INFOMOV 2016/2017 EXAM - November 8 – 17.00 - 19.00 – EDUC-ALFA

Answer these questions as elaborate as necessary. Don't be too elaborate; incorrect statements in your answer reduce your score. Negative scores for a question are not possible however.

1. A modern CPU uses a pipeline to process a sequence of instructions, inspired by the 'fetch-decode-execute-write back' sequence. (15 pts)

   a) Why does a typical modern CPU have far more stages than just the original four?
   b) Name a disadvantage of having many stages in the pipeline of a CPU.
   c) What is, in the context of the CPU instruction pipeline, a 'bubble'?
   d) How is a 'superscalar' pipeline related to instruction level parallelism?
   e) How does a compiler help a superscalar processor to run at maximum efficiency?

2. Your code contains the following snippet:

   ```
   float z = table[20];
   a /= z;
   b /= z;
   c /= z;
   d /= z;
   e += z;
   ```

   When inspecting the disassembly, you notice the compiler didn't replace the four division by four multiplications and a reciprocal. Why did it not apply this optimization? (10 pts)

3. "Going from 4-wide (SSE) to 8-wide (AVX) SIMD and beyond shows diminishing returns." Is this true or false? Explain your answer. (10 pts)

4. The way a GPU runs multiple warps on a single shading multiprocessor is similar to how CPUs perform hyperthreading. Why, do you think, does a CPU only run two threads per hyperthreaded core, while some GPUs can run up to 64 warps per SM? (10 pts)

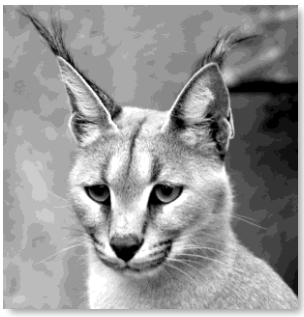
5. Explain the following concepts in 30 words or less. (15 pts)

   a) False sharing
   b) Prefetching
   c) Bélády's algorithm

6. Most reads and writes from C++ code are 4 or 8 bytes in size. Nevertheless, CPU caches typically use 64-byte cache lines. Why? (10 pts)

7. Certain AMD processors use a 48-way set associative L3 cache, while Intel uses 16-way. What reasons could each vendor have for this particular configuration? (10 pts)

8. Explain how compaction can help to improve occupancy for GPGPU algorithms that have complex flow control. (10 pts)



Good luck!