

A thin, light brown L-shaped line that starts with a horizontal segment to the right and then turns 90 degrees downward to the left, framing the top-left corner of the title.

BINGO PREFETCHER

- Team Pipeliners
- 
- A thin, light brown L-shaped line that starts with a vertical segment to the left and then turns 90 degrees downward to the right, framing the bottom-right corner of the list item.

Insights: What and Why?

- Exploits the similarity of access patterns among memory pages to prefetch
- Associates them with both longer and shorter events



@Petirep

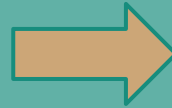
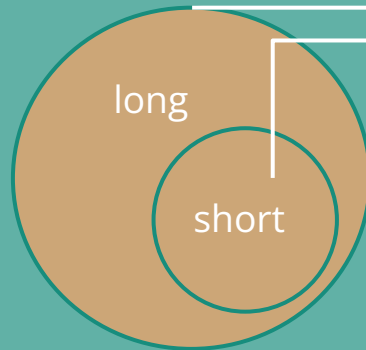
made with mematic

+ JAKE-CLARK.TUMBLR

What and Why? (Slide 2)

- One history table for both events? ... redundancy

*“Short events
being carried out
in long events”*



	Tag	

Redundant
information

Less execution time and reducing storage overhead - **BETTER RESULTS!**

Can Bingo fail sometimes?

Limitations are not limited...

- Is the hash function used to encode "PC + offset" efficient?
- Is the heuristic used for handling multiple footprints of same "PC + offset" fair?

JAL experiments...

Low five

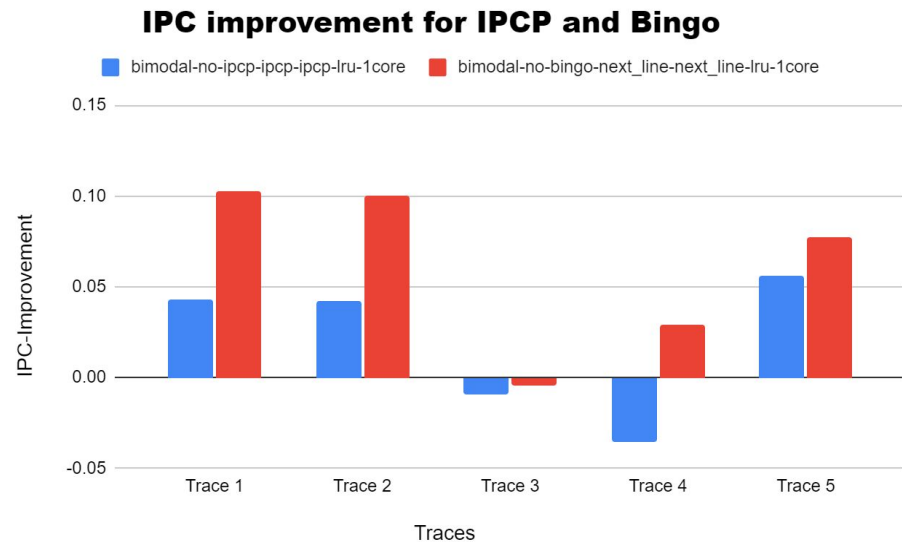


Traces with least improvement for IPCP

1. 620.omnetpp_s-141B.champsimtrace.xz
2. 620.omnetpp_s-874B.champsimtrace.xz
3. 657.xz_s-2302B.champsimtrace.xz
4. 605.mcf_s-994B.champsimtrace.xz
5. 600.perlbench_s-570B.champsimtrace.xz

Bingo & IPCP VS Baseline

Warmup - 50M instructions
Simulation - 200M instructions



Bingo VS IPCP

- Bingo > IPCP for all traces
- Why 🤔🤔💬
 - IPCP uses fixed access patterns - constant & complex stride or streaming
 - IPCP uses fixed range of prefetch degree
 - Bingo uses both longer and shorter events
 - Bingo - 16 PC bits in index (>IPCP) with help of hashing

Bingo VS Baseline

IPC increases in general

...Is that always the case??



