Hash Tables Team Research Project

CPSC 6109 - Algorithms Analysis and Design

Assignment Overview

Hash tables are a fundamental data structure used extensively in databases, operating systems, networking, compilers, and large-scale data processing systems. While classical hash table designs are well understood, **current research continues to explore improvements** related to performance, memory efficiency, concurrency, scalability, and robustness under real-world constraints.

In this assignment, you and your team get to **study recent research on hash tables** and **extend, adapt, or evaluate an existing hash table technique** for a new workload, environment, or engineering constraint.

Learning Objectives

The learning objectives of this assignment are for you to:
- Interpret and critique contemporary research on hash table design
- Identify assumptions or limitations in existing hash table approaches
- Adapt or extend a hash table technique to address a specific engineering need
- Analyze and/or empirically evaluate performance trade-offs
- Communicate technical results in a scholarly format

Topic Selection

Here are some example topics:
- Collision resolution strategies (e.g., cuckoo hashing, hopscotch hashing)
- Dynamic resizing and rehashing strategies
- Cache-aware or cache-oblivious hash tables
- Concurrent or lock-free hash tables
- Hash tables under skewed or adversarial workloads
- Memory-efficient hash tables (space–time trade-offs)
- Hash tables for external memory or SSD-based systems
- Comparative evaluation of hash table variants under realistic workloads

Your contribution may be one or more of the following:
- A **modification or extension** of an existing hash table design
- An **adaptation to a new context** (e.g., concurrency, memory constraints)
- A **comparative evaluation** under assumptions not studied in the original work

Note, just a survey or re-implementation of an existing technique is not sufficient**.**

Proposal

Create a team of up to a total of three students. As a team, select a topic. Explore this topic by conducting an initial literature review (two to three journal or conference papers). Write a proposal (approximately two pages long) listing your team members and your selected topic. Include your literature review with some explanation of how they relate to your topic. Also include what experiment(s) you plan to conduct and why the results are important. Here's a potential outline for your proposal:

- **Project title**
- **Subtitle** (the name of the selected topic if not included in the title)
- **Team members' names**
- **Introduction / Background** (including the motivation for your work, literature review references and the objectives of the proposed research)
- **Research question(s) / goal** (clearly state your research question(s), including what will be extended, adapted or evaluated)
- **Methodology of the proposed experiments** (outline how the study will be conducted (analysis, simulation, implementation, benchmarking, or a combination)
- **Expected Outcomes** (outline the potential results, their format and their implications to your research)

Ensure that your proposal answers the following questions:

- What is(are) the research question(s)?
- What are the methods to answer the research question(s)?
- What results do you expect to produce and how will you analyze them?

Please review the research proposal rubric in CougarVIEW for details about specific points.

Your proposal must be approved by me before continuing with the project.

Proposal Submission

You only need to make one submission per team to the Assignment in CougarVIEW. Other team members should submit something (for example, "<name> submitted the assignment") so that they too can see the posted feedback. The preferred format is a PDF file (typeset from a LaTeX file). Extra credit will be awarded for teams that use LaTeX and submit both a PDF and the LaTeX file.

Literature Review

As a team, conduct a more extensive literature review on your topic. Pay particular attention to gaps in related works (which are filled by your work). Provide at least five or more related works with at least one of them being within the last 7 years) and five or more other references (for example, background, original algorithm publication, etc. Each of these articles should be published in professional conference proceedings or journal (and not a textbook or just as a website). Note, papers that strictly introduce an algorithm and do not compare it to other

algorithms are not related works. (They could be appropriate citations though). The emphasis should be on synthesis and comparison, not paper-by-paper summaries. Your literature review will be integrated into your presentation and written report. Ensure that they are complete references. One option is to find the reference at scholar.google.com, then click on Cite for that reference.

Please review the literature review rubric in CougarVIEW for details about specific points.

Literature Review Submission

You only need to make one submission per team to the Assignment in CougarVIEW. Other team members should submit something (for example, "<name> submitted the assignment") so that they too can see the posted feedback. The preferred format is a PDF file (typeset from a LaTeX file). Extra credit will be awarded for teams that use LaTeX and submit both a PDF and the LaTeX file.

Research Paper

Implement your proposal and write a research paper about your work. Write a 6–8-page conference style paper. Include the following sections:

- **Abstract:** A concise summary of your research.
- **Introduction:** Introduce the problem, objectives, and significance of your research (motivation).
- **Background and Related Work:** Discuss each one of the references from your literature review and how it relates to your research.
- **Methodology:** Describe your experiments (your approach and analysis)
- **Results and Evaluation:** Present the findings of your research, including any data, graphs, or tables. Results need to reflect (as close as reasonable) to real-world scenarios. Metrics could include lookup time, insertion time, memory usage, scalability.
- **Discussion:** Interpret the results, discuss their implications, and relate them to the literature.
- **Conclusion:** Summarize the main findings and suggest possible future work.
- **References:** List all sources cited in your paper using a consistent citation style.

Format the paper using ACM or IEEE guidelines for an academic conference proceedings or journal format.

Please review the research paper rubric in CougarVIEW for details about specific points.

Research Paper Submission

You only need to make one submission per team to the Assignment in CougarVIEW. Other team members should submit something (for example, "<name> submitted the assignment") so that they too can see the posted feedback. The preferred format is a PDF file (typeset from a LaTeX file). Extra credit will be awarded for teams that submit both a PDF and the LaTeX file.

Presentation

The goal of this presentation is to **communicate your proposed hash table research clearly and professionally**, demonstrating your ability to explain the **motivation, research question, and proposed methodology** to a technical audience.

As a team, record a 7–10-minute presentation about your research project. The audience is other students in our class and me (so people with a background in algorithms). Your presentation should include:

- Introduction (team members, background/context for your project, your selected topic [with any needed definitions, key concepts, etc.] and project overview)
- Related work from your literature review
- Your methodology(ies) for the experiment(s) conducted
- Analysis and results of your experiment(s)
- Conclusions (your insights, ideas, hypotheses, etc. for future research opportunities)

This presentation should complement your written proposal, not repeat it verbatim. Please review the recording to ensure that the audio is clear and understandable.

Please review the research presentation rubric in CougarVIEW for details about specific points.

Presentation Submission

Have just one team member upload your video (or a public link to it) to the Assignment in CougarVIEW. Additionally, please submit a copy of the slides / visuals as I often find it helpful to have them. You only need to make one submission per team. Other team members should submit something (for example, "<name> submitted the assignment") so that they too can see the posted feedback. Extra credit will be awarded for teams that use LaTeX Beamer (or similar package) and submit both a PDF and the LaTeX file.

AI Policy

You are allowed to use Generative AI tools like ChatGPT or CoPilot for tasks like brainstorming, grammatical correction, outlines and to find potential sources. You must acknowledge the use of AI and properly attribute it. This includes providing in-text citations, quotations, and references.

You should include the following statement in assignments to indicate use of a Generative AI Tool: *"The author(s) would like to acknowledge the use of [Generative AI Tool Name], in the preparation of this assignment. The [Generative AI Tool Name] was used in the following way(s) in this assignment [e.g., brainstorming, grammatical correction, citation] in the [which portion of the assignment]."*

Course Alignment

This assignment directly supports **CLO1, CLO2, CLO3, and CLO5**, with particular emphasis on **algorithm synthesis and performance trade-offs**.

Note: Output from ChatGPT was incorporated in multiple sections of this document.