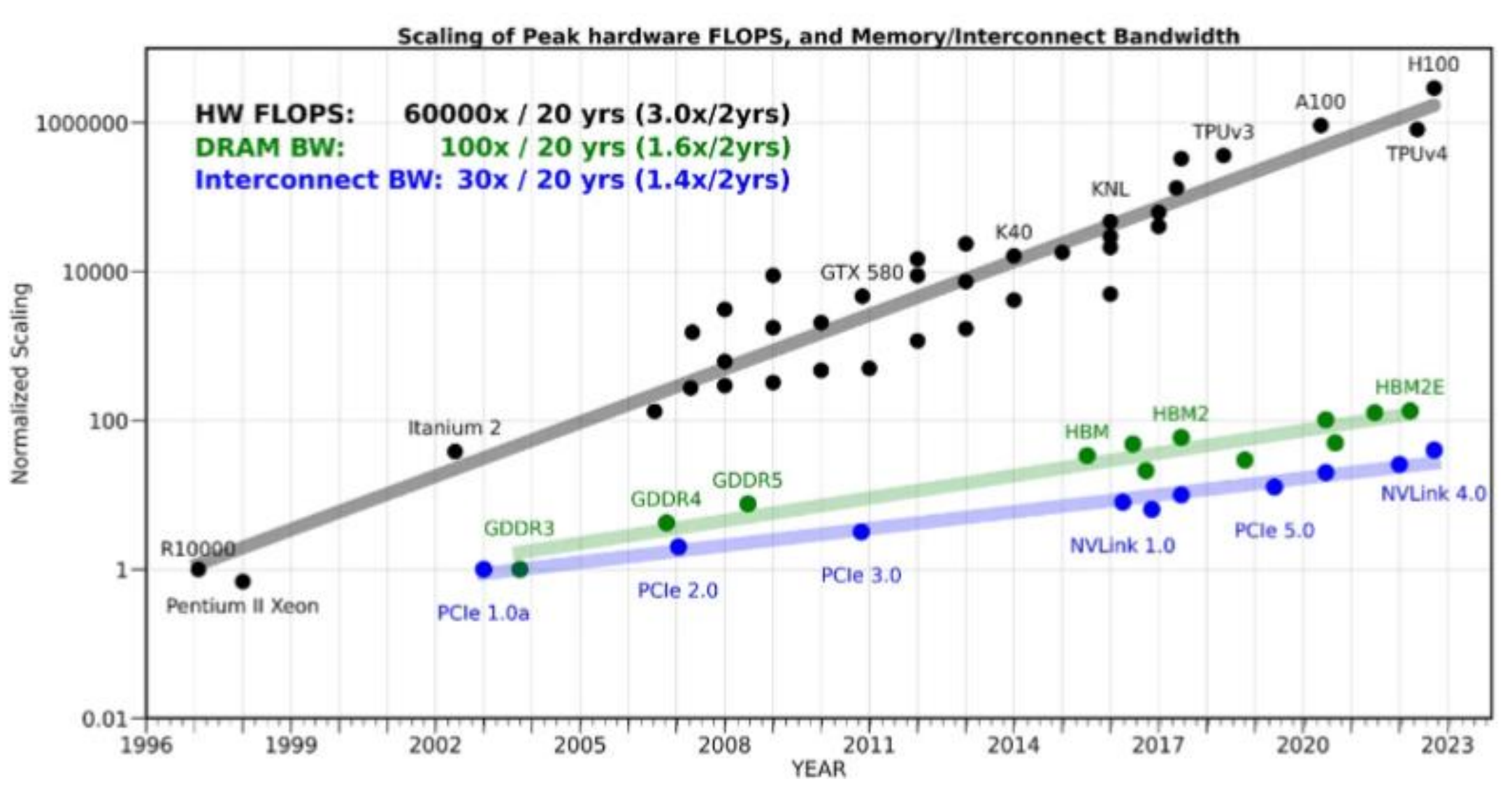
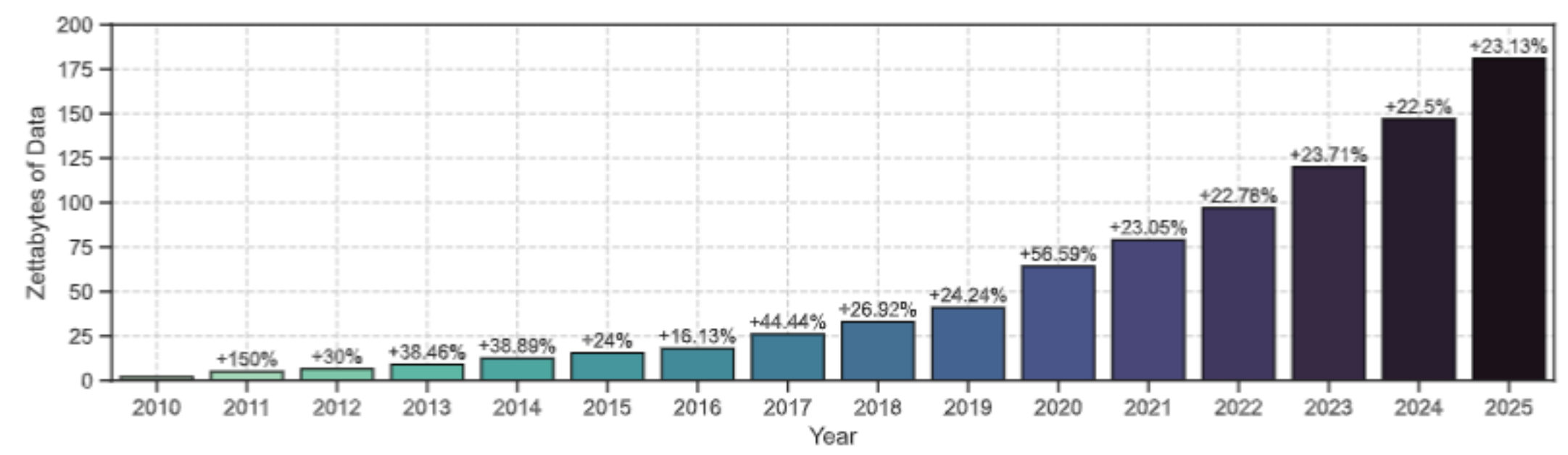


