A Title: With an (optional) informative subtitle

Author's Name Here

1. Introduction

In the first section of your[1] paper, which should be entitled "Introduction," you should introduce the subject of your paper to the reader. There are several components to this. You probably want to begin by talking about what problem your work is trying to solve, and why it is a problem worth trying to solve. Explain to your reader why they should care. This is also a good time to introduce basic nomenclature related to your subject. You can assume that your reader is a reasonably well educated individual, and has some knowledge of computer science, but don't[2] assume that they're an expert in your field. You've spent a bunch of time studying your topic (in this case, decision trees), but your reader may not have. Take the time to bring him or her up to speed; this is what the introduction is all about.

For example, you might say something like:

> "The problem of classification is a fundamental one in the field of machine learning. Successful solutions to this problem form the basis for solving a wide variety of real world problems, from medical diagnosis to airport security to mobile robotics. There are a variety of techniques for attempting to solve this problem, and none of them is perfect for all situations; the famous "No free lunch" theorem (Wolpert & Macready, 1997). It is therefore important to compare the results of different techniques to determine what the strengths and weaknesses of various algorithms are.
>
> Decision trees are one technique for performing classification, based on the idea of making a series of decisions about a given data vector based on simple tests applied to elements of that vector. The tree structure comes from the fact that each decision can have two outcomes, yielding a binary tree representing all possible paths through the set of decisions. Leaf nodes of the tree represent the fact that the results from the tests along the way to that leaf add up to enough information to correctly classify that example."

Of course, you wouldn't write *exactly* that, since that would be plagiarism. But it should give you the general idea. Also note that this, like the other examples in this paper, is just a short example of the kind of thing you should write. Do not use them as a guide for length, or for the minimal content that should be covered, as more is expected from you on both counts.

The introduction in a real paper is generally several pages, but yours doesn't need to be that long for this assignment. It should, however, be long enough to convey the information

1. Please note that this is bad form. You should never use second person in technical writing.
2. Ok, this is also bad form. Never use contractions in technical writing either!

you need to. It should move from the initial, high level overview of the topic to a more detailed description of what other related work has been done on the topic, and any other background information needed to understand the later parts of the paper. For example, you should talk about the advantages of evolutionary algorithms in general, and what other work has been done with them. More specific details of the algorithms and techniques you used should wait for later sections.

Because your introduction discusses prior related work, you should be sure to properly cite that prior related work. If your introduction does not have at least a couple of citations, then it is either inadequate in scope, or it fails to properly cite works referenced. Don't do either. Later sections of the paper should also contain proper citations where needed, but the bulk of the citations in any given paper can usually be found in the introduction, as that is where the most related publications are discussed.

Introductions will often include your testable hypothesis and how you plan to test it. While not always necessary, it is often helpful to be explicit in stating the hypothesis. A simple testable hypothesis may read something like this:

> "We hypothesize that a decision tree generated by a Genetic Algorithm (GA) will outperform a tree generated by Iterative Dichotomiser 3 (ID3). To test this hypothesis, we compared the classification accuracy of trees generated by a GA and ID3 on several data sets from the UCI repository."

Note that sometimes, you may have more than one hypothesis.

Because you are introducing the names of algorithms in your introduction, it is also a good time to introduce any acronyms or abbreviation that may often be used. For example, in the above hypothesis, we introduced the acronyms "GA" and "ID3" by putting them behind the full name in parenthesis the first time we introduced the full name in the introduction. In this example, this was done when discussing the testable hypothesis, but in almost all papers, this should be done while introducing the algorithms and why we're interested in them.

Your introduction should conclude by describing the organization of the rest of the paper; for example:

> "In section 2, we describe the theoretical basis for our algorithm, and in section 3, we describe the algorithm itself and our experiments with it. In section 4 we present the results of our experiments, and conclude in section 5 with a discussion of what these results mean, and possible directions for future work."

Not all papers have this sort of organizational statement, but it can be helpful due to the fact that the naming and organization of the sections in papers are not entirely standard. While almost all scientific papers begin with an introduction, then discuss the experiments and results, and finally conclude, the precise organization of that middle part can vary somewhat based on the subject matter and the preferences of the author (or sometimes the journal).

2. Algorithms and Experimental Methods

In this section, you describe any details and assumptions of how you implemented your algorithm. You don't need to list every single parameter value, but ones that are important

Table 1: This is a caption on the table. This could have been something like a confusion matrix or a table of performance values.

	col1	col2	col3
row1	a	b	c
row2	d	e	f

to your results should be discussed (eg. don't just list them, talk about why they have that value).

You should also describe your experimental methodology; this is where you talk about your data and what you did with it. Talk about what sorts of experiments you performed, and how you validated them. For example, if you used 7-fold cross-validation, you would say that you used it, define what it is, and discuss how you implemented it.

Data Sets

Here you should describe the data you used; where it came from, what it represents, what properties it has (eg. binary class? multi class? multi variate? continuous? dimensionality? number of examples? etc.). Talk about all the data sets you used. Be sure to mention and properly cite their source. Note that this is the only time you're allowed to cite a website. All other references need to be primary/archival sources such as conference papers, journal articles, or academic books. Also mention how you pre-processed the data, if you did.

3. Results

The results section should contain your results. It should *not* contain your interpretation of those results. That comes later. This section should be made up primarily of graphs and tables that show your data. You should also have a small amount of text describing what each of the tables and graphs shows, since the caption on the figures should be short. Having text describing the specifics of the experiment that lead to that particular table would also be good. For example,

> "Table 1 shows the average results of the three algorithms on all the data sets. The parameters used were $N = 7$, and $k = 3.27$; these parameters were found by hand, and little effort was made to tune them optimally. Each algorithm was run three times on each of the seven data sets, and the resulting accuracy scores were averaged.
>
> Figure 1 shows the results of comparing the Magic Model and Super Estimate on the Battleship dataset. The X-axis is Time in hours and the Y-axis is Cost in dollars. Note that a lower cost denoted a better performance. Each algorithm was allowed to run threes times on the dataset and cost was average for each model over the three runs."