Bingo VS Baseline[2]

- Trace 3 - Bingo performs worse than baseline
- Why 🤔🤔💬
 - unfavourable evictions
 - unfavourable prefetches
 - benchmark might not be reusing the same data

The image features a vibrant, stylized background with green and yellow geometric patterns and floating confetti. In the center, a teal banner with white text reads "Let's play with some numbers!!". Behind the banner, several bingo cards are fanned out. The top card is green and has the word "BINGO" at the top, followed by a row of numbers: 7, 20, 35, 47, 72. Below this, another card shows a grid with numbers like 1, 19, 60, 74, and 5, 68. To the left, a purple card shows numbers like 5, 17, 43, 47, 74, 14, 21, 36, 42, and a star. To the right, an orange card shows numbers like 48, 69, 72, 62, 17, 43, 47, 74, 21, 36, 42, 67, and a star. In the foreground, five large, colorful bingo balls are arranged in a semi-circle. Each ball has a letter: "B" (orange), "I" (red), "N" (dark blue), "G" (green), and "O" (purple).

BINGO

7 20 35 47 72

Let's play with some numbers!!

1 19 ★ 60 74

5 68

BINGO

5 17 43 47 74
14 21 36 42
★ 60

4 15 16
3 2

48 69
72 62

BINGO

5 17 43 47 74
21 36 42 67
★ 60

B

I

N

G

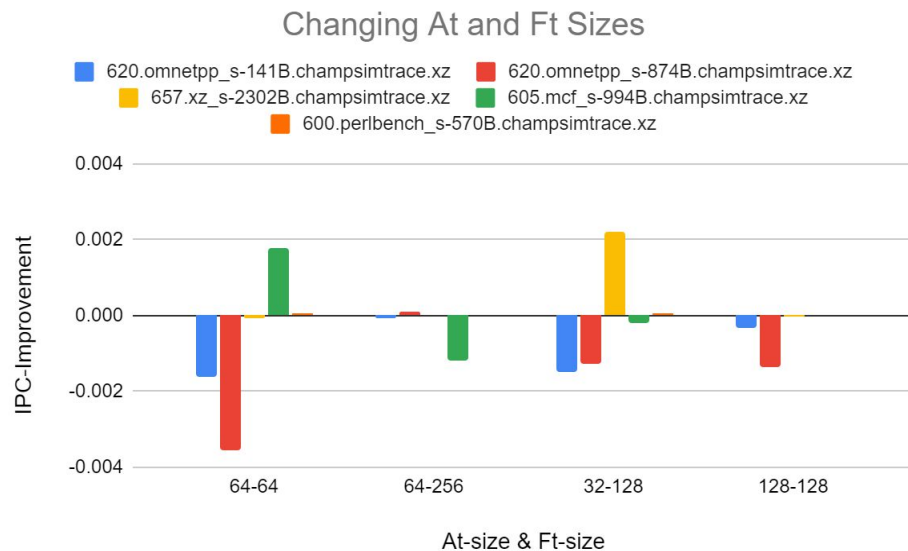
O

Experiments

- 10M Warm-up instructions, 10M Simulation instructions
- For each modification, we plot IPC improvement (= $\frac{\text{IPC with modified Bingo}}{\text{IPC with default Bingo}} - 1$)
- Modified Parameters
 - AT-size & FT-size
 - L1D_Thresh & L2C_Thresh

