EENGM0004: Engineering Research Skills

ASync 3: How to Write IPP and RRR

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Interim Project Planning (IPP) Report

To present an outline understanding of your project

- Background
- Context
- State of the arts
- Importance and impact

To frame or define your project

- Content of research
- Aims and objectives
- Principles, methodology and approaches/tasks
- Project workplan (time)
- Risks

The Recommended Structure of an IPP Report

1. Background
2. Aims and Objectives
3. Summary of Related Work
4. Methodology
5. Project Workplan
6. Risk Analysis and Mitigation
7. Resource Requirements
8. References

N.B. Templates have been provided on Blackboard for IPP writing (in both MS Word and Latex formats).

Background

Background of this research topic

- What is the context: e.g., new technology, climate change and commercial applications.
- Why this work is important?
- What is the current problem? Why has it not been solved?
- What benefits can be gained by solving this problem?

General guidance

- Logical statements with proper reference (1-2 paragraphs).
- It should connect well with the aims and objectives of the project.
- Don't confuse **background** with **summary of related work**.

Background: An Example

Project title

Deep learning based video compression

Background

The demand for greater quantities of higher quality, more immersive video content is the primary driver for internet, broadcasting and surveillance technologies. CISCO predict that, by 2022, there will be 4.8ZB of global internet traffic per year with 82% being video [1]. In this context, how we represent and communicate video (via compression) is key in ensuring that the content is delivered at an appropriate quality, while maintaining compatibility with the transmission bandwidth. Although a series of conventional coding standards [2-5] have been developed in the past few decades, these compression algorithms are still built within the rate-distortion optimisation framework as their predecessors, and neither of them is anticipated to fully meet the growing demand for future media consumption [6]. A step change in coding performance, going well beyond classical signal compression, is therefore urgently required to ease the tension between the available transmission bandwidth and the high bit rates demanded by video content.

Aims and Objectives

What do you plan to achieve? – Discuss with your project supervisors.

Aims: the general purpose of the project - the big picture!

- What problem the project aims to solve?
- What kind of innovation does it want to achieve?

Objectives: measurable outcomes of project activities

- Specific targets the project will achieve.
- How do the readers measure whether you have achieved the objectives? Try to be quantitative.
- When defining objectives, think about how easy/difficult they can be achieved.

General guidance

- 1-2 paragraphs with bullet points.
- Don't confuse project activities with aims and objectives!

Aims and Objectives: An Example

Project title

Deep learning based video compression

Aims and Objectives

*Inspired by recent breakthroughs in AI technology, the **aim** of this project is to develop a new deep learning based video compression framework, which is expected to make a step change in coding gain, targeting rate-quality performance improvement of more than 30% over the state of the art – a typical improvement figure expected from a new generation of coding standard. To achieve this, the **objectives** are:*

1. *To create diverse databases for training and evaluating deep video coding tools.*
2. *To generate baseline results for benchmarking using conventional coding methods.*
3. *To develop and train new CNN-based coding tools.*
4. *To evaluate these learning-based tools and compare with conventional approaches.*

Summary of Related Work

The state of the arts in this research area (Critical Review)

- What has been done so far: facts.
- How much of the problem has been solved, how much remains to be solved?
- What are the good and not-so-satisfactory aspects of their methodologies?
- What is your reason of saying so (evidence): e.g. results and references.

General guidance

- Form viewpoints first before writing.
- This should lead to what you are going to do.
- 1 page with references in the end.

Summary of Related Work: An Example

Project title

Deep learning based video compression

Summary of Related Work

Existing deep learning-based picture coding algorithms can be classified into two primary categories [1]. The first relates to end-to-end training and optimisation using auto-encoder type architectures. (...descriptions on typical works in this categories...) Although the solutions in this category are not yet competitive with the latest standardised codecs, such as VVC and AV1, they demonstrate significant potential for the future [2-3]. A second class contains algorithms that are designed to enhance individual coding tools within a standard codec configuration. (...descriptions on typical works in this categories...) However, it is noted that these approaches are typically associated with much higher computational complexity, which may lead to practical issues when employed for real time applications.

