**BPU Question 1**

Considering a 2-bit saturating counter BHT of 1K entries; and assuming that the processor executes the following code fragment, determine the BHT final state and calculate the misprediction ratio in the presented case. The BPU initial state is indicated in the table.

General assumptions:

* R10 is the main loop control register and is initialized to 100
* R3 and R7 are reference values set to 1
* R2 is the input register
  + the input value is the incremental sequence of integer numbers starting from 0 (in the first iteration) to 99 (during the last iteration)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Address** | **Instruction** | | **BHT (2-bit)** | **Prediction** | **misP. counter** |
| **0x0000** | **L0:** | **…** | **0** | **NT** |  |
| **…** | ; | ***Reading input values*** | **0** | **NT** |  |
| **0x0010** |  | **AND R1, R2, R3** | **0** | **NT** |  |
| **0x0014** |  | **BEQZ R1, L1** | 1-0-1-0-1-… | **NT** | 50 |
| **0x0018** |  | **…** | **0** | **NT** |  |
| **0x001C** | **L1:** | **AND R4, R1, R7** | **0** | **NT** |  |
| **0x0020** |  | **BNEZ R4, L2** | 0-1 | **NT** | 50 |
| **0x0024** |  | **…** | **0** | **NT** |  |
| **0x0028** | **L2:** | **…** | **0** | **NT** |  |
| **0x002C** |  | **DADDI R10, R10, #-1** | **0** | **NT** |  |
| **0x0030** |  | **BNEZ R10, L0** | 1-2-3-…-2 | **NT** | 3 |
| **0x0038** |  | … | **0** | **NT** |  |

L0:

AND input register, 1

If(result==0){ branch to L1)

L1:

AND result, 1

If(result!=0){branch to L2}

L2: if(contatore!=0){branch to L0)

Misprediction error = 103/300 = 34.33%

**BPU Question 2**

Considering a (2,2) correlating predictor of 1K entries; and assuming that the processor executes the following code fragment, determine the BPU final state and calculate the misprediction in the presented case. The BPU initial state is indicated in the table.

General assumptions:

* R10 is the main loop control register and is initialized to 100
* R3 and R7 are reference values set to 1
* R2 is the input register
  + the input values are the integer numbers from 0 to 99

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Address** | **Instruction** | | **2-bit predictors** | | | | **2-bit shift register** | | **misP. counter** |
| **00** | **01** | **10** | **11** |
| **0x0000** | **L0:** | **…** | **0** | **0** | **0** | **0** | 00-01-11-01-11-01-11 | |  |
| **…** | ; | ***Reading input values*** | **0** | **0** | **0** | **0** | **init** | **End** |  |
| **0x0010** |  | **AND R1, R2, R3** | **0** | **0** | **0** | **0** |  |  |  |
| **0x0014** |  | **BEQZ R1, L1** | **1** | **0** | **0** | **3** | 00  01  11  01  11  01  11 | 01  10  11  10  11  10  11 | 1-0-1-0-1-0-0-…-0 |
| **0x0018** |  | **…** | **0** | **0** | **0** | **0** |  |  |  |
| **0x001C** | **L1:** | **AND R4, R1, R7** | **0** | **0** | **0** | **0** |  |  |  |
| **0x0020** |  | **BNEZ R4, L2** | **0** | **0** | **3** | **0** | 01  10  11  10  11  10  11 | 10  01  10  01  10  01  10 | 0-1-0-1-0-0-0-...-0 |
| **0x0024** |  | **…** | **0** | **0** | **0** | **0** |  |  |  |
| **0x0028** | **L2:** | **…** | **0** | **0** | **0** | **0** |  |  |  |
| **0x002C** |  | **DADDI R10, R10, #-1** | **0** | **0** | **0** | **0** |  |  |  |
| **0x0030** |  | **BNEZ R10, L0** | **0** | **3** | **3** | **0** | 10  01  10  01  10  01  10  ..  01 | 01  11  01  11  01  11  01  ..  11 | 1-1-1-1-0-0-0-...-1 |
| **0x0038** |  | … | **0** | **0** | **0** | **0** |  |  |  |

MISPREDICTION ERROR = 10/300=1/30