So... You Want to Produce a Systematic Literature Review?

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Bits of Wisdom

• *If I have seen a little farther than others, it is because I have stood on the shoulders of giants.*
  
  Sir Isaac Newton

• *Science is supposed to be cumulative, not almost endless duplication of the same kind of things.*
  
  Richard Hamming, 1968 Turing Award
Why Do a Literature Review?

- Mandatory part of the program...
- My supervisor wants me to...
- Part of the thesis template I got...
- I want to graduate!!!
Are There Better Reasons?

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Why Do This *Systematically*? Better Reasons...

- Understand the domain and the start of the art
- Use a recognized methodology (not ad hoc)
- Avoid missing important (or sometimes better) related work
- Be evidence-based and avoid bias
- Synthesis of work and relationships
- Find gaps/trends/agreements/disagreements in existing work, or realize there are no gaps!
- Framework to compare/position your own work
- Support repeatability (rigor) and evolution
Another (More Selfish) Good Reason

• Get a publication!
  – Reviews are usually well cited. Make yours serious enough to be published!
  – There are just too many papers being published... Help people save time with a good review, with useful insights!
Why *Systematic? Evidence-Based*

- Evidence-based medicine has changed research practices (Cochrane 1972)
  - Failure to organise existing medical research cost lives
  - Clinical judgement of experts worse than systematic reviews
- Evidence-based paradigm adopted by other disciplines providing service to public
  - Social policy, Education, Psychiatry...
- *Sloooowwwllly* getting there in IT, IS, CS, and Software Engineering!
  - Work of Kitchenham and others
Systematic Reviews 1/2 [Kitchenham]

• A systematic review is
  – An overview of research studies that uses explicit and reproducible methods

• Systematic reviews aim to synthesise existing research
  – Fairly (without bias)
  – Rigorously (according to a defined procedure or protocol)
  – Openly (ensuring that the review procedure is visible to and auditable by other researchers)
Systematic Reviews 2/2 [Kitchenham]

• Support the evidence-based paradigm
  1. Start from a well-defined question
  2. Define a repeatable strategy for searching the literature
  3. Critically assess relevant literature
  4. Synthesise literature

• With thanks to Cochrane, since 1972
What is So Systematic about This?
What is So Systematic about This?

- Key search words and queries
- Searching method
- Criteria for including/excluding references
- Clear structure in appraising the evidence
- Explicit discussion of limitations (threats to validity)

- Many guidelines, but there is still room for adaptation to your context and domain
So... You Want to Produce a Literature Review

**Systematic Review Process**

1. **Plan Review**
   - Develop Review Protocol
   - Validate Review Protocol
   - Identify Relevant Research
   - Select Primary Studies
   - Assess Study Quality
   - Extract Required Data
   - Synthesise Data
   - Write Review Report
   - Validate Report

2. **Conduct Review**
   - Document Review
Review Protocol

• Specifies methods to be used for a systematic review
• Predefined protocol
  – Avoid bias... Too easy and tempting to change the research questions to fit search results!
  – In practice however, for a first review, chances are you will be cheating... Iterative approach!
• Content
  – Background, research question(s), strategy to find papers, selection (inclusion/exclusion), quality assessment criteria, data extraction and synthesis
Research Questions...

- Assessing the effect of a technology
- Assessing the frequency or rate of a project development factor
  - E.g. Rate of project failures
- Identifying cost and risk factors
- Identifying impact of technology on reliability, performance, cost...
- Pragmatic, well-focused questions
- More general questions for other purposes
  - Review of research in domain X?
Reviews Can Indeed Go Meta!

• Primary study
  – Paper on phenomenon of interest, raw material
  – May involve interviews, questionnaires, observations...
  – Not much interpretation

• Secondary study
  – Publication with interpretation (journal, thesis, review)

• Tertiary study?
  – Literature reviews as input!
  – Tertiary studies and meta-analysis look at existing reviews and surveys, often for quantitative results (e.g., aggregation of statistical results)
Executing the Review Protocol...

- read the abstract...
- look at the figures...
- ...aaaand back to surfing the web.
- ...I DID READ THAT PAPER YOU GAVE ME... I'LL DEFINITELY ADD IT TO MY REFERENCE LIST...

