Writing a Literature Review

ICS690 Seminar

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Research Papers

- Lit review: what and why?
- How to read papers?
- How to write a lit review?

Novelty of Research

- (Good) research must be novel
  - After reading a research article/thesis, what have we learned that we didn't know before and that advances the field?
  - What we know: all that's been published before
- If not novel, your work isn't research
  - Possibly beautiful, clever, useful, and marketable engineering
  - "But I spend 2 years writing a super useful piece of code using my amazing coding skills..."
  - What we learned: you're a great coder. doesn't advance the field
- If you're doing a Ph.D. thesis, novelty is paramount
  - You just can't graduate if your work isn't novel
- If you're doing a M.S. thesis, novelty is less of a concern
  - Could be implementation/evaluation of research results
- The good news: doing something novel is fun and rewarding!

Novelty of Research

- To find a research topic and ensure its novelty, read a lot of papers in your field
  - read, read, read, find gaps, choose one, fix it
- You have to start reading papers early on
  - Nothing worse than working on a project for 6 months and then realizing that you've re-invented the wheel without improving it
  - Not as bad: realizing after 6 month that there was some published work that makes your life simpler
- No matter what, you must convince the reviewers of your article that your work is better than previous work
- Papers that don't have a comparison (qualitative or quantitative) to previous work are basically rejected out right from reputable conferences/journals
  - Papers are rejected all the time because they fail to reference some relevant previous work!

What's a Lit Review?

- To do good research, you must know the literature inside out, which means that you could write a good lit review
  - and that way you won't seem clueless :)
- Definition: A survey of a body of knowledge, which critically evaluates and contrasts relevant published articles while highlighting their contributions and findings

Why Write a Lit Review?

- To write the “related work” section of a research paper, or the “related work” chapter of a Ph.D./M.S. thesis
  - So that you can highlight your own contributions and contrast them to the reviewed literature
  - Note that itemized lists of original contributions are always a very good idea in papers and theses
    - “In this paper our contributions are: 1) ... 2) ...”
- To write the lit review needed for your Ph.D. portfolio
- To publish a lit review
  - e.g., in the ACM Journal of Computing Surveys

Research Papers

- Lit review: what and why?
- How to read papers?
- How to write a lit review?

Reading Papers

- Once you have identified a research area of interest, you can start looking for relevant published work
- First, come up with a list of likely keywords
  - Being broad in the list of keywords is a good idea to not miss anything (I speak from personal experience)
- Where to find papers:
  - Free resources: Google, Google Scholar, Citeseer, Authors' Web pages
  - Journals, conference proceedings
    - ACM/IEEE digital libraries, to which universities have subscriptions
  - Finding the relevant journals/conferences for your area is key
    - so that you can look at TOCs of all past proceedings

Reading Papers

- You must read a lot of paper
  - Requires discipline
- Don’t be afraid to be broad
  - Learning new things, being exposed to ideas will always be beneficial in the long term
  - Much good research comes from combining ideas from different areas
  - Useful to define your research area
- Keep an annotated bibliography:
  - Keep track of the bibliographical information
    - bibtex entries are good
  - Write a short informal summary of each paper, with keywords
  - This will constitute an invaluable resource

Reading Papers

- You must follow references up and down
- Following references down is easy
  - Just look a “references” sections
- Following references up used to be very hard, but now is easy as well:
  - Google Scholar (let’s look at it)
  - Citeseer
- Building a graph of paper references is a good idea
  - Mental graph is ok, but written down is better

Research Papers

- Lit review: what and why?
- How to read papers?
- How to write a lit review?

The Scope

- Defining the scope is known to be difficult
  - Not too broad, not too narrow
- No silver bullet method, just rules of thumbs:
  - Can you state in a complete sentence exactly what your review is about?
  - Try to cap the number of articles you reference, and when you get over that cap, narrow your scope
- It’s common to see the scope change in the process of writing the review
- Nowadays, there are 100’s of articles on many topics, so a broad scope is very hard to do
  - Article selection is key (use critical thinking)

The Audience

- A sophisticated audience of people in your field, who are not experts in the particular area
- After reading your review, a previously uninformed researcher should be able to:
  - Engage in an intelligent conversation about the area with other researchers, including those in the area
  - Have a good idea of what's known and of what challenges and big questions remain
  - Come up with some possible research paths in the area
- A good lit review is an invaluable resource
  - You should hope to find one in your research area

