The Effect of Branches on Pipelined Performance

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1 Administrivia

Today's Objectives

1. Understand the effect of branches on pipelined performance.

2. Study techniques for reducing the effect of branches on pipelined performance.

Next Up

Read 10.1, 10.4.

1. Learn the characteristics of the types of solid state memory used in modern computing systems.

2 Warm-Up

1. A flow-through processor will have branch penalties.

   True/False

2. The outcome of an unconditional branch is always known at compile time.

   True/False

3. If the probability that an instruction is a branch instruction is 0.25, then the probability that an instruction is not a branch instruction is

   (a) 0

   (b) 0.25

   (c) 0.5

   (d) 0.75

   (e) 1

4. The term "delayed branch" refers to

   (a) the branch instruction is delayed from entering the pipeline

   (b) "bubble cycles" are inserted into the pipeline delaying execution of succeeding instructions

   (c) instructions succeeding the branch are executed

5. With static branch prediction, the branch outcome is predicted at

   (a) compile time

   (b) link time

   (c) load time

   (d) execute time

6. With dynamic branch prediction, the branch outcome is predicted at

   (a) compile time

   (b) link time

   (c) load time

   (d) execute time

3   Problem Set 15.0

1. Consider an architecture with the following characteristics:

   - Cost of a non-branch instruction: 1 cycle

   - Fraction of instructions that are branches: 20%

   - Fraction of branches that are taken: 85%

   - Fraction of delay slots that can be filled: 50%

   - Cost of an unfilled delay slot: 1 cycle

   Determine the following:

   (a) The average number of cycles per instruction

   (b) The improvement, as a percentage, if the fraction of delay slots that are filled can be increased to 85%.

2. Consider the following repeating pattern (e.g., in a loop) of branch outcomes:

   `T, T, T, NT, NT`

   (a) What is the accuracy of always-taken and always-not-taken predictors for this sequence of branch outcomes?

   (b) What is the accuracy of the saturating counter branch predictor (pg. 455 in the textbook) and the alternative branch predictor (pg. 456 in the textbook) if this pattern is predicted forever? Assume that the initial state of each predictor is strongly taken.

   (c) What is the accuracy of the saturating counter branch predictor (pg. 455 in the textbook) and the alternative branch predictor (pg. 456 in the textbook) if this pattern is predicted forever? Assume that the initial state of each predictor is weakly not-taken.