Department of Computer Science

Project Dissertation Leaflet

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Contents

Chapter 5

Dissertation

5.1 Introduction

The dissertation is the main piece of evidence demonstrating what you have achieved within your final year project. Most of the decision–making regarding the grade that your project will be allocated is based on the dissertation. All writing you undertake must take account of the audience — the project dissertation must be written not only as a piece of academic writing for the dissemination of your work, but also for the assessment of your project by the Examiners.

This document provides guidance on the completion of the dissertation, providing information on possible content for various forms of project. Some of the information is *required* – such as the layout and page appearance – whilst other details are for your interpretation with the help and guidance of your project supervisors – the detailed contents of the sections, for example. You should use your judgement based on the kind of project you have attempted, the effort put into each part of the project and the parts of the project you wish to emphasise, as to how to address the non-mandatory areas.

5.2 The Purpose of the Dissertation

The final year project is very important. Not only does it represent three units, a significant proportion of the marks towards your degree classification, but it is also a showcase in which you can demonstrate your achievement within the degree programme as a whole. As such, the Programme Boards of Examiners within the Department of Computer Science pay particular attention to the project outcome when making degree classification decisions for borderline candidates. In job interviews you will often be asked about your final year project, and

some job interview panels may request to see your dissertation. Finally, it also provides an opportunity for you to pursue an interest in a topic within the remit of Computer Science which may well be beyond the core syllabus of your degree programme, and may allow you to gain greater insight into the research interests of the staff of the Department of Computer Science.

Whilst many students put a lot of effort into the choice and subsequent execution of their project, writing the dissertation is often neglected until the last few weeks of the project period. In fact, some students enjoy the project work to such an extent that the dissertation is almost forgotten. Such neglect is a major mistake, not least because *it is through your report that your project will be primarily judged.* Although this document will seek to guide your report writing for the purpose of assessment, you should be aware that there are many other reasons why you should write project report:

- "Communication", which includes written communication, is a key skill that will be required throughout your working career. The project dissertation requires you to communicate a complex problem, process and solution in a succinct, critical and focused manner. In the workplace, any evaluation of purchasing options, management alternatives, financial decisions (etc.) will require the same skills.

- Writing helps you to assimilate the work you have completed, assess its value and completeness, and to judge it. It is common to learn as much from the writing as in the practice. In particular, good writing will help you to *understand* what you have done and why. Writing forces you to lift above the minutae of the project details and view how you have done in more general terms.

- The Dissertation is the permanent record of your achievement and abilities. It should represent the culmination of your learning and application of knowledge.

It is therefore important that you give appropriate time to the development of a well-written and presented project dissertation. The following sections provide detailed guidance on the structure and guidelines on content for your project. Section 5.3 identifies the typical chapter and section headings for various types of project, which you can adopt wholesale or adapt to your style of project. Section 5.4 identifies the *required* style for the dissertation, with additional guidelines to help you with common writing problems within subsection 5.4.2. Section 5.5 provides details on what you are required to submit on the project deadline date, and the penalties for late submission. Within the final section (section 5.6) you are provided with details of the marking process which may help you to focus your write-up so that it addresses the assessment areas.

5.3 Dissertation Structure

Your project dissertation should have a number of key aims which you will seek to satisfy by the use of an appropriate dissertation structure. The aims can be identified as follows:

The project dissertation should:

- Clearly identify the problem you are tackling, including the reasons why the problem is important and worth investigation;

- Discuss the academic background to the project – this includes an identification of previous work in the area of the project and its relevance to your work, and a critical appraisal of that work, and selection of appropriate knowledge, tools, techniques, and/or methods for use in your project;

- Identify a potential solution to the problem, using appropriate methods and techniques to identify the requirements of the potential solution and to identify the structure and approach to the solution.

- Describe key aspects of the investigation, development of the solution and the results (as appropriate);

- Draw conclusions from the work;

- Critically appraise all aspects of the project, including the identification of possible further work, analysis and appraisal of the approaches, techniques and methods used, and elaboration of the lessons learnt.

These aims are independant of the style or topic of the project and should be interpreted appropriately for an investigation of requirements, a software development task, or an experimental research project (for example).

The structure of the project provides a mechanism that allows you to meet these aims. Structure is important . . . it provides the reader with a framework within which to place the detail being presented and it ensures that progress is made through the key aspects of the dissertation.

There are two levels to the project structure – detail and sections that will always be present, and sections that you will adjust according to the needs of your project.

5.3.1 Required Structure

The following details are required in all project dissertations:

- Title Page ...see section 5.5 for details

- Abstract

- Acknowledgements

- Signed Declaration

- Contents List

- Introduction

- Literature Survey

- Main Body ...this is the varying part of the structure

- Conclusions

- Bibliography

- Appendices

The Abstract

The abstract immediately follows the title page, and is presented on a page on its own. It consists of a brief summary of no more than 300 words which accurately outlines the main aims and achievements of your dissertation.

A [fictitious] example:

The travelling salesman problem is a deceptively simple combinatorial problem in which the shortest tour of a number of cities must be constructed. Previous forms of solution to this problem are investigated and the relative merits of the competing approaches are considered. The approach of Durbin and Willshaw (1987) is shown to hold promise for further refinement. A detailed specification and design for a solution using their 'Elastic Net' method is developed and an implementation is produced and tested. Experiments are conducted using a number of standard test tours and the results are compared with published results for the 'Self-Organising Map' (SOM) approach. It is shown that the Elastic Net method generates tours which are within 5% of the optimal tour length. It is noted that this is higher than the tours computed with the SOM approach and requires a larger run-time. It is concluded that, whilst of theoretical interest, this approach is not appropriate for application to the travelling salesman problem.

