HIGH PERFORMANCE COMPUTER ARCHITETURE

ASSIGNMENT 01

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SR no: 21760

A1. Cost-effective branch predictors

(A) To evaluate (MPKI and IPC) SPEC programs:

1) 638.imagick_s-824B.champsimtrace.xz
2) 627.cam4_s-490B.champsimtrace.xz
3) 623.xalancbmk_s-202B.champsimtrace.xz

BTB entries = 2048
Hardware cost for each branch predictors = 128 Kbytes
Warmup instructions: 200 million
Simulation instructions: 250 million

(A.1) GSHARE PREDICTOR

Hardware cost $= 2^{History\ Length} \times$ *Counter bits* $= 2^{18} \times 2 = 128$ *KB*

GSHARE PREDICTOR						
	MPKI	**cumulative IPC**	**instructions Simulated**	**cycles**	**Branch Prediction Accuracy**	**Average ROB Occupancy at Mispredict:**
623.xalancbmk_s-202B	0.1805	2.5	250000002	99986896	99.93%	100.6
627.cam4_s-490B	4.676	1.796	250000002	139170044	95.04%	62.92
638.imagick_s-824B	0.4266	3.457	250000000	72325559	99.74%	160.9

(A.2) PERCEPTRON PREDICTOR

Hardware cost = (History Length + 1) × Perceptron bits × Number of perceptron bits
= (18 +1) × 8 × 6900 =128 KB

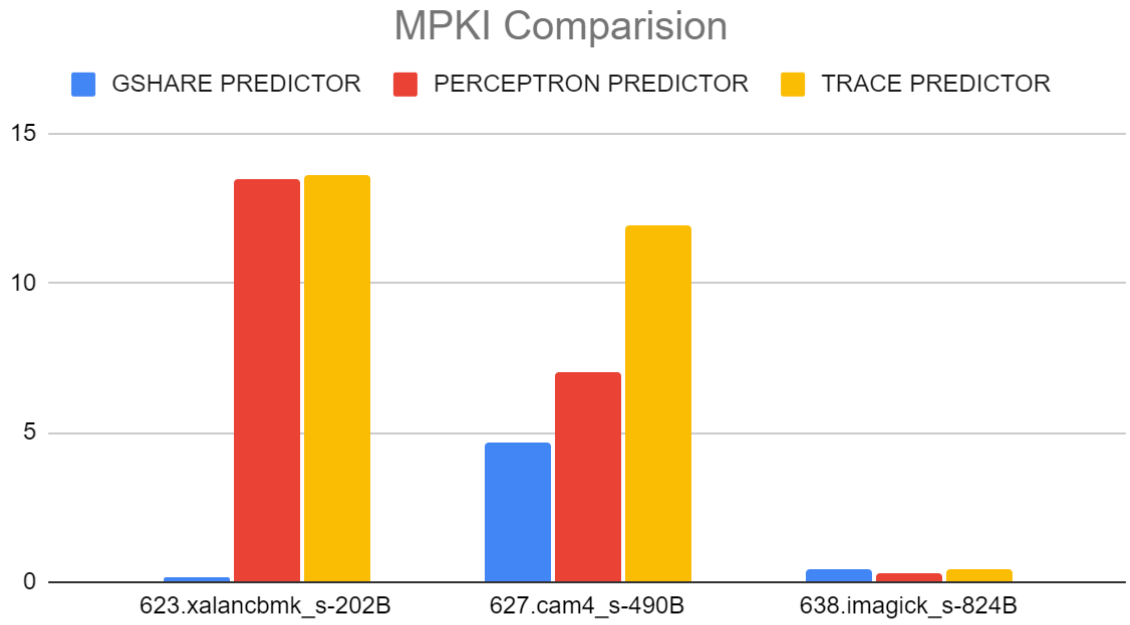
PERCEPTRON PREDICTOR						
	MPKI	**cumulative IPC**	**instructions Simulated**	**cycles**	**Branch Prediction Accuracy**	**Average ROB Occupancy at Mispredict:**
623.xalancbmk_s-202B	13.45	1.06	250000000	235849864	95.13%	47.86
627.cam4_s-490B	7.011	1.693	250000002	147636084	92.56%	39.87
638.imagick_s-824B	0.3033	3.487	250000000	71694584	99.81%	171.2