The Writing Approach

- Don’t dive too deeply into technical details
  - Readers can always go hunt references if they want!
- Instead, give the essence of existing knowledge

- Instead of quoting, describe all previous research with your own words
  - Allows you to synthesize the research
  - Allows you to harmonize terminology
  - Provides a single “voice” for the lit review

- Plagiarism:
  - You can quote sentences and include figures
  - They must all clearly reference published work

The Writing Approach

- It’s very easy to lose the reader in a lit review
  - After all, this is supposed to be all new to the reader, and comes from many sources
- Provide the reader with “umbrella” sentences at the beginning of sections/paragraphs
  - e.g., “In this section we review those works that have proposed cache-oblivious algorithms for linear algebra kernels.”
- Provide “signposts” throughout
  - e.g., “We have seen that the work in [10] advocates for the use of spectral decomposition. By contrast, the work in [12] ...”
- Provide brief “so what?” summaries at key points
  - e.g., “Based on the results in [8,12,18,42], reviewed in the previous section, the success of an approach based on compiler-drive optimization seems unlikely at best.”

The Writing Approach

- Make sure your bibliographical references are all correct, complete, and all there!
- Make sure that they are sorted nicely
  - Alphabetical by Author is what most reader will expect

The Structure

- Standard structure:
  - Introduction
  - Body
    - Multiple sections
  - Conclusion

- Let’s say a few words about each section

Lit Review Introduction

- Identify the issue
  - What it is?
  - Why we should care?
    - What are the applications
- Point out overall trends in what's been published so far
  - Major conflicts
  - Major methodological differences
- State how the lit review is organized
- State why some literature is not included

Lit Review Body

- The most difficult task is to organize the body of the lit review
- One must categorize published works
- The goal is to find common denominators to group some works into a single category, and to find discriminants to contrast the categories
- Some authors try to come up with a hierarchical taxonomy
  - Not all powerful, and, taken to the extreme, an exercise in futility
- Some authors present large feature/property tables
- Let's see some examples
  - [1] "A survey of top-k query processing techniques in relational database systems", Ilyas et al., ACM CSUR, 40(4), 2008
  - [2] " Decentralized access control in distributed file systems", Miltchev et al., ACM CSUR, 40(3), 2008
  - [3] "Anomaly Detection: A survey", by Chandola et al., ACM CSUR, 41(3), 2009

Hierarchical Taxonomy [1]

