Universidade de Aveiro

Mestrado em Engenharia de Computadores e Telemática

Arquitecturas de Alto Desempenho

Branch Prediction

Academic year 2021/2022 Exercises adapted from *Computer Architecture: a Quantitative Approach*

1. A (m,n) correlating branch predictor takes into account the execution behavior of the previous m branches to choose among 2^m n-bit branch predictors in predicting a particular branch. A (m,n) local branch predictor works in a similar fashion, but only keeps track of the past behavior of an individual branch, through its m previous instances, to predict its future behavior.
   There is a design trade-off involved with such predictors: *correlating branch predictors* require little memory for global history, which allows them to maintain n-bit branch predictors for a large number of different branch groups (thus, reducing the probability of branch instructions reusing the same predictor), while *local branch predictors* require substantially more memory for local history and, because of that, are limited to keep track of a relatively smaller number of branch instruction groups.
   Consider a (1,2) correlating branch predictor that can track four branches, requiring 16 storage bits, versus a (2,2) local branch predictor that can track two branches using the same amount of memory. For the branch outcomes listed in the table bellow

Branch PC (decimal word address)	**Outcome**
1816	T
2172	NT
3108	NT
2172	NT
3108	NT
1816	T
3108	NT
1816	T
2172	T

   provide the prediction, the table entry used to make the prediction, any updates to the table as a result of the prediction and the final misprediction rate of each predictor.
   Initialize each predictor to the following values

Correlating branch predictor				
entry	**branch group**	**last outcome**	**internal state**	**prediction**
0	0	NT	0	NT
1	0	T	2	T
2	1	NT	3	T
3	1	T	0	NT
4	2	NT	3	T
5	2	T	3	T
6	3	NT	0	NT
7	3	T	1	NT

Local predictor				
entry	**branch group**	**last two outcomes**	**internal state**	**prediction**
0	0	NT, NT	3	T
1	0	NT, T	0	NT
2	0	T, NT	0	NT
3	0	T, T	2	T
4	1	NT, NT	0	NT
5	1	NT, T	0	NT
6	1	T, NT	2	T
7	1	T, T	3	T

and assume that the global history register states that the last global branch was NT and that the local history table states that the last two local branches were T, NT and T, T for its two entries, respectively.

2. Consider now a *tournament branch predictor* built with the correlating branch predictor and the local branch predictor of problem 1. For the branch outcomes listed in the table of problem 1, provide the prediction, the table entry of the *choice prediction buffer* used to select the prediction, any updates to the table as a result of the prediction and the final misprediction rate.
Initialize the choice prediction buffer to the following values

Tournament branch predictor				
entry	**branch group**	**last outcome**	**internal state**	**selection**
0	0	NT	1	GB
1	0	T	0	GB
2	1	NT	2	LC
3	1	T	3	LC
4	2	NT	1	GB
5	2	T	3	LC
6	3	NT	1	GB
7	3	T	0	GB