Research Skills

WORKSHOP 1

PROPOSALS

This Week – Introduction and Proposal

- What is research? What are research skills?

- Why undertake a research project?

- Choosing a research project/area?
  - Types of project.
  - Forming a hypothesis/research question
  - Choosing a research framework.

- Research project pipeline.

- Project Proposal - The what, the why, the how!
  - Background information
  - Research question/hypothesis
  - Benefits
  - Proposed methodology
  - Project Plan
  - Expected Results
  - Conclusion

What is Research?

- Investigations to advance the state of knowledge.
  - Who's knowledge? Depends on the level of research!

- To advance knowledge you need to know something about the current state of knowledge.
  - Read books
  - Read journal and conference articles
  - Talk to people, at college, at conferences, workshops etc.

- There are a number of skills in the armory of a good researcher:
  - Should be capable of reviewing the literature in a comprehensive and critical manner.
  - Should have an appreciation and respect for research ethics and abide by them.
  - Should be capable of creative thought (particularly in the technical sciences). Research journal or diary always helps here.
  - Should be familiar with a number of research methodologies (i.e. ways to implement/carry out the research).
  - Should be able to articulate their research in the written and spoken word through reports, papers, presentations, seminars etc.
  - Should be able to present results by putting them in context in the area of research

Research Motivations

- Why undertake a research project?
- Because you have to ☺

- Because you want to!
    - Research can change peoples lives.
    - To satisfy natural innate curiosity.
    - To achieve a sense of satisfaction.
    - To have some fun along the way.

- The project will harvest a lot of knowledge and skills you've learned over the last 3 to 4 years.
- It will be your showcase in interviews as it is tangible and you know a lot about it.

Choosing a research project

- There are many different types of research project in computing. One might involve the creation of a new algorithm, another one might involve comparison of a number of algorithms. Another one might not use algorithms at all.
- Research projects can be:
  - Creative – invent new things, e.g. an algorithm, a technique, a piece of hardware.
  - Experimental – design an experiment, make some measurents, analyse the data, derive the results/conclusions.
  - Theoretical – deals with proofs, formalisms etc.
  - Comparative – Unify a body of results, rank or categorise, generalise.
  - Cross disciplinary – Bioinfomatics, AI, financial, anything that involves data.
- Choosing a project that's right for you
  - Choose something your interested in, that will capture your imagination.
  - Choose something that you will be able to do (exploit your strengths), look into the technical aspects beforehand and make sure you think you can reach that level, don't sell yourself short either.
  - Choose a project that will have some benefit to somebody
  - Ideally at end of the project there will be some aspect of originality but don't let this be the main factor at the outset. Keep the problem domain narrow.
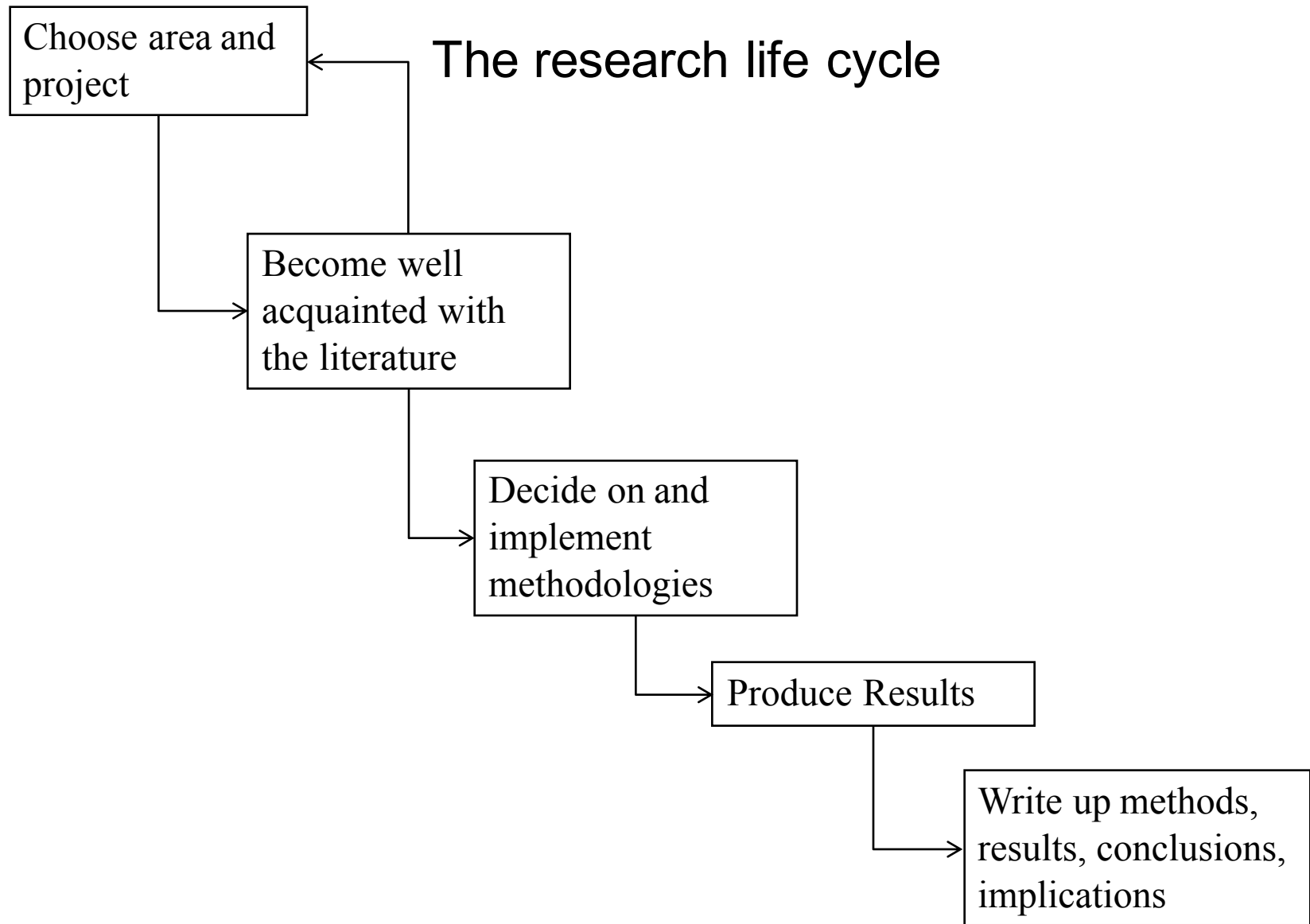
Choosing a research framework

