Programming Assignment #5: MatMul Optimization

Prof. Jae W. Lee (jaewlee@snu.ac.kr)
Department of Computer Science and Engineering
Seoul National University

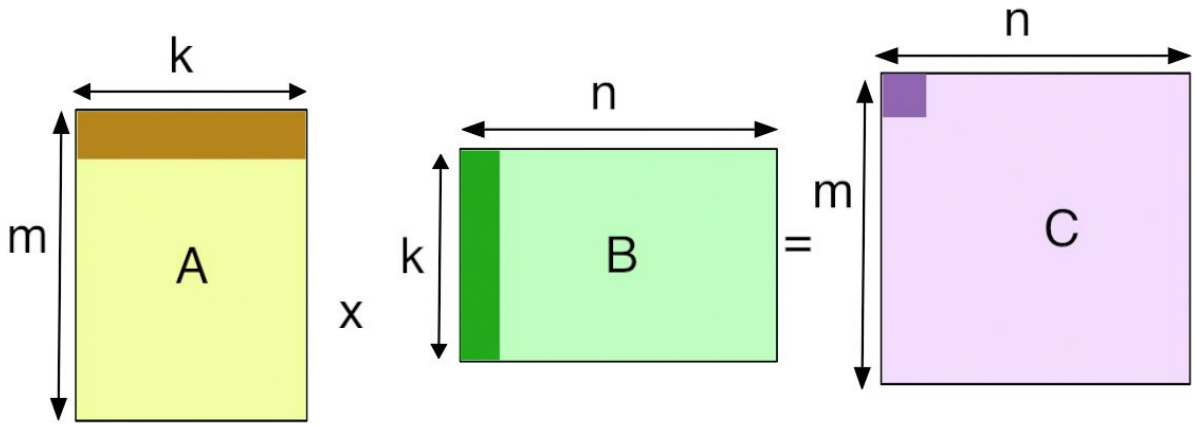
TA (snu-arc-uarch-ta@googlegroups.com)

Contents

- Goal of Project - p.3
- Explanation - p.4
- Environment setup - pp. 5-7
- Grading Policy - pp. 8-10
- Submission - p.11

Goal of this project

- **Optimize the given matrix multiplication operation.**
  - Problem size: m=1024, n=1024, k=4096



Explanation

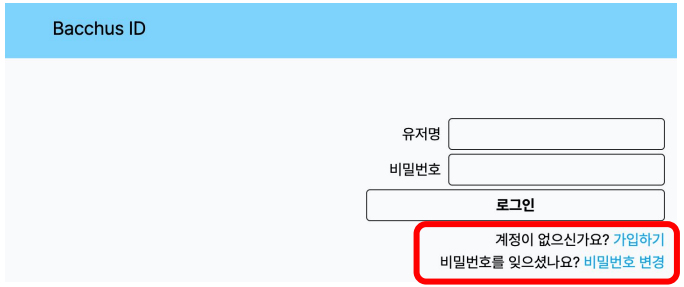
- **Optimize the given matrix multiplication with...**
  - Blocking
  - Loop unrolling
  - Loop reordering (i,j,k)
  - SIMD operations
  - Inline assembly (you'll need to study x86_64 ISA…)
  - Many others...
  - You are **not allowed** to write multi-thread program (i.e. openmp, pthread) or use accelerators(i.e. GPUs).
- **File to modify**
  - Only matmul.c

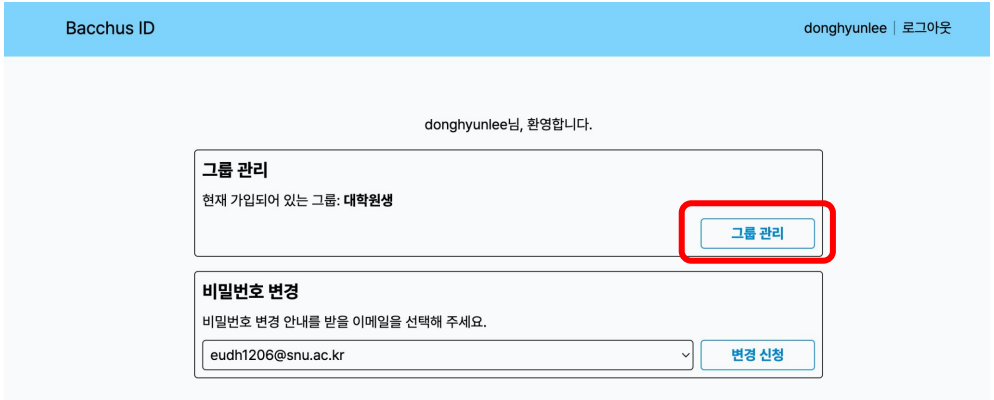
Environment setup

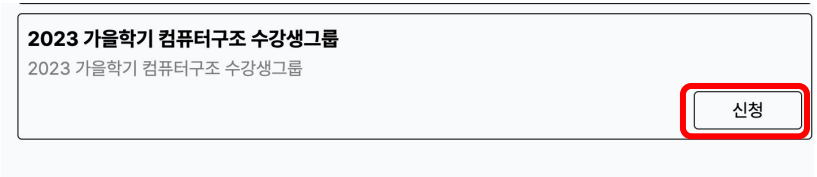
- **You may use any Linux environment for development.**
  - Performance will be measured using HW lab computers.
  - We recommend you to do the measurement at the HW lab before submission. **Please do not use HW lab computers for development! Only use them for testing your code's performance.**
  - We have added HW lab access permissions to S-card for students who are not CSE major.
  - For those who are not CSE major, please sign up for our group in id.snucse.org! You will need your account to access computers in HW lab. (Instruction are at the next page)
- **You can get assignment files from git repo.**
  - `git clone https://github.com/SNU-ARC/2023_fall_comarch_PA5`

