RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS
Course Code: BRMK557
Module-2

A. **Literature Review and Technical Reading,** New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar, Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.

B. **Attributions and Citations:** Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.

Text book referred: Dipankar Deb, Rajeeb Dey, Valentina E. Balas "Engineering Research Methodology", ISSN 1868-4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981-13-2947-0 (eBook), https://doi.org/10.1007/978-981-13-2947-0

A. LITERATURE REVIEW AND TECHNICAL READING

➢ The primary goal of literature review is to know the use of content/ideas/approaches in the literature to correctly identify the problem that is vaguely known beforehand, to advocate a specific approach adapted to understanding the problem, and to access the choice of methods used.

➢ It also helps the researcher understand clearly that the research to be undertaken would contribute something new and innovative.

➢ The quality of such review can be determined by evaluating if it includes appropriate breadth and depth of the area under study, clarity, rigor, consistency, effective analysis.

NEW AND EXISTING KNOWLEDGE

New knowledge in research can only be interpreted within the context of what is already known and cannot exist without the foundation of existing knowledge.

➢ The new knowledge can have vastly different interpretations depending on what the researcher's background, and one's perception of that new knowledge can change from indifference to excitement (or vice versa), depending on what else one knows.

➢ The significance can normally be argued from the point of view that there is indeed an existing problem and that it is known by looking at what already exists in the field.

➢ The existing knowledge is needed to make the case that there is a problem and that it is important.

➢ One can infer that the knowledge that is sought to be produced does not yet exist by describing what other knowledge already exists and by pointing out that this part is missing so that what we have is original. To do this, one again needs the existing knowledge: the context, the significance, the originality, and the tools.

➢ Normally, one finds this knowledge by reading and surveying the literature in the field that was established long ago and also about the more recent knowledge which is in fact always changing.

➢ With this foundation in place, the new knowledge that one will make will be much more difficult to challenge than without that strong foundation in place which is ensured with lots of references to the literature.

➢ Often, but not always, the textbooks contain the older established knowledge, and the research papers the newer work. Reading the textbooks on one topic provide the established knowledge and the background to be able to read the newer work usually recorded in the research papers.

➢ The research paper is written for other researchers out on the edge of knowledge, and it assumes that the reader already knows a lot in that field

➢ The review process must explain how a research item builds on another one. An effective review of literature ensures a firm foundation for advancing knowledge, facilitates theoretical growth, eliminates as areas that might be of interest, and opens new avenues of possible work.

➢ Generally, a good literature survey is the first expectation of a supervisor from the research student, and when done well can create a good impression that the state of art in the chosen field is well understood.

➢ A good literature review would not draw hasty conclusions and look into the individual references to determine the underlying causes/assumptions/mechanisms in each of them so as to synthesize the available information in a much more meaningful way.

➢ A good literature survey is typically a two-step process as enumerated below:

  ♦ Identify the major topics or subtopics or concepts relevant to the subject under consideration.

  ♦ Place the citation of the relevant source (article/patent/website/data, etc.) in the correct category of the concept/topic/subtopic.

➢ It could be that as one is reading and comes across something that one considers to be very important for one's work. Naturally, one highlights that section or underlines it, or put an asterisk in the margin, so that one could come back to it later. Effectively, one is saying that it is important and hence the marking so as not to forget it.

➢ A comprehensive literature survey should methodically analyse and synthesize quality archived work, provide a firm foundation to a topic of interest and the choice of suitable research methodologies, and demonstrate that the proposed work would make a novel contribution to the overall field of research.

ANALYSIS AND SYNTHESIS OF PRIOR ART

➢ After collecting the sources, usually articles, intended to be used in the literature review, the researcher is ready to break down each article and identify the useful content in it, and then synthesize the collection of articles (integrate them and identify the conclusions that can be made from the articles as a group).

➢ A researcher should analyze the relevant information ascertained in below table by undertaking the following steps:

- Understanding the hypothesis,
- Understanding the models and the experimental conditions used,
- Making connections,
- Comparing and contrasting the various information, and
- Finding out the strong points and the loopholes.