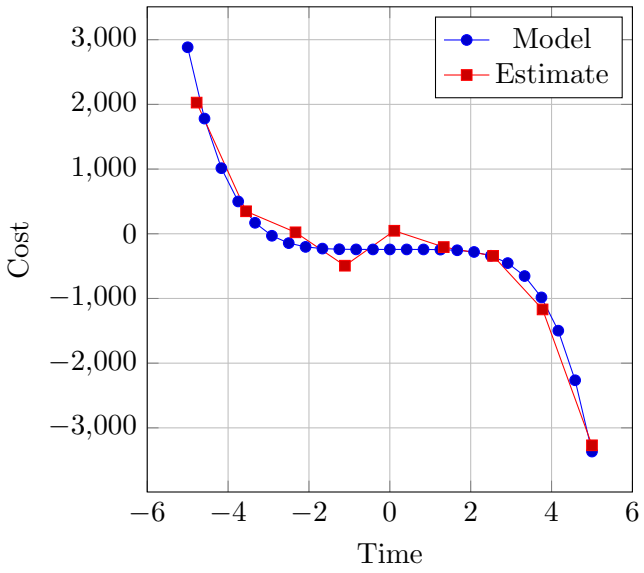

Figure 1: Results of comparing Magic Model and Super Estimate on the Battle Ship dataset. Cost is in dollars and time in hours.

I'm not going to tell you exactly what tables or graphs you should have here, since it will depend a bit on your results. You should be sure that your results section contains sufficient data to support your conclusions about the relative strengths and weaknesses of the different algorithms. You should also be sure that your data is complete; that is, don't leave data out simply because it doesn't support the point you're trying to make.

You should also be sure that your results are clear and interpretable. Seven pages of raw binary data will do nothing to edify your reader. Similarly, a 1 inch square graph with 12 lines plotted on it will be difficult to extract meaning from, as will a graph with poor (or no) labels on the axes. Your results should be legible both on screen and in hard copy.

You don't want to present results that are just raw data, since that is hard to interpret. But you don't want to over abstract, either, since that leads to results that have little or no meaning (eg. "the average over all different data sets, algorithms, and parameters" is a completely useless statistic for comparing algorithms).

You should have several pages of results; one or two tables are unlikely to be sufficient to describe your experiments. If they are, you need to do more experiments.

4. Discussion

The discussion section is where you discuss your interpretation of the data you presented in the results section. This is where you tell the reader how great your algorithm is, and how interesting it is that *this* performed better than *that* on some given data set. You can also speculate about causes for interesting behaviors; for example, if you think you might know why it fails so badly on some particular case, or if you have an insight into why it did well on another case. You don't want to be making wild guesses, but as long as you make

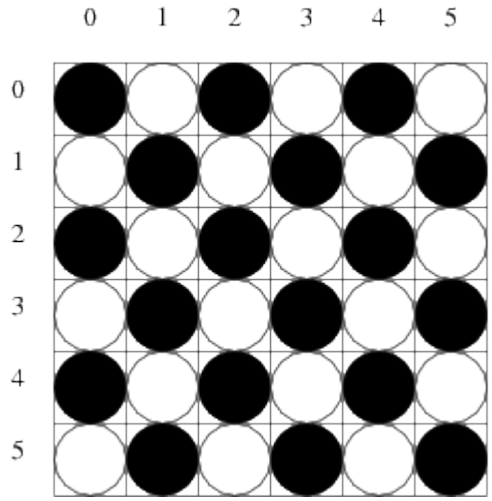

Figure 2: This is a caption on a figure. This particular figure is meaningless and is offered only as a place holder.

it clear that you are not making claims of factual proof, you can go out on a limb a little. For example,

> "In most cases, algorithm A outperforms algorithm B with a significance of 99.8%. However, as can be seen from Figure 2, when applied to the E. E. Smith data set, algorithm A does no better than random chance. It seems likely that the failure of algorithm A to learn is due to the extremely sparse distribution of that data set. Because of algorithm A's heavy reliance on data being densely sampled from the true underlying distribution, any sparse data set is likely to show this behavior."

5. Conclusions

The conclusion section should be relatively short, and should not be a summary of your paper. It should, however, bring up what you learned and what impact your results have on the rest of the field (and society as a whole, if applicable). You should conclude, and bring your paper to an end with any parting thoughts that are appropriate.

Certain types of papers can be ended with a "Summary" section instead of a "Conclusions" section, in which case you would, in fact, summarize the main points of your paper. For this paper, you should write a Conclusions section, not a Summary.

Conclusion also often contain information about what else you would like to do. Sometimes this is a separate subsection, or even a section, entitled "Future Work." The basic idea here is to talk about what the next steps to take would be. This is of benefit to others who are interested in your work and may want to help advance it. It is also a chance for you to acknowledge shortcomings in your work; since we never have infinite time to prepare a

paper, there are always more experiments that would have been nice to include. If you list them as future work, then it at least makes it clear that you didn't do those things because you didn't have time, rather than because you didn't realise that they were important to do.

In your paper, you should include a brief discussion of avenues for possible future work in your Conclusions section. It should be tied in with the rest of your conclusion, and should not be an unrelated section tacked on the end (or the middle).

References

Wolpert, D. H., & Macready, W. G. (1997). No free lunch theorems for optimization. *Evolutionary Computation, IEEE Transactions on*, *1*(1), 67–82.