AM 213A, Winter 2024
Homework 1 (40 points)

Posted on Tue, Jan 19, 2024
Due 11:59 pm, Thu, January 18, 2023

Submit your homework to Gradescope on Canvas

- Use LaTeX or MS-words like text editors for homework. A scanned copy of handwritten solutions will be acceptable on an exceptional case-by-case only with permission from the instructor.

- Your report needs to have relevant discussions on each problem to describe what you demonstrate. In this coursework, do not simply copy and paste any screen outputs (e.g., screenshots) from your code execution and provide them as answers. Instead, discuss code results required for each problem and display them concisely with logical justification. For all coding problems, showing screen outputs only from your code execution is insufficient and will lose points.

- To disprove, you need to provide a counter-example.

- All homework submissions should meet the deadline. Late homework will be accepted under emergencies with permission from the instructor.

- Submit all code and reports using the following naming conventions:

  - The theory and computational report should be together in one PDF named as `LastnameFirstname_Report_hwX.pdf` where X is the homework number

  - The supporting code for each homework should be provided in a single compressed directory named as `LastnameFirstname_Code_hwX.tar.gz` or `LastnameFirstname_Code_hwX.zip`
    * Include only source files (e.g. `*.f90`, `*.c`, etc.) and the needed Makefile
    * Do **not** include object files, module files, executables, or data files.

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1. **(5 pts)** Choose one scientific language for the coursework from (i) Fortran 90 (or above), (ii) C, or (iii) Python. If your choice is Python, you must justify your choice either by showing that you meet one of the conditions outlined in the course Canvas page "About the Class" or by submitting a short written approval (e.g., email) from your research advisor(s), which confirms the use of Fortran/C is not crucial for your research and Python would be sufficient. If you don't have any advisor, consult with the instructor by the end of Week 1 (1/12/24).

2. **(25 pts)** **Fortran users:** Download a short tutorial on Fortran 90 (by Prof. P. Garaud). Study all 16 exercise problems therein. Submit your code implementations and descriptions of your code results for the last five problems from Exercise 12 to Exercise 16 (5 points each). Even though you do not need to submit any for Exercise 1 – Exercise 11, mastering these problems is important to do Exercise 12 – Exercise 16.

   C or Python users: Do Exercise 12 – Exercise 16 using your choice of language.

3. **(5 pts)** Use your language choice to write a routine to approximate π using the sum of the series,

$$\pi = \sum_{n=0}^{\infty} 16^{-n} \left(\frac{4}{8n+1} - \frac{2}{8n+4} - \frac{1}{8n+5} - \frac{1}{8n+6} \right) \qquad (1)$$

Since you can only add up to a finite number of terms in practice, say, summing up to the Nth term, you need a stopping criterion on N to obtain an accurate enough numerical approximation. For instance, you can stop the summation if the absolute value of the difference between your approximation π_{appx} and the reference (or true) solution of π_{true} defined as $\pi_{true} = \texttt{acos(-1.d0)}$ becomes smaller than a threshold value, e.g.,

```
threshold = 1.e-8
diff = abs(pi_appx - pi_true)
if diff > threshold
  continue summing up
else
  break
endif
```

Report the number of terms N and the difference (`diff`) for four threshold values, $10^{-4}, 10^{-8}, 10^{-12}$, and 10^{-16}. Make sure to use double precisions for all real variables in your implementation using a proper compilation flag(s).

In this homework, it is mandatory to use a makefile to compile your code. In the makefile, you should first test your code with debugging flags before using optimization flags. The format of your makefile doesn't matter too much, but it is recommended to follow the Fortran example of "Makefile5" in the Makefile section in Chapter 2 of the AM 129 lecture note (see the link provided on the HW1 Canvas page).

4. **(5 pts)** Read and understand the pages on Canvas, particularly the following pages with care:

   – Office Hours

- Grading Policy
- About the Class

Most importantly, "Grading Policy" and Course Mission and Preliminary Requirements in "About the Class" are very essential. After reading them, write the following statement and sign it with your signature.

"As a student at UC Santa Cruz, I hold myself to a high standard of academic integrity. By signing this statement, I affirm my commitment to honor the UC Santa Cruz Code of Student Conduct and to encourage other students to do the same.

I pledge that the work I submit on homework and exams will be my own. I will not solicit help from anyone, I will not consult unauthorized sources, and I will not provide unauthorized help to others.

I am aware that failure to abide by these commitments may result in sanctions ranging from no credit for the work in question to failing the class, to suspension from the university."