Table 1.1: The literature survey grid

	Source 1	Source 2	...	Source M
Topic 1		✓		
Topic 2	✓			✓
⋮				
⋮				
Topic N	✓	✓		

➢ A literature survey grid of N topics and M sources is shown above to help crystallize the information in different categories.

➢ It is always good to be suspicious of the claims made in the sources that have been thoroughly reviewed, especially in the case of tall claims.

➢ If one is amenable to easily accept whatever is available in the literature, one may find it difficult to go beyond it in one's own work and may also fail to carefully analyse with a suspicious bent of mind one's own results subsequently.

➢ The goal of literature survey is to bring out something new to work on through the identification of unsolved issues, determine the problems in the existing models or experimental designs, and present a novel idea and recommendations.

➢ No matter where one gets the available information, one needs to critically evaluate each resource that the researcher wishes to cite. This methodology analyses available materials to determine suitability for the intended research.

➢ Relying on refereed articles published in scholarly journals or granted patents can save the researcher a lot of time.

➢ Here are a few criteria that could help the researcher in the evaluation of the information under study:

    ✚ **Authority:** What are the author's credentials and affiliation? Who publishes the information?

    ✚ **Accuracy:** Based on what one already knows about the topic or from reading other sources, does the information seem credible? Does the author cite other sources in a reference list or bibliography, to support the information presented?

    ✚ **Scope:** Is the source at an appropriate comprehension or research level?

BIBLIOGRAPHIC DATABASES

➢ "Bibliographic databases" refer to "abstracting and indexing services" useful for collecting citation-related information and possibly abstracts of research articles from scholarly literature and making them available through search.

➢ Performing simultaneous searches through such large databases may allow researchers to overtly rely on any one database and be limited by the intrinsic shortcoming of any one of them for quality research.

➢ A researcher should be able to quickly identify the databases that are of use in the idea or problem that one wishes to explore.

Web of Science

➢ Web of Science (formerly known as ISI or Thomson Reuters) includes multiple databases, as well as specialized tools.

➢ It is a good search tool for scholarly materials requiring institutional license and allows the researcher to search in a particular topic of interest, which can be made by selection in fields that are available in drop down menu such as title, topic, author, address, etc.

➢ The tool also allows sorting by number of citations (highest to lowest), publication date.

➢ Put quotes around phrases, add more keywords, or use the "Refine Results" panel on the left to narrow down the search by keyword, phrases in quotation marks, type of material such as peer-reviewed journal articles, date, language, and more.

➢ "Cited reference search" option enables a researcher to trace articles which have cited a formerly published paper. Using this element, it is possible to find how a familiar idea has been applied, improved, or extended subsequently.

➢ A structured search like this that enables narrowing and refining what one is looking for is effective to ensure that the results throw up relevant sources and time spent in studying those is likely to be well utilized.

➢ Based on the researcher's need the search result can be broadened or narrowed down using the built-in fields provided in this website.

➢ When clicked on any of the search results, this website provides the title of the paper, authors, the type of journal, volume, issue number and year of publication, abstract, keywords, etc., so that the researcher has enough information to decide if it is worthwhile to acquire the full version of the paper.

Google and Google Scholar

➢ Google is a great place to start one's search when one is starting out on a topic. It can be helpful in finding freely available information, such as reports from governments, organizations, companies, and so on. However, there are limitations:

  ♦ It's a "black box" of information. It searches everything on the Internet, with no quality control - one does not know where results are coming from.

  ♦ There are limited search functionality and refinement options.

➢ Google Scholar limits one's search to scholarly literature. However, there are limitations:

  ♦ Some of the results are not actually scholarly. An article may look scholarly at first glance but is not a good source upon further inspection.

  ♦ It is not comprehensive. Some publishers do not make their content available to Google Scholar.

  ♦ There are limited search functionality and refinement options.