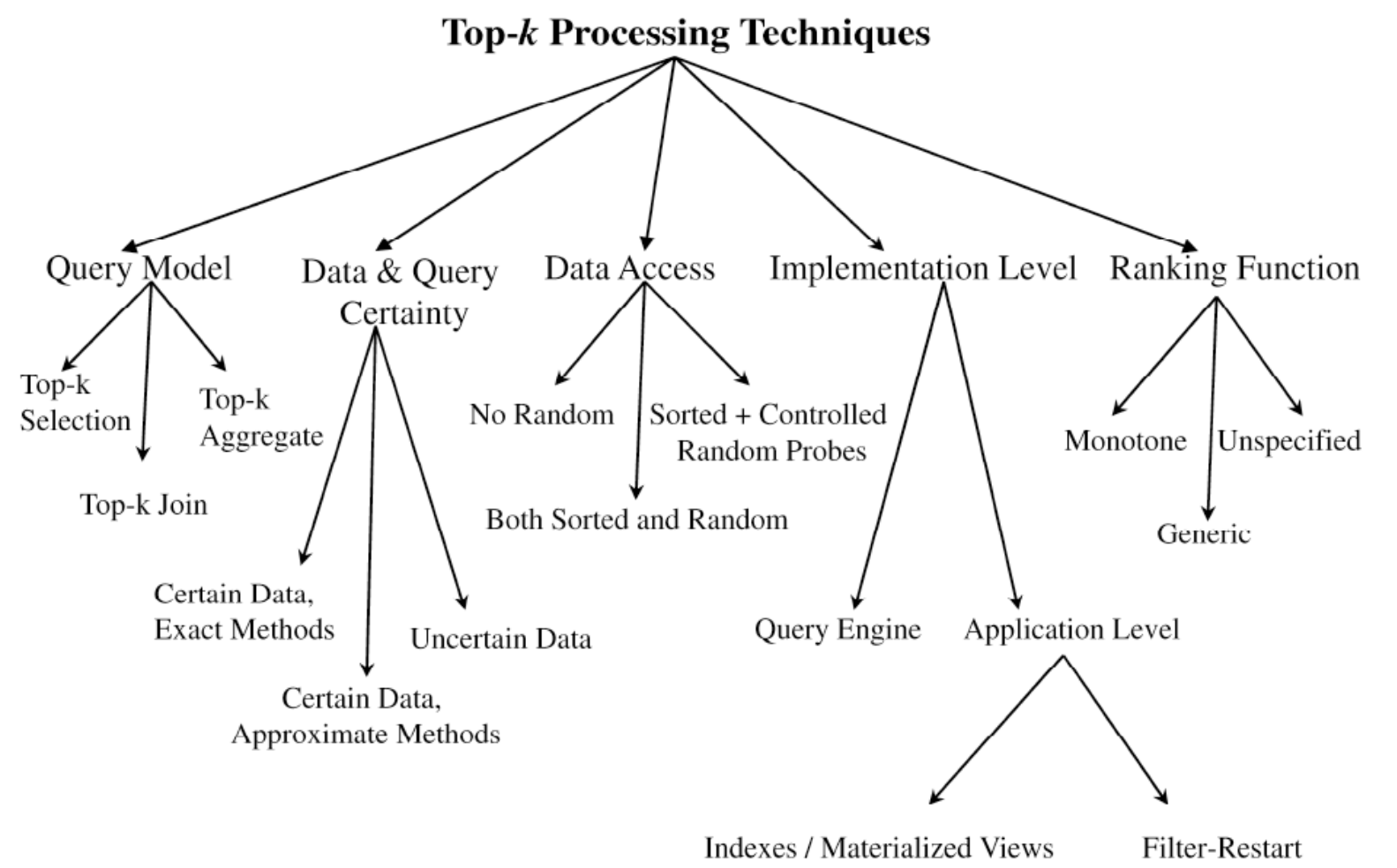

Fig. 3. Classification of top-k query processing techniques.

Feature Table

Table I. File system classification

	Status[1]	Authentication	Authorization	Granularity	Autonomous Delegation	Revocation
NFS	P	AUTH_SYS, Kerberos	ACL (UNIX)	File system	No	ACL
NFSv4	P	Kerberos, LIPKEY, SPKM	ACL (NT)	File	No	ACL
AFS& Coda	P	Kerberos	ACL (AFS)	Directory	No	ACL
CIFS	P	Plaintext password, Challenge-Response, Kerberos	ACL	Directory	No	ACL
xFS	E	AUTH_SYS, Kerberos	ACL (UNIX)	File system	No	ACL
Truffles	E	Public Key (X.509)	ACL (UNIX)	Volume	Limited	No
Bayou	E	Public Key	AC Certifi-cate	Data Collection	Limited	Revocation certificate
WebFS	E	Public Key (X.509)	Hybrid	File	Limited	ACL, CRL, OLA[2], Certificate Expiration
CapaFS	E	No	Capability	File	Limited	CRL, Timeout
SFS	E	Public Key	ACL (UNIX)	File	No	ACL, CRL
GSFS	E	Public Key	ACL (SFS)	File	Limited	ACL, CRL
DisCFS	E	Public Key	Trust Mgmt.	File	Yes	Credential Expiration

Approach Table [3]

Technique Used	Section	References
Mixture of Models	Section 7.1.3	Byers and Raftery [1998],Spence et al. [2001],Tarassenko [1995]
Regression	Section 7.1.2	Chen et al. [2005], Torr and Murray [1993]
Bayesian Networks	Section 4.2	Diehl and Hampshire [2002]
Support Vector Machines	Section 4.3	Davy and Godsill [2002],Song et al. [2002]
Neural Networks	Section 4.1	Augusteijn and Folkert [2002],Cun et al. [1990],Hazel [2000],Moya et al. [1993],Singh and Markou [2004]
Clustering	Section 6	Scarth et al. [1995]
Nearest Neighbor based Techniques	Section 5	Pokrajac et al. [2007],Byers and Raftery [1998]

Table X. Examples of anomaly detection techniques used in image processing domain.

