

The Problem

The Heart of the Research Process

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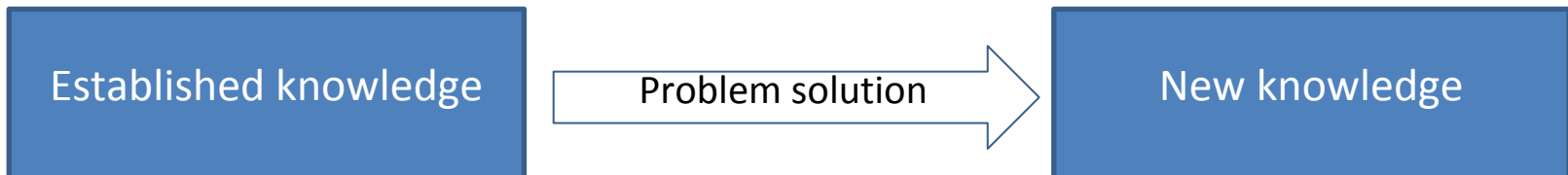
The Research Problem (I)

- The heart of the research problem
- The axis around which the entire research endeavor revolves
- How to find a research problem?
- Problems in need of research are everywhere
- Identify a research problem. Then, clearly state it using precise and unmistakable terms.
- Likely to take a lot of your time and energy
 - The problem should be worth them !!.

Identifying a Research Problem

Good research starts with a good question to ask.

- Two criteria:
 1. A research problem should address an **important question**, such that the answer can actually make a difference.
 2. The solution to the research problem should **expand the frontiers of knowledge**.
- In order to meet both criteria, the research project must involve not only collecting data, but also **interpreting the collected data**.



Types of Research (I)

Basic Research

Produces new knowledge, without considering its possible application or use.

- Standard acceleration of gravity = 9.80665 m/s^2
- Can a researcher find the sixth decimal value of gravity at a certain position on Earth?
- What would that be used for?

Applied Research

Directed towards a specific practical objective

- What is the performance price of content integrity verification in LRU caching in data networks?
- Finding optimal preemptive schedules for independent jobs on unrelated parallel processors.

Types of Research (II)

Basic Research

Produces new knowledge, without considering its possible application or use.

Applied Research

Directed towards a specific practical objective

- Difference between basic and applied research is a blurry one:
 - Answering questions about basic theoretical issues often informs current practices.
 - Answering questions about practical problems may enhance theoretical understandings of particular phenomena.

Four situations to avoid (I)

Problems that lack the interpretation-of-data component are not suitable for research.

1. Avoid research projects that simply pursue self-enlightenment. E.g.:
 - Learn how multicore processors work
 - Mechanisms for forwarding data packets provided by Multi-Protocol Label Switching (MPLS)

Four situations to avoid (II)

2. Avoid research projects whose sole purpose is to compare two sets of data.

- e.g. Latency and throughput of the T-MAC and S-MAC energy-saving protocols in wireless sensor networks.
- Data must be interpreted by the researcher.

Four situations to avoid (III)

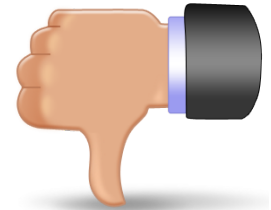
3. Avoid research projects that simply calculate a correlation coefficient between two sets of data to show a relationship between them.

- Nothing more than statistics
- Computer be done faster by computers
- Finding a correlation between two variables is just the beginning of a possible research project.

Four situations to avoid (IV)

4. Avoid research projects that result only in a *yes* or *no* answer.

Is homework beneficial to children?



|-- VS --|

Which components of homework are beneficial to children?



Guidelines to Find a Legitimate Problem

Finding a legitimate problem (I)

- Look around: Questions that need answers are everywhere.
 - You might find problems in your professional practice or in everyday events.



Finding a legitimate problem (II)

- Read the literature: Inform yourself on what things are already known about your topic of interest.
 - More important, literature review is likely to tell you what things still need to be done in the area. For instance:
 - Address suggestions for future research that another researcher identified
 - Replicate research projects in a different setting
 - Apply an existing perspective or theory to a new situation
 - Explore unexpected or contradictory findings in previous studies.
 - Challenge research findings that seem to contradict what you know or believe to be true.
 - From literature, you can extract:
 - Potential research designs and methods of measurement.
 - A theoretical base on which to generate hypotheses and build a rationale for your own study.
 - A new writing style, a way to effectively present certain data, a particular approach to data analysis.
 - Keep a record of helpful journal articles and other sources

Finding a legitimate problem (III)

- Seek the advice of experts: Ask questions such as
 - What needs to be done?
 - What burning questions are still out there?
 - What previous research findings seemingly don't make sense?
 - Experienced researchers are happy to talk with people who are just starting out.
- Attend professional conferences.
 - By attending sessions of interest you can learn what is interesting and what is not in your field.
 - Make contacts and ask questions to more experienced individuals
 - Share ideas

Finding a legitimate problem (IV)

- Choose a topic that intrigues and motivates you
 - Choose a topic based on what you personally want to learn more about.
 - Again, it will require a lot of time and energy
- Choose a topic that others will find interesting and worthy of attention
 - You will have more chance to get your work published in conferences and journals.
 - Additionally, your future employers will feel more attracted if you are doing research in a hot topic in your field.
- **Do not** use a [10 secs CS topic generator](#)

Guidelines to State a Research Problem

Stating the research problem (I)

After identifying a research problem, it must be articulated so that it is carefully phrased and represents the single goal of the total research effort.

- Researchers get off a strong start when they begin with an unmistakably clear statement of the problem.
 - Any person who reads English should be able to read it and understand it.
 - State it completely by using one or more grammatically complete sentences.

Stating the research problem (II)

- Think through the feasibility of the project that the problem implies.
 - Think about the practical implications of the problem that you are stating.
 - It is great to have ideas. It is much better to have practical ideas.
- Say precisely what you mean
 - Do not assume other people will be able to read your mind.
 - Try to make clear and explicit your assumptions and the constraints of your research project when stating the problem.
 - A poorly articulated problem statement may negatively affect your reputation as a researcher of integrity and precision. It may also affect the reputation of your project.
 - (?) The problem should be stated in the very first words of an abstract.

Stating the research problem (III)

- State the problem in a way that reflects an open mind about its solution.
 - Good researchers keep open minds about what they might find during the execution of the research project. Perhaps they will find the result they expect, perhaps not.
 - A hypothesis should not be part of the statement of the problem.



Stating the research problem (IV)

- Edit your work
 - Use precise words, not approximate words.
 - Use simple words, concrete nouns and active, expressive verbs.
 - Eliminate unnecessarily wordy phrases.

Dividing the Research Problem into Subproblems

- Motivation
- Subproblems versus Pseudo-Subproblems
- Characteristics of Subproblems
- Identifying Subproblems
- Tips

Motivation- Why?

- The research problem may be too complex to attack directly
- May overwhelm or even intimidate researcher
- However, almost all research problems can be divided into subproblems

Motivation- Solution

- Taking on a research topic in the form of its subproblems is easier to address
- Can make the different aspects of the problem clearer to the researcher
- Also easier to manage time and resources as you can develop a tentative plan
- Helps maintain morale when you reach milestones with solution of each subproblem

Subproblems vs Pseudo-Subproblems

- Some obstacles or contingencies encountered during research may appear
- These are nonessential to the problem and are artificial concerns
- However, they may need to be addressed creatively or by seeking support

Subproblems vs Pseudo-Subproblems (Examples)

- What is the best way to choose a sample?
- How large should a representative sample of a population be?
- What instruments or methods should be used to gather the data?
- What statistical procedures should be used to analyze the data?

Subproblems vs Pseudo-Subproblems (Direction)

- Use resources listed at the end of Chapter 2 for further guidance
- Lookup “Research,” “Methods,” or “Methodology” in a library catalog or Internet
- Bug the professors in our department (I would imagine that’s our best resource)

Characteristics of Subproblems

1. Each subproblem should be a completely researchable unit.
 - Same research methodology applies
2. Each subproblem must be clearly tied to the interpretation of the data.
 - Again, stay true to true research methods
3. The subproblems must add up to the totality of the problem.
4. Subproblems should be small in number.
 - You want to finish your PhD in time, right?

In CS talk, approach this like an OO system design :)

Identifying Subproblems

- Many novices have difficulty seeing the subproblems in the main problem
- Mainly due to unclear problem statement
- Authors suggest mapping out ideas on paper or using software
 - Paper-and-Pencil Approach
 - Brainstorming Software

Every Problem Needs Further Delineation

- Overview
- Stating the Hypotheses and/or Research Questions
- Delimiting the Research
- Defining the Terms
- Stating the Assumptions

Overview

- Stating the hypotheses and/or research questions
- Delimiting the research
- Defining the terms
- Stating the assumptions
- CS: Rehashing the problem mathematically?

The Setting of the Problem

Stating the Hypotheses and/or Research Questions

- Difference between hypotheses and research questions
 - Experimental vs Qualitative Research
 - Speculative vs Non-Speculative
- Subproblems should be pursued similarly as the main problem
 - Follow all the steps of any other research effort

Distinguishing Null Hypotheses from Research Hypotheses

- Sometimes easier to prove or discredit an opposite hypotheses
 - Teens enrolled in Program A will graduate from high school at a higher rate than Teens in Program B
 - There will be no difference in high school graduation rates of teens enrolled in Program A vs Program B
- Hypotheses with negated statements form **null hypotheses**:
 - ... no consistent relationship between variables ...
 - ... no patterns in data ...

Identifying the Variables under Investigation

- We are familiar with the parts of a scientific experiment: variables, controls, constants
- The **variable** is any quality or characteristic that has multiple values
- **Independent variables** is the part that the researcher directly manipulates
- **Dependent variable** is attributes influenced by changes in independent variables
- **Mediating variables** attempt to explain why independent variables affect dependent variables
- **Moderating variables** influences the strength of the relationship between independent and dependent variables

Identifying the Variables under Investigation

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Delimiting the Research

- Clearly state what you intend and do not intend on investigating
 - Interesting questions that may arise during the process of research can take you off course
 - Research problem can grow exponentially
- Only when you truly understand your problem can you discover essentials
- Characteristics of Byrd's motets vs all influences in Palestrina-Byrd problem

Defining the Terms

- Researches make the assumption that followers will
- Even with common words, we all have different perspectives
- May introduce new words to better capture an idea in our research
- A definition at least contains
 - a. The terms- of course include the words being def.
 - b. The genera- class to which the concept being defined belongs
 - c. The differentia- The specific characteristics that distinguish the concept from other members

Defining the Terms- (Tips)

- Avoid circular definitions
- For fuzzy terms, include an operational definition which defines your interpretation

Stating the Assumptions

- Do not leave any question in followers' minds about conditions
- State even the assumptions that seem basic and implicit to you
- Need to make sure your conclusions leave few questions about the conditions under which you made observations

Importance of the Study

- Why did you take on this problem?
- What practical value does this have?

Ordering the Topics in a Research Proposal

- A good logical flow in the presentation on your research
 - Problems, subproblems, hypotheses, questions
 - Statement of delimitations, definitions, assumptions
- Following the checklists in the book in order is a good baseline
- Looking at other good papers is another good idea

Chapter Recap- First Half

- The problem is the heart of the research process
- Identifying a research problem
 - Has to be important and extend the frontier of knowledge
- Types of research:
 - Basic Research
 - Applied Research
- Find a legitimate problem
- Clearly state the research problem

Chapter Recap- Second Half

- Dividing Research Problems into Subproblems
 - Subproblems vs Pseudo-Subproblems
 - Characteristics
 - Identifying
- Every Problem Needs Further Delineation
 - Stating Hypotheses and/or Research Questions
 - Null Hypotheses
 - Identify Variables
 - Delimiting the Research
 - Defining Terms
 - Stating the Assumptions
 - Importance of the Study
 - Ordering the Topics Proposal