COMPUTER SCIENCE TRIPOS Part II – 2019 – Paper 9

11   Optimising Compilers (tmj32)

(a) Describe the phase-order problem in a compiler and illustrate your answer with some example code.   [4 marks]

(b) You are advising a semiconductor design company on building a compiler for their latest processor. The processor has the following features:

   • Sixteen 64-bit registers (`r0-r15`) and sixteen 32-bit registers (`s0-s15`), the latter corresponding to the lower 32 bits of each of the 64-bit registers.

   • A one-cycle branch delay slot after each control-transfer instruction (i.e. the instruction after a branch is executed before the branch takes effect).

   • Complex arithmetic instructions that implicitly use `r15` as their first source operand.

   What are the challenges of code generation for this processor, given these features and how can they be addressed within the compiler?   [8 marks]

(c) To ease compilation, the chief designer suggests that the processor's instructions could be executed directly in SSA form (i.e. all destination registers unique). This would use a small cache to provide fast access to the most recently used virtual registers. Discuss the advantages and disadvantages of such an approach from the compiler writer's viewpoint.   [8 marks]