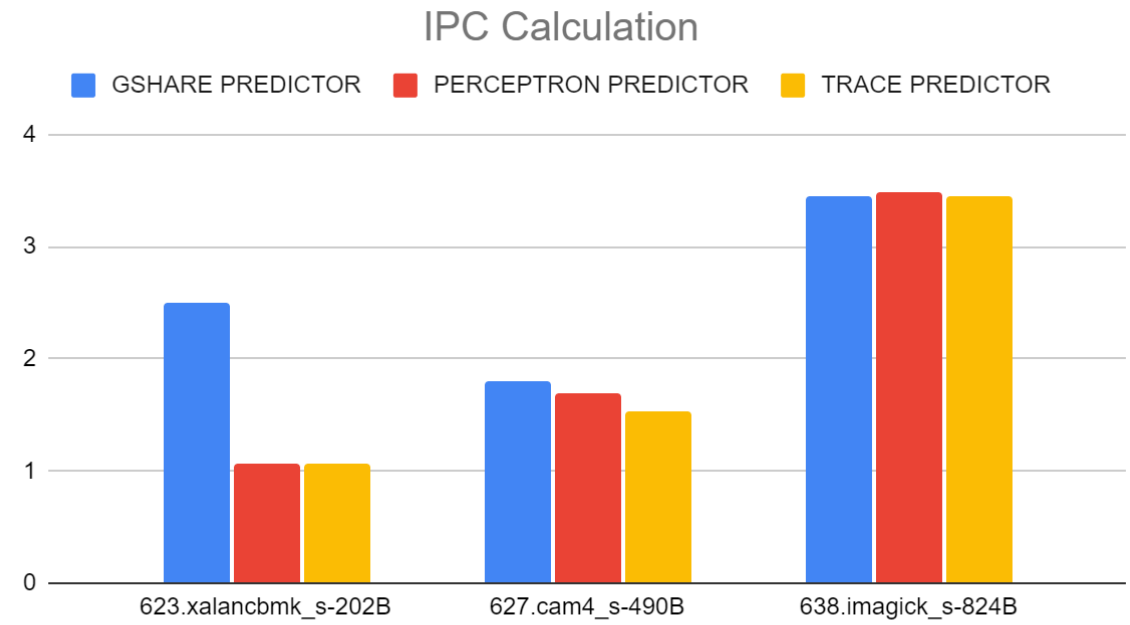
(A.3) TAGE PREDICTOR

Hardware cost = TAGE Predictor size + Base Predictor size+ History Buffer Size = 128 KB
where, TAGE Predictor size = number of TAGE tables × (counters + tag bits) × $2^{Index\ Bits}$

TRACE PREDICTOR (Number of tables: 4)						
	MPKI	**cumulative IPC**	**instructions Simulated**	**cycles**	**Branch Prediction Accuracy**	**Average ROB Occupancy at Mispredict:**
623.xalancbmk_s-202B	0.1108	2.519	250000004	99245147	99.96%	116.5
627.cam4_s-490B	4.585	1.799	250000002	138977639	95.13%	63.42
638.imagick_s-824B	0.2948	3.488	250000000	71672067	99.82%	178.3

Conclusion:


MPKI Comparision
GSHARE PREDICTOR
PERCEPTRON PREDICTOR
TRACE PREDICTOR
15
10
5
0
623.xalancbmk_s-202B
627.cam4_s-490B
638.imagick_s-824B


IPC Calculation
GSHARE PREDICTOR
PERCEPTRON PREDICTOR
TRACE PREDICTOR
4
3
2
1
0
623.xalancbmk_s-202B
627.cam4_s-490B
638.imagick_s-824B

(B) TAGE predictor keeping the storage budget for the predictor to 128KB and different set of history lengths and different table sizes:

(B.1) Table Size = 4 *History Length = 112 Kilobytes*

TRACE PREDICTOR (Number of tables:4)						
	MPKI	**cumulative IPC**	**instructions Simulated**	**cycles**	**Branch Prediction Accuracy**	**Average ROB Occupancy at Mispredict:**
623.xalancbmk_s-202B	0.1108	2.519	250000004	99245147	99.96%	116.5
627.cam4_s-490B	4.585	1.799	250000002	138977639	95.13%	63.42
638.imagick_s-824B	0.2948	3.488	250000000	71672067	99.82%	178.3

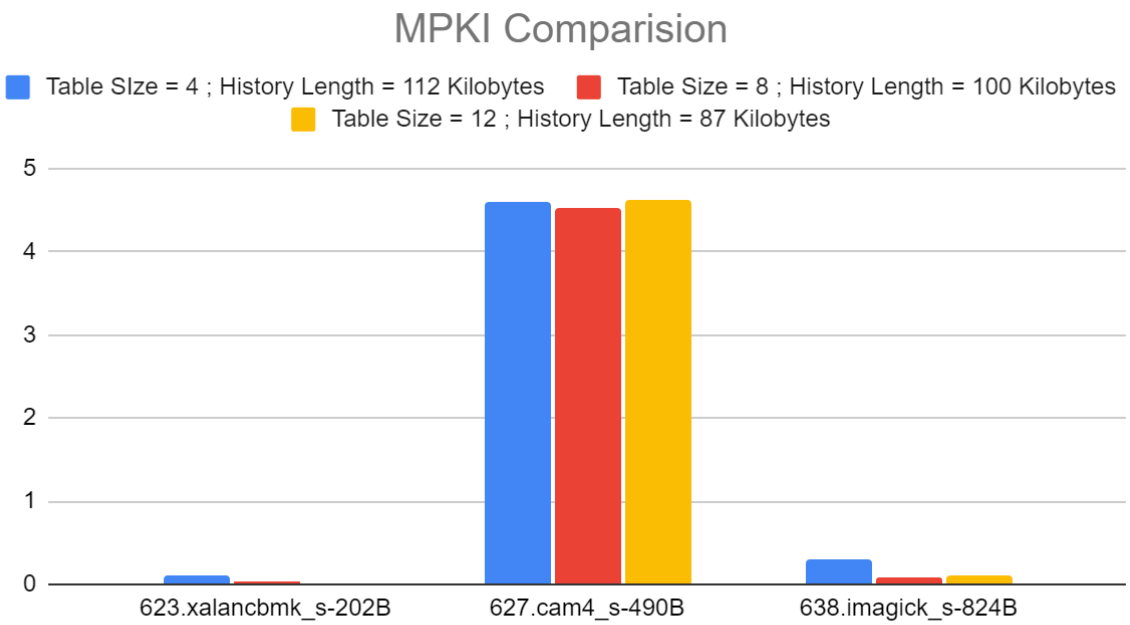
(B.2) Table Size = 8 *History Length = 100 Kilobytes*

