Heidelberg University
Institute of Computer Engineering
Computer Engineering Group

Holger Fröning
Georg Weisert

Introduction to High-Performance Computing
Winter Term 2020/2021

Exercise 1

- **Hand in via Moodle until 23:59 on Monday 16 November, 2020**
- **Include all names on the top sheet. Hand in a single PDF.**
- **A maximum of three students is allowed to collaborate on the exercises.**
- **In case an exercise requires programming:**
  - **include clean and documented code**
  - **include a bash script for compiling**

1.1 Reading

Read the following two papers and provide reviews as explained in the first lecture (see slides):

1. Michael J. Flynn and Patrick Hung. 2005. Microprocessor Design Issues: Thoughts on the Road Ahead. IEEE Micro 25, 3 (May 2005), 16-31.
2. Walker, 2008, benchmarking Amazon EC2 for high-performance scientific computing, The USENIX Magazine, 33(5).

(20 points)

1.2 Moore's Law

1. Apply Moore's Law (or one of the derived ones, see lecture) to the currently fastest supercomputer worldwide (see http://www.top500.org). In which year will the performance of the fastest supercomputer exceed one Exaflop? (1 Exa = 10^{18} or 1000 Peta)
2. Determine the growth rate of the TOP500 list by using the fastest system from 11/2007 and 1/2011. According to this growth rate, when (which year) will a supercomputer exceed one Exaflop?

(5+5 points)

1.3 Amdahl's Law

1. The CPU of a webserver is to be improved. For web applications, the new CPU is 10 times faster than the old one. Consider the case that the old CPU is spending 40% of its execution time for calculations and the remaining time for IO, which performance improvement can be expected according to Amdahl's law?
2. A common floating-point (FP) operation is the square root operation (FPSQR). In a complex calculation, 20% of the execution time is spent for calculating square roots. For an optimization, two possibilities do exist: (1) Improve only the implementation of FPSQR, so that it is accelerated by a factor of 10. (2) Improve all FP operations by a factor of 1.6. Assume that half or the execution time is spent for FP operations. Compare both alternatives and identify the optimal solution.
3. An application is to be implemented as parallel program for an execution on 128 processors. In order to achieve a speedup of 100x, how big (in percent) can the serial fraction of the application be?

(5+5+5 points)

Total: 45 points