Acknowledgements

In this section you should acknowledge those who have helped you or offered you advice during your project. It is common courtesy to include an acknowledgement to your project supervisor. People sometimes also include acknowledgement of family and friends who have helped to proof-read the work or provided emotional support. The acknowledgement should be brief and succinct.

Contents List

This section should be be entitled "Contents" and should provide a list of chapter, section and subsection headings with their appropriate page number. You are *strongly* advised to use the features provided within LaTeX or your word-processing software to auto-generate this page. This ensures that the details are correct and reduces a lot of labour-intensive and painstaking work. An example contents page is provided at the start of this document (although you should note that this document is in 'article' style and therefore not structured with chapters as a dissertation would be).

Introduction

This section will be relatively short. It should introduce the reader to the problem that is to be tackled, and provide a brief indication of the context within which the problem exists. This will include some consideration of appropriate related literature and/or past attempts at solving the problem, although the main consideration of previous work should be left until the Literature Survey. The most important part of the introduction is the identification of why the problem is of particular interest and worthy of further study. The introduction should seek to draw the reader into the remainder of the dissertation, whetting their appetite to learn more of the problem and its solution. It should introduce the structure of the document and provide a framework for the reader as progress is made through the remainder of the dissertation.

The Literature Survey

A Literature Survey has already been considered within the preparatory classes for the unit CM30082 and in the additional handouts provided. Comments on the literature survey will have been handed back to you recently. These will provide feedback on your writing style, your use of references, content and structure. You should use this feedback in the re-working of the Literature Survey for the dissertation and to inform your production of the remainder of the dissertation.

The Main Body

This contains the substantive sections of the project and will, together with the Introduction, Literature Survey and Conclusion, typically be between 40 and 100 pages in length, and ideally *70 to 80 pages of focused well planned writing.* No project should exceed a total of 100 pages on these sections.

The structure of this part is highly dependant on the type of project you are producing. Some guidance on the types of project and their contents are given in subsection 5.3.2, below

Conclusion

The conclusion is a key part of the dissertation. It should be the natural end-point of the flow of argument that started from the Introduction with the identification of the problem to be tackled. It should draw upon the problem description and the literature survey, using the results to compare the work done with the expected outcome and with previous or related work. It should draw together the lessons learnt from your critical evaluation of the development/ implementation/ research processes used within the project. It should lead to a set of natural conclusions about the achievements made and the ways in which the difficulties encountered would be tackled if the project were to be run again. It should clearly identify any contributions to current knowledge or practice that the project provides. The conclusion should therefore be the culmination of the project, highlighting the achievements of the project, identifying things that have been done well, noting areas which could have been done better or tackled in a different way, and relating the work of the project to your intended system (as detailed in the Introduction) and related work (as discussed in the Literature Survey).

Bibliography

No work you do will exist in a vacuum. You will alway be "standing on the shoulders of giants" – using the work of others to inform your own work. This is a particularly important aspect of degree-level work. Your degree studies are based on the acquisition of skills in the gathering, reading, assimilation and utilisation of the work of others, as revealed in books, journals, specialist publications and academic papers. Your dissertation *must* evidence the investigative work you have completed in order to understand the topic area, gain an understanding of previous work done in the area, and identify an appropriate way in which to tackle your project. This is primarily revealed within the Literature Review, but should be evidenced throughout the dissertation in the context of the ongoing critical evaluation of your work and results.

Wherever you use ideas or work of another person, quote from a source, or refer to another piece of work you *must* include an appropriate reference. These references will all be gathered

into a Bibliography which appears at the back of the dissertation before the appendices. The Bibliography will *not* include other reading which you have conducted which is not referenced within the dissertation body . . . if you wish to include this information then you can do so by having a separate Bibliography section, calling the section which lists the references the 'References' section.

You should ensure that all references are identified as they are used, including the points where you are using ideas but not quoting a reference. If you are quoting, the extent of material quoted must be clearly identified. All references should be in one consistent *standard* format – normally following the 'Numerical' or else the 'Author-Date System' (as seen in the Harvard systems).

The following text samples use the Numerical system:

> *. . . a solution to the consecutive state problem was presented[1].*

and the reference cited would appear as:

> [1] Barry, A.M., 'Aliasing in XCS and the Consecutive State Problem : 1 - Effects', *Proceedings of the Genetic and Evolutionary Computing Conference*, GECCO'99, pp. 19-26, Morgan Kaufmann, 1999

In contrast, the following text samples use the Author-Date system:

> *. . . a solution to the consecutive state problem was presented (Barry, 1999).*

or

> *. . . Barry (1999) presented a solution to the consecutive state problem.*

and the reference cited would appear as:

> Barry, A.M. (1999), 'Aliasing in XCS and the Consecutive State Problem : 1 - Effects', *Proceedings of the Genetic and Evolutionary Computing Conference*, GECCO'99, pp. 19-26, Morgan Kaufmann

In general the Author-Date system is more helpful to the reader and the author. The reader may know the field and be able to identify the work from the author's name and the date of the publication without having to reference the Bibliography. The author does not have to recall the number of a publication each time it is to be referenced — recollecting the name and

year is sufficient and, in general, much simpler. Whichever system is chosen, it is important to ensure that the system is used consistently and correctly throughout. It recommended that a typesetting system like LaTeX is adopted, since this will automatically collate a bibliography and insert appropriate references in a single selected style. If you are using a word-processor, you will have to do more work to ensure that the references are correct and in the same style.

