



## CIS 4930/ CIS 6930 (Spring 2024)

### Hardware Accelerators for Machine Learning

Dept. of Computer Science & Engineering

### Guidelines for Course Project

#### Summary

This document provides detailed information about the Course Project (CP) to be carried on as part of the CIS 4930/ CIS 6930 (Hardware Accelerators for Machine Learning) class. The goal of the CP is to provide students with an exciting, fruitful experience where they can apply the concepts learned in the classroom to solve real-world problems through a hands-on implementation. Students are expected to work in groups (more information below). ***The execution of the CP is divided into three milestones, with distinct due dates and points distribution. A project presentation and a final report are also required for the CP and will count toward the final grade of a student.***

#### Project Description

##### ***Implementation of High-Accuracy Classification Problems with GPUs and FPGAs***

Considering the broad topic defined by the title above, each large group will choose to focus on a specific problem (some examples: classification of traffic signs with CNNs, classification of fruit images with CNNs, etc.). Please be creative! Since this class has 80 enrolled students I expect different problems for each group.

**IMPORTANT: Vetted topic: Handwritten digits classification with MLPs. (Reason: Examples used in class already focus on this problem.)**

#### Group Work

Students are expected to work in large groups of eight people. ***Large groups with more or less than eight people are highly discouraged and will require special permission from the instructor. Within a group, students will subdivide into two teams of four people.***

- ***Team A (4 people): This team will be responsible for the GPU Implementation. The use of the GPU in Google Collab is expected.***
- ***Team B (4 people): This team will be responsible for the FPGA Implementation. The use of the Arty S7 Xilinx Spartan-7 FPGA (borrowed from the instructor) is expected. Other FPGA can be used if available but will not be provided by the Instructor or TAs.***

More guidelines (next page):



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- *The deliverables listed in this document should be turned in for the large group of 8 people (not separately for each team A and B).*
- *Each large group will elect two representatives (ideally from teams A and B), which will coordinate the smooth information exchange between the two teams and will organize the preparation of deliverables for each milestone (with the participation of all members).*

#### Milestone 1: Group Formation and Literature Review

*Points: 4*

- **Group Formation:** Students will organize themselves into large groups, and further subdivide into teams A and B. At this stage, you should inform the instructor (by writing, on a separate page in your report), the name of each person that is part of the group, and which team they belong to (A or B). Also, please outline the responsibilities/expectations defined by the group members for each person. You should also inform the names of the two representatives elected by the group. They will coordinate the smooth information exchange between the two teams A and B, and will organize the preparation of deliverables for each milestone (with the participation of all members).
- **Literature review:** Students will conduct a literature review about the topic of their project and narrow down their implementation to a specific machine learning task. A minimum of 6 and a maximum of 10 references should be cited and discussed. These references should be closely related to the task chosen by the group. Please note that scientific articles (i.e., papers) from reputable, peer-reviewed journals and conferences are the most acceptable form of reference. Technical reports, dissertations, and master thesis can also be used, when necessary, but priority should be always given to scientific articles. Any other form of reference is not acceptable without explicit authorization from the instructor.

The discussion for each reference should be 1 paragraph, in which you should include (i) a problem statement that defines what the authors are working on, (ii) the methods that they are using, (iii) why they use such methods (if disclosed), (iv) results they report, (v) possible deficiencies identified with their approach (if you can think of any).

*Deliverable for Milestone 1: Written Report (formatting guidelines in Appendix 1)*

*The report should contain a front page with the names of the group components, course number, semester, etc. It should also have an additional page with the group formation, which needs to*



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*have all the information outlined above. Last, this report should have a section, “Literature Review”. There is no minimum number of pages for the “Literature Review”, and the maximum number is 3. Remember that you will be graded based on the quality of your work, so try to include as much detail as possible in your literature review without being unnecessarily prolix. The use of AI bots such as Chat GPT to complete any task in this report is highly discouraged. **Keep in mind that the professor and TAs reserve the right to ask questions about the contents of the report to any of the group components. If the use of these tools is suspected and detected, points will be deducted from the whole group grade with maximum severity.***

#### Milestone 2: Description of Methods

*Points: 8*

*Submission Deadline: See syllabus.*

**Students must provide a brief description of methods.** For this, you must describe what you have done/ are planning to do for the implementation of your project, and how you are doing it/ will do it. At this point, you should be able to describe the specific machine learning problem you are focusing on, and the architecture of the neural network you are implementing (how many layers, parameters, the training and inference methods, etc.). Keep in mind that the different hardware platforms may require different specifications, so please consider it carefully. You should define at this stage which datasets you will be using in your experiments (and why), and which metrics you will employ to measure performance in both GPU and FPGA.

