysis methods used in the study affect the outcome of within- and cross-company effort estimation accuracy studies?
3. Which experimental procedures is most appropriate for studies comparing within- and cross-company estimation models?

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Take out a sheet of paper and for the next 5 minutes identify the PICO structure of your research project:

- **Population?**

- **Intervention?**

- **Comparison?**

- **Outcomes?**

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Review Protocol

- Defines the review procedures and acts as a log

- The protocol should contain:
    - Background and rationale
    - Research questions
    - Search strategy for primary studies
    - Study selection criteria
    - Study selection procedures
    - Study quality assessment checklists and procedures
    - Data extraction strategy
    - Synthesis of the extracted data
    - Dissemination strategy
    - Project timetable

- Ensures consistency

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- Ensures validity

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  - scope the research questions
  - validate the search strings
  - validate the inclusion/exclusion criteria

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- Be open to modifying questions during protocol development

- Once finalized, you should review the protocol for validity

Phase 2: Conduct Review

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Conducting the Review

A review is conducted by executing the following tasks:

1. Identification of research
2. Selection of primary studies
3. Study quality assessment
4. Data extraction and monitoring
5. Data synthesis

This step focuses on the search strategies that will be used to find primary studies, which include:

Research Identification

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- Primary Study Identification
  - Manual Search
  - Database Search

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- Snowball sampling

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- Grey Literature

ROAR

Manual Search

- Manual search can be conducted in the following locations:
  - Prominent Author's webpages
  - References of existing literature reviews
  - Known Conferences for the research area
  - Known Journals for the research area

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- **Goal:** Obtain a representative sample of papers then conduct snowball sampling.
  - The tradeoff between manual and database search is
    - Less false positives up front than with database search
    - Requires more rounds of snowball sampling
    - Underrepresentative samples lead to higher chance of missing key primary studies

Database Search

Use when you do not have enough knowledge to conduct a manual search

- The process is as follows:
  1. Develop your search string
  2. Database selection
  3. Search execution

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Note that there is always a tradeoff between:

- finding all relevant primary studies
- being overwhelmed with false positives to be removed manually
- Thus, we need to calibrate our search string

- Use the research questions to create sets of keywords

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- You should have one set per item of your PICO(C) question criteria

Search String

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  - **OR** together keywords within a set
  - surround sets with parentheses
  - **AND** together the sets
- If necessary, refine the expression to improve your results.

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- You should analyze the sensitivity of the results of your search to refine the search string.

Search String Examples

From Kitchenham et al.

- **Population:** software or web project
- **Intervention:** cross-company project effort estimation model
- **Comparison:** single-company project effort estimation model
- **Outcomes:** prediction or estimation accuracy

Leads to the following search strings:

- **Population:** `software OR application OR product OR web OR www OR Internet OR World-Wide Web OR project OR development`
- **Intervention:** `cross company OR cross organization OR cross organisation OR multiple-organizational OR multiple-organizational model OR modeling OR modelling effort OR cost OR resource estimation OR prediction OR assessment`
- **Comparison:** `within-organization OR within-organization OR within-organizational OR within-organisational OR signle company OR single organisation`
- **Outcomes:** `accuracy OR mean magnitude relative error`

Search String Examples

The Final Search string becomes:

```
(software OR application OR product OR web OR www OR Internet OR World-Wide Web OR project OR development)
AND (cross company OR cross organization OR cross organisation OR multiple-organizational OR
    multiple-organizational model OR modeling OR modelling effort OR cost OR resource estimation OR
    prediction OR assessment)
AND (within-organization OR within-organization OR within-organizational OR within-organisational OR
    single company OR single organisation)
AND (accuracy OR mean magnitude relative error)
```

ROAR

Take the next 5 minutes, using the same sheet of paper from before, for each of the PICO items define a set of search strings:

- **Population?**

- **Intervention?**

- **Comparison?**

- **Outcomes?**

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  - IEEExplore
  - ACM Digital Library

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- You should use 2 or more general indexes such as:
  - INSPEC/Compendex
  - Web of Science

Database Selection

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  - ScienceDirect
  - SpringerLink

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- Realize: you cannot find all primary studies for a given topic, and the what is found is simply a sample

Search Execution

- Keep a detailed record or the search findings.
  - Number found
  - Included studies
  - Excluded studies
  - Duplicate studies

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When to Stop Searching

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When to Stop Searching

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- To save time, adopt search stoppage criteria (and don't forget to note them in the report)
  - If using database and another complementary search (manual or snowball)
    - Stop when the manual or snowball does not return a certain number of selected studies (i.e., < 4 new studies added to the list of primary studies)
  - Use a time budget (based on funding or time constraints) and create a list of reviewed studies and a list of not considered studies