Manolis Katsaragakis*, Francky Catthoor*, Dimitrios Soudris*
 *Microprocessors and Digital Systems Laboratory, ECE, National Technical University of Athens, Greece
 *Katholieke Universiteit Leuven, Kasteelpark Arenberg 10, 3001 Heverlee, Belgium
 *emmanouil.katsaragakis@student.kuleuven.be, francky.catthoor@esat.kuleuven.be,
 *{mkatsaragakis, dsoudris}@microlab.ntua.gr

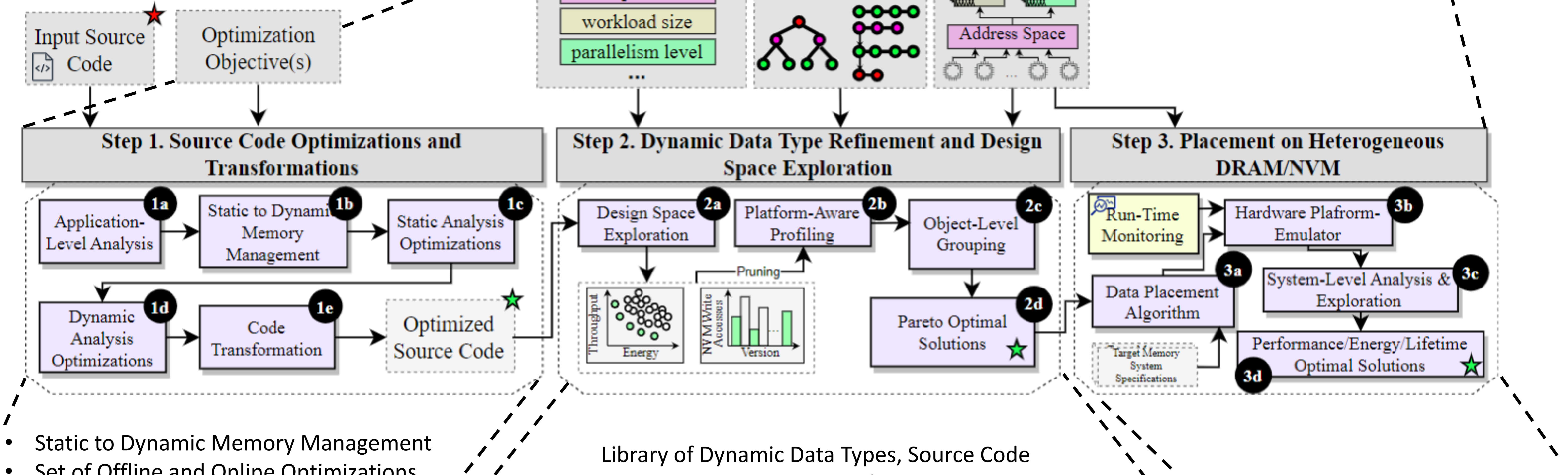


The Memory Wall Bottleneck¹

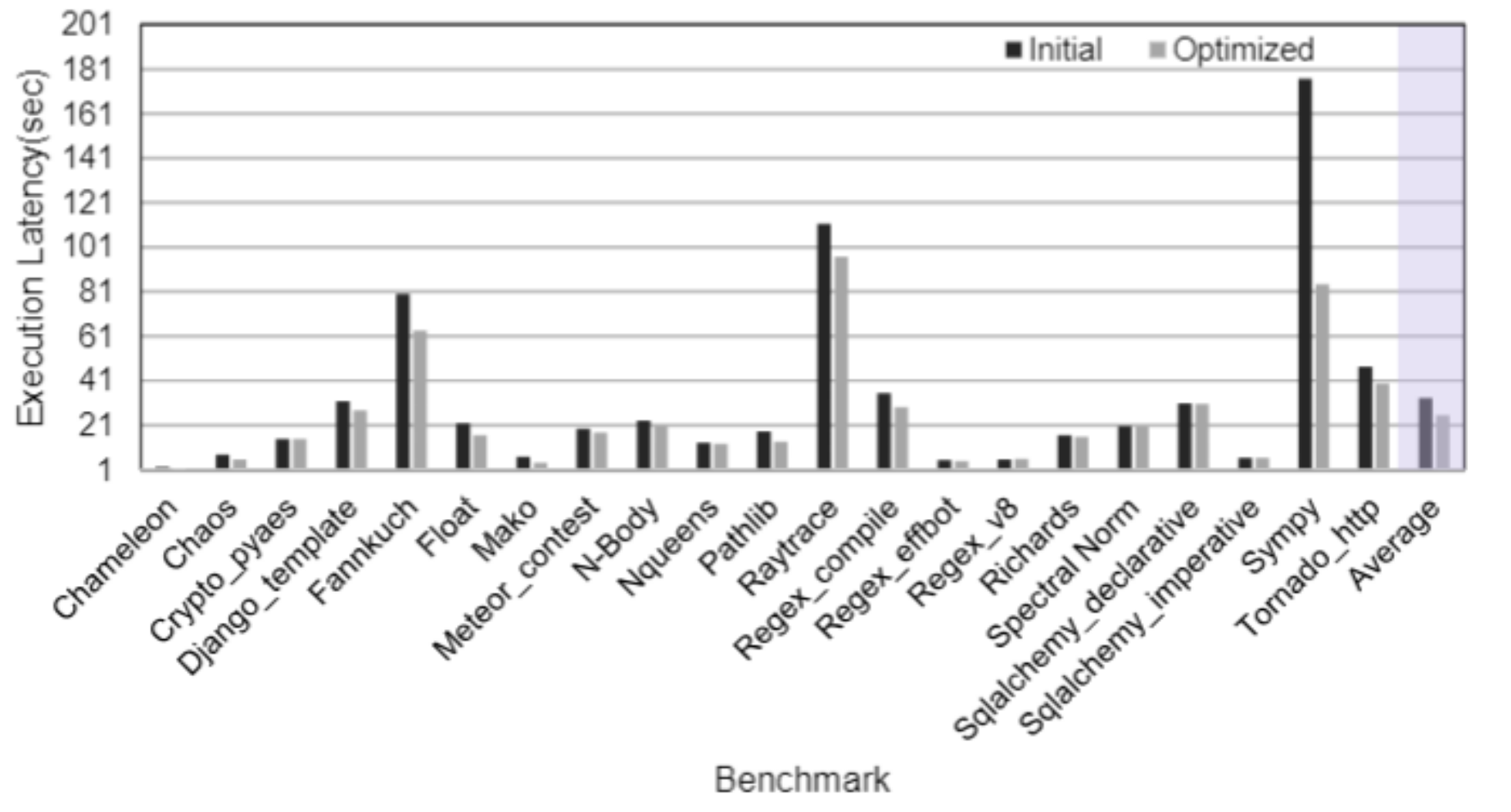
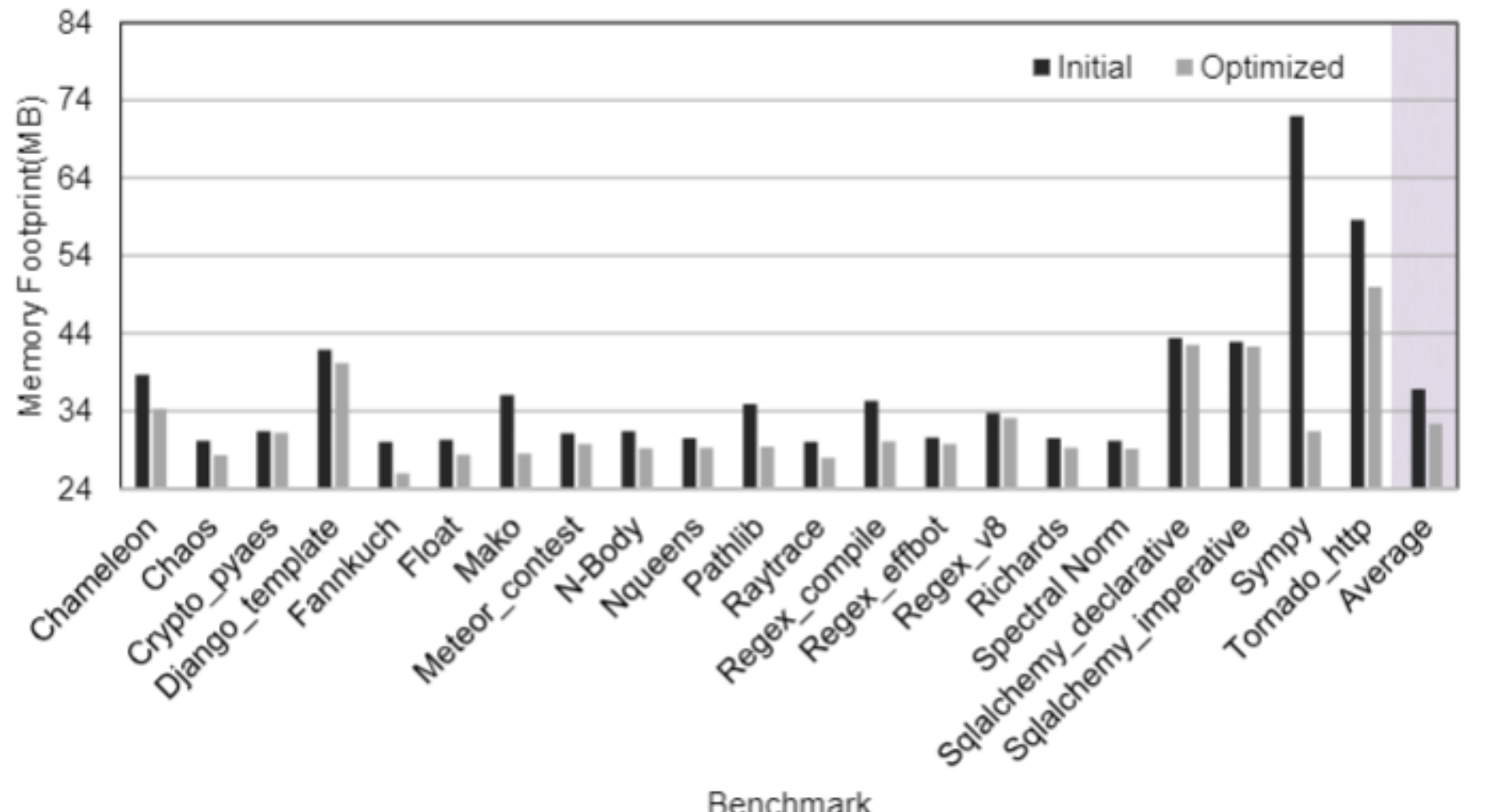