➢ There are search operators that can be used to help narrow down the results. These help one to find more relevant and useful sources of information.

➢ Operators can be combined within searches. Here are some basic ones that one can use:

  ♦ OR - Broadens search by capturing synonyms or variant spellings of a concept.

  ♦ Brackets/Parentheses ( ) - Gather OR 'synonyms of a concept together, while combining them with another concept.

  ♦ Quotation marks " " -Narrow the search by finding words together as a phrase, instead of separately.

  ♦ Site - limits the search to results from a specific domain or website.

- File type - limits the search to results with a specific file extension one could look for pdf's, PowerPoint presentations, Excel spreadsheets, and so on.

➢ The Search Tools button at the top of the Google results gives you a variety of other options, such as limiting the results by date.

➢ To find the best resources on a topic, one should search in academic databases, in addition to Google.

➢ Databases provide access to journal articles and conference proceedings, as well as other scholarly resources.

➢ One gets more relevant and focused results because they have better quality control and search functionality. One should choose a database based on subject area, date coverage, and publication type. Interfaces vary between databases, but the search techniques remain essentially the same.

EFFECTIVE SEARCH: THE WAY FORWARD

➢ A scholarly publication is one wherein the published outcome is authored by researchers in a specific field of skill. Such work cites all source contents used and is generally peer reviewed for accuracy and validity before publication.

➢ Essentially, the audience for such works is fellow experts and students in the field. The content is typically more complex and advanced than those found in general magazines.

➢ While most of the engineering researchers need to refer articles that appear in scholarly journals, books or other peer-reviewed sources, there is also a substantially useful content in more popular publications. These are informal in approach and aim to reach a large number of readers including both the experts in the field and also amateurs, but the content focuses on news and trends in the field.

➢ Research outcomes are not typically first disseminated here but are usually meant for general reading. A researcher should use all search tools for comprehensive search.

➢ A researcher must consider what type of information is needed, and where it could be found. Not all information is available online. Some information is only available in print.

➢ It can take time for scholarly and peer-reviewed information to be published. One might not be able to find scholarly information about something currently being reported in the news. The information may not be available, or studies on a topic of interest to the researcher have not occurred.

➢ Searching is an iterative process:
- Experiment with different keywords and operators
- Evaluate and assess results, use filters.
- Modify the search as needed; and
- When relevant articles are found, look at their citations and references.

➢ After the search is complete, the researcher needs to engage in critical and thorough reading, making observation of the salient points in those sources, and summarize the findings.

➢ A detailed comparison and contrast of the findings is also required to be done.

➢ This entire process may be needed to be done multiple times.

➢ The conclusion of the entire process of literature survey includes a summary of the relevant and important work done, and also the identification of the missing links and the challenges in the open problems in the area under study.

➢ One must note that the literature survey is a continuous and cyclical process that may involve the researcher going back and forth till the end of the research project.

➢ It is very important to not lose sight of the purpose of an extensive search or literature survey, for it is possible to spend a very significant amount of one's time doing so and actually falsely think that one is working hard.

➢ Nothing will come of it unless one is an active reader and spends sufficient time to develop one'sown ideas build on what one has read.

➢ It is not as if literature survey ends and then research begins, for new literature keeps appearing, and as one's understanding of the problem grows, one finds new connections and related/evolving problems which may need more search.

INTRODUCTION TO TECHNICAL READING

➢ It is obvious that the number of papers relevant to a particular researcher is very few, compared to the actual number of research papers available from peer-reviewed technical sources.

➢ It is also important to know where to read from; relying on refereed journals and books published by reputed publishers is always better than relying on easily available random articles off the web.

➢ While reading an engineering research paper, the goal is to understand the technical contributions that the authors are making. Given the abundance of journal articles, it is useful to adopt a quick, purposeful, and useful way of reading these manuscripts.

➢ It is not the same as reading a newspaper. It may require rereading the paper multiple times and one might expect to spend many hours reading the paper.