The way in which references are written for books, journals, conference papers and internet references differs so that the reader can tell them apart. The following are [fictitious] examples using the Author-Date system (notice that where an author has multiple publications in one year a letter is added to the year to differentiate the publications):

Barry, A.M. (2000a), 'Data Mining with XCS', *Proc. Famous Intl. Conf.* (FIC00), 23-34, Bath Publishers.

Barry, A.M. (2000b), *Perfect Projects*, 2nd Edition, Bath Publishing, London.

Barry, A.M. (2002), 'Writing Brilliant Project Reports', available from Internet [http://www.bath.ac.uk/reports.pdf] (5 October 2002)

A comprehensive yet compact guide to citing and references is available from the Library and via a link from the CM30082 website.

Appendices

The appendices provide the location where details that would otherwise break up the flow of the text can be located. These may be explanations of an area related to the current topic but an aside to the main flow of the text, or volumous and detailed requirements, design, implementation or testing details. In general your text should discuss the process and results of your work, identifying and discussing the key decisions made and their outcome. It should have a clear flow and direction of argument towards natural conclusions. Detailed consideration of the products of the project may well break up this flow, and so you should judiciously select appropriate issues and details to discuss and refer the reader to the appendix for the remainder of the detail.

Other content that you should also consider placing in the Appendices *may* include some or all of the following:

- If you are using special tools to build your system you might wish to provide the reader with a *brief* description of these tools. This description is probably best placed in an appendix, and the reader directed to the appendix at the appropriate point in the main text of your dissertation.

- An appendix could be an appropriate place to put the test plans and test results from testing your system. If you have a very large number of test plans and test results then it is preferable to include only a representative subset, and to state briefly the scope of the tests whose results are not shown. Remember that your testing strategy should be described in the main body of the dissertation where you described the work you have carried out, and the reader directed to the appropriate appendix to find the detailed test plans and results.

- If your system is designed to be used and/or maintained by others then you could include the user and maintenance guides as another appendix.

- It is usual to place your code into an appendix, so that the reader can see your coding style and commenting standards. Provide a short overview at the start of the appendix to allow the reader to find their way around the code. Just presenting the code with no explanation is inappropriate. You should layout the code listing so that you get at least two original pages per A4 page. If you have a large amount of code, then you should consider including only a subset of the code – perhaps only the most important components or the most complex components. In general, if the two-up layout code listing is longer than 20 pages, then you should leave some of it out. You are *required* to include a CD with *all* the products of your project stored on it, in any case.

The appendices are normally numbered separately from the main document (Appendix A, B, C, . . . , rather than Chapter 1, 2, 3, . . .). A document processing system like LATEX will provide the appropriate numbering, but you may have to be more careful if using a word-processor.

5.3.2   Variant Structure

The main body of the dissertation will vary depending upon the style of the project you select. There are many possible project forms, but this section will discuss possible structures for two main forms of project — the software development project and the research project.

Software Development Project

The fact that this kind of project focuses on the development of a software product does not remove the requirement to ensure that the dissertation is a piece of academic writing, and the dissertation should reflect this in an appropriate investigation of the context in which the problem exists – relevant technologies, related products and algorithms – within the introduction and the Literature Survey. The dissertation should ensure that appropriate evaluation and critique is evidenced throughout. To facilitate this, the chapters of the dissertation describing the development process should *not* be a simple exhaustive list of the requirements

/ design / classes or functions, etc. Rather, each chapter should provide an overview of the task(s) undertaken and a high-level walk-through the main features of that stage, and then identify key (and interesting) areas and/or issues that the remainder of the chapter will discuss. The details can be placed within the Appendices and referred to as required.

The main chapters will typically be:

Requirements Analysis and Requirements Specification This chapter should identify the process of requirements capture and analysis that was adopted (explaining why a particular technique or method was adopted rather than competing techniques, if necessary). The section should identify and discuss key requirements, and focus particularly upon areas of particular challenge, difficulty or conflict. An appropriate scoping of the desired system is a key part of any project, reflecting an appropriate understanding of the resource limitations that impinge on the project. The chapter should be careful to identify areas of the process of requirement analysis and specification which were particularly 'successful' or demonstrate good practice, and be appropriately self-critical of areas where difficult compromises have had to be made.

Design The design chapter should indicate how the problem, as specified within the requirements, is analysed to create a potential solution, and how the details of the proposed solution are captured using an appropriate method. The design chapter will typically address the problem of method choice, but should not simply regurgitate the well-known details of myriad competing design methods. The chapter should then introduce the overall architecture of the design (the high-level design) so that the reader can gain an understanding of the approach being adopted. The chapter should *not* be allowed to become a catalogue of key classes or design components. Instead, it should select key parts of the design which are particularly important, illustrate the selection of particular approaches from a range of possible design decisions, or show the application of particular design patterns for the solution of identified problems. Of particular importance are areas of the design which resolve key viewpoint conflicts that were identified in requirements capture and analysis.

