15-745 F25 Project Milestone Report

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1 Major Changes

None.

2 What You Have Accomplished So Far

So far, we have implemented two LLVM passes:

- `AoSDetectionPass`: Finding `GEP` instructions that access stack-allocated *Array of Structures* (AoS) data and are safe to be transformed to *Structure of Arrays* (SoA) accesses.
- `AoS2SoAPass`: Rewriting eligible AoS accesses to SoA accesses, and rewriting stack-allocated AoS data to SoA form.

3 Meeting Your Milestone

Previously, we've stated that "we hope to have completed the basic analysis pass for identifying AoS for possible transformation and are close to completing the compiler pass for transforming AoS to SoA" to be our milestone goal. Currently, we have concrete implementations of both analysis and rewrite passes for stack-allocated data, and are finishing up supporting heap-allocated data. Therefore, we consider ourselves successfully meeting the milestone goal.

4 Surprises

We have not encountered any major surprise so far. However, we did underestimate the impact of differences between stack-allocated (`alloca`) and heap-allocated (`call @malloc/calloc`) objects on the implementation of the LLVM passes. Additionally, testing for the eligibility of transformation for chained `GEP` instructions presented more edge cases than we initially anticipated.

5 Revised Schedule

For the remainder of the semester:

Week 5 (Nov 17): *Nov 20 milestone.*
Both: Extend the implementation to support heap-allocated data structures.
Both: Add new microbenchmarks using heap-allocated AoS.
Both: Evaluate the effectiveness of the AoS-to-SoA transformation for optimizing memory accesses on all microbenchmarks.

Week 6 (Nov 24): *Week of Thanksgiving.*
Both: Evaluate the optimization using the benchmarks.
Both: Start working on the project report and poster.
Both (if time permits): Evaluate the optimization using applications from well-established benchmark suites.
Yufei (if time permits): Implement profitability heuristic for determining whether the AoS-to-SoA transformation should be performed.
Sun A (if time permits): Add cache-line-aligned padding between SoA arrays.

Week 7 (Dec 1): Both: Work on the project report and poster.

6 Resources Needed

We have all the resources needed to complete this project.