Branch Prediction competition

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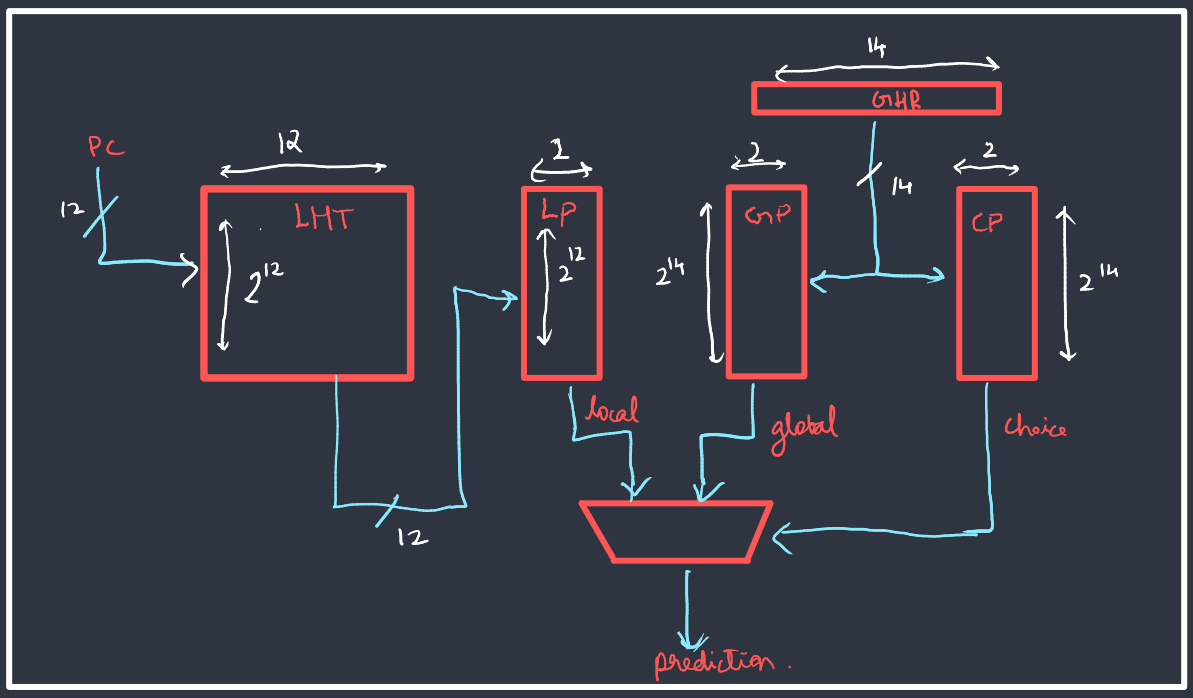
Branch Predictor Implementations

1 . Tournament Branch Predictor

Overview

Alpha 21264 Tournament branch predictor consists of a combination of a two-level local and a global level branch predictor. The prediction of either of them is chosen by a two bit prediction scheme. The schematic for the tournament branch predictor is shown below.



Size analysis

The above diagram details the dimensions of the blocks used. The total number of bits used in blocks totals to

$$2^{12} \times 12 + 2^{12} \times 2 + 2^{14} \times 2 \times 2$$

$$= 122880 \text{ bits}.$$

The other bits used registers and temporary registers totals upto less than 512 bits. Hence the developed branch predictor is well within the $2^{17}+512$ range and thus satisifies the constrain on number of bits.