If the user interface specification and design is an important part of the project, then it may be appropriate to dedicate a separate chapter to this component of the system. It is common for project students to spend considerable time rehearsing principles of user interface design that are readily accessible from key texts. Whilst it is important that these principles are used and applied, extensive regurgitation of this material is often unnecessary and simple reference can be made to the appropriate sources. If, however, the project is investigating new approaches to user interface development, then a more in-depth consideration of the principles of user interface design may be appropriate in the Literature Survey.

Detailed Design and Implementation   This chapter will follow the same approach as the Design chapter, presenting an overview of the software architecture and a high-level discussion of the implementation process. It will reflect on appropriate implementation approaches, algorithm choices and language choice, using the more detailed discussion provided within the Literature Survey to justify decisions taken. It will include discussion of any ancillary techniques used to ease implementation (such as the use of source code control systems and associated release plans). The discussion should not descend to become a simple catalogue of classes or methods, but should select non-trivial components, interesting implementation techniques, or important algorithm choices to discuss. It is important to take time to decide which design and implementation issues warrant discussion and which do not.

System Testing   Although the test plan will have been developed after the development of the requirements specification, the *process* of testing should be discussed following the discussion of the implementation. The chapter should begin with a description of the testing strategy and how this is reflected within your test plan. It should provide a high-level overview of the test plan, and then focus on particular testing outcomes which are of interest. For example, a particularly complex section of code or interaction between classes may require very careful data selection and results extraction in order to demonstrate conformance to the requirements, and the problems involved in generating and applying appropriate test data might be discussed. On the other hand, one or more tests may reveal that the behaviour was not as expected, and it might be appropriate to discuss how further tests were created to isolate and enable rectification of the problem. You should evaluate how appropriate the processes and techniques you applied were in hindsight.

It is unlikely, given the constraints upon the project, that detailed and sufficient tests can be applied across all parts of the software product. If you have to make difficult choices about the areas you will test, you should explain how these choices were made and demonstrate how these choices maximise the benefit of testing whilst reducing effort required.

As in the other chapters, details of the test plan and results are likely to be inappropriate for inclusion within the body of this section, and should normally be relegated to the appendices.

Investigation / Research Project

The investigation, or a research project, is typically a project in which, based on the Literature Survey, hypotheses about a particular approach, technique or solution are proposed and tested through appropriately developed experimentation. Often a prototype system or a program implementing an hypothesised approach will be created and the experiments will be conducted on or using this software.

There is a tension in such projects between the need to discuss the development of the software

used within the experiments and the need to detail and discuss the experimental method and the experiments themselves. In general a decision should be made as to whether the major effort will be in the software development or within the experimentation. In the former case, it may be more appropriate to follow the structure of the Software Development Project (above) with an additional chapter on the experiments and their results. In the case where the experiments are the most important element in the project, or where previously implemented software is being adapted and applied experimentally, the following chapter headings and content will normally be more appropriate:

Experimental Hypotheses This chapter will use the background to the problem identified within the introduction, and the details of previous related work provided within the Literature Survey, to lead to one or more hypotheses which are going to be tested in your investigation. The chapter will typically be short, drawing together the relevant threads of the literature review to identify why a new or alternative approach to a problem may be appropriate. It should then identify in a clear and concise manner (usually in one or two sentances) the main hypotheses that are to be tested. This will possibly be followed by further discussion of the techniques that will be applied or experimental approach that will be used in order to test the hypotheses.

Note that this chapter may not be necessary – it could be more appropriate to include it as a section which forms the natural culmination of the Literature Survey.

Design of Experiments This chapter should identify the choice of experiments which you will undertake in more detail. Typically it will identify the particular test 'environment' that will be used — the highly controlled part of the problem domain which the experiment is going to manipulate. It should identify how potentially confounding variables in the problem domain will be controlled (how you will ensure that the results you see actually reflect the application of the new approach and do not result from some side-effect). If software is to be written for the experiments, the section should detail the main algorithm(s) sufficient to allow another person to reproduce the experiments. If the software is particularly complex, one or more chapters may be required to document the technique appropriately. If existing software is being applied, then the chapter should identify the software and (where appropriate) any changes that have been made to it. Any parameterisation of the experimental software or approach should be identified and discussed, and the parameters selected for the various experiments identified. Again, the it is important that sufficient detail is presented in a succinct and unambiguous manner to enable the work to be repeated. For each experiment, it is very important that the criteria by which the experiments will be judged successful are clearly stated — this may involve the use of appropriate [statistical] confidence tests.

Experimental Results   This chapter will describe how the experiments were undertaken, reflecting the experimental design identified in the preceeding chapter. Where more than one experiment is undertaken, they will usually be presented in turn. The results of each experiment are shown using appropriate textural and/or graphical presentations and/or summary statistics. The discussion of the results may highlight expected results or trends, or highlight unexpected results. If the results prompt further experimentation to investigate particular phenomena more closely, these experiments and their results will also be included within this chapter. Where the results of experiments are not readily summarised or easily graphically presented, it may be particularly appropriate to discuss the results within the chapter and refer the reader to relevant appendices for the detailed results.

Analysis of Results   This chapter analyses the results obtained, possibly applying appropriate statistical confidence tests, in order to evaluate the hypotheses. Using the results it will be concluded that the null hypotheses are supported or denied. The implications of these findings should be discussed, and the significance of the results for the field identified. It may be appropriate to reflect upon whether the experiments chosen were appropriate, and if the results were not useful or inconclusive what needs to be done in order to construct more useful experiments. It could also be appropriate to decide whether the methodology chosen for the investigation was appropriate, and what changes might be necessary.