Zeta-bytes of data produced²

PhD Thesis Objective(s): Provide and end-to-end Dynamic Memory Management Flow for Performance, Energy and NVM-Lifetime Optimization



- Static to Dynamic Memory Management
- Set of Offline and Online Optimizations
- Source-to-Source Transformations
- Experiments:
 - *Pyperformance* Benchmark Suite
 - Raspberry pi4



Data Structure	Short Description
VEC	An array that can grow or shrink dynamically (Vector)
SLL	Single Linked List
SLLR	SLL with a pointer to the last accessed element
DLL	Double Linked List
DLLR	DLL with a pointer to the last accessed element
MAP-RB	An associative container (map in STL) that stores pairs of key-value in a Red-Black tree
MAP-AVL	A map that stores key-value pairs in an AVL tree

```
#include <vector>
#include <map>
//Include our library of data implementations
#include <ddtr>

using namespace std;
class SamplePoint (...);

//Native data structure implementation
//vector<SamplePoint> v1;
//Replacing with library data structure
ddtr_vector<SamplePoint> v1;

//Native data structure implementation
//map<int, SamplePoint> mp1;
//Replacing with library data structure
ddtr_map<int, SamplePoint> mp1;

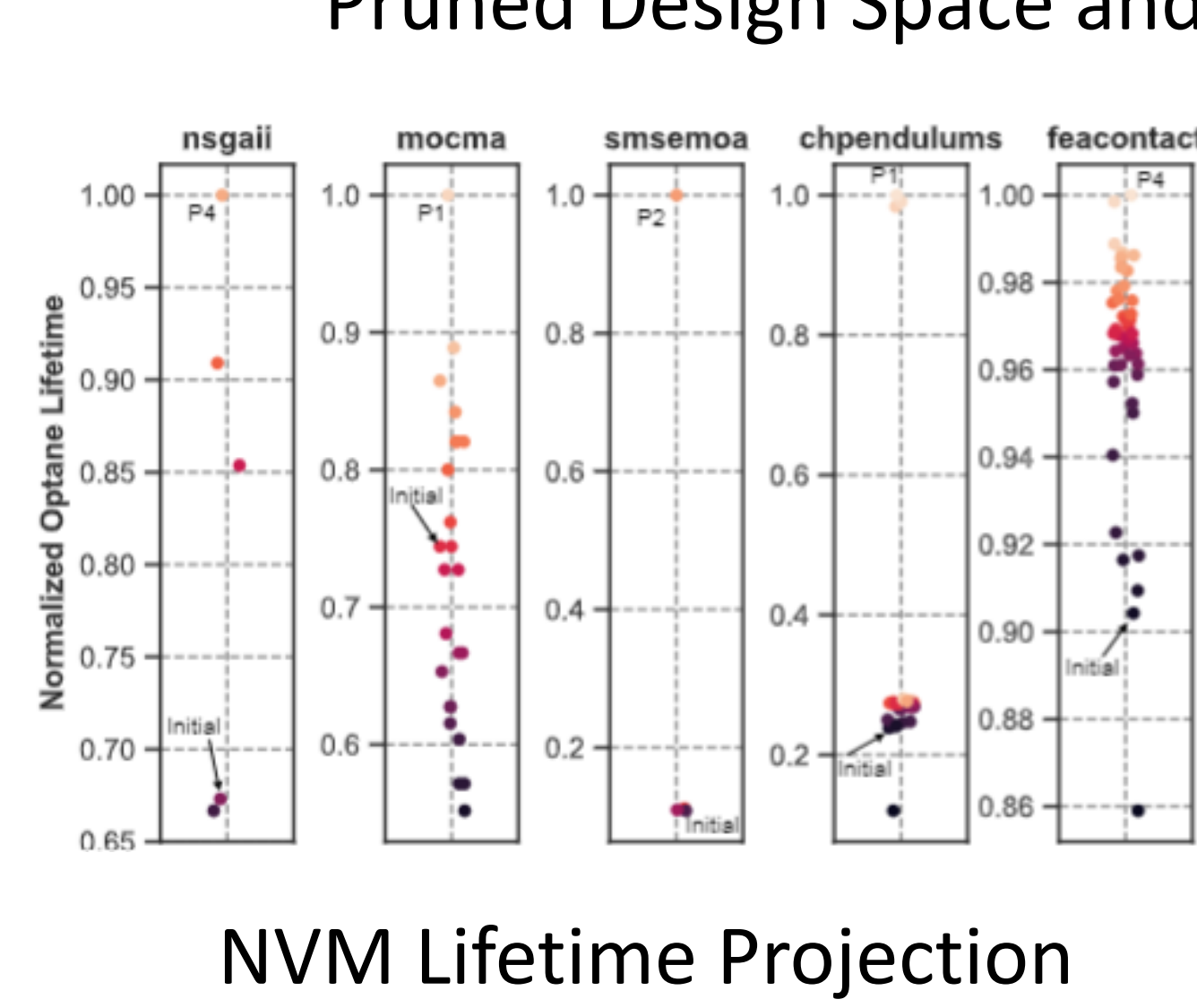
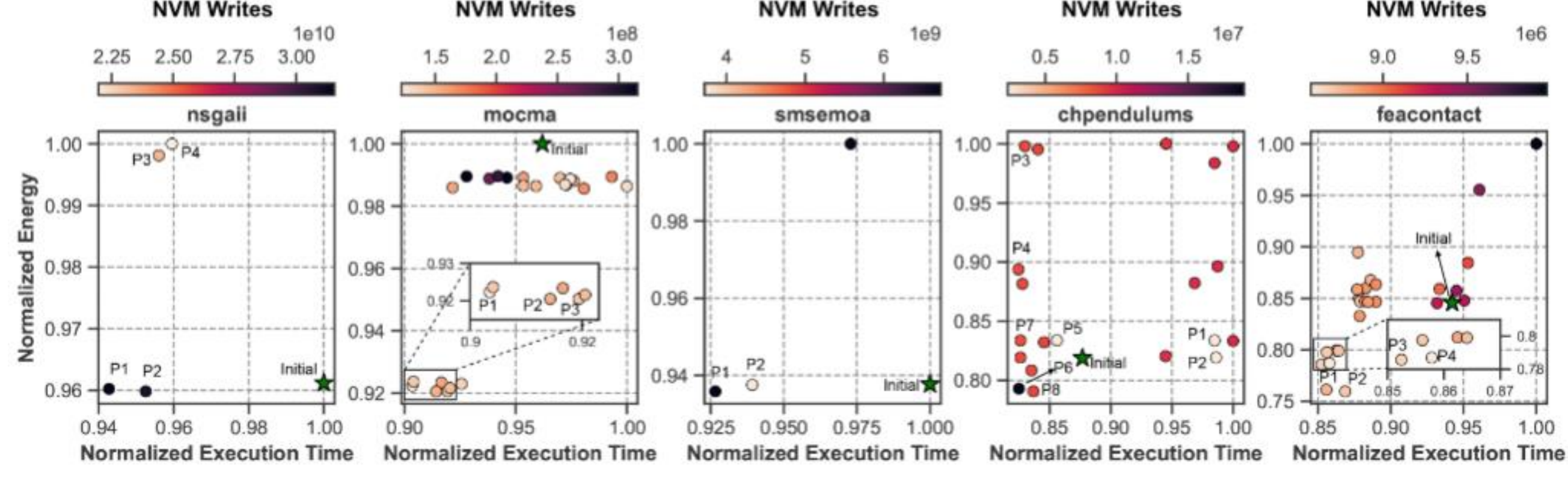
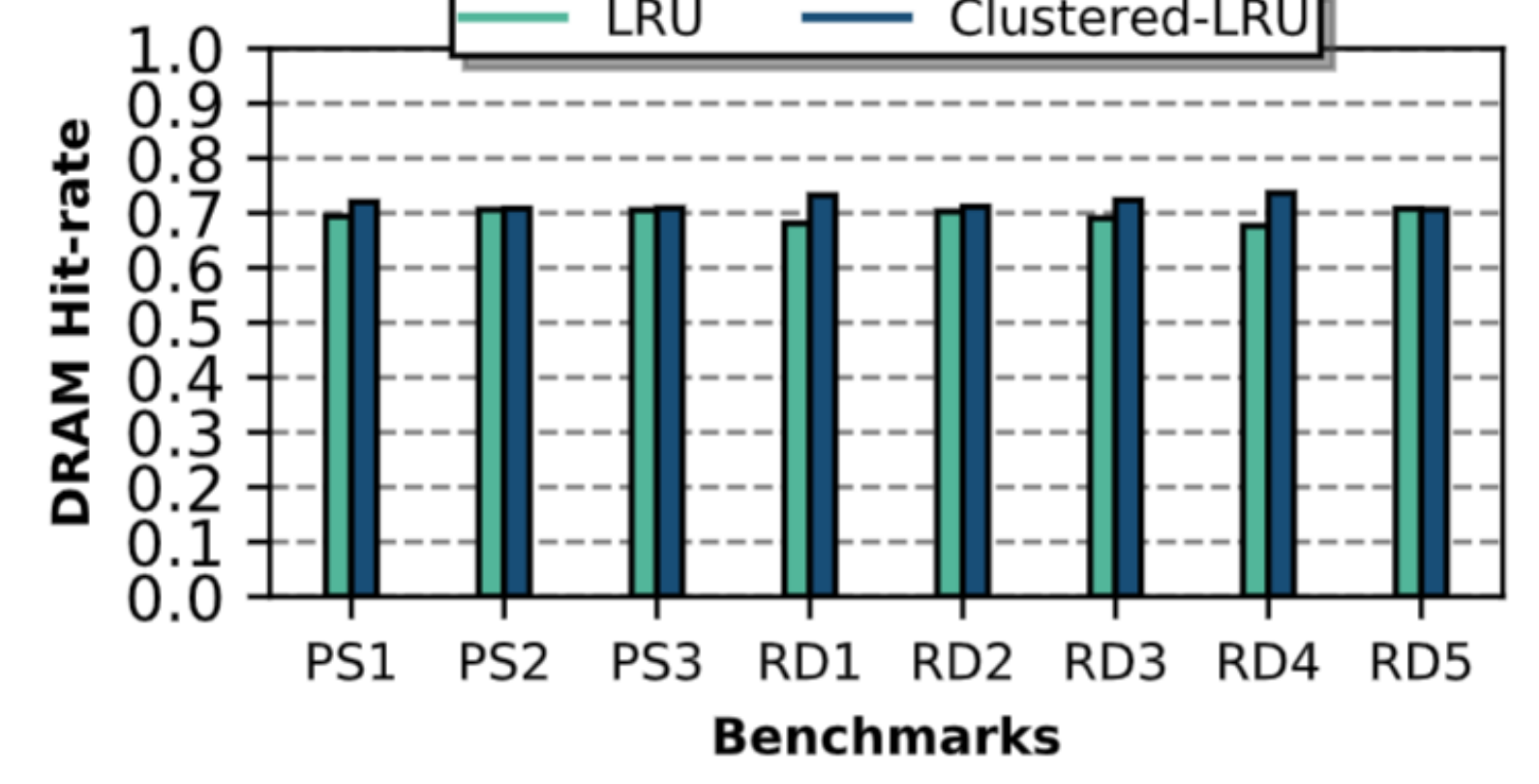
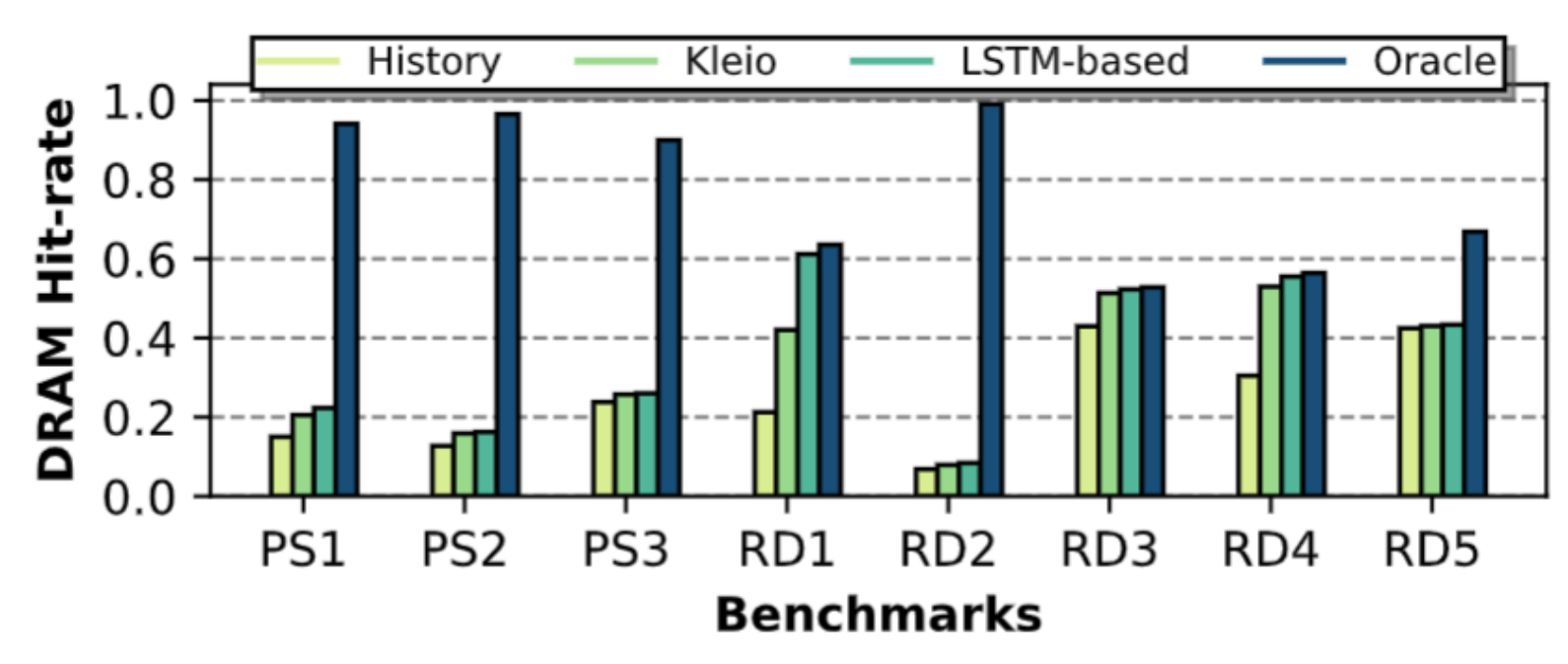
//Defining iterator
map<int, SamplePoint>::iterator itr;

//Inserting element
mp1.insert(pair<int, SamplePoint>(1, new SamplePoint()));
```

