Linköping University
Department of Mathematics
TANA21/22 Scientific Computing (Beräkningsmatematik) Autumn 2019

# How to Write-Up Project Tasks

A specific format should be used for the write-up of the tasks assigned for the project portion of the course. This format follows a style similar to a scientific paper, whose purpose is to inform the reader about the results of a scientific investigation. Depending on how complicated the problem is, the sections *do not* need to be long or involved. Often two to three sentences may be all that is required. For more complex tasks, the details and/or discussion may be more extensive.

The motivation for this format structure is two-fold:

1. Computers are an incredible tool for numerical mathematics, **but** they are also great at spewing out tons of unorganized and/or incomprehensible information. The format helps students to organize their results and, in the process, think critically about the results and interpret them. This, hopefully, fosters a greater understanding of the material as well as helps the students catch any errors.

2. For a more practical reason, by compartmentalizing discussions of the mathematics, the numerics, and their interpretation by the students it makes it more straightforward to grade the project report.

The write-up should be formatted on standard A4paper. Numerical results reported in Tables or visually in Figures must be **real**. All figures should be computer generated. The project report should be written in a word processor or typeset with LaTeX to ease the presentation of mathematical formulae.

## I. Statement of the Problem

A short synopsis of the problem.

**Example:** Use a fourth order Taylor polynomial to approximate $f(x) = \exp(x)$ on the interval $[-1, 1]$ and estimate the error. Demonstrate that the error estimate is valid.

## II. Description of the Mathematics

Briefly describe the mathematics behind the problem.

**Example:** Describe the general ansatz of the Taylor approximation and the form of the remainder. Derive the approximation for $\exp(x)$ and derive a bound for the error.

## III. Description of the Algorithm

Write down and explain the numerical method and how you implemented it. Describe any differences or reformulation that had to be considered for the numerics compared to the math "on paper".

**Example:** You would show how the evaluation of the Taylor polynomial is factored and explain why this is the most efficient way to evaluate the polynomial. You might also copy (by hand) the relevant piece of code for comparison to a mathematical formula.

# IV. Results

Present the results of your computations. Use Tables and Figures to organize and concisely present the work. A concise, easy to read format is very important!

**Example:** You might collect the information about the test and results from the Taylor approximation into a table:

Table 1: Comparison of predicted and computed errors for a fourth order Taylor approximation of the function $f(x) = \exp(x)$.

| $x$ | $\exp(x)$ | $T_4(x)$ | Error estimate | True error |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Notice that the table has a heading and is numbered for easy reference. The same should be true of figures. Always include a short description to inform the reader what is being presented.

# V. Discussion: The Most Important Part!

Discuss your results. Show that you understand the meaning of the results you obtain. If you predicted in Section II that the error is less than some bound and this is reflected in your table, say so. For example, "As predicted, the results show that the actual error is less than the estimate". If your predictions don't come true, try to explain why. You could have a mistake in your code or there are assumptions made in Section II that aren't valid. A good explanation could salvage an otherwise incorrect set of numbers. Your mission is to convince the reader of this section that you know what the answers should be and that you did indeed get them. Not only are correct answers important, but the fact that you can demonstrate understading of *why the answers are correct* is important.

Think about it like this, if you can't convince someone that the results are correct, how will you know when they are incorrect? This view is somewhat different than that of other exercises in this course where the student presents solutions and the examiner determines the grade based on the correctness of the solution. The reason for the difference is that the computer is doing the work! I don't trust the computer, and you shouldn't either.

# VI. Program Listing (optional)

This can be included for completeness if desired. Grading of the project and the report **will not** take programming style or structure into account, but we might want to comment on more efficient ways of coding something.