ECE 462/562
Spring 2020

Project Description

The goal of this project is to give you experience in doing research and enable you to become familiar with commonly used architectural simulations and research methodologies. 462 students are allowed to perform a survey of a topic in computer architecture (e.g., survey of cache replacement techniques) for your project.

You will be required to write a concise and clear research report detailing your research project, methodology, experiments, and results. You will need to determine what experiments need to be performed and what results will be reported. You should anticipate the most relevant questions and be able to justifiably pick and choose which results you will be presenting. You could examine a topic by writing your own simulator (not recommended, unless absolutely necessary), or by modifying your choice of architectural simulator, e.g., GEM5, Simplescalar (only sim-outorder is allowed), Sniper, etc. You may also choose to leverage the open-source RISC-V architecture for your project (I strongly recommend this option).

Deliverables and Deadlines

Deliverable	**Deadline**	**Percentage**
Group members	5pm, January 29	5%
Proposal	5pm, February 17	10%
Status report and log file	5pm, March 27	Report: 5%, Log file: 5%
Final report and log file	5pm, April 27	Report: 70%, Log file: 5%

Please take note of the deadlines above, as absolutely no late work will be accepted. All submissions must be made through Dropbox on D2L.

All submitted files much be PDF. Please read submission instructions for file naming conventions. *You will lose points for not adhering to the conventions.*

Group Members

You will be required to work on this project in groups of 2 to 4 (a different number of group members will need explicit permission from me). I encourage multi-individual groups to help you to gain experience in collaborating and working with others. Note that all groups will be graded the same. I do not expect more work from a group of 4, neither do I expect less work from a group of 2. You must submit your group members by the date listed above.

Project Proposal

You must submit your proposed project topic and a brief (1 to 2 page) document detailing your proposed work by the deadline above. I encourage you to email me your topics and a brief (few lines to one paragraph) description of your topic *before* the proposal deadline, so that I can give early feedback. You have 3 options for selecting your research topic:

- Propose and implement an original idea.
- Implement, validate, and/or evaluate an existing idea. Graduate students must improve on the existing idea if using this option.
- Survey the research done on a topic

The document must contain the following information:

- Project title
- Names and email addresses of group members
- Description of the topic. What are you going to do?
- Motivation for the topic. Why is this topic interesting or important?
- Related work. What has been previously done similar or related to this topic? (Limit this to 3 – 5 important related works. Your final project will have many more).
- Proposed methodology. *How* do you intend to perform the project? Provide details of evaluation strategy, methods, simulators, etc.
- Proposed timelines. Provide a chart or table with the proposed timeline for work broken up among the group members.
- Anticipated results.
- References.

Note that your project may evolve or change as the semester progresses. However, you are required to have a meaningful plan from the onset.

Status Report

You must submit a status report by the deadline listed above. The status report should be no more than 2 pages per group and should describe the progress made thus far, report any deviations from the proposal, preliminary results, and milestones that must be completed to successfully complete the project. You will be graded on the simple act of turning in your status reports with the necessary information. In rare cases, mid-course corrections with respect to your final goals may be allowed, with explicit permission from me.

Log Files

Each ***individual*** must submit detailed log files by the deadlines listed above. The log files should be broken down by weeks, and must contain an entry for that individual's activities on the project. I encourage you to keep a weekly log, which will be collated and submitted in a single document by the deadline. *The log file must also contain your estimate of the percentage contributions of all the members of your group.* Since it's a private submission, you need not share this document with your group members.

Final Report

You will write your final report in the current IEEE research paper format. The report will be graded based on what you discover in doing the project, how coherently you present your results, how well you put your work in perspective with respect to other research. The paper should be no more than 6 pages, two column, single spaced, 9-pt or 10-pt font, fully justified. Please take a look at previous IEEE papers to get an idea of the different sections, contents, length, etc. The paper should basically contain the following sections (there may be variations depending on what needs to be reported):

Abstract: 100 – 200 words describing what you did and a summary of the results.

1. Introduction: Background information and a longer summary of what you did and results you got. You should also briefly mention how your technique differs from previous work in this section.

2. Related work: Provide brief summaries of previous work related to your work including a cross-reference to the paper listed in the references section. Clearly distinguish your work from previous work, and show how your work differs from, improves, and/or extends previous work. Be careful not to trash anyone else's work.

3. Methodology: Describe what you did, how you did it, how it works, algorithms, etc. Use diagrams, charts, figures, etc. where necessary.

4. Experimental results: (a) Describe your experimental setup; (b) concisely present and analyze your results. Use graphs to illustrate results. Provide an in-depth analysis on what the results mean and what the trends reveal.

5. Conclusions and Future Work: Summarize your work and results. Summarize any future work that could be done.

6. References: List of papers cited throughout your paper.

Potential Topics

I strongly encourage you to come up with your own research topic/project ideas, and get some feedback from me *before* your proposal is due. You may either talk to me in person during my office hours or send me an email with a brief single-paragraph description of your idea, and I will give you some feedback on the idea.

Here are a few high-level ideas to get you started:

- *****Select a RISC-V implementation (e.g., PULP, Rocket Chip) and optimize it for a class/domain of applications or for a specific application. You may select a domain of applications that interests you (e.g., healthcare, irregular applications, machine learning, etc.) Compare your implementation with the original implementation to analyze the improvement. (This option is highly recommended)

- Select a paper that interests you from a recent computer architecture conference within the past 5 years (the more recent, the better; see note below about conferences). Carefully read the paper to understand it, and reproduce the main results using a simulator (e.g., GEM5, Sniper) or

RISC-V. Evaluate the technique presented in the paper, find ways to improve the technique, and quantify your improvements.

- Optimize a component of a RISC-V implementation. For example, the Rocket Chip only supports the MI, MSI, or MESI coherence protocols. Implement the MOESI, MESIF, or other variant protocols and compare to the existent protocols.

- Analysis of cache block lifetimes of different kinds of applications (e.g., graph applications like GAP benchmark suite, medical applications, etc.) and the suitability of emerging memories, such as reduced retention STTRAM caches, for those applications. Compare your analysis with SRAM behaviors. (Ref: http://www2.engr.arizona.edu/~tosiron/papers/2018/LARS_DATE18.pdf).

- Implement and analyze a subset of applications (e.g., HERMIT benchmark suite) on the RISC-V architecture (Ref for HERMIT: http://www2.engr.arizona.edu/~tosiron/papers/2018/HERMIT_IoTJ18.pdf).

- Analyze a set of applications that have not been previously analyzed, and derive new insights from the applications' execution characteristics.

- Etc.

With respect to related work, note that in computer architecture, conferences are MORE important than journals. Some important architecture conferences and journals include: International Symposium on Computer Architecture (ISCA), Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), International Symposium on Microarchitecture (MICRO), International Symposium on High Performance Computer Architecture (HPCA), IEEE Transactions on Computers, ACM Transactions on Embedded Computer Systems, IEEE Computer, IEEE Micro, International Conference on Computer Design (ICCD), Design Automation Conference (DAC), Design Automation and Test in Europe (DATE), etc. A good resource/search engine for searching for papers is Google Scholar: (www.scholar.google.com).