

## Assignment 4

Roll no - CS21S042  
CS21S023

### Config parameters for Branch Predictor

1. Last k bits of PC used for indexing in Local history table, k = 11 bits
2. Local history length = 11 bits
3. Local prediction table counter = 3 bits
4. Global history length = 14 bits
5. Global prediction table counter = 2 bits
6. Choice prediction table counter = 2 bits

### Working of the tournament branch predictor

We wrote two functions in the predictor.cc - GetPrediction and UpdatePrediction.

#### **GetPrediction(UINT64 PC)**

We create a k bitmask (11-bitmask) and perform logical AND operation with PC which yields the last k bits of PC. We use this as the index to get the value of local history in the local history table. Local history table store last 11 outcomes of that branch. We use this as the index in the local prediction table which has 3-bit counters. We check if the value of the counter is strictly greater than half of the maximum value of counter. If it is greater then we predict branch is taken else we predict branch not taken based on local history prediction. Similarly, we use the value in the global history register as the index in the global prediction table where 2-bit counters are stored. If the value of the counter is strictly greater than half the maximum value of the counter then we predict the branch is taken else we predict the branch is not taken based on global history prediction. If local prediction and global prediction match then we simply return the same prediction else we consult the choice prediction table. We used the value of the global history register as the index in the choice prediction table which has 2-bit counters. If the value of the counter is greater than half the maximum value of the counter then we return the prediction given by global prediction logic else we return the prediction given by local prediction logic.

#### **UpdatePredictor(UINT64 PC, OpType opType, bool resolveDir, bool predDir, UINT64 branchTarget)**

We check if the prediction of global prediction logic and local prediction logic matches. If they are the same then no need to update the choice prediction table but if they are different then we decrement the counter if the prediction of local prediction logic matches with the actual branch taken else we increment the counter implying global prediction logic was correct. We update counters in the local prediction table and global prediction table. We increment the counter if the branch was actually taken else we decrement the counter. We update local history and global history by doing a left shift and then setting the value of the last bit to 1 if the branch was actually taken and then we do a logical AND operation with their respective mask so that the leftmost bit is discarded.

## Storage justification

Total LHT size =  $2^{11} * 11 \text{ bits/entry} = 22 \text{ Kilo bits}$

Total LPT counters:  $2^{11}$

Total LPT size =  $2^{11} * 3 \text{ bits/counter} = 6 \text{ Kilo bits}$

GHR size = 14 bits

Total GPT size =  $2^{14} * 2 \text{ bits/counter} = 32 \text{ Kilo bits}$

Total CPT size =  $2^{14} * 2 \text{ bits/counter} = 32 \text{ Kilo bits}$

Total Size = LHT size + LPT size + GPT size + CPT size + GHR = 92 Kilo bits + 14 bits

Total Size(in Bytes) = 11.50175 KiloBytes

## Results on 223 traces

LONG_SERVER-1	7.405
LONG_SERVER-2	1.734
LONG_SERVER-3	17.861
LONG_SERVER-4	2.106
LONG_MOBILE-10	4.553
LONG_MOBILE-11	3.004
LONG_MOBILE-12	3.560
LONG_MOBILE-13	0.016
LONG_MOBILE-14	11.154
LONG_MOBILE-15	0.126
LONG_MOBILE-16	2.073
LONG_MOBILE-17	1.423
LONG_MOBILE-18	2.445
LONG_MOBILE-19	0.258
LONG_MOBILE-1	0.366
LONG_MOBILE-2	1.309
LONG_MOBILE-3	7.468
LONG_MOBILE-4	0.005
LONG_MOBILE-5	0.006
LONG_MOBILE-6	7.821
LONG_MOBILE-7	9.075
LONG_MOBILE-8	0.001
LONG_MOBILE-9	3.741
SHORT_SERVER-100	10.304
SHORT_SERVER-101	4.708
SHORT_SERVER-102	0.945
SHORT_SERVER-103	0.551
SHORT_SERVER-104	8.591
SHORT_SERVER-105	14.289
SHORT_SERVER-106	6.278
SHORT_SERVER-107	0.285
SHORT_SERVER-108	18.826
SHORT_SERVER-109	6.809
SHORT_SERVER-10	0.632
SHORT_SERVER-110	3.479
SHORT_SERVER-111	13.939