Note that this chapter should be distinct from the Conclusion chapter of the project, which will include reflection upon the results but will go beyond the experimentation itself to reflect upon the project as a whole — what was learnt from it and its relevance to your studies.

5.4   Dissertation Style Guidelines

The actual content of your dissertation is the *most* important thing. Nonetheless, if your project is poorly or inappropriately presented the reader may be discouraged from reading your project with the appropriate degree of attention. In the worst case the reader may even find it difficult to identify the main points that are being made because of an inappropriate dissertation layout. The production of professional documentation is an integral part of the project.

The following sections discuss in more detail the requirements and various recommendations in regard to layout and style. [1]

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[1] This section has extensively used material from C.P. Willis "Guidelines for Dissertation Projects". The author is grateful for the permission of Dr Willis to use (and modify) this material.

5.4.1 Layout

Page Appearance

Do not try to be innovative and clever with the document style. The dissertation should convey information about the project that was undertaken rather than to show-off experience (or otherwise) in document layout.

The most important aspects of document design are clarity and consistency:

- **Clarity** – choose layouts, fonts and so on, so that the reader finds it easy to read;

- **Consistency** – keep to the chosen layouts, fonts and numbering conventions throughout the document.

Most word-processing packages or type-setting packages allow the user to identify the styles of various paragraphs and sections. These ensure that the package enforces the layout and appearance, and so maintains consistency without the author having to recall the conventions that were used previously. It is important to make use of these facilities, which will require time to set up before the document production is started.

Fonts and Font Size   Choose a font that is easy to read, and conveys the right message about the information that it is being used to report. Although there may be a need to use several different fonts, do not use too many, because this can make a page look far too "busy", and hard to read.

For the main text use one of the "standard", proportionally-spaced, serifed fonts. Sans serif fonts are not really suitable for the main text, but can be useful for specifications, diagrams and pseudo-code algorithms. For reproduction of code it is usually appropriate to use a mono-spaced font so that the layout of the code is preserved.

This document is written in a proportionally-spaced, serifed font. The serifs are the tiny bars on the ends of some of the letter strokes. This sentence uses a proportionally-spaced, sans serif font. It is sans (without) serifs because there are no bars on the ends of any of the letter strokes. `This sentence is in a mono-spaced (fixed width), serifed font.` The earlier fonts are proportionally-spaced, which means that each letter only takes up as much space at it needs. Thus, in Times, an i takes up far less space than an m. In a mono-spaced font, each letter takes exactly the same space.

You also need to consider the font sizes that will be used. For the main text, *a font size of 11 point is strongly recommended*. 10 point is often rather too small to read comfortably, but 12 point can also look unreasonably large, although this is dependant on the font chosen. Font sizes can differ considerably from font to font. The three sample fonts above are all in 12

point, but look different in size from each other. Once the font and the font size to be used in the document has been chosen, do not vary it:

<div align="center">

_{Different} <small>font</small> sizes can be very distracting to the reader.

</div>

Spacing   Appropriate use of white space will make your document look attractive and easy to read (though, obviously, do not use too much, or the document will look quite strange). This document modifies the default LaTeX layout to decrease the margins, but still has a lot of white space around the central text. This is a layout which is similar to that in many published books, and ensures that the line length is appropriate for easy "scanning" from one line to the next. Word-processed documents tend to use a longer line length, which can create difficulty in reading the text. As a minimum, there should be at least a one inch border around the page with some additional space left at the edge where the dissertation is bound to allow for the binding.

In the days of typewritten dissertations, which used mono-spaced sans serif fonts, the spacing between lines was very important. Single line spacing was too close together for comfortable reading. With word-processor or typeset fonts, this is not such a problem. Provided sufficient space is left in the margins for comments there is no need to use 1.5 or double spacing. *You are, therefore, not advised to use 1.5 or double spacing.*

It is important to consider the spacing between paragraphs. Some people choose to have no extra space between paragraphs, and just indicate the start of a paragraph by indenting the first line (the layout style of this document). This is not particularly user-friendly, and makes it very hard for the reader to see where one paragraph ends and another begins. Pages formatted in this way look very uniform (especially if the text is fully justified as it is here) and give the impression of being complex and inaccessible. An obvious gap between paragraphs without paragraph indent is an appropriate use of white space that makes it much easier to see the start of a paragraph.

Finally, a decision is required on whether the text will be fully justified, or simply left justified. This document is fully justified, giving it a more professional appearance but possibly making it more difficult to read. It is recommended that justified text is used in the dissertation, and it is important to remain consistent in the use of the chosen justification style throughout the dissertation.

Numbering

It is normal practice to number chapters, sections and sub-sections, and for the numbering system adopted to clearly identify the structure of the document. LaTeX and some word-processing packages will produce a table of contents on demand, and the layout of the table

of contents generated by these tools is normally appropriate. It is difficult to produce a table of contents by hand, but if this is required it is important to ensure that layout conventions in the table of contents are adhered to. The Table of Contents provided with this document is a useful guide to the layout conventions that should be adopted.