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- Can be done either by:
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- This process continues until no new studies are added

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- To reduce threats to validity it is wise to have more than one reviewer
  - Because selection is based on researcher judgment, you need to address this
  - After all researchers have made their assessments
    - Measure the **inter-rater agreement** with **Cohen's Kappa**
    - Use the **Think-Aloud technique** to attempt to come to a consensus
    - Measure the inter-rater agreement again
    - Report all of this in the final report

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  - Start by removing those which can easily be excluded from their title or abstract alone
  - Next expand to those studies which can be excluded by their introduction and conclusions
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- Remove any papers with more than one version (conference and journal) keeping only the most recent version

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- We need to define inclusion/exclusion criteria to select our primary studies.

Inclusion and Exclusion

- We need to define inclusion/exclusion criteria to select our primary studies.
    - The relevance of the topic of the article -> does it answer the research questions
    - The venue of publication and type of publication
    - The time period considered (typically 10 years, usually excluding the current partial year)
    - Requirements on evaluation (avoid if research has not yet reached maturation for evaluation)
    - Restrictions with respect to language

Inclusion Criteria

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- "Articles that are not written in English"

- "Context, objectives, or research method are manifestly missing"

Publication Bias

- There is a bias associated with published primary studies
  - They typically focus on positive results and discount negative results

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- There is a bias associated with published primary studies
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- To overcome this bias you should consider gray literature
  - Technical Reports
  - Dissertations and Theses
  - Rejected Publications
  - Works in progress

Study Quality Assessment

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  - Can be used to analyze cause of contradicting results
  - Can be used in weighting the value of evidence from primary studies

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- Note that the quality of the study not the reporting are to be evaluated

Data Extraction

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- You should conduct a small data extraction using your forms on a subset of studies to validate the form

ROAR

Data Synthesis

There are several approaches to synthesize the data from a literature review

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- **Meta-analysis** (most advanced and most constrained)
  - Requires primary studies to be of the same type, with the same hypotheses, have the same measures, and report on the same explanatory factors

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  - **Natrative synthesis** - the story originating in the primary studies

  - **Comparative analysis** - logic to explain cause and effect

  - **Case survey** - aggregate primary studies using a survey instrument (can be analyzed using statistical methods)

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  - **Case survey** - aggregate primary studies using a survey instrument (can be analyzed using statistical methods)

Independent of approach used, a sensitivity analysis should take place

Phase 3: Document Review

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The results of your research should be published where your intended audience can review it

Reporting the Review

The results of your research should be published where your intended audience can review it

Practitioner Oriented

1. Practitioner Journals and Magazines
2. Press Releases to popular or specialist press
3. Short summary leaflets
4. Posters
5. Websites
6. Direct communication

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Academia

1. Academic Journals
2. Academic Conferences

- If publication constraints prevent providing necessary detail for replication, write an accompanying Tech Report which can be posted online.

Related Readings

- Chapter 4 of "Experimentation in Software Engineering" 2nd Edition by Wohlin et al.

- Kitchenham and Charters, "Guidelines for performing Systematic Literature Reviews in Software Engineering", version 2.3 - on moodle.

- Numerous additional articles, for a full list, please email me at isaacgriffith@isu.edu

Tools

- DistillerSR
  - 19.95/mo for students
- JBI SUMARI
  - 130/yr for individuals
  - facilitates the entire review process
- Rayyan.ai
  - There is a Free-tier and Student Tier 4/mo
  - useful for screening and coding of studies
- SysRev
  - Basic - 0/mo, Premium - 10/mo
  - lacks most of the necessary features

- Abstrackr
  - free
  - used for automated abstract screening for systematic reviews.
- CADIMA
  - free
  - web tool facilitating the conduct and documentation of systematic reviews, systematic maps, and other literature reviews
- Of course, there is the most basic tool – A Spreadsheet

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  - lacks most of the necessary features
- Personally, I would choose CADIMA
  - based on data from https://www.ifis.org/en/research-skills-blog/software-tools-to-support-your-systematic-review-processes

- Abstrackr
  - free
  - used for automated abstract screening for systematic reviews.
- CADIMA
  - free
  - web tool facilitating the conduct and documentation of systematic reviews, systematic maps, and other literature reviews
- Of course, there is the most basic tool – A Spreadsheet

ROAR

A final word

- SLRs are extremely useful studies
  - Help new researchers gain entry into a field of research
  - Develops the background section of a thesis or dissertation
  - Serve as the first key publication of your graduate degree
  - Help you identify current research challenges

Are there any questions?