SHORT_SERVER-112	9.476
SHORT_SERVER-113	12.395
SHORT_SERVER-114	4.562
SHORT_SERVER-115	15.450
SHORT_SERVER-116	24.996
SHORT_SERVER-117	22.293
SHORT_SERVER-118	21.755
SHORT_SERVER-119	18.074
SHORT_SERVER-11	1.598
SHORT_SERVER-120	22.876
SHORT_SERVER-121	1.849
SHORT_SERVER-122	2.179
SHORT_SERVER-123	1.437
SHORT_SERVER-124	0.207
SHORT_SERVER-125	0.578
SHORT_SERVER-126	1.642
SHORT_SERVER-127	1.200
SHORT_SERVER-128	13.643
SHORT_SERVER-129	16.215
SHORT_SERVER-12	0.074
SHORT_SERVER-130	10.229
SHORT_SERVER-131	18.540
SHORT_SERVER-132	6.484
SHORT_SERVER-133	5.571
SHORT_SERVER-134	1.149
SHORT_SERVER-135	4.473
SHORT_SERVER-136	1.446
SHORT_SERVER-137	14.092
SHORT_SERVER-138	1.768
SHORT_SERVER-139	2.048
SHORT_SERVER-13	0.101
SHORT_SERVER-14	0.107
SHORT_SERVER-15	0.117
SHORT_SERVER-16	6.350
SHORT_SERVER-17	3.564
SHORT_SERVER-18	13.484
SHORT_SERVER-19	2.973
SHORT_SERVER-1	7.450
SHORT_SERVER-20	4.218
SHORT_SERVER-21	12.458
SHORT_SERVER-22	3.222
SHORT_SERVER-23	10.744
SHORT_SERVER-24	4.915
SHORT_SERVER-25	20.068
SHORT_SERVER-26	6.261
SHORT_SERVER-27	14.439
SHORT_SERVER-28	9.760
SHORT_SERVER-29	7.625

SHORT_SERVER-2	6.929
SHORT_SERVER-30	11.655
SHORT_SERVER-31	3.095
SHORT_SERVER-32	10.186
SHORT_SERVER-33	13.813
SHORT_SERVER-34	14.112
SHORT_SERVER-35	12.128
SHORT_SERVER-36	31.139
SHORT_SERVER-37	16.791
SHORT_SERVER-38	13.770
SHORT_SERVER-39	6.040
SHORT_SERVER-3	1.734
SHORT_SERVER-40	10.215
SHORT_SERVER-41	26.089
SHORT_SERVER-42	7.557
SHORT_SERVER-43	9.796
SHORT_SERVER-44	9.271
SHORT_SERVER-45	9.547
SHORT_SERVER-46	8.150
SHORT_SERVER-47	12.530
SHORT_SERVER-48	14.140
SHORT_SERVER-49	22.556
SHORT_SERVER-4	3.773
SHORT_SERVER-50	10.836
SHORT_SERVER-51	21.162
SHORT_SERVER-52	18.365
SHORT_SERVER-53	36.376
SHORT_SERVER-54	27.892
SHORT_SERVER-55	11.212
SHORT_SERVER-56	43.502
SHORT_SERVER-57	35.997
SHORT_SERVER-58	19.497
SHORT_SERVER-59	8.041
SHORT_SERVER-5	2.388
SHORT_SERVER-60	7.526
SHORT_SERVER-61	24.497
SHORT_SERVER-62	23.657
SHORT_SERVER-63	24.148
SHORT_SERVER-64	5.685
SHORT_SERVER-65	12.665
SHORT_SERVER-66	12.454
SHORT_SERVER-67	7.142
SHORT_SERVER-68	0.048
SHORT_SERVER-69	20.958
SHORT_SERVER-6	0.878
SHORT_SERVER-70	11.860
SHORT_SERVER-71	5.369
SHORT_SERVER-72	15.758