Accuracy Analysis

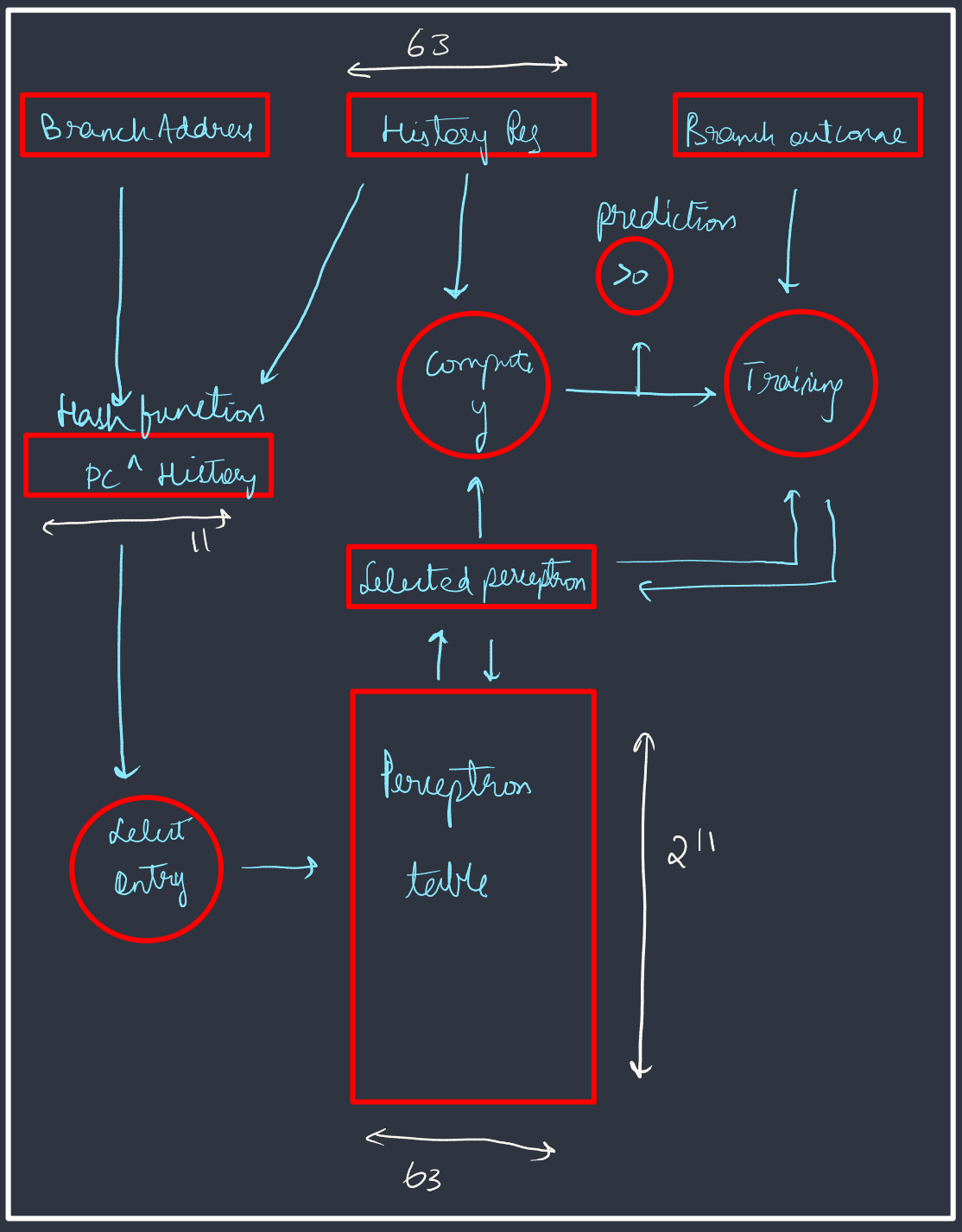
The accuracy of the predictor for the 4 provided benchmarks are tabulated below

Benchmark name	Mispredictions rate per 1000 instructions
Gcc	22.433
Astar	2.625
H264	6.677
Namd	16.380
Gradescope evaluation	14.19

2. Custom Branch Predictor

Overview

A perceptron predictor with modified table index was used as the custom predictor for the assignment. The design was based on the paper " Improved latency and accuracy for neural branch prediction".
The detailed diagram is shown below



Unique features of the design

- The thetha or threshold for the design, which gives the least number of mispredictions was experimentally determined to be 43.
- The hash function for the table lookup address was PC was xored with the Global history register. This reduced the misprediction rate significantly.
- The each weight in the perceptron table was iniliazed to 1. This improved the misprediction rate by 1-2%.

Size analysis

From the above diagram is it evedent that there is only one perceptron table in the predictor. The size of the table is 63×2^{11} bits. This amounts to 129024 bits. The rest of the registers and the temporary memory units collectively add up to less than 512 bits. Hence, the design is less than the maximum allowed threshold of 2^{17}.

Accuracy Analysis

The accuracy of the predictor for the 4 provided benchmarks are tabulated below

Benchmark name	Mispredictions rate per 1000 instructions
Gcc	14.954
Astar	1.848
H264	5.896
Namd	8.282
Gradescope evaluation	9.301

References:
1. Daniel A. Jiménez. 2005. Improved latency and accuracy for neural branch prediction. ACM Trans. Comput. Syst. 23, 2 (May 2005), 197–218. https://doi.org/10.1145/1062247.1062250