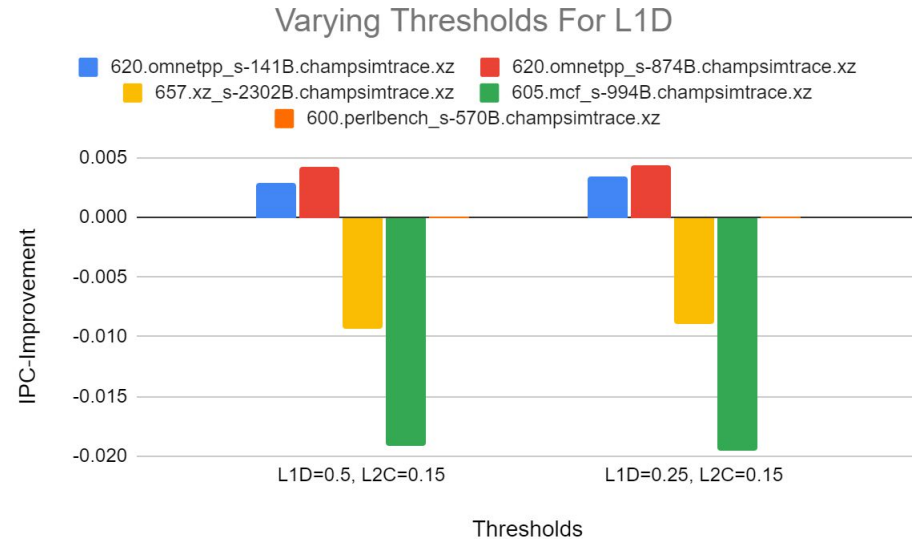
AT-size and FT-size

Default Accumulation table size - 64
Default Filter Table size - 128



L1D & L2C Thresh

Default L1D threshold - 0.75
Default L2C threshold - 0.25



***Decrease in threshold →
Prefetches increase but relevance decreases: opposing
effects***

We tried few more...

None of them actually worked :(

Let us try something new.....

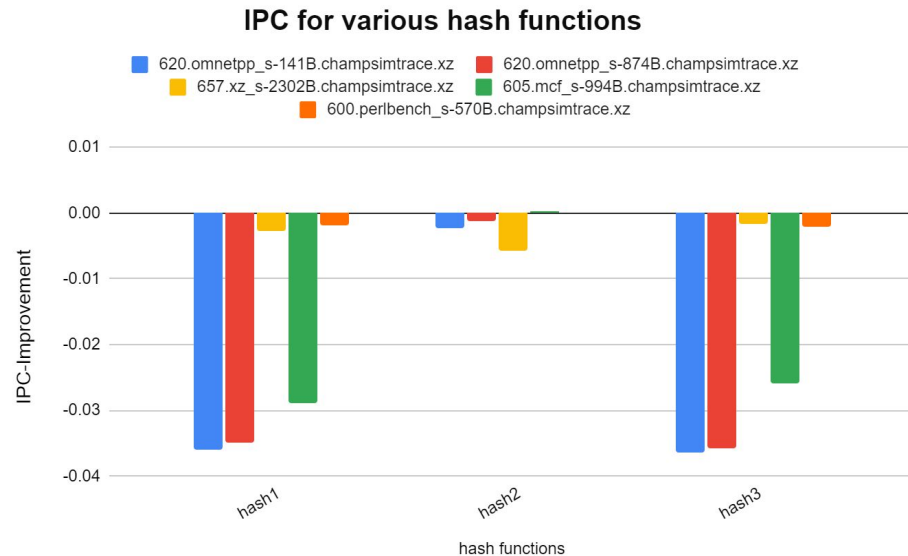


What if we change the Hash function?

hash 1 - <https://stackoverflow.com/a/12996028>

hash 2 - <https://www.modernescpp.com/index.php/hash-functions>

hash 3 - <https://stackoverflow.com/a/57556517>



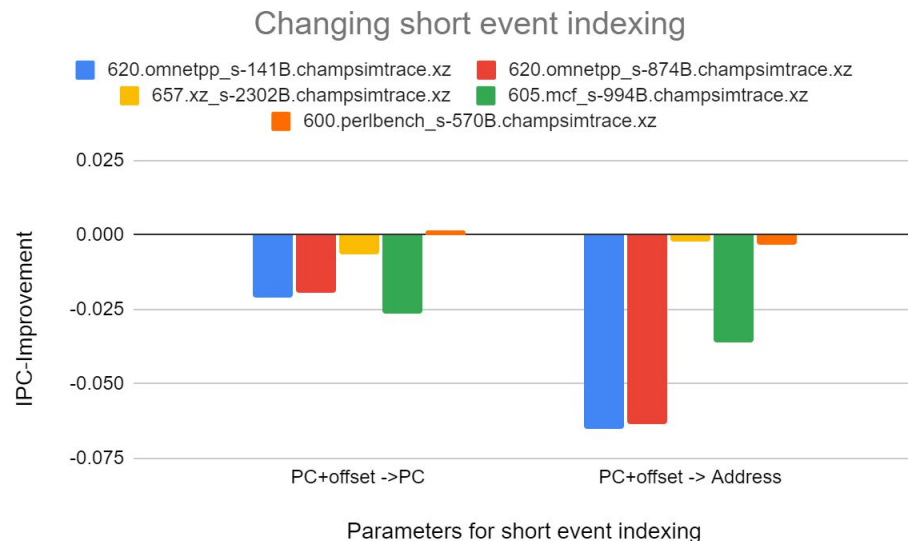
Default hash function outperforms
- ***condenses info from entire key***