➢ Amount of time to be spent will get ascertained after an initial skimming through the paper to decide whether it is worth careful reading.

➢ There will also be papers where it is not worth reading all the details in the first instance. It is quite possible that the details are of limited value, or simply one does not feel competent to understand the information yet.

➢ Start out the skimming process by reading the title and keywords (these are anyways; probably what caught the initial attention in the first place). If on reading these, it does not sufficiently seem to be interesting; it is better to stop reading and look for something else to read.

➢ One should then read the abstract to get an overview of the paper in minimum time. Again, if it does not seem sufficiently important to the field of study, one should stop reading further.

➢ If the abstract is of interest, one should skip most of the paper and go straight to the conclusions to find if the paper is relevant to the intended purpose, and if so, then one should read the figures, tables, and the captions therein, because these would not take much time but would provide a broad enough idea as to what was done in the paper.

➢ If the paper has continued to be of interest so far, then one is now ready to delve into the Introduction section to know the background information about the work and also to ascertain why the authors did that particular study and in what ways the paper furthers the state of the art.

➢ The next sections to read are the Results and Discussion sections which is really the heart of the paper. One should really read further sections like the Experimental Setup/Modeling, etc., only if one is really interested and wishes to understand exactly what was done to better understand the meaning of the data and its interpretation.

➢ A researcher will always need to be searching for the relevant literature and keeping up to date with it. If one is busy with a small project, the advisor might just give a single important paper to read. But with a larger one, you will be searching for one's own literature to read. For this one will need a strategy as there is just too much work out there to read everything.

CONCEPTUALIZING RESEARCH

➢ The characteristics of a research objective are that it must have new knowledge at the center and that it must be accepted by the community of other researchers and recognized as significant.

➢ Besides being original and significant, a good research problem should also be solvable or achievable. This requirement already asks us to think about the method and the tools that could be used to obtain that new knowledge.

➢ Now, the significance and the originality and all the theory that we read and tools and methods that we need to take on a problem, all of these normally come from the existing recorded literature and knowledge in the field.

➢ Coming up with a good research objective, conceptualizing the research that meets all of these requirements is a tough thing to do. It means that one must already be aware of what is in the literature. That is, by the time one actually has a good research objective, one is probably already an expert at the edge of knowledge else it is difficult to say with confidence that one has a good research objective.

➢ So, when working at the research (Ph.D) level, one needs to be prepared to become that expert, one needs to be continually reading the literature so as to bring together the three parts:

- Significant problem,
- The knowledge that will address it, and
- A possible way to make that new knowledge.

➢ How these three aspects would come together will be different for every person doing research and it will be different in every field, but the only way to be that expert is by immersing oneself in the literature and knowing about what already exists in the field.

➢ However, if one is working on a research project that is of a smaller scope, then conceptualizing the research is possibly too tough to do, and one does not have the time that it takes to become that expert at the edge of knowledge.

➢ In this case, the researcher needs the help of someone else, typically the supervisor who may already be an expert and an active researcher in that field and may advise on what a good research objective might be.

➢ An established researcher in any field should be able to immediately point to the landmark literature that one should read first. Otherwise, one would need to spend a lot of time reading the literature to discover.

CRITICAL AND CREATIVE READING

➢ Reading a research paper is a critical process. The reader should not be under the assumption that reported results or arguments are correct. Rather, being suspicious and asking appropriate questions is in fact a good thing.

➢ Have the authors attempted to solve the right problem? Are there simpler solutions that have not been considered? What are the limitations (both stated and ignored) of the solution and are there any missing links? Are the assumptions that were made reasonable? Is there a logical flow to the paper or is there a flaw in the reasoning? These need to be ascertained apart from the relevance and the importance of the work, by careful reading.

➢ Use of judgmental approach and boldness to make judgments is needed while reading.

➢ Flexibility to discard previous erroneous judgments is also critical.

➢ Additionally, it is important to ascertain whether the data presented in the paper is right data to substantiate the argument that was made in the paper and whether the data was gathered and interpreted in a correct manner.