SHORT_SERVER-73	13.827
SHORT_SERVER-74	5.361
SHORT_SERVER-75	8.422
SHORT_SERVER-76	5.880
SHORT_SERVER-77	8.601
SHORT_SERVER-78	3.250
SHORT_SERVER-79	5.378
SHORT_SERVER-7	0.451
SHORT_SERVER-80	5.411
SHORT_SERVER-81	2.273
SHORT_SERVER-82	16.694
SHORT_SERVER-83	1.707
SHORT_SERVER-84	9.820
SHORT_SERVER-85	15.497
SHORT_SERVER-86	5.621
SHORT_SERVER-87	5.687
SHORT_SERVER-88	10.584
SHORT_SERVER-89	15.411
SHORT_SERVER-8	4.315
SHORT_SERVER-90	10.602
SHORT_SERVER-91	13.033
SHORT_SERVER-92	7.250
SHORT_SERVER-93	10.417
SHORT_SERVER-94	5.935
SHORT_SERVER-95	4.019
SHORT_SERVER-96	10.011
SHORT_SERVER-97	20.236
SHORT_SERVER-98	11.724
SHORT_SERVER-99	11.895
SHORT_SERVER-9	0.568
SHORT_MOBILE-10	0.666
SHORT_MOBILE-11	0.017
SHORT_MOBILE-12	0.014
SHORT_MOBILE-13	0.016
SHORT_MOBILE-14	0.549
SHORT_MOBILE-15	3.086
SHORT_MOBILE-16	5.889
SHORT_MOBILE-17	0.002
SHORT_MOBILE-18	0.229
SHORT_MOBILE-19	0.578
SHORT_MOBILE-1	0.971
SHORT_MOBILE-20	7.564
SHORT_MOBILE-21	7.209
SHORT_MOBILE-22	3.616
SHORT_MOBILE-23	3.014
SHORT_MOBILE-24	0.001
SHORT_MOBILE-25	0.002
SHORT_MOBILE-26	0.000

SHORT_MOBILE-27	0.036
SHORT_MOBILE-28	0.007
SHORT_MOBILE-29	5.907
SHORT_MOBILE-2	8.774
SHORT_MOBILE-30	3.749
SHORT_MOBILE-31	0.016
SHORT_MOBILE-32	0.544
SHORT_MOBILE-33	0.461
SHORT_MOBILE-34	0.238
SHORT_MOBILE-35	0.119
SHORT_MOBILE-36	0.030
SHORT_MOBILE-37	1.617
SHORT_MOBILE-38	2.073
SHORT_MOBILE-39	1.452
SHORT_MOBILE-3	3.796
SHORT_MOBILE-40	0.158
SHORT_MOBILE-41	0.827
SHORT_MOBILE-42	35.782
SHORT_MOBILE-43	10.629
SHORT_MOBILE-44	3.617
SHORT_MOBILE-45	0.537
SHORT_MOBILE-46	4.892
SHORT_MOBILE-47	4.133
SHORT_MOBILE-48	0.005
SHORT_MOBILE-49	2.341
SHORT_MOBILE-4	5.201
SHORT_MOBILE-50	8.213
SHORT_MOBILE-51	0.047
SHORT_MOBILE-52	16.840
SHORT_MOBILE-53	2.880
SHORT_MOBILE-54	9.371
SHORT_MOBILE-55	9.235
SHORT_MOBILE-56	0.371
SHORT_MOBILE-57	0.383
SHORT_MOBILE-58	0.411
SHORT_MOBILE-59	0.030
SHORT_MOBILE-5	14.083
SHORT_MOBILE-60	8.256
SHORT_MOBILE-61	4.206
SHORT_MOBILE-6	10.941
SHORT_MOBILE-7	10.168
SHORT_MOBILE-8	1.670
SHORT_MOBILE-9	0.366

**AMEAN**

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