- Applications:
- Databases (TPC-C, YCSB)
 - ML-based (Shark-ML)
 - Physics Engine (Chrono)
- Target Hardware:
- DRAM/Intel Optane DCPM

- Integration of LSTMs for page placement, enhanced with neighbor pages behavior
- Clustered-LRU replacement policy

Benchmark Suite	Benchmark	ID	Application Domain	Page Write Accesses	Page Read Accesses
PARSEC [1]	Blackscholes	PS1	Finance	4881	66216
	Bodytrack	PS2	Computer Vision	32411	122374
	Streamcluster	PS3	Data Mining	165495	31915
Rodinia 3.1 [3]	Backprop	RD1	Machine Learning	290869	302419
	Eplustree	RD2	Graph Theory	108274	346723
	Hotspot	RD3	Physics Simulation	5186	197473
	K-means	RD4	Data Mining	187364	356603
	Lut	RD5	Linear Algebra	370481	329342



Key Outcome: up to **58.7%** less execution time, up to **48.3%** less energy consumption, up to **72.6%** less NVM accesses

Key Outcome: **21.6%** average extended lifetime of Optane DCPM

Key Outcome: **20.2%** less energy consumption on average

Key Outcome: *clustered-LRU* provides up to **8.1%** further optimization compared to LRU

1. <https://medium.com/riselab/ai-and-memory-wall-2cb4265cb0b8>
 2. <https://www.statista.com/statistics/871513/worldwide-data-created/>