Environment setup

- **Sign up for our group in id.snucse.org!**







Environment setup

- **Change the code in matmul.c, make, and run.**
  - Performance means relative performance of your implementation to the TAs.

```
(base) dhlee@dhlee-desktop:~/2023_fall_comarch_PA5$ ls
input.txt  main.c  Makefile  matmul.c  matmul.h  matmul_TA.so
(base) dhlee@dhlee-desktop:~/2023_fall_comarch_PA5$ make
gcc -Wall -Werror -std=c99 -O1 -Wno-unused-result -c main.c -o main.o
gcc -Wall -Werror -std=c99 -O1 -Wno-unused-result -c matmul.c -o matmul.o
gcc  main.o matmul.o -o matmul_test ./matmul_TA.so
(base) dhlee@dhlee-desktop:~/2023_fall_comarch_PA5$ ./matmul_test input.txt
Your time: 1.155090s, TA time: 1.224241s
Performance: 105.986633%
```

Grading Policy

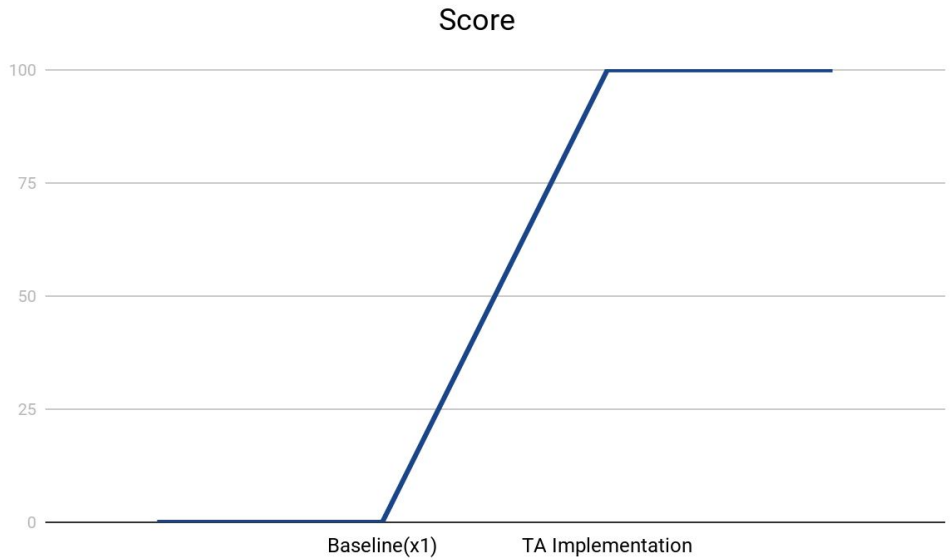
- **Performance : 90%**
  - We will grade your submitted code on a **HW lab computer**.
  - We will measure the performance of your code using the same problem size with the given input.txt.
  - All execution times will be measured by **the minimum** of 5 runs.
  - If you do hardware-specific optimization (e.g., cache optimization, SIMD), you must target the HW lab computer.
- **Write-up** : **10%**
- **For late submission:**
  - A deduction of 10% p per 24 hours
  - After next 120 hours, submission will not be accepted.

Grading Policy

- **Rules**
  - If your code is faster than TA's, you will get all points(performance > 100%).
    - If it is slower, we will use a grading curve on next slide.
  - Basically, you are not allowed to change the compilation flags.
    - If you need additional compilation flags for SIMD operations, contact TAs.
  - If your code is incorrect, you will get a very low score.
    - We may test the correctness of your code with other inputs with the same problem size (*m*: 1024 *n*:1024 *k*:4096).

Grading Policy

- **Grading curve**
  - If you do not give any change to the baseline code in matmul.c, you will get 0 points.



Submission

- **Write-up**
  - Briefly describe your implementation.
  - If you were allowed to use additional compilation flag, specify them in the report.
  - Filename: [student_id].txt (example: 2023-12345.txt)
  - Please use ‘UTF-8’ encoding if possible
  - **Please** submit it in **txt** format. Other formats are not accepted.
- **Compress your source code and write-up into a single zip file**
  - Compress **matmul.c** and your report
  - Filename should be [student_id].zip (example: 2023-12345.zip).
  - **Please** submit it in **ZIP** format. Other formats are not accepted.
- **Submission deadline: by 23:59 on December 8, 2023 (Fri)**