The Chapters are the first level of units which divide up your dissertation, and are numbered 1, 2, 3, and so on. Do not start with a Chapter 0. The second level units are sections which divide up each chapter. These are numbered so that it is immediately clear to which chapter they belong. For example, 1.1, 1.2, 1.3 are in Chapter 1, while 2.1 and 2.2 are in Chapter 2. In this sample contents list there are also third level units, which divide up some of the sections. These subsections are also numbered so that it is clear which section they belong to. Thus, 1.1.2 is in section 1.1, while 2.2.1 is in section 2.2.

It is not normal practice to use any further levels of numbering, such as 1.2.2.1. Any further subdivision of the contents that is required should use un-numbered headings, which should not appear in the contents list.

Diagrams

If diagrams, or figures as they are more usually called, are to be included then these will also be numbered. It is usual to number a figure according to the chapter it is in. Thus the first figure in chapter 1 will be Figure 1.1, the second figure will be Figure 1.2, and so on. Do not number figures according to the section or subsection they are in; that is, a diagram which resides in 1.3.2 will still be numbered Figure 1.x, not Figure 1.3.2.x.

Where a figure appears in your dissertation you must give it an appropriate number and a caption that describes what it shows. See Figure 5.1 as an example. (Note that the numbering of this figure is appropriate for a short article, such as this, but would be incorrect for a dissertation divided into chapters).

It is very useful for the reader if a list of figures which includes the page number where each is to be found is included on a page after the contents list.

Tables

Tables are numbered and named in a manner similar to that of figures. The numbering for tables and figures should each increase independently of one another . . . Figure 1.1 would be followed by Figure 1.2, but not Table 1.2 unless an earlier table had appeared in Chapter 1.

Table 5.1 indicates the normal layout for a table. Notice that the caption for a table appears *above* the table, whereas the caption for a figure appears *below* the figure.

Table 5.1: Student Progression for Undergraduate Programmes

Category	1998/9	1999/0	2000/1
Software Development	17	13	7
Systems Support	2	1	1
Product Support	0	0	1
Systems Analysis	0	0	3
Technical Writer	0	0	1
Applied Research	0	1	0
Project Management	2	0	0
Total in related employment	21	15	13
Unrelated full-time employment	0	1	0
Short-term employment	0	1	1
PhD	0	0	2
MSc	0	1	0
Student Union (Sabbatical)	0	0	0
Total in employment	21	18	16
Not available for employment	1	1	1
Unemployed	0	0	1
Unknown	7	7	7

Equations

Equations are also numbered where the equation is important or will be referred to elsewhere in the text, such as Equation 5.1. Equations that represent an intermediate result or which appear in the flow of the text and will not be referred to again need not be numbered. Notice that the number occurs to the right hand side of the equation. The equation number may be incremented from 1, or may include the chapter number, such as 1.1 ... just select a system and apply it consistently.

$$p' = p + \beta\,(P - p) \quad . \tag{5.1}$$

Notice that is normal to end an equation with a full-stop (although you should ensure that there is space between the equation and the full-stop so that it cannot be mistaken as part of the equation). More complex equations can be included, such as Equation 5.2, and it is clear in this case how the inclusion of the full-stop ensures that the reader is aware that the equation has finished and that the text that follows is not merely a comment in the middle of a set of equations.

$$\kappa = \begin{cases} \ln\left(\alpha\right) \frac{\varepsilon - \varepsilon_0}{\varepsilon_0} m & (\varepsilon > \varepsilon_0) \\ 1.0 & \text{(otherwise)} \end{cases} . \tag{5.2}$$

Referring to Sections

Rather than repeat earlier text, it is appropriate to refer to the section that the text you wish to refer to appears within. "See Chapter 1" would refer to a chapter, and to refer to a section or subsection it is normal to say "see section 1.1" or "see section 1.1.2". To refer to a point in a bullet list a phrase like "see bullet point 2 in section 1.3.2" might be used. Appendices are treated like chapters, but using the letter of the Appendix rather than a number.

Most word-processing and text layout packages allow the identification of cross-references so that the package can insert the correct reference automatically when instructed. This facility is extremely useful and prevents many errors. You are strongly advised to make use of these automated facilities whenever possible.

Other Details

You should ensure that you typeset your dissertation on A4 paper, and you should print it single-sided for all but the Appendices. *All pages must be numbered appropriately* ... note that the pages in the Table of Contents and prior to the first chapter are normally numbered using roman numerals and page numbering is restarted from 1 on the first page of Chapter 1.

5.4.2 Writing Style

As an author, it is important to ensure that any reader of the dissertation reads it all, and does not give up and stop reading because of irritation or boredom. This means that the dissertation *must* be expressed in good English. In this context, good English means being clear, interesting, informative and lexically and grammatically correct.

Your dissertation is a scientific report ... do not write in the first person (that is, "I designed the interface to...", "I tested each component separately"). In general the dissertation should be written in the passive tense, though use of "we" as in "we have shown that..." or "as we have described..." can also be acceptable, so long as it is not over-used. The following are examples of acceptable styles:

> *The initial descriptions of the two methods may lead one to conclude that there is little or even no link between the theories or their use. However, in later chapters,*

> *explanation-based learning and completion will be exploited in a new theory which combines important attributes of both methods.*
>
> *In this paper it is demonstrated that explanation-based completion optimises the completion procedure by removing the undirected search that is a feature of standard completion methods.*
>
> *We will now examine the EBC paradigm in the context of a particular class of equational theories - those which describe abstract data types. We will then exploit EBC to reuse ADT specifications, by discovering mappings to previously implemented specifications.*

It is also important to maintain a professional *attitude* in your writing. Do not use the dissertation as an opportunity to complain about things that went wrong. Equally, the dissertation should not be written in a 'jokey' style or use casual language or slang. Be careful not to use complex language in an attempt to impress ... it is almost always used incorrectly, appears 'false' and therefore has the opposite effect.

