Arizona State University
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# ADJ - Ruleset 1v2

Summary: In this handout, we review the basic ideas and ruleset involved in solving ADJ problems.

## 1 Introduction

The goal of ADJ assignments is simple: they are a way to practice **strengthening and defending** your ideas through engineering design. Our ideas are precious, and we should keep them safe. We should endeavor to make them strong so that they can survive away from us, among other competing ideas.

Consider: in a typical essay answer homework question, the student is asked to provide a solution to a short problem statement. The student provides an idea that answers the question, and if it looks good, the grader will give marks. But: was it a good answer? How can someone (student or grader) even evaluate the correctness of answer? If it's not a numerical answer, is it at all obvious? It's not uncommon to look at a question, and think: "why didn't they like that??!?" Here, our question was been left alone and needed to be able to justify itself to an evaluator. You aren't there in the room to point out stuff to the grader, your idea must be able to stand alone.

A typical issue is that a problem is either misunderstood, or not approached in a sound way. In that case, it's difficult to specify a solution, as well as to check if a solution is correct, or be able to compare it to other answers. A second issue is not producing the support for answer to show that it is better than alternatives. For some examples of answers which could be strengthened, consider the following legacy exam question:

> Consider the algorithmic task of changing a photograph into the art style known as cubism. In such a filter, regions of pixels are transformed into rectangular regions with a single color. For example, the following image:
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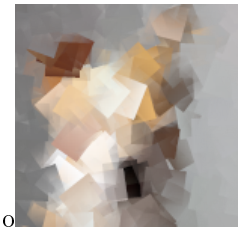
>  would be filtered to 
>
> Say we want to design a image filter algorithm to apply a cubism filter. Of the five issues in multi-core programming, which is the most problematic for multi-threading this problem? Justify.

1. "Data splitting" **Concerns:** Is this right? This answer doesn't include justification. What if it's a guess? The reader will have questions, "Why not pick something else?"

2. "Communication between threads as some of the image depends on the area outside of the assigned portion in a single thread. The final result may be different depending on how the combination of the threads into the 2d array representing the image is processed." **Concerns:** Communication isn't one of the five issues, so even if the idea is good, it doesn't answer the specific question being asked. The second sentence starts to describe something that sounds like a race condition, but without using the proper terminology itt's hard for the reader to identify what's new and why it's being described. Here, we intended to strengthen our answer but we've sort of gotten lost.

3. "Balance could come up if the image is large and the size of the rectangles vary in size a great deal. Then we risk one thread getting a bunch of big rectangles and another a bunch of small ones." **Concerns:**

This isn't really an answer - the fundamental idea is correct but it does not take a stance on "most problematic", rather it makes the smaller claim that something might be an issue. But: our idea is correct and could be made strong. We also see that the answer says "size of rectangles vary in size", although the image has them all the same size (good thought but perhaps a mismatch in problem understanding?).

4. "Here we would have a problem with data splitting. If two threads were to be working on the same portion of the bitmap, then you would have the same pixels trying to be modified and would end up with a mesh of colors rather than two distinct cubes." **Concerns:** The argument is predicated on "two threads working on the same portion". This is a true statement, but specific to a particular algorithm which solves this problem. This is a bit dangerous to do since the prompt asked us about the problem in general. The sentence also mentions "two distinct cubes" - what does this mean? There are many cubes in the image. Again, the reader will have questions that the answer doesn't address.

All of these are examples of answers that make an effort to answer the stated problem but which a particularly annoying evaluator could find fault in. The issue is that while these answers are potential solutions for the problem, they are not self-supporting. They do not say "I am *the* answer", but rather "I am *an* answer." In this assignment, we want to do better. Too often, answers given on homework are not rigorously supported. Although they have the spirit of being an answer, they may be ambiguous or incomplete. If, in addition to being evaluated as being a solution, the answer was evaluated as being the "best", it would not fair well because is either not well-founded or not sound. They lack the support needed to be an idea that can stand up to competing ideas. Here we will aim to make our ideas and arguments strong. They should stand up to review, and demonstrate that they are the correct solution to the problem being stated.

This document is separated into three sections: Introduction, Base Requirements, and Further Requirements. You have almost finished reading the Introduction section already. In Base Requirements, we will discuss the minimum requirements for submissions to be graded. Lastly, Further Requirements discusses solution requirements which will be reviewed during grading.

## 1.1 Answer Format

Let a problem which you are answering be called $P$. A solution to $P$ is compartmentalized into three sections (analysis, design, justification), each worth different point values. These internal values are given in the problem sets.

- **Analysis (call it A):** In this section, you should define your immediate problem, and any useful corollaries. The answer should be in terms of the problem itself, and not be biased in any towards a possible solution. It is possible that some portions of your analysis will not be needed later - indeed, this is expected since otherwise we do not have multiple inputs to a design thought process, meaning there is only one choice, and so the answer would be immediate.