*Deliverable for Milestone 2: Written Report (formatting guidelines in Appendix 1)*

*The report should contain one section, i.e., “Description of Methods”. There is no minimum number of pages for the report, and the maximum number is 5 (excluding the front page, which should contain the names of the group components with their respective teams, course number, semester, etc.). Remember that you will be graded based on the quality of your work, so try to include as much detail as possible without being unnecessarily prolix. **Keep in mind that the professor and TAs reserve the right to ask questions about the contents of the report to any of the group components. If the use of these tools is suspected and detected, points will be deducted from the whole group grade with maximum severity.***



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#### Milestone 3: Updated Description of Methods, Experimental Results

Points: 10

Submission Deadline: See syllabus.

- a) **Students should provide an updated description of methods.** As the project execution continues, changes might need to be made to the methods. This is totally fine and somewhat expected. These changes, however, should be justifiable and well-documented. Note that updating the methods is NOT the same as changing your entire project, which could put you in trouble considering how far in the semester we will be at the point when this report is due. *Examples of updated methods could be tuning/redesigning your algorithm if the results of your experiments are not as expected.*
- b) **Students should report all the experimental results obtained so far.** Note that, although I expect you to report as many results as possible at this point, you still have some time to perform more experiments until the presentation and final report deadlines, if needed. That means that if the results are only partial thus far, that should not be a problem. A preliminary discussion of your current (and expected) results should also be included, but you can make it short (1 page maximum).

*Deliverable for Milestone 3: Written Report (formatting guidelines in Appendix 1)*

*The report should contain two sections, i.e., “Updated Description of Methods” (the same as last milestone, with updates highlighted in bold), and “Experimental Results”. There is no minimum number of pages for the report, and the maximum number is 9. Remember that you will be graded based on the quality of your work, so try to include as much detail as possible without being unnecessarily prolix. **Keep in mind that the professor and TAs reserve the right to ask questions about the contents of the report to any of the group components. If the use of these tools is suspected and detected, points will be deducted from the whole group grade with maximum severity.***



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#### Project Presentation

*Points: 8*

*Submission Deadline (slides): See syllabus.*

1. **Presentations will be conducted in two parts, during the lectures on 4/18 and 4/20.** The order of presentation will be decided by drawing. However, note that the deadline to upload your slides to Canvas is the same (04/17/2023), regardless of which day you are presenting. You should limit your presentation to a maximum of 8 slides, and each group will have 10 minutes to present. *Given the short time slot allocated to each presentation, it is highly suggested that the group elect just one or two presenters to speak on behalf of the entire group (teams A and B).*

*Deliverable for Presentation: Slides (maximum of 8)*

*The presentation slides should contain all the parts of the execution of your project and should be clear enough for the whole class to understand.*

#### Final Report

*Points: 10*

*Submission Deadline: See syllabus.*

*Deliverable for Final Report: Written Report (formatting guidelines in Appendix 1)*

*The report should include the bibliographic study (milestone 1), a detailed description of the methods, progress, and the final results of your project. There is no minimum number of pages for the report, and the maximum number is 12 (excluding the front page). Remember that you will be graded based on the quality of your work, so try to include as much detail as possible without being unnecessarily prolix. **Keep in mind that the professor and TAs reserve the right to ask questions about the contents of the report to any of the group components. If the use of these tools is suspected and detected, points will be deducted from the whole group grade with maximum severity.***



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#### **Appendix 1 – Report Formatting Guidelines**

1. All reports should be typed. Handwritten reports will not be accepted, with no exceptions.
2. MS Word or Latex are both acceptable as text editors.
3. Please use Calibri, Arial, or Times font size 12 for the body of the text, section, and subsection titles.
4. The body of the text should use a justified alignment.
5. Section titles should be bolded and use central alignment.
6. Use double-spaced text, with one-inch margins all around.
7. Indent all paragraphs one-half inch. Alternatively, you can insert a blank line between paragraphs, and not indent the paragraphs.
8. A title page including the title, author, course and instructor's name, institutional affiliation, and date, should be included as the first page of your report.
9. All pages (except the title page) should be numbered.
10. There is no need to include a list of content, a list of figures, a list of tables, etc.
11. However, when present, figures and tables should be always numbered, reasonably formatted, and contain a meaningful description.

#### **Tips to accomplish a formal, professional style:**

- Avoid informal words and phrases. Such words and phrases include jargon, colloquial expressions, contractions, slang, and casual language.
- Try to use active voice – when the subject of the sentence is the person or thing doing the action of the verb or in the state expressed by the verb. This is the voice with which we are most familiar; the subject performs the action of the sentence.
- Explain abbreviations and acronyms at their first appearance.
- Minimize the use of adverbs and adjectives.