JORGE CHAM @ THE STANFORD DAILY

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Some Potential Search Databases

- SpringerLink ([http://www.springerlink.com/](http://www.springerlink.com/))
- Google Scholar ([http://scholar.google.ca/](http://scholar.google.ca/))
- Even plain Google/Bing, sometimes (especially for commercial products)
- Many more on [Wikipedia](http://www.wikipedia.org)
- In your protocol, choose those that make sense in your context.
Non-Academic Databases

- Canadian Periodical Index Quarterly (CPIQ)
- National Bureau of Economic Research (NBER)
- Organisation for Economic Co-operation and Development (OECD)
- ... 

But in practice:
- Make sure selected academic and non-academic are reliable and have sufficient search options to handle the complexity of your queries
- Past issues with Factiva, Ebrary, Social Science Research Network ...
Some Important Advice

- Be ready to use the **Advanced Search** options, always
- Get your **VPN access** if you want to work from home
- For technologies, do not underestimate **patents** (Google Scholar)!
- Your university **librarian** can help!
  - Mish Boutet. mboutet@uottawa.ca

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Keywords and Queries

- Quickly **test** your queries, especially for scope
  - Not too broad (scope creep, unfeasible)
  - Not too narrow (empty net, nothing to learn)
- Think of all possible **synonyms**
  - “literature review” vs “literature survey”
- Think of possible **spellings**
  - modelling/modeling, behaviour/behavior
- Check already retrieved papers for possible keywords and their combinations
- Make sure to follow the search engines rules. All engines have different limitations...
Play a Little, for Scoping and for Understanding Engine Limitations

- Interested in a review of "Computer Security"?
  - Google Scholar returns **350,000 results**! (was 328,000 in February!)
  - When do you want to finish your thesis? 😊
- "Computer Security" AND Cloud?
  - 15,300 results
- "Computer Security" AND Cloud AND Amazon (since 2014)
  - 1040 results (was 550 in February)
- "Computer Security" AND Cloud AND Amazon AND Prolog (since 2014)
  - 10 results... and many irrelevant. **Too restrictive?**
- "Computer Security" AND Cloud AND Amazon AND (Prolog OR ".NET") (since 2014)
  - 512 results... but much **garbage** (net instead of .NET)...
  - ...

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Even Advanced Queries Have Limitations (Google Scholar)

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More Specialized, But Still Limited (SpringerLink)
Getting There (PubMed)

Use the builder below to create your search

Builder

All Fields
Affiliation
Author
Author - Corporate
Author - First
Author - Full
Author - Identifier
Author - Last
Book
Date - Completion
Date - Create
Date - Entrez
Date - MeSH
Date - Modification
Date - Publication
EC/RN Number
Editor
Filter
Grant Number
ISBN

Search

AND

Show index list

Show index list

History

There is no information available.

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Just How Complex Can Queries Get?

1. Consent/ or "consent (research)="/n2. "confidentiality (research)="/ or "Privacy and Confidentiality="/n3. HIPAA.mp./n4. "Health Insurance Portability and Accountability Act="/n5. (Opt-in or opt in or opt-out or opt out or non-consent or no consent or full consent or explicit consent).tw./n6. (waive$ adj3 consent).tw./n7. (waiver or consent status).tw./n8. (identifiable adj3 (data or information)).tw./n9. Data Protection Act.tw./n10. (Health and Social Care Act).tw./n11. Human Rights Act.tw./n12. (Caldicott or PIPEDA or Personal Data Protection Directive).tw./n13. (privacy adj3 act$).tw./n14. De-identif$.tw./n15. (Personal information protection and electronic documents act).tw./n16. (double-cod$ or double cod$ or single-cod$ or single cod$ or Re-identif$ or reidentif$ or deidentif$ or anonymous$ or anonymis$ or pseudonymiz$ or pseudonymis$ or reconsent$ or anonymity or identifiability).tw./n17. ((express$ or knowledgeable) adj3 consent).tw./n18. (data adj3 unlink$).tw./n19. ((strip$ or remov$ or delet$) adj3 identifier$).tw./n20. ((linked or linkable or coded) adj3 (information or data)).tw./n21. ((unidentif$ or non-identif$ or nonidentif$) adj3 (data or information)).tw./n22. (bias or biases).mp./n23. (audit$ or registr$ or observational or epidemiolog$).tw./n24. (health services$ or medical record$) adj3 (research or study or studies)).tw./n25. (quality of health care$) or "outcomes (health care)"/ or outcome assessment/ or quality assessment/ or nursing audit$ or "process assessment (health care)"/ or program evaluation/ nutrition assessment/ or exp Medical Records$/ or sampling methods$.
26. CROSS SECTIONAL STUDIES/ or PROSPECTIVE STUDIES/
27. epidemiological research$ or exp health services research/
28. registries, disease$ or registries, implant$ or registries, organ$ or registries, trauma$ or surveys$ or exp vital statistics$.
29. (QUALITY OF CARE RESEARCH$) or Quality Assurance$ or Audit$ or databases$.
30. or/35-43
31. and/23,34,44
32. limit 45 to english
33. limit 46 to yr="1990 - 2007"
How to Handle Complex Queries?