- Choosing the right topic or idea is obviously very important as its what you are going to be studying for quite some time. What is also important however is choosing the right framework or tools to carry out your research. Questions that should be answered are:

  - If there is development, what language will I use?

  - If there is stats, what package will I use?

  - What will I use to write reports, Word, LaTex, etc

  - Where will I source my literature?

  - What package will I use for graphs/diagrams, e.g. Excel, Matlab, R, etc

  - What will I use for creating posters and presentations, PowerPoint, publisher, open source etc?

  - What tools are there for organising references, what will I use?

Forming a hypothesis/research question

- When you have decided which area you wish to research, and have narrowed it down to a manageable project you should try and state the main objectives in the form of a research hypothesis or research question(s).

- A hypothesis is an assertion that you plan on testing to validate/invalidate. For example, or quicksort is faster than mergesort except in certain instances, the reflectivity of a road marking can be meassured from its image etc.

- The above can be formulated as research questions also, is quicksort faster than mergesort in all cases? Etc etc. Resarch questions are a bit more flexible in how they are phrased.

- Your hypothesis/research questions should ultimately be clear and concise. It may take some time before this happens (i.e. after a comprehensive lit review) but you should have clear objectives when executing your methodologies.

The research life cycle

Choose area and project

Become well acquainted with the literature

Decide on and implement methodologies

Produce Results

Write up methods, results, conclusions, implications

Research Methodologies

- This is quite a generic term that causes a lot of confusion. The reason for this is that its all-encompassing. A research methodology is any activity you perform that facilitates the generation of results and the answers to your research questions.

- Research methodologies
  - Reading literature and analysing, consolidating same.
  - Data collection – interviews, surveys, web crawling
  - Algorithm derivation and implementation
  - Coding
  - Applying Statistics
  - making measurements
  - experimental design
  - proving theorems
  - mathematical modeling
  - making predictions
  - and so on

Research Proposal

- The first piece of CA you are tasked with is to write a research proposal for your final year project. You may think that this is merely a rough description of what you are going to do for the next year but there is more to it than that.

- It should be a well thought out and structured document with a number of headings, specifically it should include the sections listed below

  - Title
  - Background
  - Main research question(s)
  - Justification/Benefits
  - Feasibility
  - Proposed Methodologies
  - Expected Results
  - Conclusion
  - References
  - Project plan

  - See next slides for explanation of headings.

Research Proposal

- **Title**: Self explanatory, although do not get to caught up in this, it will change.
- **Background**: This should provide context for the research questions. Should have a description of the area you are going to work in. should make reference to some existing work in that area (Couple of paragraphs)
- **Main research question(s)**: Here you should list in as concise a form as possible what are the main research questions. You may then elaborate on them so as to explain them better. A paragraph or two.
- **Justification/Benefits**: Why do this research project at all? Who is going to benefit from it and in what way? What will be the implications of this research. Couple of paragraphs.
- **Feasibility**: Is the project technically feasible? Have you looked into the technical requirements? Are you comfortable with those. A paragraph.
- **Proposed Methodologies**: It may be very early on in the project to say with any degree of precision how you are going to carry out the research but you should have some idea. Try to articulate the methods and techniques you plan on using. Say why you think this may be a good approach to take. Couple of paragraphs. Try and use bullet points here.

Research Proposal

- **Expected results**: What do you expect the outputs of the research to be. There may be a number of possible outcomes. Be sure to mention all that you can envisage.
- **Conclusion**: Briefly summarise what you plan on researching.
- **References**: Will be revisited later in detail. For now be sure to reference other work you mention in your proposal [1]. The format for references is very important in research. For now put a number after the prose that refers to somebody else's work (like above) and then include an entry in your references section for it that has sufficient information for the reader to find it if they so wish, like below.
  References
  [1]   Hofmann, Markus. 2014. COMP H4028 Research Skills Workshop Notes. Workshop 1. pp. 12.
- **Project plan**: this should take the form of a Gannt chart showing each of the work packages in graphical format. Instructions on how to create this in excel are on Moodle. Be sure to think about the work packages. Generic work packages alone such as analysis, design, code, test will not do. They should be specific to your project. You should also have a list of deliverables (i.e. the tangible outputs of the work packages) along with when you anticipate having them. A textual descriptions of the work packages should also be present. Best presented using a table.

Research Proposal

- In the proposal, use bullet points, numbered lists, figures and diagrams, tables etc. where possible to aid its readability.

- This is worth 15% of the total marks for the module. It will also be useful in planning your final year project and reporting on same.