➢ Critical reading is relatively easy. It is relatively easier to critically read to find the mistakes than to read it so as to find the good ideas in the paper. Anyone who has been a regular reviewer of journal articles would agree to such a statement.

➢ Reading creatively is harder, and requires a positive approach in search. In creative reading, the idea is to actively look for other applications, interesting generalizations, or extended work which the authors might have missed? Are there plausible modifications that may throw up important practical challenges? One might be able to decipher properly if one would like to start researching an extended part of this work, and what should be the immediate next aspect to focus upon.

TAKING NOTES WHILE READING

➢ A researcher reads to write and writes well only if the reading skills are good.

➢ The bridge between reading and actually writing a paper is the act of taking notes during and shortly after the process of reading.

➢ There is a well-known saying that the faintest writing is better than the best memory, and it applies to researchers who need to read and build on that knowledge to write building on the notes taken.

➢ Many researchers take notes on the margins of their copies of papers or even digitally on an article aggregator tool.

➢ In each research paper, there are a lot of things that one might like to highlight for later use such as definitions, explanations, and concepts.

➢ If there are questions of criticisms, these need to be written down so as to avoid being forgotten later on. Such efforts pay significantly when one has to go back and reread the same content after a long time.

➢ On completing a thorough reading, a good technical reading should end with a summary of the paper in a few sentences describing the contributions.

➢ But to elucidate the technical merit, the paper needs to be looked at from comparative perspective with respect to existing works in that specific area.

➢ A thorough reading should bring out whether there are new ideas in the paper, or if existing ideas were implemented through experiments or in a new application, or if different existing ideas were brought together under a novel framework.

➢ Obviously, the type of contribution a paper is actually making can be determined better by having read other papers in the area.

READING MATHEMATICS AND ALGORITHMS

➢ Mathematics is often the foundation of new advances, for evolution and development of engineering research and practice. An engineering researcher generally cannot avoid mathematical derivations or proofs as part of research work.

➢ In fact, these are the heart of any technical paper. Therefore, one should avoid skimming them.

➢ By meticulous reading of the proofs or algorithms, after having identified the relevance of the paper, one can develop sound understanding about the problem that the authors have attempted to solve.

➢ Implementation of an intricate algorithm in programming languages such as C, C++ or Java is prone to errors.

➢ And even if the researcher is confident about the paper in hand, and thinks that the algorithm will work, there is a fair chance that it will not work at all. So one may wish to code it quickly to check if it actually works.

READING A DATASHEET

➢ Researchers in different fields of engineering will need to read certain types of documents. For example, mechanical and civil engineers would need to read drawings related to mechanical parts and buildings. Researchers in the field of electronics need to read datasheets.

➢ On occasions, researchers in other fields may also need to incorporate a certain electronic part in which case careful reading of the datasheet is imperative.

➢ The same principles like initial skimming of the datasheet are required to ascertain whether further careful reading is needed.

➢ Datasheets are instruction manuals for electronic components, which (hopefully) details what a component does and how one may use it. Datasheets enable a researcher (or a working professional) to design a circuit or debug any given circuit with that component.

➢ The first page of the datasheet usually summarizes a part's function and features, basic specifications, and usually provides a functional block diagram with the internal functions of the part.

➢ A pin out provides the physical location of a part's pins, with special mark for pin 1 so that the part can be correctly plugged into the circuit. Some parts also provide graphs showing performance versus various criteria (supply voltage, temperature, etc.), and safe region for reliable operation which should be carefully read and noted by the researcher.

➢ One should be also in the lookout for truth tables which describe what sort of inputs provide what types of outputs, and also timing diagrams which lay out how and at what speed data is sent and received from the part.

➢ Datasheets usually end with accurate dimensions of the packages a part is available in. This is useful for printed circuit board (PCB) layout. When working with a new part, or when deciding which part to use in the research work, it is recommended to carefully read that part's datasheet to come up with a bit of shortcut that may potentially save many hours later on.