- **Design (call it D):** In general, design has the flavor of picking some choice among a set of possible options. Design is subjective - in and of itself, we cannot state that a particular design is best. This section should take an axiomatic (built from the results of the analysis) approach to constructing a solution which meets a metric (defined in analysis) by which a design may be judged to provide a satisfactory/optimal answer to P. (For some problems, design will take the form of designing an argument which states a position on a claim made in the question prompt. In others, it will literally mean designing an algorithm.)

- **Justification (call it J):** Given that we have a design, we want to argue that this design is: a) well-founded, sound, and solves the problem, and b) is the optimal design for the problem. A justification is an easily verifiable piece of information (here: readable by a 3rd party) that shows this statement is correct (think of a justification as a certificate for the goodness of your design).

Overall, we wish to show that a problem under analysis (A), soundly yields a design (D), such that the design is the optimal solution to the problem. The justification (J) is a sound argument that the design is the optimal solution for the problem given the analysis. Hence your answer to problem $P$ has three parts: $A$, $D$, *and* $J$.

### 1.1.1 Background Knowledge

We call the corpus of background knowledge $K$. $K$ represents the set of ground truth facts that may be taken as assumptions/axioms in your analysis. Hence, we more accurately state: $Analysis(P|K) = A$. $K$ will be maintained by the instructional staff as a document on the course Canvas. $K$ is initially empty.

# 2 Basic Requirements

As a base expectation, your submissions must demonstrate both attention to instructions, and professionalism. Specifically (and exhaustively), we require the following to assign a non-zero grade to a submission:

1. The author(s) of the submission must be clearly defined in the document, as well as the answers to specific questions. Answers must be clearly labeled as analysis, design, or justification, and follow the overall goal for each subsection mentioned in Subsection 1.1.
2. Solutions must be in the spirit of the problem. Do not submit solutions to some "clever" edge case of the problem(s).
3. Proper use of English - this means spelling and grammar. Assignments must not have more than three spelling errors, or more than one major grammar error (which distract from readability).
4. Writing must be clear and semi-formal. Do not use first person or ambiguous writing.
5. The submissions rules in the PDF for the problem set are followed exactly.

**Penalty:** Failing to following any of the basic requirements laid out in this section, will result in the student receiving an automatic zero grade on the assignment.

If you are concerned that your solutions do not met the above requirements for grading, you may bring them to office hours for a pre-check to confirm that they are ready to submit.

# 3 Further Requirements

1. Any assumptions you make in analysis should be both explicitly stated to be assumptions, and reasonable from the prompt. **Penalty:** points will be deduced per standard review of your logic.
2. Do not submit anything that you do not understand, or which you do not think actually works. Your explanation must convince the reader that you know and understand what is happening. **Penalty:** zero grade on that subsection (i.e.,. analysis, design, justification).

   **Note:** If you are unable to produce an answer to a subsection, then you may optionally write "We are not able to produce a satisfactory answer for this portion.", in which case you will receive half a point for giving an accurate statement and assessment.
3. You may not use explicit information outside of $K$. Citations and references are not permitted. This includes the textbook, course material, internet sources, etc. **Penalty:** zero grade on that subsection.

   **Corollary:** since ASU academic integrity policy restricts use of anything not cited, this means your solution must be entirely of your own construction.

## 3.2 Grading

The primary metric for grading is:

| |
|---|
| Your arguments must be well-founded, sound, and solve the problem stated in an optimal way. |

Answers which satisfy the statement in the proceeding box will receive full credit. Informally, this statement can be understood to imply that your problem should be defensible from alternative answers.

## 3.3 Extra Credit

During a typical engineering design process, some set of alternatives is generated, each of which provides a basic solution to the problem, but among which only one can be classified (according to a well-specific metric) to be optimal. For each question, one alternative justification aligned with an alternative design (which provides a solution but is not optimal) may be given in your answer, for a potential 1 point extra credit. These should be included in your submission as an appendix.

## 3.4 Notes and Suggestions

- **Be careful:** self explanatory. Think about everything that you write.
- **Length:** unless otherwise stated, the suggested length of a solution to a specific problem is one or two pages (1" margin, 12 point font). In general, the ideal length of an answer is what is needed to answer it soundly and concisely.
- **Human Language:** human language is an inherently under-specified way of communicating knowledge. Be careful with your words, and their meaning. As a rule, there is no reason to assume that any reader will share your definitions of the concepts being used. Also be careful with the implicit semantics of words - words means things. Write what you mean, and mean what you write. Avoid global quantifiers.
- **Assumptions:** do not make arbitrary or implicit assumptions. Either make explicit reasonable assumptions, or ask for clarification from the instructor so that they update $K$.
- **Latex:** consider using Latex to do your write up. Latex is a programming language mean to do typesetting. It's useful since it handles mathematical formulas well, and has a text based format (meaning it can be versioned in Git). LyX is a good toolchain and editor it.