Methodology

What should be included?

- Describe the activities (e.g. in several work packages) planned to achieve project objectives.
- In each work package (WP)/research activity, detailed approaches are described with a specific objective.
- Expected deliverables can also be included for each WP.

General guidance

- 1-2 pages with proper references.
- Describe the relationship between each WP.

Methodology: An Example

Project title

Deep learning based video compression

Methodology

This project consists of four work packages. The initial work on video database development (WP1) is key to this project's success. The baseline results (WP2) and the development of the new learning based coding methods (WP3) are clearly dependent on its outcomes. The new coding tools will be finally evaluated and compared with conventional coding approaches (WP4).

WP1: Database development

***Objective**: To create diverse databases for training and evaluating deep video coding tools*

***Approach**: Learning-based compression approaches demand volumes of training material much greater than typically used for conventional compression or existing machine learning methods. These should include diverse content covering different formats and video texture types. As far as we are aware, no such public data sets for this purpose currently exist. In this WP, we will first collect existing content publicly available online. New video content will also be captured using the professional cameras available. All the collect content and new captured footage, covering different formats, video features and texture types, will form new training and evaluation databases, which will ensure generalization for the deep learning models.*

***Deliverables**: publicly available datasets for training and evaluating deep video coding tools.*

Project Workplan

What should be included?

- Graphical representation of the work plan.
- Specify the timeline and milestone for each work package.

General guidance

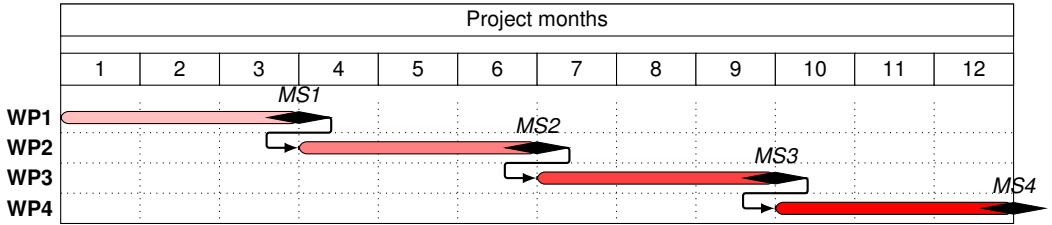
- Use a Gantt Chart.
- Make sure all the details in the Gantt Chart are readable.

Project Workplan: An Example

Project title

Deep learning based video compression

Project Workplan



Risk Analysis and Mitigation

What should be included?

- A detailed risk description and their corresponding WP.
- Risk impact scale: from low to high.
- Detailed mitigation plans.

General guidance

- Summarise all the information is a single table.
- State if the project is still able to be delivered.

Risk Analysis and Mitigation: An Example

Project title

- Deep learning based video compression.

Risk Assessment

Number	Description	WP	Impact Level	Mitigation measures
1	Video capture facility availability	WP1	Medium	Book in advance.
2	HPC availability and potential disruption	WP2/3/4	High	Allocate enough time for CNN training and coding method evaluation. Prepare local PCs as backup.
3	Storage for database and results	WP1/2/3/4	Medium	Calculate the total storage needed in this project and set up both cloud and local storage.

Resource requirements

What should be included?

- A list of resources needed in this project.

General guidance

- Summarise all the information is a single table.