Possible Short events

Default indexing - PC+offset for short events

Replaced with

- PC
- Address



PC indexing decreases accuracy, increases match probability
Address indexing decreases accuracy and match probability

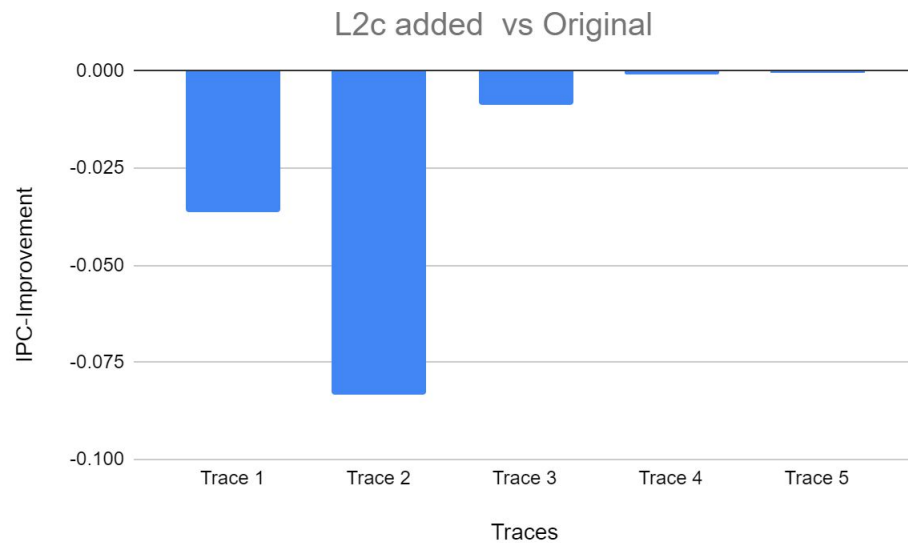
Failed Again..... :(

But we won't give up :)



Bingo for L2C.....

L2C with Bingo parameters same as L1D



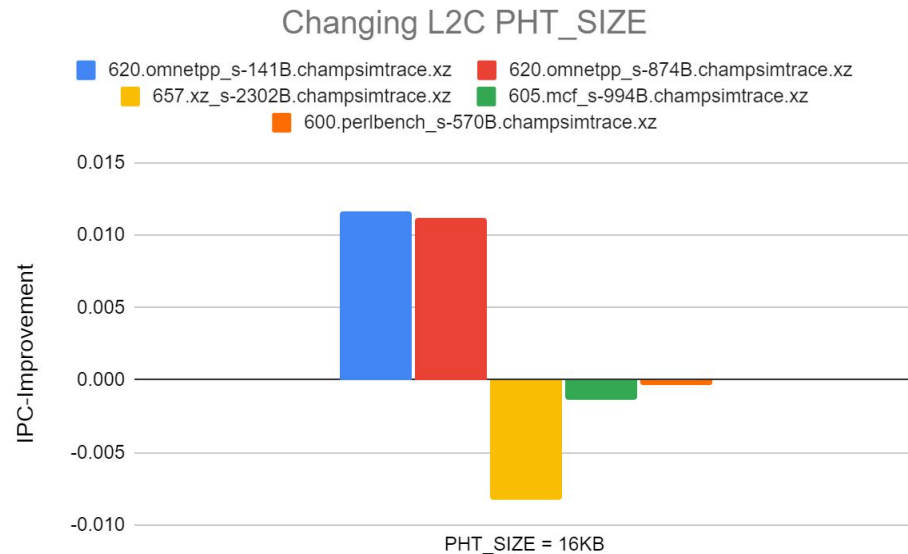
Restart the number-game....