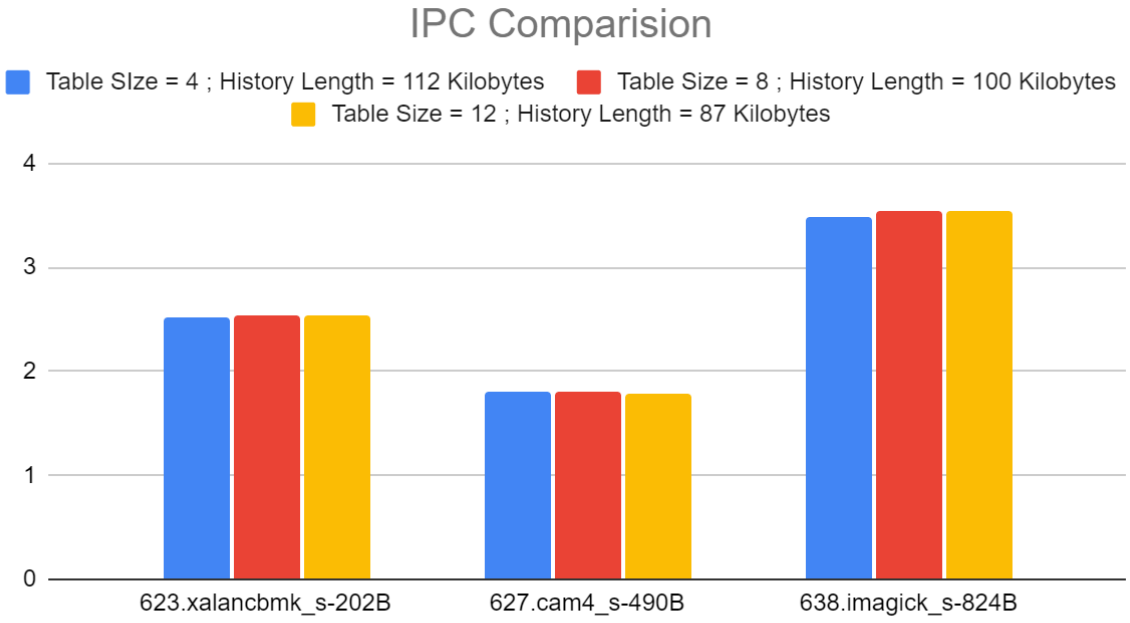
TRACE PREDICTOR (Number of tables:8)						
	MPKI	**cumulative IPC**	**instructions Simulated**	**cycles**	**Branch Prediction Accuracy**	**Average ROB Occupancy at Mispredict:**
623.xalancbmk_s-202B	0.0246	2.537	250000004	98553533	99.99%	277.3
627.cam4_s-490B	4.534	1.796	250000002	139232970	95.19%	54.12
638.imagick_s-824B	0.08914	3.54	250000000	70625639	99.94%	300.1

(B.3) Table Size = 12 *History Length = 87 Kilobytes*

TRACE PREDICTOR (Number of tables:12)						
	MPKI	**cumulative IPC**	**instructions Simulated**	**cycles**	**Branch Prediction Accuracy**	**Average ROB Occupancy at Mispredict:**
623.xalancbmk_s-202B	0.01961	2.533	250000004	98705309	99.99%	279.9
627.cam4_s-490B	4.617	1.792	250000002	139545966	95.10%	51.29
638.imagick_s-824B	0.09757	3.537	250000000	70681407	99.94%	295

Conclusion:

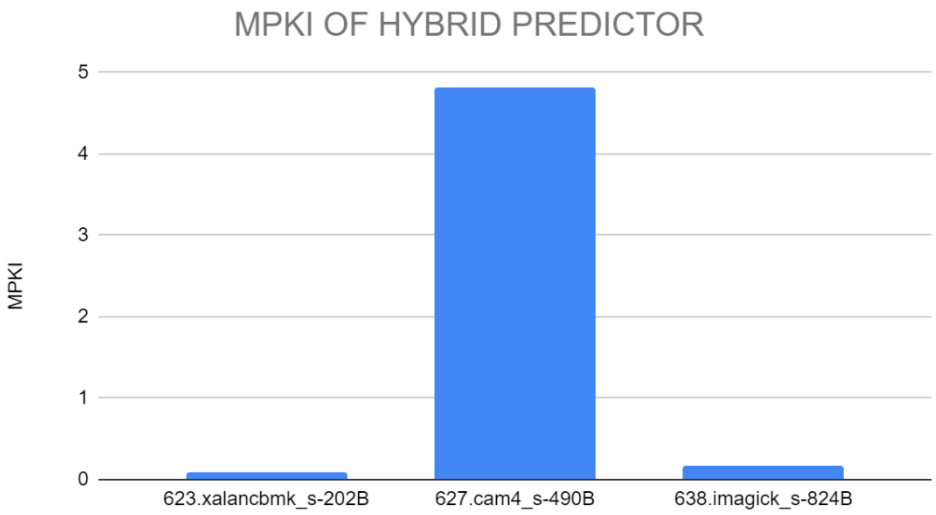

MPKI Comparision
Table SIze = 4 ; History Length = 112 Kilobytes
Table Size = 8 ; History Length = 100 Kilobytes
Table Size = 12 ; History Length = 87 Kilobytes
5
4
3
2
1
0
623.xalancbmk_s-202B
627.cam4_s-490B
638.imagick_s-824B