An Example

No.	Resource	WP
1	Source code for XXX	WP2/3
2	A workstation with high spec GPU	WP1/2/3/4
3	HPC facility for parallel computing	WP 3/4

References

Types of Bibliography Styles

- **MLA**: Girod, Bernd, et al. “Distributed video coding.” Proceedings of the IEEE 93.1 (2005): 71-83.
- **APA**: Girod, B., Aaron, A. M., Rane, S., & Rebollo-Monedero, D. (2005). Distributed video coding. Proceedings of the IEEE, 93(1), 71-83.
- **Chicago**: Girod, Bernd, Anne Margot Aaron, Shantanu Rane, and David Rebollo-Monedero. “Distributed video coding.” Proceedings of the IEEE 93, no. 1 (2005): 71-83.
- **Harvard**: Girod, B., Aaron, A.M., Rane, S. and Rebollo-Monedero, D., 2005. Distributed video coding. Proceedings of the IEEE, 93(1), pp.71-83.
- **Vancouver**: Girod B, Aaron AM, Rane S, Rebollo-Monedero D. Distributed video coding. Proceedings of the IEEE. 2005 Jun 27;93(1):71-83.

General Guidance

- The bibliography style should be consistent in a document.
- Various reference management software can be used for different editing environment: e.g., EndNote for MS Word and JabRef for Latex.

The Purpose of Research Review Report (RRR)

Justification of the Project

- Why is this project worthwhile?
- Why would your approach be the optimal approach?

What should be included in the RRR

- The big picture of the research scene.
- Summary of existing works and problems remaining to be solved.
- Summary of how other people approached the problem and the merits/shortcomings of their approaches.
- Conclusion on what must be done, and your approach is worth trying!

The Structure of RRR

1. Introduction
2. Literature review
3. Summary and conclusions
4. References
5. Appendix: MSc Interim Project Plan (IPP) v2

N.B. Templates have been provided on Blackboard for RRR writing (in both MS Word and Latex formats). Typically it is approximately 12-15 pages long (IPP v2 excluded).

Introduction

What should be included?

- Describe the context, the main research area, and the specific topic(s) you will be addressing (Background in IPP).
- Present aims and objectives for the project in order to provide focus for the research review for both yourself and the reader (supervisor) (Aims of Objectives in IPP).
- These could be revised versions of those submitted in the MSc IPP v1.

General guidance

- 3-4 Paragraphs including bullet points for Aims of Objectives.

Literature review

What should be included?

- This would comprise several sub-sections for the different aspects that your project is related.
- It is important to choose the right level of the information included.
- You need to **summarise** existing works before you do **comparison** and critical commenting.
- Your comments should be clearly identifiable as different from others' summary (avoid plagiarism).

General guidance

- The content and length are highly dependent on the project you are working on.
- This section could be one of the chapters in your final thesis with adaptation.

Literature Review: An Example

Project title

Deep learning based video compression

Structure

- Sub-section 1: Conventional video coding standards
- Sub-section 2: Deep learning based coding tools
- Sub-section 3: End-to-end optimised coding architectures
- Sub-section 4: Coding performance evaluation

Existing work description and comments

As an alternative to the enhancement of specific coding tools within a conventional compression framework, several authors have investigated deep network architectures for end-to-end training and optimisation. Balle et al. presented a general framework for rate-distortion optimized image compression based on nonlinear transforms, which consists of multiple convolutional filters and nonlinear activation functions [1]. This work was reported to offer improvements over JPEG and JPEG2000 based on PSNR and MS-SSIM [2]. ... Although these new approaches present a radical departure from conventional coding strategies and, while it is not yet competitive with state-of-the-art conventional video codecs, such as AV1 and VVC, it holds significant promise for the future.

Summary and conclusions

What should be included?

- You should summarise the **main findings** in the context of your project.
  - Which methods from the literature are most likely to give you expected results in your project?
  - Is the choice clear, or is there a need to compare tools/approaches as part of your project (i.e. it becomes an objective in itself)?
- Justify the **urgency** and **importance** to do your project and the proposed methodology.
  - Have you identified questions that need to be addressed in your project?
  - What is the difference that your project will bring in compared to the research review you have just completed?

General guidance

- 2-3 paragraphs on the summary and conclusions.