When you tell a really
bad idea to your...
friend: **best friend:**



L2C PHT Size

Greater Pattern History Table(PHT) size
for greater capacity

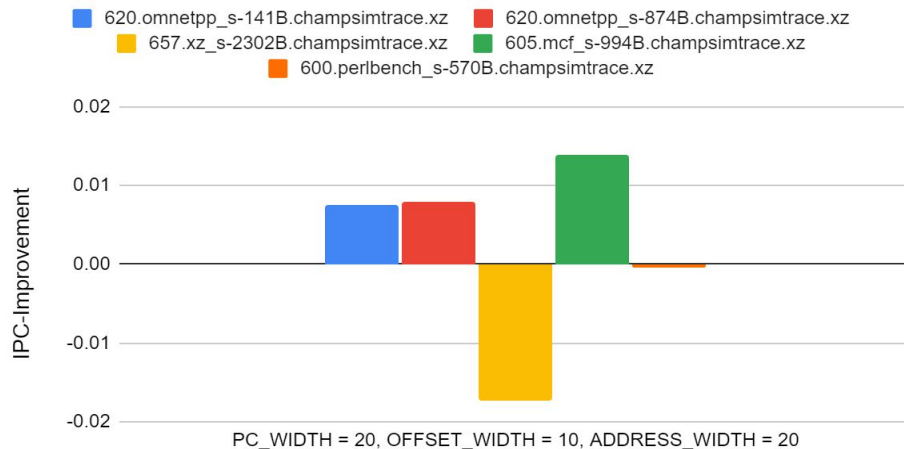


Able to store more history - might increase IPC

L2C Index and tag bits

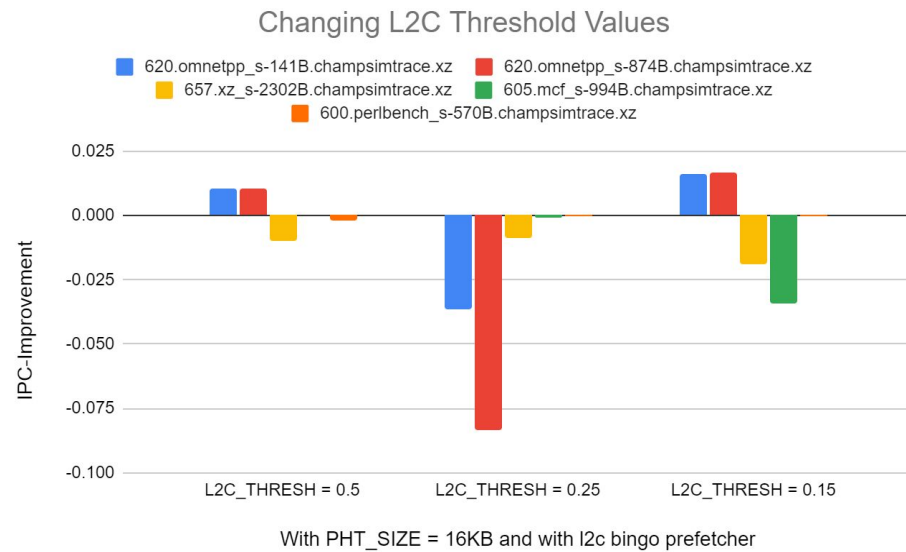
Greater number of bits for
extracting more information