Be very careful to proof-read your dissertation very carefully (if you are not a native English speaker it is important to ensure that a native English speaker also proof-reads your dissertation to correct phrasing errors that you may not detect). It is very easy to miss out words or write a sentence which does not make sense when typing the dissertation. Some word processors have grammar checkers, but these are rarely beneficial – use a friend or member of your family to check the grammar and sentence construction.

Obviously, you should always use a spelling checker to ensure that the spelling is correct, but spelling checkers cannot pick up missing words, nor can they recognise a mistake where the wrong word is used or a word is missing (for example, using "were" instead of "where"). Again, careful proof-reading is needed.

Finally you need to use a dictionary to ensure that the meaning you are attributing to a word is correct. This is a frequent error. Here are some actual examples from coursework:

> *"the conjunction of these two components provides the final solution..."*

where "conjunction" should have been "combination".

> *"The attainment of items on the screen allows the user to..."*

where "attainment" should have been "arrangement".

Apostrophes

One of the most common problems seen in students' documents is the incorrect use of apostrophes in words. The two main uses of apostrophes in English are: writing contractions and indicating possession.

Contracted words, such as "can't" for "cannot", "doesn't" for "does not" and "isn't" for "is not", are inappropriate in a scientific document such as a dissertation – *do not use them.*

When an apostrophe *should* be used, and used correctly, is to indicate possession (ownership). Thus we write about "the unit's contents", which is "the contents belonging to the unit". Similarly, we say "the students' courseworks", which are "the courseworks belonging to all the students".

If you are writing that "the program should match its specification", or that "the need to test software at all stages of its development cannot be over emphasised", you do *not* need the apostrophe in the "its". (The word "its" only needs an apostrophe if you are using it as the shortened form of "it is". Thus, "it's hot today", and "if it's possible, please may I leave early", are both correct uses of "it's". However, since "it's" is a contracted word it should not be used in the dissertation.

Here are some example sentences showing correct use of apostrophes which indicate ownership:

> *Prior to this, the programmer had to map all the data structures required by a particular problem solution into the language's available types.*

> *This is really an extension of Guttag's early approach, where, instead of equating all error terms to the same error constant, we now introduce a constant for each type of error.*

> *Readers' experiences of media are many and varied.*

> *Since students can independently pursue their own courses of study, the instructors have more time to pay attention to the students' work.*

As a general rule, we never use an apostrophe when writing plural forms. Thus a programming language might provide modules, loops, records and arrays. It is wrong to write "module's", "loop's", "record's" and "array's" if you simply want to indicate more than one module, loop and so on.

Further reading on punctuation and its correct use is available in the Library.

5.5 Submitting the Dissertation

It is very important that the dissertation copies are submitted with the appropriate layout and binding.

The University offers a binding service. Information about the time required for binding, costs, and further details may be obtained from the Print Unit (located on the ground floor of 8West).

You *must* submit the your dissertation in accordance with the following instructions:

1. Two paper copies of the dissertation must be submitted to the Department Office (1W2.23) by the submission date of **Friday 3 May 2013**. Both of these copies will be kept, so if you wish to ensure you have your own copy of the thesis then you will need to get an extra copy printed and bound. Each copy of the dissertation should include a CD-ROM containing all files and resources pertaining to the project securely bound *inside* the rear cover of the project.

2. Each copy of the disseration must be "thermal" bound (often also called "tape" bound) with a clear acetate front cover. This is a *requirement* for archiving purposes and cannot be changed. Any other binding will not be accepted when you hand in. Ensure you leave sufficient time for the binding process to be completed before the submission deadline.

3. The first page of the submission *must* have the following:

   - The full title of the dissertation
   - Your name
   - The full title of your programme of studies
   - The year ... 2013

4. The second page of each copy of the dissertation will be a full title-page which will read:

   FULL TITLE OF DISSERTATION

   submitted by ....

   COPYRIGHT

   Attention is drawn to the fact that copyright of this dissertation rests with its author. The Intellectual Property Rights of the products produced as part of the project belong to the University of Bath (see http://www.bath.ac.uk/ordinances/#intelprop).

This copy of the dissertation has been supplied on condition that anyone who consults it is understood to recognise that its copyright rests with its author and that no quotation from the dissertation and no information derived from it may be published without the prior written consent of the author.

Declaration

This dissertation is submitted to the University of Bath in accordance with the requirements of the degree of Bachelor of Science in the Department of Computer Science. No portion of the work in this dissertation has been submitted in support of an application for any other degree or qualification of this or any other university or institution of learning. Except where specifically acknowledged, it is the work of the author.

your signature

5. Candidates wishing to include copyright material belonging to others in their dissertation are advised to check with the copyright owner that they will give consent for the inclusion of any of their material in the dissertation. If the material is to be copied other than by photocopying or facsimile then the request should be put to the publisher or the author in accordance with the copyright declaration in the volume concerned. If, however, a facsimile or photocopy will be included, then it is appropriate to write to the publisher alone for consent.

