CS-683 Project checkpoint 1

Improving IPCP with Irregular Access Support using ISB

Sm Arif Ali, Soumik Dutta
Team Gandiva
23m0822@iitb.ac.in, 23m0826@iitb.ac.in

Problem statement

- Instruction Pointer Classifier-based Prefetcher (IPCP) handles regular patterns but falls short for irregular memory accesses.
- Need for efficient handling of irregular access patterns for applications like graph processing.
- An example access pattern involving *temporal locality* can be seen below:

A B C X Y X Y X Y A B C X Y ..

Where these are memory address accesses

Prior Works

- Bouquet of Instruction Pointers (ISCA ‘20): Established IPCP, categorizing regular memory access patterns.

- Linearizing Irregular Accesses (MICRO ‘13): Introduced Irregular Stream Buffer (ISB) to address irregular accesses.

First IP prefetcher: Constant stride

Second IP prefetcher: Complex stride

Third IP prefetcher: Global stream

Fourth prefetcher: Next-line

Temporal Stream:

A B C X Y X Y X Y *A* B C

GHB
A
B
C
X
Y
X
Y
X
Y
A

(a) GHB

Physical Address	Structural Address
A	19
B	20
C	21
X	22
Y	23

(b) ISB

Figure 1: Metadata for GHB (left) and ISB (right).

Image ref- fig1: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8980330;
fig2: https://dpc3.compas.cs.stonybrook.edu/slides/bouquet.pdf

Goal of the Project

- Integrate ISB into IPCP framework to create a new Irregular Access (IA) class.
- Improve prefetching for workloads with irregular memory access patterns.

First IP prefetcher: Constant stride

Second IP prefetcher: Complex stride

Third IP prefetcher: Global stream

ISB prefetcher: temporal stream

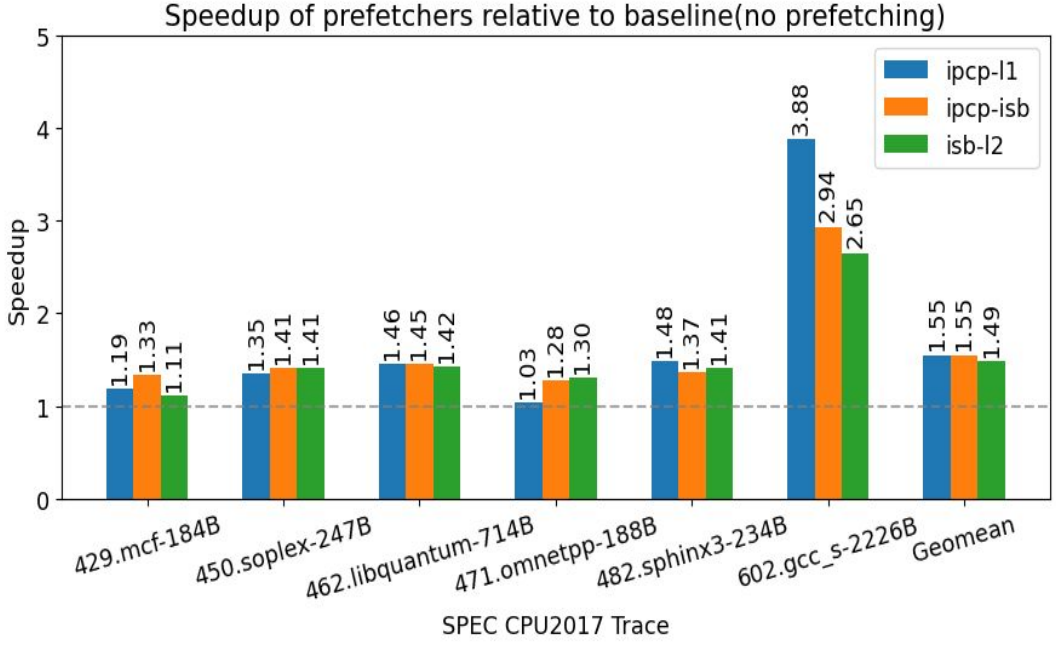
Fourth prefetcher: Next-line

Work done so far

- Integrated IPCP and ISB separately in ChampSim.
- Configured and executed GAP and SPEC-CPU benchmarks separately.
- Initial integration of ISB within the IPCP framework completed, with early tests results.

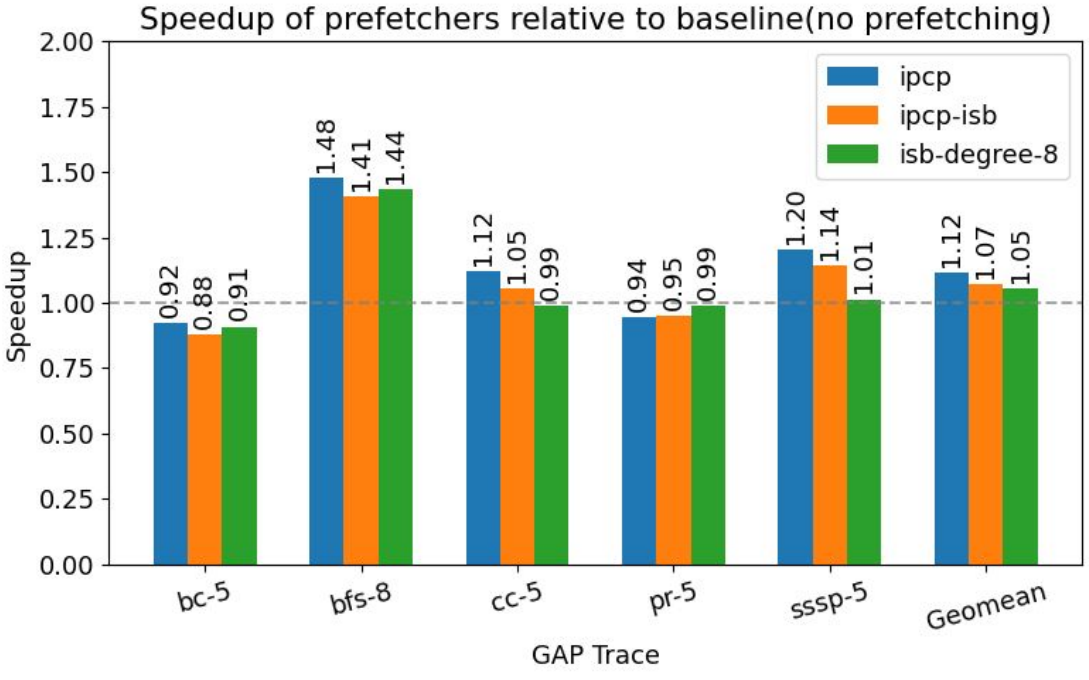
Initial Test Results with SPEC-CPU17

- Combined IPCP-ISB shows comparable performance to individual IPCP and ISB.
- No significant performance gain observed, but no degradation either.



Initial Test Results with GAP

- Combined IPCP-ISB shows degradation of performance than individual IPCP and ISB.
- Further tuning and parameter adjustments needed.



Plan for checkpoint-II

- Use confidence counter to influence prefetch decision in ISB - Soumik
- Adapt prefetch degree in ISB based on accuracy. - Soumik
- Share the IPCP IP-Table with ISB - Arif
- Adjust ISB parameters: lookahead distance, buffer size, and stream length - Arif
- Refine classification logic for the new Irregular Access(IA) class - brainstorming together

Github link

- https://github.com/ArifAli-0/CS683-Project.git

Video link

- https://www.youtube.com/watch?v=JrZYAXMjjzY