PHY904, section 4
Homework Assignment 1

Håkon V. Treider
MSU id: treiderh

January 2016

Introduction

The tests have been run on Mac OS X (10.11.3) with a 2.5 GHz Intel Core i7.

In this homework assignment we are going to inspect the scaling of a simple matrix-matrix multiplication algorithm. I have chosen to go with the C-code supplied by the course material. This report will basically jump straight to the results from the computations.

Objectives

1. Gain experience running programs and checking performance
2. Use performance models to gain insight into the behaviour

1 Results

Note: The different test are run 10 times, and the best (minimum) run time is picked out. This is better than i.e. taking the average, since the bias is always one-sided.

Assuming the reader is familiar with the assignment text, I'll start by computing the constants c_1 and c_2.

$$c_1 = \frac{t_{N=100}}{2N^3} = \underline{3.53 \times 10^{-10}} \tag{1}$$

$$c_2 = \frac{1}{f_{cpu}} = (2.5 \times 10^9 \text{ Hz})^{-1} = \underline{4 \times 10^{-10}} \tag{2}$$

We can see that the values are in accordance with each other. Using these constants, we make an estimate using the formula

Table 1: Actual computation times, performance and estimates

N	Perf. MFLOP/s	Time (sec)	Formula time c_1	Formula time c_2
100	2.83e+03	7.06e-04	7.06e-04	8.00e-04
200	2.59e+03	6.18e-03	5.65e-03	6.40e-03
400	2.29e+03	5.58e-02	4.52e-02	5.12e-02
800	1.37e+03	7.48e-01	3.61e-01	4.10e-01
1000	1.61e+03	1.24e+00	7.06e-01	8.00e-01
1200	3.32e+02	1.04e+01	1.22e+00	1.38e+00
1400	2.92e+02	1.88e+01	1.94e+00	2.20e+00
1600	2.94e+02	2.79e+01	2.89e+00	3.28e+00
2000	2.46e+02	6.52e+01	5.65e+00	6.40e+00

$$t(N) \approx 2cN^3 \tag{3}$$

The results can be seen in table 1 or visually in figure 1 and 2.

Conclusion

We can see the formula works well for small matrices up to and including N=1000. Larger matrices do not follow eq. 3, but when looking at the logarithmic plot we can see that the scaling is the same ($\mathcal{O}(N^3)$), but with a larger constant factor in front.

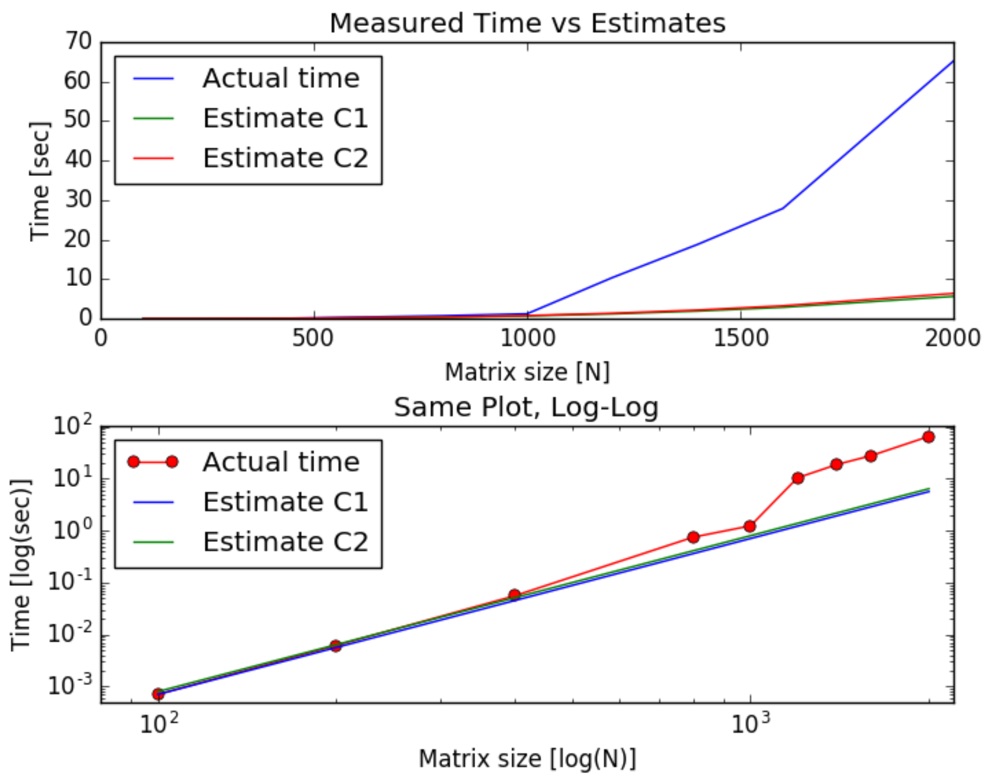

Figure 1: Visualization of measured time vs estimates. Deviations after N=1000 visible

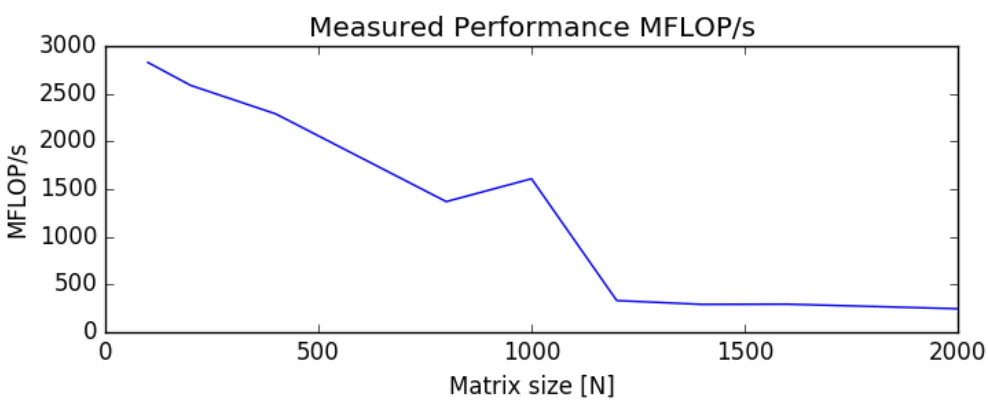

Figure 2: Measured performance visualized in MFLOP/s vs matrix size N