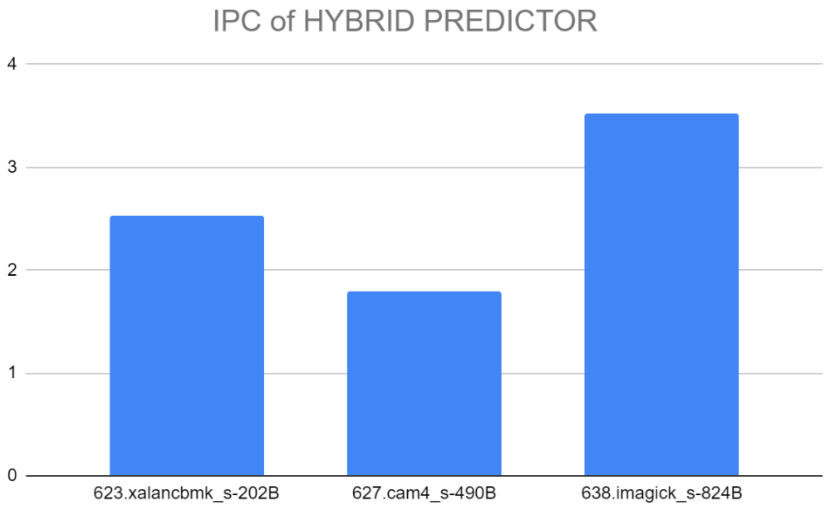

IPC Comparision
Table SIze = 4 ; History Length = 112 Kilobytes
Table Size = 8 ; History Length = 100 Kilobytes
Table Size = 12 ; History Length = 87 Kilobytes
4
3
2
1
0
623.xalancbmk_s-202B
627.cam4_s-490B
638.imagick_s-824B

(C) HYBRID PREDICTOR

HYBRID PREDICTOR						
	MPKI	**cumulative IPC**	**instructions Simulated**	**cycles**	**Branch Prediction Accuracy**	**Average ROB Occupancy at Mispredict:**
623.xalancbmk_s-202B	0.0821	2.525	250000004		99.97%	133.7
627.cam4_s-490B	4.81	1.788	250000002	139821273	94.90%	60.68
638.imagick_s-824B	0.1625	3.521	250000000	71003759	99.90%	221.6

Conclusion:





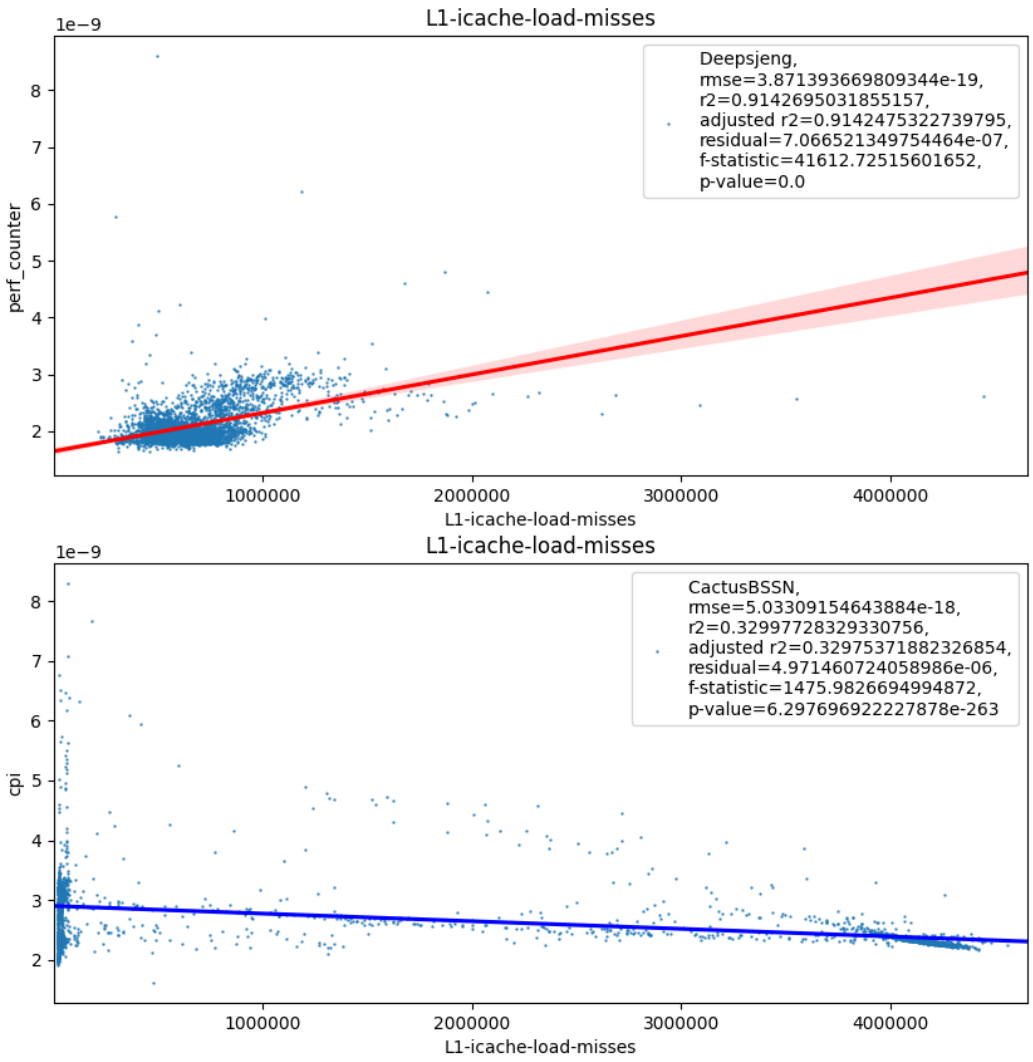
A2. Obtaining CPI Stack for Programs using Hardware Performance Counters and Linear Regression

Benchmarks used:

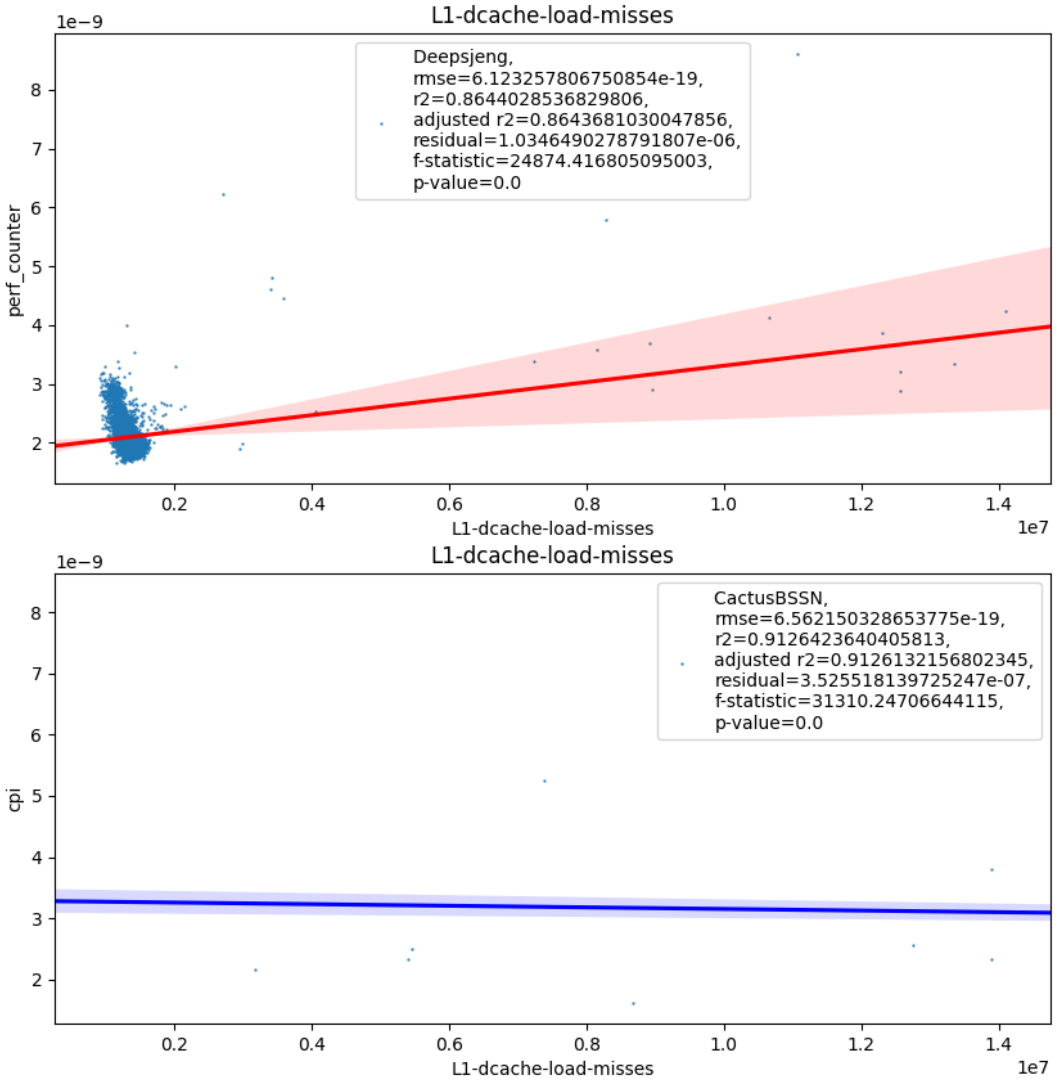
1. 531.deepsjeng_r 3903
2. 507.cactuBSSN_r 2998

Linear Regression Models:

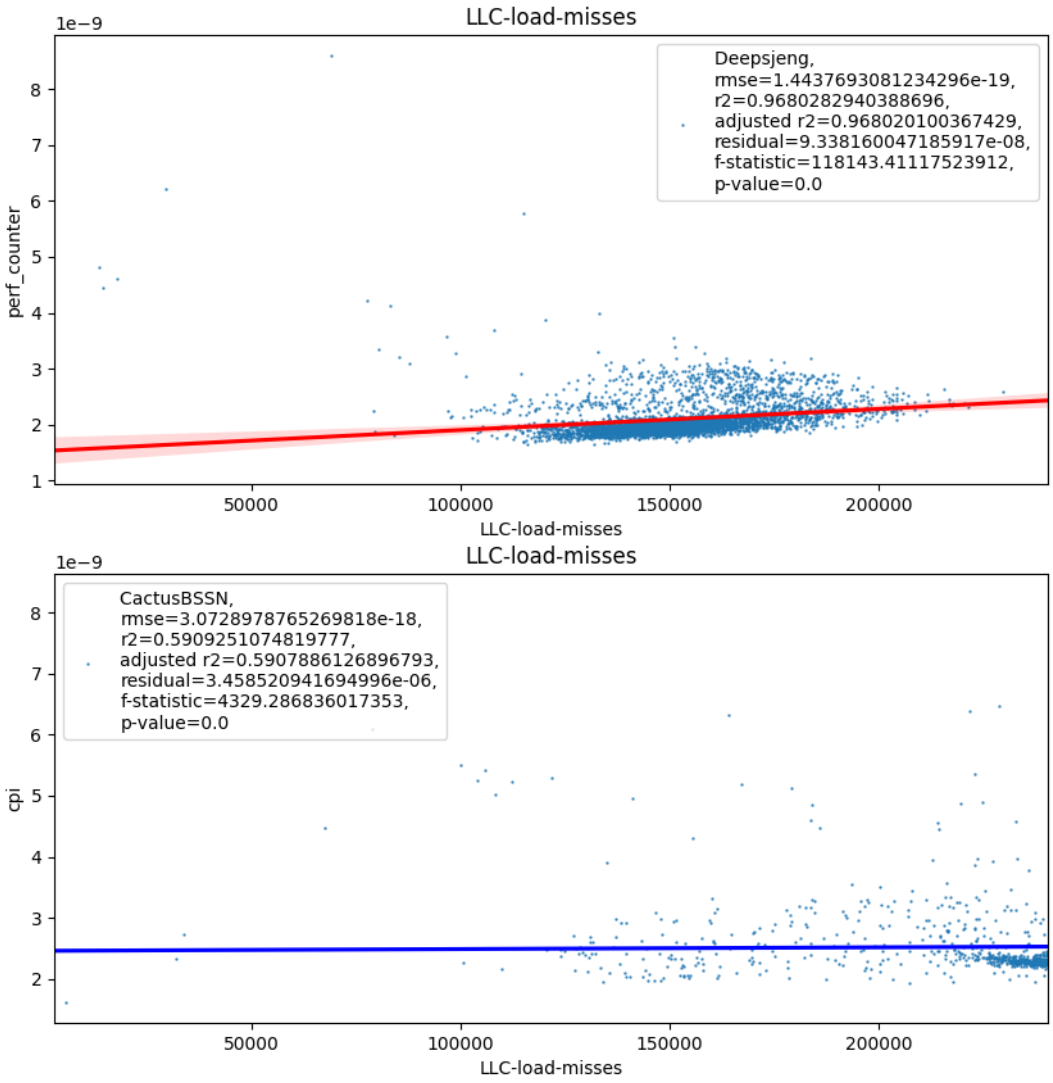
2.1) Regression plot of L1-I Cache misses:



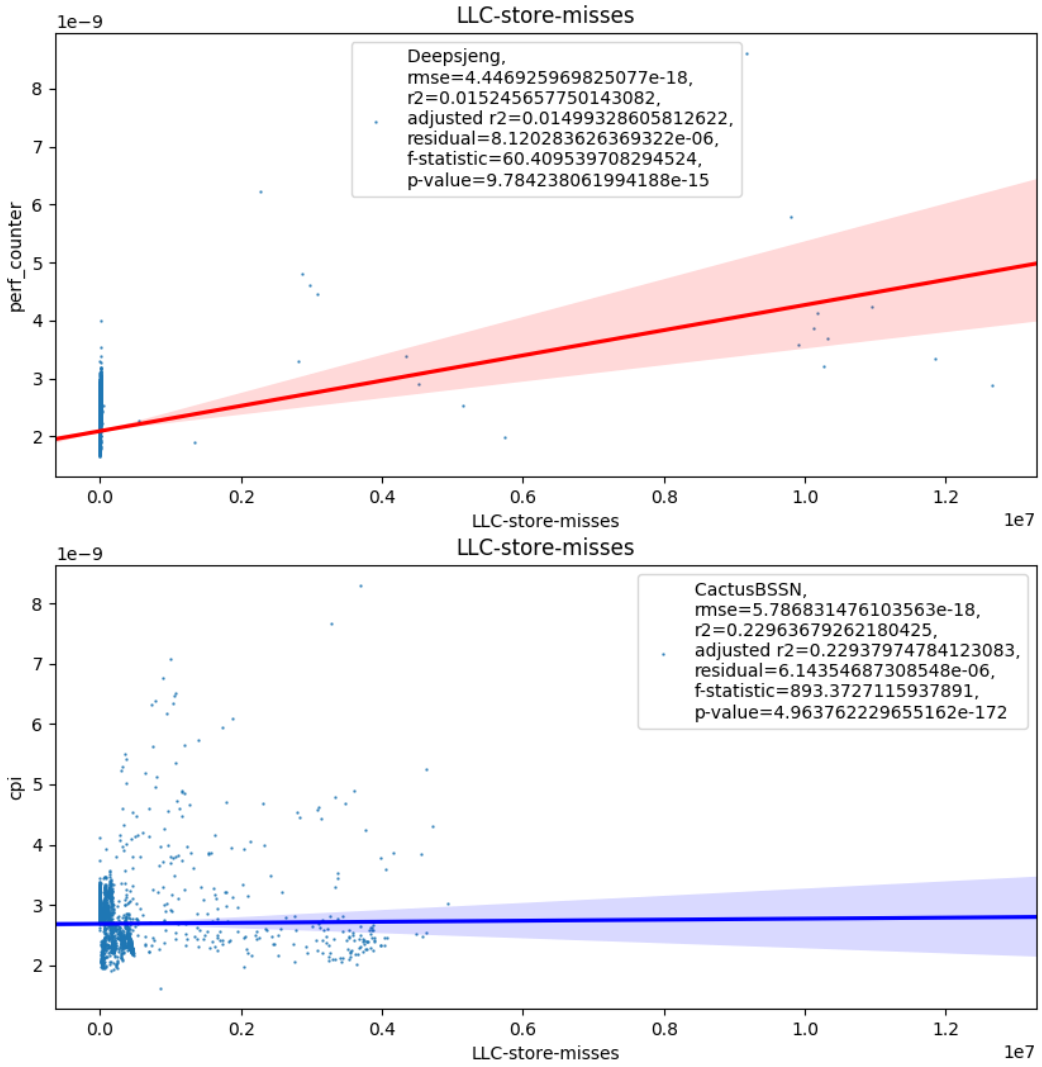
2.2) Regression plot of L1-D cache misses:



