Department of Computer Science
National Tsing Hua University
CS4100 Computer Architecture
Spring, 2019
Homework 1
Deadline: 2019/03/14 10:10

1. Install and use AndeSight™ for RISC-V program development.
   (1) Follow the instructions below to install "AndeSight™":
      (a) Go to "http://www.andestech.com/surpport.php?id=4".
      (b) Fill in the blanks and submit your information.
      (c) Wait for about 1 day to get the license.
      (d) Install AndeSight™ using the given license.
   (2) Create a new Andes C project:
      (a) Project name: "ADD".
      (b) Choose "NX25F" as the CPU in Chip Profile.
      (c) Project type: Andes Executable->Hello World ANSI C Project.
      (d) Tool Chains: nds64le-elf-mculib-v5d.
      (e) All the others remain the same.
   (3) Replace ADD.c in the project with the one on iLMS.
   (4) Press the button "Build 'Debug' for project 'ADD'" in the toolbar.
   (5) Press the button "Profile" in the toolbar.
   (6) Profile as "Application Program".
   (7) Press the button "Resume" in the debug window.
   (8) Do the same things above for project "MUL".

   Answer the following questions. (Use default optimization setting -Og)
   (a) Based on your understanding of the characteristics of the two programs, explain the differences in their profile (CycC and InsC).
   (b) What are the average CPI for ADD.c and MUL.c for "fib" function respectively?
   (c) What are the CPU execution time for ADD.c and MUL.c for "fib" function, respectively, on a processor with a clock rate of 4.0 MHz?
   (d) Determine the clock rate required to give a further 10% reduction in CPU time for the processor in (c) while maintaining the number of instructions and with the CPI unchanged.
   (e) Compiler will affect program performance. Compile ADD.c and MUL.c with two optimization levels, -O0 and -O3. Compare the performance of "fib" function in ADD.c and MUL.c for different optimization levels. You should write CycC, InsC and CPI. (To change optimization level, see Fig. 1)
   (f) Compile ADD.c as in (e) and record InsC numbers only. Assume that there are only 3 types of instruction A, B, C in "fib", whose CPIs are 1, 2, 3. The CPU runs at 5 KHz. What is the IPS

(instructions per second) rating for “fib” if this function is compiled for -O0 with 40% of A, 40% of B, 20% of C? Calculate the IPS rating for -O3, where it consists of 30% of A, 20% of B, 50% of C. Is “fib” faster when compiled with O3? Justify your answer.

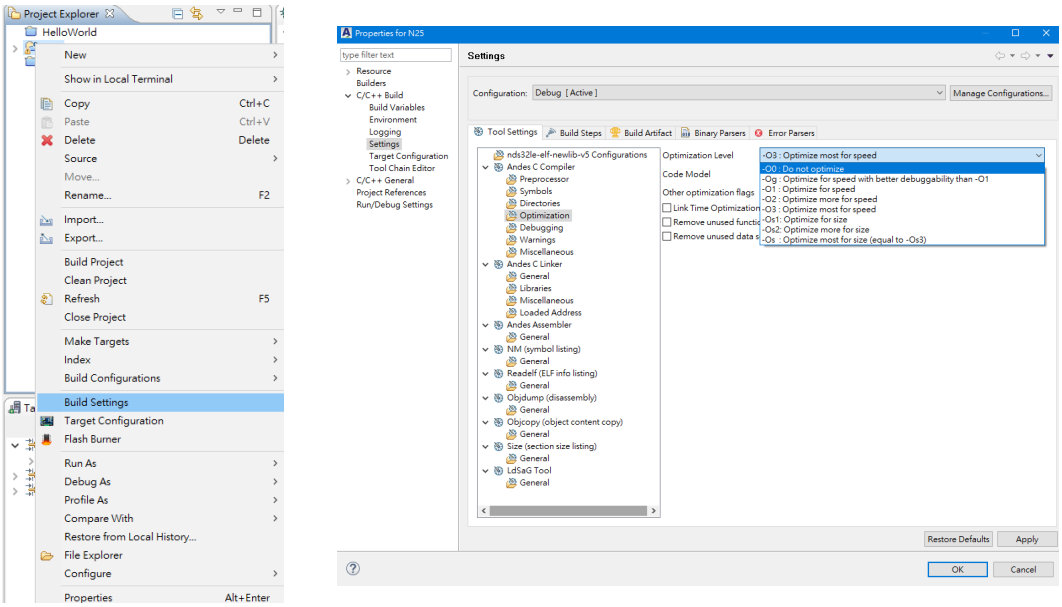

Fig. 1

2. Here is the definition of Amdahl’s law.

$$S_{\text{latency}}(s) = \frac{1}{(1-p) + \frac{p}{s}}$$

where

S_latency is the theoretical speedup of the execution of the whole task.

s is the speedup of the part of the task that benefits from improved system resources.

p is the proportion of the execution time that the part benefiting from improved resources originally occupied.

Consider a program that has a multiplication part constituting 60% of the execution time and a division part constituting 40% of the execution time.

(a) Now you want the program to run 4 times faster. You can make the division run at most 3 times faster and the multiplication run at most 8 times faster. Can you meet the goal by making only one improvement? If you can, which one? Justify your answer.

(b) If you can make multiply as well as divide improvements, what is the speedup of the improved machine relative to the original program? Can you meet the goal in (a)?