

~~2-bit prediction~~ ①

1a. ~~problem~~

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
matrix 1	T	T	T	T	N	T	T	T	N	T	T	T	T	N	T	T	T	T	N	
matrix 2	T	N	T	N	T	N	T	N	T	N	T	N	T	N	T	N	T	N	T	N
matrix 3	T	T	T	T	T	T	T	T	N	T	T	T	T	T	T	T	T	T	N	

1b. ~~problem~~

* always predict not taken

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
matrix 1	X	X	X	X	✓	X	X	X	X	✓	X	X	X	X	✓	X	X	X	X	✓
matrix 2	X	✓	X	✓	X	✓	X	✓	X	✓	X	✓	X	✓	X	✓	X	✓	X	✓
matrix 3	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	✓				

branch accuracy

- * matrix 1: $4/20 = 1/5$
- * matrix 2: $10/20 = 1/2$
- * matrix 3: $2/20 = 1/10$

1c. ~~problem~~

1-bit branch prediction

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
matrix 1	X	T	T	T	X	X	T	T	T	X	X	T	T	T	X	X	T	T	T	X
matrix 2	X	✓																		
matrix 2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
matrix 3	X	✓	✓	✓	✓	✓	✓	✓	✓	X	X	✓	✓	✓	✓	✓	✓	✓	✓	X

branch accuracy

- * matrix 1: $8/20 = 2/5$
- * matrix 2: $0/20$
- * matrix 3: $4/20 = 1/5$

1d.

iteration	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
matrix 1:	x	✓	✓	✓	x	✓	✓	✓	✓	x	✓	✓	✓	✓	x	✓	✓	✓	✓	x
matrix 2:	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
matrix 2:	x	✓	x	✓	x	✓	x	✓	x	✓	x	✓	x	✓	x	✓	x	✓	T	T
matrix 3:	x	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	T	T	T

branch accuracy

matrix 1: 5/20

matrix 2: 10/20

matrix 3: 3/20

2.

Address	Block # (4 bytes)	Block # (8 bytes)	Cache position (32 * 4- bytes)	Cache set (16*8-byte 2-way SA) 16/2=8 sets	Cache outcome (32*4-byte)	Cache outcome (16*8-byte 2-way SA) 16/2 = 8 sets
44	$44/4=11$	$44/8=5$	$11\%32=11$	$5\%8=5$	Miss	Miss
100	$100/4=25$	$100/8=12$	$25\%32=25$	$12\%8=4$	Miss	Miss
164	$164/4=41$	$164/8=20$	$41\%32=9$	$20\%8=4$	Miss	Miss
110	$110/4=27$	$110/8=13$	$27\%32=27$	$13\%8=5$	Miss	Miss
166	$166/4=41$	$166/8=20$	$41\%32=9$	$20\%8=4$	Hit	Hit
168	$168/4=42$	$168/8=21$	$42\%32=10$	$21\%8=5$	Miss	Miss
102	$102/4=25$	$102/8=12$	$25\%32=25$	$12\%8=4$	Miss	Hit
46	$46/4=11$	$46/8=5$	$11\%32=11$	$5\%8=5$	Hit	Hit

3

$= 4\text{KiB} = (4 \times 2^{10} = 4096)$, find the physical address that corresponds to virtual address 18000_{10} ?

Virtual page #	Physical page #
1	14
2	10
3	2
4	6
5	8

Virtual ~~addr~~ page number $:= 18000 / 4096 = 4 \text{ R } 1616$
 virtual page 4, offset 1616

Find physical page # = virtual page 4 = physical page 6

physical address $:= 6 \times 4096 + 1616$
 $= 26192$