Meta-Table! [3]

		1	2	3	4	5	6	7	8
Techniques	Classification Based	√	√	√	√		√		
	Clustering Based	√	√	√			√		
	Nearest Neighbor Based	√	√	√			√		√
	Statistical	√	√	√		√	√	√	√
	Information Theoretic	√							
	Spectral	√							
Applications	Cyber-Intrusion Detection	√					√		
	Fraud Detection	√							
	Medical Anomaly Detection	√							
	Industrial Damage Detection	√							
	Image Processing	√							
	Textual Anomaly Detection	√							
	Sensor Networks	√							

Table I. Comparison of our survey to other related survey articles.1 - Our survey 2 - Hodge and Austin [2004], 3 - Agyemang et al. [2006], 4 - Markou and Singh [2003a], 5 - Markou and Singh [2003b], 6 - Patcha and Park [2007], 7 - Beckman and Cook [1983], 8 - Bakar et al [2006]

Lit Review Conclusion

- Your own thoughts
  - Evaluate the state-of-the-art
  - Promising directions
  - Open challenges
  - Broader relationship with entire discipline
- Presumably, you're interested in the area of your lit review, so you should have thoughts!
  - Note that your own thoughts should be permeating the lit review as well, but the conclusion is a key place

Ph.D. Portfolio Lit Review

- This is a stand-alone lit review
  - You don’t have to talk about your own work in it at all
    - You may hint at promising/fertile research directions of course, which may be your own
  - It is NOT a Ph.D. Proposal!
- In fact, it does not have to be in your thesis area
  - Of course, it makes your life easier if it is since you’ll already have done the lit review
- You should start thinking about it early on!

How to make it Interesting!

- A big problem with lit reviews is that they are just boring to read
  - Especially those written for the PhD Portfolio (in general, not all!)
- What makes a lit review interesting is Critical Thinking
- It's a "review" not a "summary"
  - Shouldn't be 95% description of previous work and only 5% discussion

The Worst Lit Review

- Author 1 did something
- Author 2 did something else
- . . .
- Author n did something else
- Conclusion: a lot of work has been done and it’s all very impressive

How to make it interesting!

- Critical appraisal: evaluate strengths and flaws/limitations of reviewed works
  - While remaining civil
- Establish relationships between the reviewed works
  - Mention competing approaches/authors
  - Mention approaches subsumed by others
  - Pit approaches against each other based on published results/comparative studies
  - Mention when some comparative studies should be done but haven’t been done

How to make it interesting

- Identify open questions
  - From “future work” sections
  - From your own ideas
- Give a sense of historical development in the field
  - Identifying main phases of advances, so that you can tell the “story” of the field
- “Call” authors on their claims for novelty
- For each reviewed paper, knowing what they claim to accomplish and what they “punt on” is more important than how they do it in terms of structuring the lit review
- Write the lit review without giving any technical details and see if it reads well/interesting
  - Can you actually tell the story of the lit review in 10 minutes?
- Pick the topic appropriately
  - Writing a fascinating lit review is easier for some topics

The Not-Worst Lit Review

- The problem is this
- In one of the first works, Author 1 did this
  - It was great, but had one big problem
- Authors 2,3,4 tried to solve it, but unsatisfactorily for these reasons
- Then Authors 5 finally proposed a good solution launching a new era, that unleashed a whole set of new works
- Building on the work by Author 5, Authors 6 and 7 have proposed different approaches, and its difficult to tell which one is best
  - Both claim greatness, but ...
- ....
- At this point, open questions are ...., and perhaps works by Authors 20, and 21 provide first steps toward answers.

Read Lit Reviews!

- You should be reading lit reviews
  - To learn about important topics
  - To understand what there is to do in a potential research area
- Where to find good lit reviews?
  - ACM Computing surveys is a standard source
  - Keywords like “survey”, “review”, “taxonomy”, help locate lit reviews
  - Lit reviews are often cited as well

Conclusion

- Writing a good lit review is known to be difficult
  - I review many bad ones for journals!
- It's normal to go through many revisions of it as you write it
- But in the end the result is extremely useful, to you, and to others

- Read papers, read papers, read papers