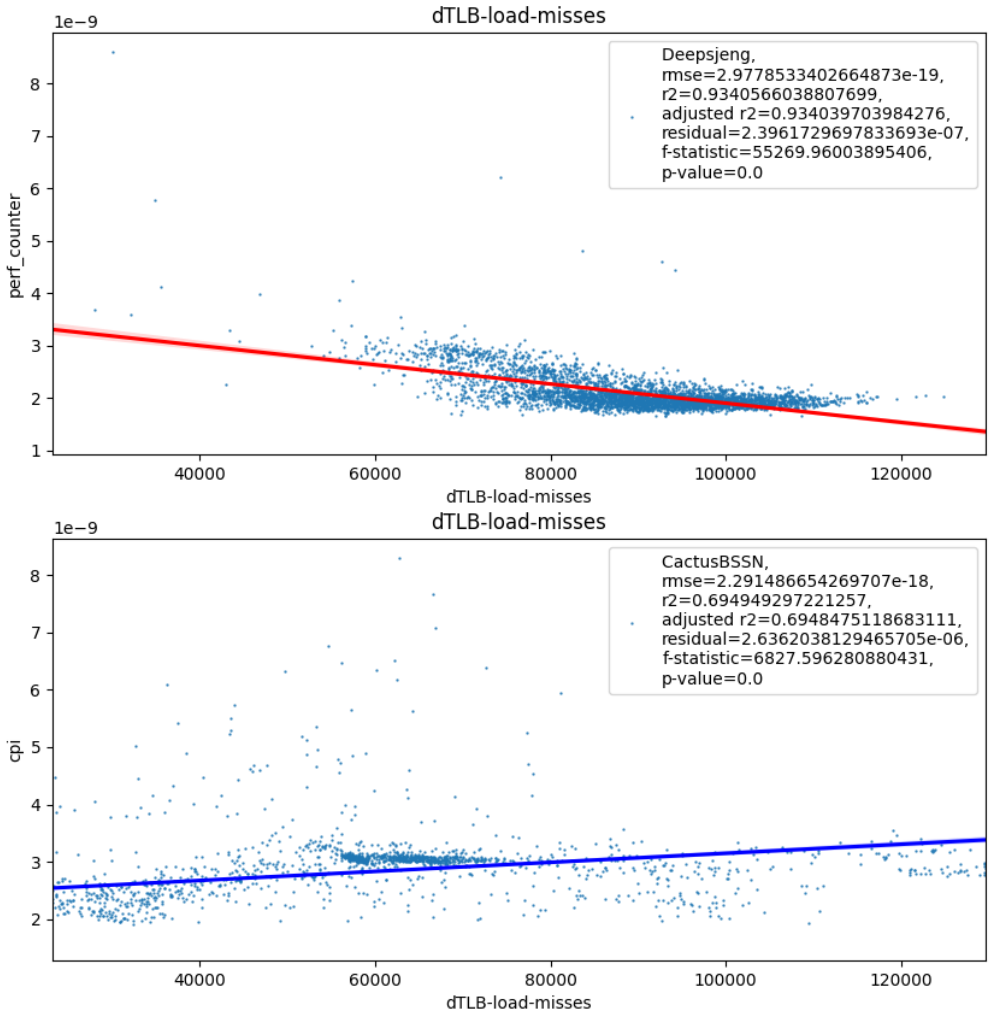
2.3) Regression plot of LLC load misses:



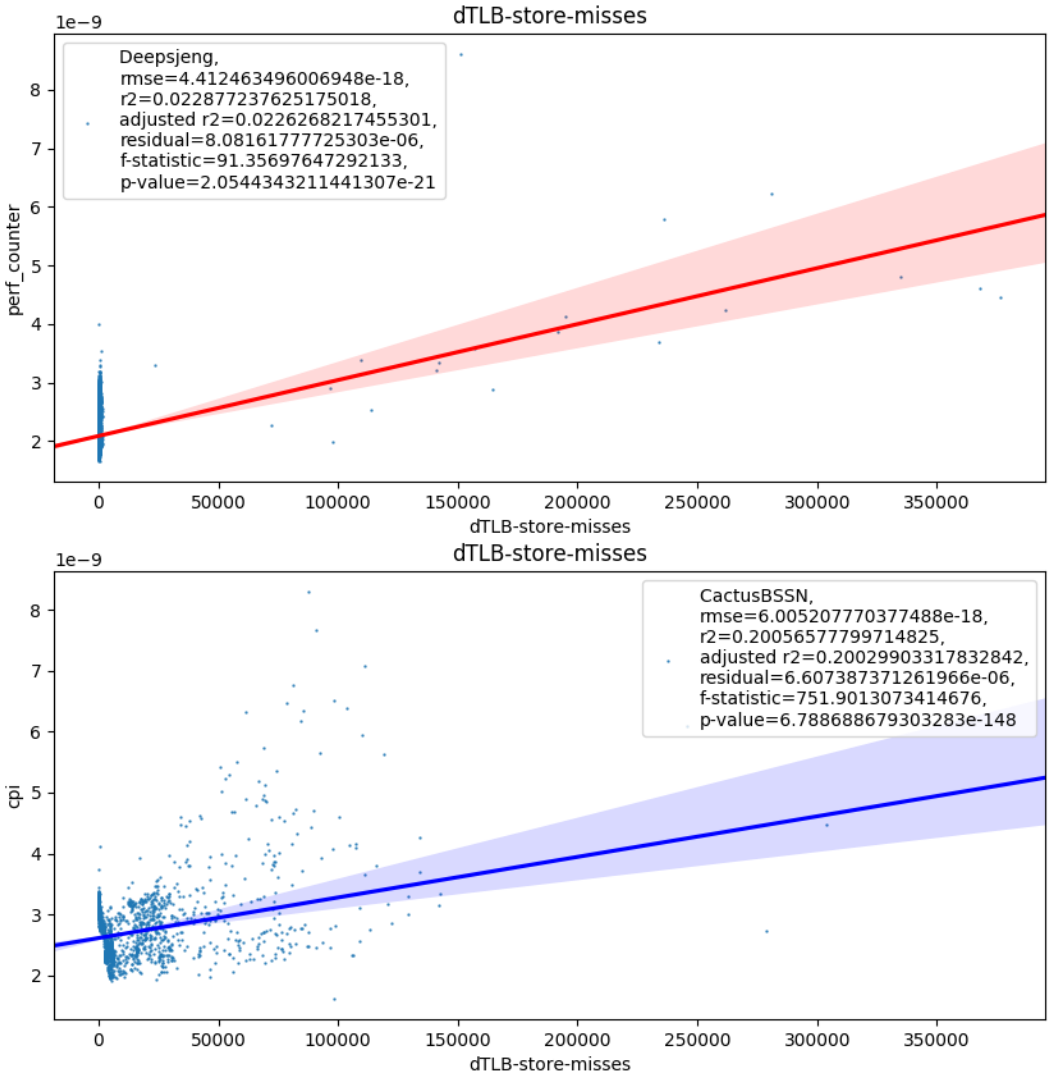
2.4) Regression plot of LLC load misses:



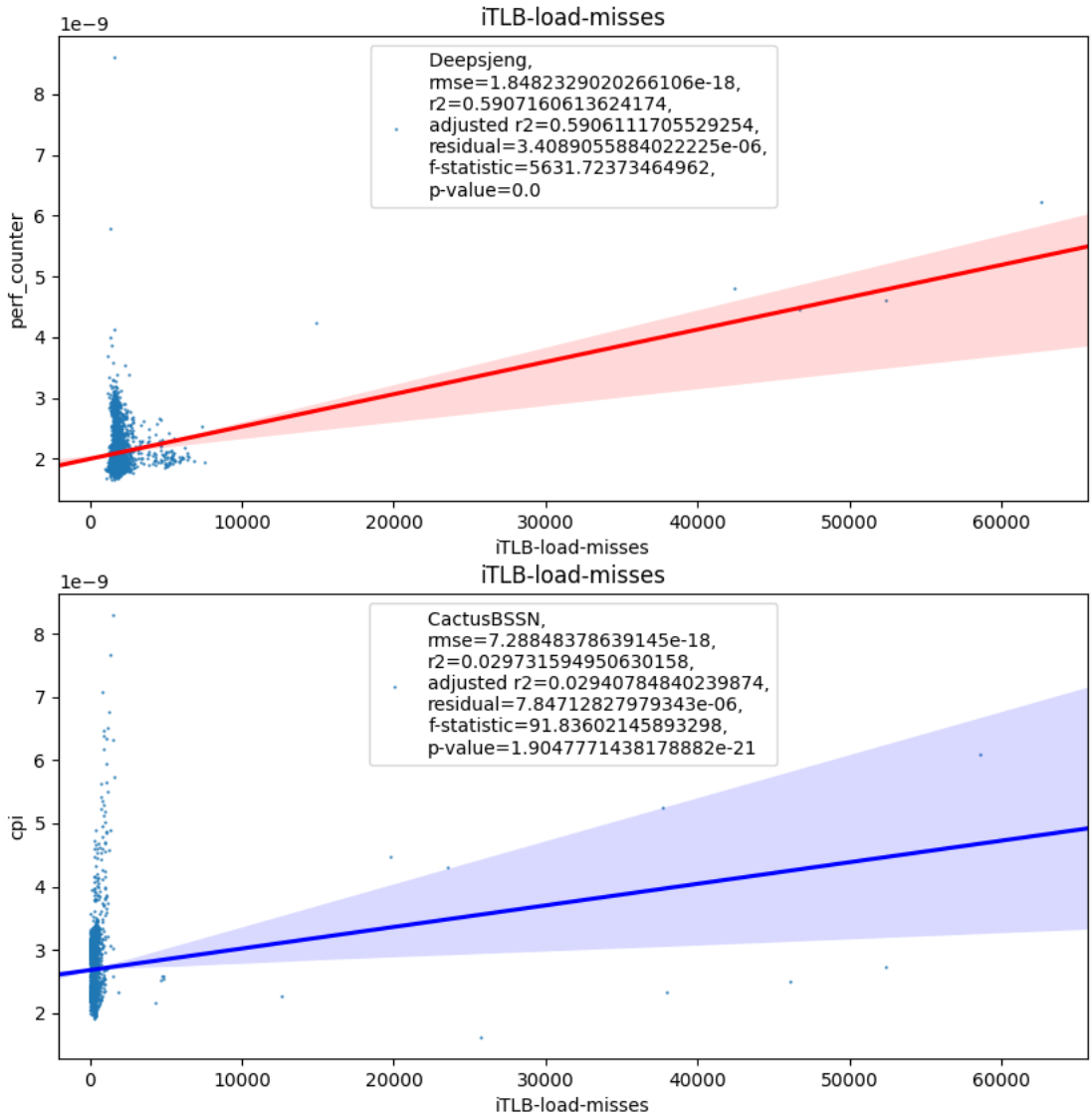
2.5) Regression plot of DTLB Load Misses:



2.6) Regression plot of DTLB Store Misses



2.7) Regression plot of I-TLB Misses:



2.8) Regression plot of Branch Mispredictions: