CSIP5403: Research Methods and Applications

Lecture 5: Formulating A Research Problem

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Outline

General Comments

First identifying and then specifying a research problem might seem like research tasks that ought to be easy and quickly acomplished. However, such is often not the case.

General Comments

After an initial review of literature, the formulation of a research problem is the first and most important step of a research process

A research problem is like the foundations of a building. If the foundation is well designed and strong, the building will also be strong.

Similarly, if the research problem is well formulated, you can expect a good study to follow. The research type and process depend on the research problem.

General Comments

Remember, this is the most crucial step

Take time over formulating your problem, for the clearer you are about your research problem, the easier it will be for you later on

You must have a clear idea with regard to what you want to find out about and not what you think you must find

Considerations in Selecting a Research Problem

To help you ensure your study is manageable and you will remain motivated, considerations are:

- Interest
- Magnitude
- Measurement of concepts
- Level of expertise
- Relevance
- Availability of data
- Ethical Issues

Interest

- Should be the most important consideration in selecting a research problem
- Select a topic which interests you

Magnitude

- Should have sufficient knowledge about the research process to be able to visualise the work involved in completing the proposed study
- Narrow the topic down to something manageable, specific and clear
- Manageable in terms of: time and resources at your disposal

Measurements of Concepts

- If you are using a concept in a study, make sure you are clear about its indicators (variables) and their measurements
- Example: Effectiveness of recommender systems in e-commerce business
  - what determines effectiveness – customer satisfaction – quality of recommendations with respect to purchases
  - how it will be measured – increase in revenue

Level of Expertise

- Make sure you have an adequate level of expertise for the task you are proposing
- You may receive help from supervisor and others, but you need to do most of the work yourself

Relevance

- Select a topic that interests you but also that is of relevance to you as a professional
- Ensure that your study adds to the existing body of knowledge, bridges current gaps or is useful in policy formulation

Availability of Data

If your study will need collection of data from secondary sources

- Make sure that these data are available and in the format you require

Ethical Issues

- In the course of conducting a research study, the study population (if any) may be
  - adversely affected by some of the steps of such study
  - expected to share sensitive and private information
- Ethical issues need to be addressed properly before research study starts

Steps in Formulating a Research Problem

1. Identify a broad area of interest
2. Dissect the broad area into sub-areas
3. Select what is of most interest to you
4. Raise research questions
5. Formulate objectives
6. Assess your objectives
7. Double–check

1. Identify a Broad Area of Interest

Generally influenced by your own experiences

- Sustain your interest and stimulate your imagination
- Within your range of competencies
- Manageable in size
- Potential to make a contribution to body of knowledge
- Based on obtainable data
- Demonstrate your independent mastery of both the subject and method

1. Identify a Broad Area of Interest

"My study is about . . . "

- Use a single sentence that completes the above thought
- Make it short
- Aim at getting a working title for your research

1. Identify a Broad Area of Interest

Example:

- In real world decision making, such as public security, we have a large body of data from various heterogeneous information sources that often conflict with each other and provide inconsistent knowledge.

2. Dissect the Broad Area into Sub-areas

- All broad areas have many aspects or issues
- Dissect the broad area into sub-areas accordingly
  - Consult others
  - Initial literature review
- Eventually develop an exhaustive list of sub-areas

2. Dissect the Broad Area into Sub-areas

Example showing one specific sub-area:

- It is a challenging task to yield an optimal consensus decision, given the range of individual decisions it is possible to obtain in terms of these knowledge sources.

3. Select Most Interest to You

- You can use a process of elimination
- End with something that is manageable: time, expertise and resources available
- Important enough to merit investigation?
  - Will findings make a contribution to body of knowledge?
  - Will findings make a difference for others?
  - Lead to definition of new problems or other research?

3. Select Most Interest to You

Example with same specific sub-area of research – different wording

- Merging dynamical multiple source information in an adaptive manner to reduce the disagreements among the multiple sources, and to automatically seek a decision with a maximal consensus

4. Raise Research Questions

What is it you want to find about in this sub-area?

- Make a list of whatever questions you may ask relevant to the sub-area
- If too many questions to be manageable, eliminate some

4. Raise Research Questions

Example – no need to use question mark?

- Lay the foundations for an entirely new form of automated decision-support under uncertainty in dynamic environments, which could make a significant contribution to future developments of intelligent systems that model multiple source knowledge bases.

Automated Decision Making Under Uncertainty in Dynamic and Inconsistent Environments

5. Formulate Objectives

Aim of study and objectives:

- The main objective or aim of a study is your research question written in a different way by use of action-oriented words as:
  - to find out
  - to determine
  - to ascertain
  - to examine
- Break down 'aim' into specific objectives (task oriented)
- Some researchers prefer reverse process:
  - Start from 'aim and objectives' and then formulate research questions from them

5. Formulate Objectives: Free from Ambiguity

- Objectives are goals you set out to attain in your research study
- Informs the reader of what you want to attain
- Extremely important to word them clearly and specifically

5. Formulate Objectives: Free from Ambiguity

- Main aim – Overall statement of what you want to find out about
- Objectives – Specific aspects of the topic you want to investigate within the main framework of your research study
  - Achieving all objectives will lead to archive main aim
  - Numerically listed, each objective containing only one aspect of the study
  - Use action-oriented words or verbs when writing them
- Wording clearly, completely and specifically communicates to the reader your intentions

5. Formulate Objectives: Example – Aims

The project aims to:

- develop an advanced framework for automated decision support under uncertainty;
- adaptively resolve conflicting and inconsistent knowledge from multiple dynamical sources of information; and
- merge heterogeneous information to arrive at a decision autonomously.

5. Formulate Objectives: Example – Hypothesis

*The **hypothesis of this research proposal** is that a mathematical and computational framework integrating type-2 fuzzy models, group decision making models and evolutionary data fusion techniques for merging multiple dynamical and inconsistent sources of information in an adaptive manner will reduce the disagreements among them, and automatically seek a decision with a maximal consensus.*

5. Formulate Objectives: Example – Specific objectives

1. To establish a fundamental new framework for managing inconsistent multiple source knowledge bases by introducing type-2 fuzzy set theory into existing possibility theory, in which uncertain information can be truly characterised by uncertain values rather than precise crisp values.
2. To develop a model to identify the inconsistency of knowledge bases over time from the consensus modelling perspective.
3. To design a feedback mechanism with the aim to reduce inconsistency among multiple source knowledge bases over time.
4. To create an on-line information merging method over large data streams for fast aggregating uncertain information in knowledge bases.
5. To generate and test an exemplar fuzzy knowledge base system in a domain characterised by uncertain and conflicting information from multiple sources - that of security applications for example.
6. To implement a software prototype of adaptive consensus decision making given heterogeneous knowledge bases under the uncertainty environment.

6. Assess Objectives

Make sure objectives can be achieved taking into account

- the time,
- resources, and
- technical expertise

7. Double–check

Go back and give final considerations to whether you are sufficiently interested in the study, and have adequate resources to undertake it

Research Variables

- Variable: any characteristic that can take on more than one value
  - Examples: speed, level of hostility, accuracy of feedback, reaction time
- Research involves the study of the relationship between variables
  - Therefore, there must be at least two variables in a research study (or there is no relationship to study)

Measuring Variables in Research

- Measurement: Process by which we assign numbers to indicate the amount of some variable present
- Sometimes the number assignment is easy to understand (e.g., time is measured in number of seconds)
- Sometimes it is more arbitrary (e.g., 1 for male and 2 for female)

Scales of Measurement

- Based on how closely the scale matches the real number system
- Different scales of measurement
  - Nominal
  - Ordinal
  - Interval
  - Ratio

Nominal Scales

- A naming scale: Each number reflects an arbitrary category label rather than an amount of a variable
  - Examples: diagnostic categories, male/female, preference for products
- Produces nominal or categorical data
- Has mathematical property of identity
  - No ordering is implied
  - No mathematical operations can be performed on resulting codes

Ordinal Scales

- A scale that indicates rank ordering
  - Reflects the order, but not the amount of a variable
  - Examples: order of finish in a race, class rankings
- Produces ordered data
- Has mathematical properties of identity and magnitude
  - Invariant under monotone increasing transformations

Interval Scales

- A scale that has equal intervals
  - The scale indicates amount, but there is no zero point on the scale
  - Examples: temperature on the Celsius scale
- Produces score data
- Has the mathematical properties of identity, magnitude, and equal intervals
  - Invariant under a transformation of the form $y = x + b$
  - Addition and subtraction can be used

Ratio Scales

- A scale that fits the number system well
  - The scale has a true zero and equal intervals, just like the real number system
  - Examples: distance, length, weight
- Produces score data
- Has the mathematical properties of identity, magnitude, equal intervals, and a true zero
  - Invariant under positive linear transformations of the form $y = a * x$, $a > 0$
  - All basic mathematical operations may be applied

Objective Measurement

- Objective measures are the hallmark of science
  - Produce the same result no matter who does the measurement
  - Therefore, scientific principles will apply no matter who tests these principles
- Objective measures reduce biases that could distort results

Summary

- The formulation of a research problem is the most important step in the research process
- No specific guidelines but the model presented is a useful framework
- Articulation of objectives to de done clearly – specific and free from ambiguity
- Measuring variables is central to research and several scales of measurement exist
- The goal is to produce objective, accurate measures of your variables