6. Restrictions of the use of dissertations by others for the purposes of study should be the exception rather than the rule. If confidential information (e.g., information which is the subject of a patent application or information about which a prior IPR agreement has been signed) is included in a dissertation, some restriction is necessary. If access is to be restricted, permission must be sought through the procedures set out in the appropriate Regulations. A statement signed by the author and worded as follows should be placed on the foot of the title-page of each copy of the dissertation:

   - If there are no restrictions:

     This dissertation may be made available for consultation within the University Library and may be photocopied or lent to other libraries for the purposes of consultation.

     Your signature

   - If there are to be restrictions:

This dissertation may not be consulted, photocopied or lent to other libraries without the permission of the author[2] for 3 [3] years from the date of submission of the dissertation.

Your signature

7. The standard Departmental coursework submission sheet must be completed and bound into the project as the *third* page of the dissertation.

8. The dissertation should be word processed or typeset, and the printing should be of sufficiently high quality to ensure that clear photocopying can be obtained. Colour should be used sparingly, and should not prevent clear grey scale copies from being made.

9. The dissertation must be printed single sided onto white A4 paper within the range 70g/m^2 to 100 g/m^2 with single line spacing. The font size used should normally be an 11 point standard serif font. The margin on the binding edge of the page should not be less than 40mm. Other margins should not be less than 30mm.

10. All pages must be numbered, including introductory pages, appendices, reduced copies of computer print-outs, etc. A single sequence of Arabic numerals should be used for the main body of the dissertation. This is to facilitate photocopying and binding, so pages may remain in the correct order. (Roman numerals may be used to number sequential sub-sets of the whole work.)

11. One electronic copy of the dissertation in PDF must be submitted on Moodle by the submission deadline You should name the PDF file you create as follows:

surname-initials-dissertation-20XX-YY.pdf

replacing the items in italics appropriately. A PDF format copy is readily created if you are using LaTeX. If you are using MS Word on Windows we recommend installing PDFCreator, available from:

http://sourceforge.net/projects/pdfcreator/

This which will allow you to 'print' the document to a PDF file. If you are using OpenOffice, it has a built-in capability to export as PDF. If you are using any other

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[2] If the author has included in the dissertation confidential information obtained from a third party whose interests also require protection and from whom permission for consultation, photocopying or lending is also to be sought, the third party's name will be inserted after 'the author'.

[3]Three years is the normal amount, but you can reduce it.

word processing software, you will need to seek advice from your project supervisor about how to most effectively produce PDF or PS output. Linux and MacOS-X both have built-in PDF export facilities available for most applications.

12. One electronic copy of the code files and any additional files used for the project need to be submitted via Moodle by the submission deadline. These files should be contained in a ZIP or tar-gz file. You should name the archive file:

surname-initials-code-20XX-YY.zip or *surname-initials*-code-200XX-YY.tar.gz

replacing the items in italics appropriately. You should check that the zip file can be opened and items within it read before you submit it. If the zip file is large you should check with the Project Coordinator what should be included and what files can be submitted exclusively on CD-ROMs.

5.6 Marking Method and Criteria

Projects are marked through a double-blind marking process. In cases where there is a mark dispute between the markers a panel will consider the project and resolve the mark. All projects are made available to the External Examiner for consideration.

In marking a project, the following criteria will be used:

1. Basic Criteria:

   (a) Understanding of the problem
   (b) Planning and control of the project
   (c) Selection and deployment of appropriate techniques
   (d) Achievement of the objectives of the project
   (e) Quality of the products of the project

2. Additional Criteria:

   (a) Clarity of objectives and/or hypotheses
   (b) Knowledge, critical evaluation and use of the Literature
   (c) Justification of decisions taken
   (d) Solution of conceptual problems
   (e) Selectivity, clarity and focus in discussion

    (f) Critical evaluation of own work and achievements

3. Exceptional Criteria:

    (a) Significant contribution to or extension of existing knowledge / methods / techniques

    (b) Clear evidence of originality (conception or novel application of concepts / methods / tools)

    (c) Inclusion of a significant amount of material that is publishable in a peer-reviewed national conference (or) production of original products that have significant academic or commercial potential

After consideration of the criteria, examiner will decide on a classification area for the project using the following guide:

0-24	Bad Fail	The project is inadequate in all of the basic criteria
25-34	Clear Fail	The project is inadequate in more than one of the basic criteria but not all
35-39	Marginal Fail	The project is inadequate in one of the basic criteria without additional qualities in the additional criteria that may compensate.
40-49	3rd Class	The project is adequate in the basic criteria
50-59	2:2	The project is at least average on all the basic criteria, and on most of the additional criteria
60-69	2:1	The project is at least good on the basic criteria and most additional criteria
70-79	Low 1st	The project is mainly excellent and otherwise good on all the basic and additional criteria
80-89	High 1st	The project is excellent on all basic and most additional criteria and good or excellent on more than one of the exceptional criteria
90-100	Outstanding	The project is excellent on basic and additional criteria, good or excellent on all exceptional criteria

The marking of the dissertation is treated as an *examination*, and so falls under all the rules of examinations within the University. This means that no feedback on the marking decisions for the project is available, and the mark given to the project will be released along with the other unit marks on the mark transcripts. Under no circumstances should any student seek to obtain an early release of the project mark from their project supervisor or any other member of staff within the Department.