Optimal Behaviour of PC_Width and other parameters For L2C-BINGO



More information → better prefetches

L2C Threshold in L2C prefetcher

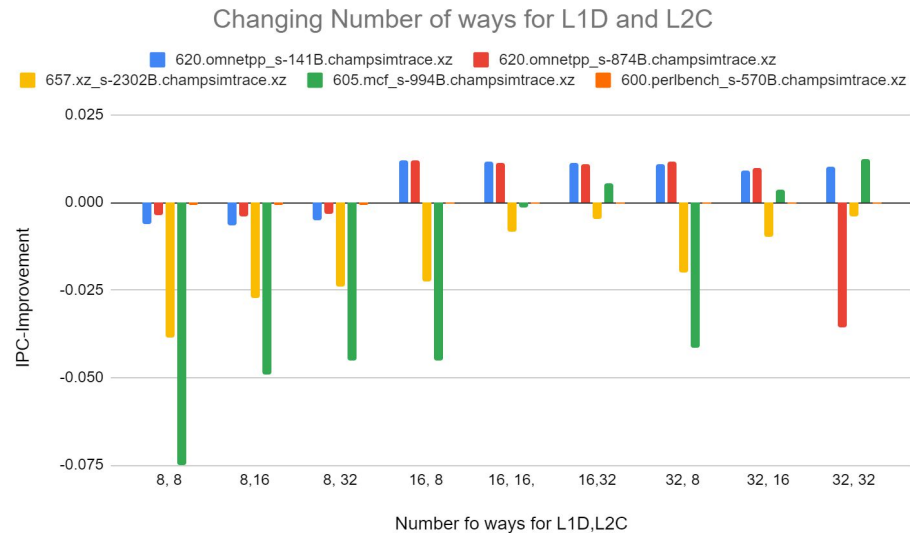


Decrease in threshold →

Prefetches increase but relevance decreases: opposing effects

L1D and L2C ways

Default PHT ways in L1D - 16

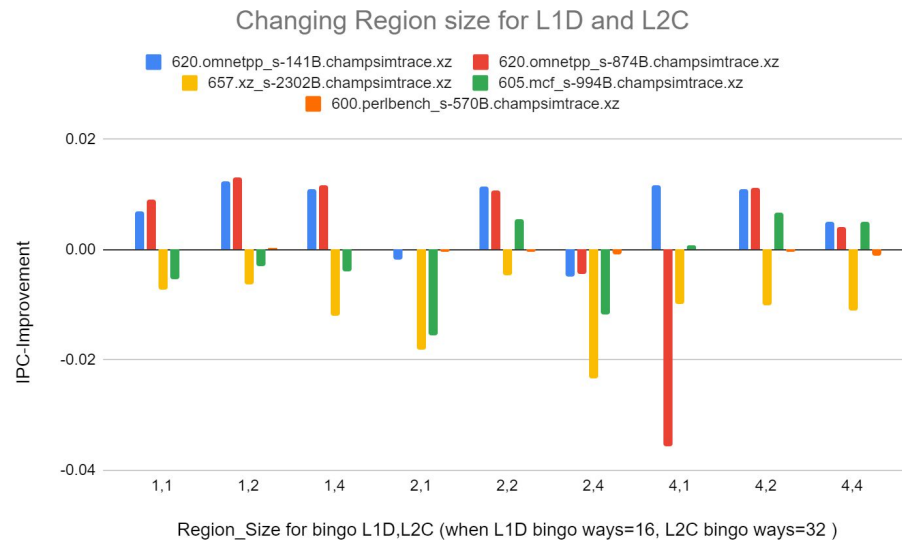


***Increase in ways →
Match probability for longer events increase***

L1D and L2C Region Size

Default Region size for L1D - 2KB

Large region size contributes to large pattern length



Increasing pattern length →
***prefetching time increases and number of useful
prefetches increases - opposing factors***



Tuning table sizes - AT, FT, PHT

No improvement on either
increasing or decreasing table sizes

... default sizes are already optimal



Tuning L1D and L2C threshold

Improves for some traces and
decreases for others

... increased prefetches, decreased
relevance opposing each other

Conclusions



Exploring different short events

No improvement

... PC + offset might be optimal



Trying out different hash functions

No improvement

... default hashing might be optimal

Conclusions[2] → Extending Bingo to L2C

Played with PHT size, Index and Tag bits, number of ways and region size

On an average, best improvement obtained for

- PHT size = 16K, Num ways = 32 & remaining same as L1D

Finally improvement! ...by adding L2C prefetcher



Division of Labor

Name	Roll Number	
Ilindra Lakshmi Sai Shreya	190050050	L2C, Reasons(20%)
Palti Ramyasri	190050078	L2C, Reasons(20%)
Pokala Mohith	190050084	L1D, Reasons(20%)
Poluparthi Preetham	190050085	L1D, Results and Plots(20%)
Punna Hitesh Kumar	190050093	L1D, Results and Plots(20%)

An anime-style illustration of a young man with short, spiky orange hair and purple eyes. He is wearing a dark blue jacket with a light blue inner lining and a white pocket. He is reaching out with both hands towards a shower of falling petals. The petals are in various colors: green, yellow, orange, and pink. The background is a dark, starry night sky with a gradient of purple and blue. The overall mood is romantic and nostalgic.

Arigatōgozaimas