Grading Scheme for Assignment 3: L1 Cache Simulator

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Overview

This document outlines the detailed grading scheme for Assignment 3 in COL216. The goal is to fairly evaluate student implementations of a quad-core L1 data cache simulator using the MESI protocol, while allowing for reasonable design-specific variations. Each submission will be evaluated on the correctness of output statistics and adherence to expected behavior under the MESI protocol and timing constraints.

Grading Strategy

Each student's simulator generates output statistics for four cores and an overall bus summary. We assign weights to each output parameter and compute a score based on how closely the student results match the reference values. Reasonable deviation is permitted.

Per-Core Statistic Weights

Each core contributes equally to the overall grade. For each core (Core 0 through Core 3), the statistics are weighted as follows:

Metric	**Weight**
Total Instructions	0.10
Total Reads	0.05
Total Writes	0.05
Total Execution Cycles	0.20
Idle Cycles	0.10
Cache Misses	0.10
Cache Miss Rate	0.10
Cache Evictions	0.05
Writebacks	0.05
Bus Invalidations	0.10
Data Traffic (Bytes)	0.10

Each core's total contribution sums to 1.0.

Bus Summary Weights

Two metrics are reported in the overall bus summary, weighted equally:

Metric	**Weight**
Total Bus Transactions	0.50
Total Bus Traffic (Bytes)	0.50

Penalty for Deviation

Let R be the reference value and S be the student value for any metric. Define the relative deviation as:

$$\delta = \frac{|S - R|}{\max(R, \varepsilon)} \quad \text{where } \varepsilon = 1 \text{ to avoid division by zero}$$

The penalty for a given metric is then defined as:

$$\text{penalty}(\delta) = \min(1.0, \frac{\delta}{T})$$

where T is a metric-specific tolerance:

- Performance metrics (cycles, traffic, misses): $T = 0.05$
- Instruction counts: $T = 0.01$
- Noisy coherence metrics (evictions, invalidations): $T = 0.10$

The effective score for a metric becomes:

$$\text{score}_{\text{metric}} = \text{weight} \times (1 - \text{penalty}(\delta))$$

Final Score Calculation

Let C_i be the total weighted score for Core i (where $i = 0, 1, 2, 3$) and B be the total bus score. Define:

- Core weight = 0.8
- Bus weight = 0.2

Then the final score (out of 100) is:

$$\text{Final Score} = 100 \times \left(\frac{C_0 + C_1 + C_2 + C_3}{4} \times 0.8 + B \times 0.2 \right)$$

Example

If the reference total execution cycles is 4000 and the student reports 4100, then:

$$\delta = \frac{100}{4000} = 0.025 \quad \text{and } T = 0.05 \Rightarrow \text{penalty} = 0.5$$

If the weight for execution cycles is 0.2, then:

$$\text{score}_{\text{cycles}} = 0.2 \times (1 - 0.5) = 0.1$$

Interpretation

This scheme ensures that:

- Reasonable deviations in output are tolerated
- Catastrophic errors (e.g., wrong MESI logic) are penalized more
- Student design decisions that cause minor variation are not unfairly punished