Assignment 3 : Dynamic Branch Prediction

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A.) Case 0]

t		1-bit over prediction
✗ 1	NT	T(1) ✗ → 0(NT)
2	NT	NT(0) ✓
3	NT	NT ✓
4	NT	NT ✓
5	NT	NT ✓
6	NT	NT ✓
7	NT	NT ✓
8	NT	NT ✓
9	NT	NT ✓
10	NT	NT ✓

misprediction rate = (1/10)

t	2-bit over prediction (11)
✗ 1	T(11) ✗ → 10 (T)
✗ 2	T(10) ✗ → (00)(NT)
3	NT(00) ✓
4	✓
5	✓
6	✓
7	✓
8	✓
9	✓
10	✓

misprediction rate = (2/10)

Case 1.]

t		1-bit over-prediction
1	T	T(1) ✓
2	T	T ✓
3	T	T ✓
4	T	T ✓
5	T	T ✓
✗ 6	NT	T → 0(NT) ✗
✗ 7	T	NT → 1(T) ✗
8	T	T ✓
9	T	T ✓
10	T	T ✓

misprediction rate = (2/10)

t	2-bit over prediction
1	T(11)
2	T(11)
3	T(11)
4	T(11)
5	T(11)
✗ 6	T(11) ✗ → 10 (T)
7	T(11)
8	T(11)
9	T(11)
10	T(11)

misprediction rate = (1/10)

Case2.]

	t		1bit outprediction
	1	T	T(1)
X	2	NT	T X → NT(0)
X	3	T	NT X → T(1)
X	4	NT	T X → NT(0)
X	5	T	NT X → T(1)
X	6	NT	T X → NT(0)
X	7	T	NT X → T(1)
X	8	NT	T X → NT(0)
X	9	T	NT X → T(1)
X	10	NT	T X → NT(0)

misprediction Rate = 9/10

	t	2bit out-prediction.
	1	T(11)
X	2	T X → T(10)
	3	T(10) → T(11)
X	4	T(11) → T(10)
	5	T(10) → T(11)
X	6	T(11) → T(10)
	7	T(10) → T(11)
X	8	T(11) → T(10)
	9	T(10) → T(11)
X	10	T(11) → T(10)

misprediction Rate = 5/10

B.) $2^2 = 4$ BHTs, (2,2) — 2 bits in BHT (2 bit prediction)

Exercise 2 →

	TT	T NT	NT T	NT NT
b1				
b2				
b3				
b4	01	11	11	10

initially = (1111 11 11)

t				
1	10	11	11	11
2	10	11	11	11
3	00	11	11	11
4	01	11	11	11
5	01	11	11	10

misprediction rate = 4/5

Global History Shift Register =

✗ t=1 | b2 | b3 | | NT | T |

at t=1, b4 = NT

Our prediction at TT = 11 (Taken)

Now, 11 = 10 but still its taken.

✓ t=2 | T | NT |

at t=2, b4 = T, Taken

Our prediction at TNT = 11 ie.. Taken

✗ t=3 | T | T |

at t=3, b4 = NT

Our prediction at TT = 10 ie.. Taken

Now, 10 = 00, its NT now

✗ t=4 | T | T |

at t=4, b4 = T (Taken)

Our prediction at TT = 00, NT

Now, 00 = 01, but still its NT

✗ t=5 | NT | NT |

at t=5, b4 = NT

Our prediction at NTNT = 11, T

Now, 11 = 10, but still its taken

Exercise 3 and 4]

(3,1) — $2^3 = 8$ BHT, 1 bit in each BHT ⇒ So there will be $2^3 = 8$ BHTs and 1 bit in each BHT

	TTT	TTNT	TNTT	TNTNT	NTTT	NTTNT	NTNTT	NTNTNT
b1								
b2								
b3								
b4	1	1	1	1	0	1	1	0
b5								

initally = 1 1 1 1 1 1 1 1

1	1	1	1	1	0	1	1	1
2	1	1	1	1	0	1	1	1
3	1	1	1	1	0	1	1	1
4	1	1	1	1	0	1	1	1
5	1	1	1	1	0	1	1	0

We saw in the class for first 5.

✗ t = 1 | NT | T | T |

at t = 1, b4 = NT

our prediction at NTTT = 1 ie.. T

So, 1 = 0

✓ t = 2 | T | T | NT |

at t = 2, b4 = NT

Our prediction at TTNT = 1 ie.. T

✓ t = 3 | NT | T | T |

at t = 3, b4 = NT

our prediction at NTTT = 0 ie.. NT

✓ t = 4 | T | T | T |

at t = 4, b4 = T

our prediction at TTT = 1, Taken

✗ t = 5 | NT | NT | NT |

at t = 5, b4 = NT, our pred at NTNTNT = 1

so 1 = 0 (NT)

⇒ Continuing with 6, 7, 8, 9, 10.

6	1	1	1	1	0	1	1	0
7	1	1	1	1	0	1	1	0
8	1	1	1	1	0	1	1	0
9	1	1	1	1	0	1	1	0
10	1	1	1	1	0	1	1	0

✓ t = 6 | NT | T | T |

at t = 6, b4 = NT

our prediction at NTTT = 0 ie.. NT

✓ t = 7 | T | T | NT |

at t = 7, b4 = T

our prediction at TTNT = 1 ie. Taken

✓ t = 8 | NT | T | T |

at t = 8, b4 = NT

our prediction at NTTT = 0 ie.. NT

✓ t = 9 | T | T | T |

at t = 9, b4 = T

our prediction at TTT = 1 ie.. Taken

✓ t = 10 | NT | NT | NT |

at t = 10, b4 = NT

our prediction at NTNTNT = 0 ie.. NT

misprediction Rate for Exercise 4 from 6 to 10

$\Rightarrow 0/5$

And misprediction Rate for combined Exercise 3 and 4 from 1 to 10

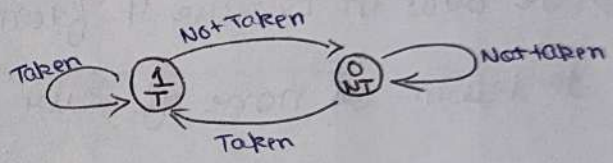
$\Rightarrow 2/10$

⇒ We saw in Exercise 4 from t=6 to 10 that predictor has started to learn as none of our prediction is wrong.

Exercise 5] (0,1) — no of bits in BHT $= 2^0 = 1$ BHT and 1 bit in each BHT

no correlation
($2^0 = 1$ BHT)

	t	B4	Prediction.
X	1	NT	T(1) X → NT
X	2	T	NT X → T
X	3	NT	T X → NT
X	4	T	NT X → T
X	5	NT	T X → NT
✓	6	NT	NT ✓ → NT
X	7	T	NT X → T
X	8	NT	T X → NT
X	9	T	NT X → T
X	10	NT	T X → NT



=> initially we are starting with 1 (T)

=> misprediction Rate = 9/10

As we initially start with 1 (T), this is our prediction but actually B4 at t=1 is NT so we have to change from T to NT. Same continues but when we reach 6th we assume NT and B4 at t=6 is also NT so only 1 prediction is correct.