• Queries might have to be **split** into multiple sub-queries, and results (list of papers) **merged** manually.
• Lists from multiple engines require merging too.
• Downloading the papers themselves is also painful...!
Document your Queries

- List your **exact queries** in your thesis!
  - Allows repeatability by others
  - Allows **YOU** to **repeat** the queries before submitting your thesis...
  - As your work spans many years, it is good to **refresh** your review before submission, just in case!

- Different engines have different syntaxes and limitations
  - Document your **abstract** queries in your thesis, as if you were not limited by the intricacies of the concrete search engines
  - You might want to keep **concrete** queries for yourself, to run them again later
Is This Query Too Complex?

("Business process compliance" OR "Business Process Compliance Management" OR "Regulatory Compliance" OR "Regulatory Compliance Management" OR "Legal Compliance")

AND

("Systematic review" OR "Systematic Survey" OR "Literature Review" OR "Literature survey" OR "State-of-the-art")

AND

("Assess*" OR "Measure*" OR "Monitor*")
Is This Query Too Complex?

("Business process compliance" OR "Business Process Compliance Management" OR "Regulatory Compliance" OR "Regulatory Compliance Management" OR "Legal Compliance")

AND

("Systematic review" OR "Systematic Survey" OR "Literature Review" OR "Literature survey" OR "State-of-the-art")

AND

("Assess*" OR "Measure*" OR "Monitor*")
Simpler and Better Query

("Business process compliance" OR "Regulatory compliance" OR "Legal compliance")
AND
("Systematic review" OR "Systematic survey" OR "Literature review" OR "Literature survey" OR "State-of-the-art")
AND
("Assess*" OR "Measur*" OR "Monitor*")

How many concrete Google Scholar queries do we need to run here?
What Years Should Be Covered?

- This depends on the novelty of the subject
- One option is to start with the year not included in the last literature review of the field [Antonova]
- If no previous reviews, go by when the first relevant study was published
- If overlapping, but not identical topic of review, ok to use the same studies
- Can also be systematic for a recent period, and ad hoc before (to include seminal papers)
Keep a Table of Returned Papers

• This is your raw data!
• You may take note of different characteristics (columns)
  – source engine(s), year published, type (conference/journal/thesis/patent), country, query that returned it, number of Google Scholar references...
• Can be used for statistics and trends
• Can form an Appendix in your thesis
What To Do Once You Have 300 Papers to Read? (1/2)

• Use specific and explicit inclusion/exclusion criteria
• Might want to focus on the abstract and perhaps on the introduction/conclusion sections first (filtering)
• A paper is of low quality or irrelevant or in a language you don’t understand? Exclude!
• A paper cites another interesting paper not returned by your initial queries? Include!
What To Do Once You Have 300 Papers to Read? (2/2)

• Reduce to a manageable number of papers
  – <40 for a review, maybe more for a systematic mapping
• Document how many (and which) papers got filtered out (or added) at each step
• Involve a second person to do the same exercise in parallel and compare (hard and costly!), or minimally to review your decisions (cheaper), in order to avoid bias
Time to Assess the Papers

- Define criteria for their categorization and evaluation
- Read and evaluate the papers!
- Do not simply report on Author W did X and author Y did Z...
- Look for commonalities/differences, trends, and cross-cutting observations. Critical analysis!
- Include a **tabular summary** of your evaluation
  - Will allow you to add one row at the end of your thesis, with your own work!
  - Do not make your evaluation scale too simplistic (yes/no); include partial satisfaction levels
Organization (Potential Orders)

- Topical
  - by main topics or issues
- Chronological
  - by the dates the research was published
- Problem-Cause-Solution
  - moves from the problem to the solution
- General-to-Specific
  - examine broad-based research first and then focus on specific studies that relate to the topic
- Specific-to-General
  - discuss specific research studies so conclusions can be drawn
- Others...
Write About...

- Significance of what exists
- Gaps or areas of disagreement that beg for more research (from you!)
- The 3-4 approaches closest to what you have in mind for your research (your competition)
- Conclusions
- Limitations of your own review
Limitations = Threats to **Validity**

- *Construct validity*: Specifies how well the methodology and protocol helped answered the research questions
- *Internal validity*: Examines any bias and confounding factors
- *External validity*: Specifies how much of the results can be generalized
- Many other types...
- Consider them (with mitigations) in advance
  - Could influence your lit review protocol
- Report on threats mitigated *and* on the remaining ones
Typical Threats for Literature Reviews (1/2)

• Publication bias
  – Negative findings may not get published
  – Positive findings may get published more than once

• Selection bias
  – Inclusion and exclusion criteria can create bias
  – Tempting to use only criteria where we know our own approach will score well and show uniqueness!

• Language bias (i.e. English Language)
  – One language only... Enough?
  – Authors might be more likely to report positive findings in an international English language journal and negative findings in a local journal
Typical Threats for Literature Reviews (2/2)

- Protocol
  - Inconsistent use of terms by the community
  - Bias introduced by having only 1-2 person(s) involved in the review for data collection, data filtering, data analysis and data reporting
    - But we can’t expect more in a thesis lit review!
  - Time limits! You cannot spend 5 years doing a review
    - Still, you may want to budget several months to do this well
- ... and more!
Beware of Common Pitfalls

• Don’t focus on getting rid of the review; target the Truth!
• Do not be superficial
  – Say something about the papers and their contributions
  – Do not include just counts per year
  – Show something that was not obvious before
• Do not use statistics if you do not use a substantial number of papers
Be Careful with References

• In your bibliography or list of references, be attentive to detail...

• Completeness of information for each item
  – Authors, title, journal (with editors, volume and issue number) or conference (maybe with series and number), publisher, pages, year, maybe the DOI

• Stick to consistent conventions
  – Order, style (e.g., italic), periods/colons/quotes, author first full name or first letter, “and”, “In:”, ...

• Cite properly in the text!
Be Careful with Plagiarism/Fraud

• **Real problem**, more general than for just literature reviews
• Reference words, data, ideas properly
• Plagiarism and fraud hurt everybody's reputation!

• **MUST READ**
  – “**Beware of plagiarism**” document
  – Academic integrity at [uOttawa](http://uOttawa) and at [Carleton](http://Carleton)
  – **Consequences** at uOttawa
  – **Academic fraud** and **student guide**
Is This Systematic Stuff Easy?

• No! Requires more effort than informal reviews
• Difficult for lone researchers
  – Standards require two researchers, to minimize individual bias
  – Involve your supervisor!
• Incompatible with requirements for short papers
  – But pretty good for theses!
Do I Really Have to Do All This?

- There are many types of reviews, with different expectations in terms of search scope, process, analysis and synthesis
  - Scoping review, systematic mapping, systematized review...
- Good comparison
  - [Summary table](#) from Duke University
Take My Advice Seriously!

I HAVE NO REAL-WORLD EXPERIENCE AND I AM INCOMPETENT AT EVERYTHING.

BUT UNLIKE ANY OF YOU, I HAVE A PH.D., AND THAT MEANS YOU HAVE TO TAKE ME SERIOUSLY.

IS PRETENDING ALLOWED?

TOTALLY. IT ALL LOOKS THE SAME TO ME.
From My Own Experience (1/2)

- Not perfect (still learning!)
- All of my Ph.D. students who did a systematic literature review had it published!
  
  
  
  
From My Own Experience (2/2)

- All of my Ph.D. students who did a more ad hoc or narrative literature review did not get it published!

- One of my best cited paper is a literature review
References and Further Reading

- Systematic literature reviews in software engineering – A systematic literature review (2009)
- A typology of reviews: an analysis of 14 review types and associated methodologies (2009)
References (Online Presentations)

- B. Kitchenham: Evidence-Based Software Engineering and Systematic Reviews (2005)
- E. Antonova: Systematic Literature Review