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DeLorean: Directed Statistical Warming through Time Traveling

Best Paper Nominee

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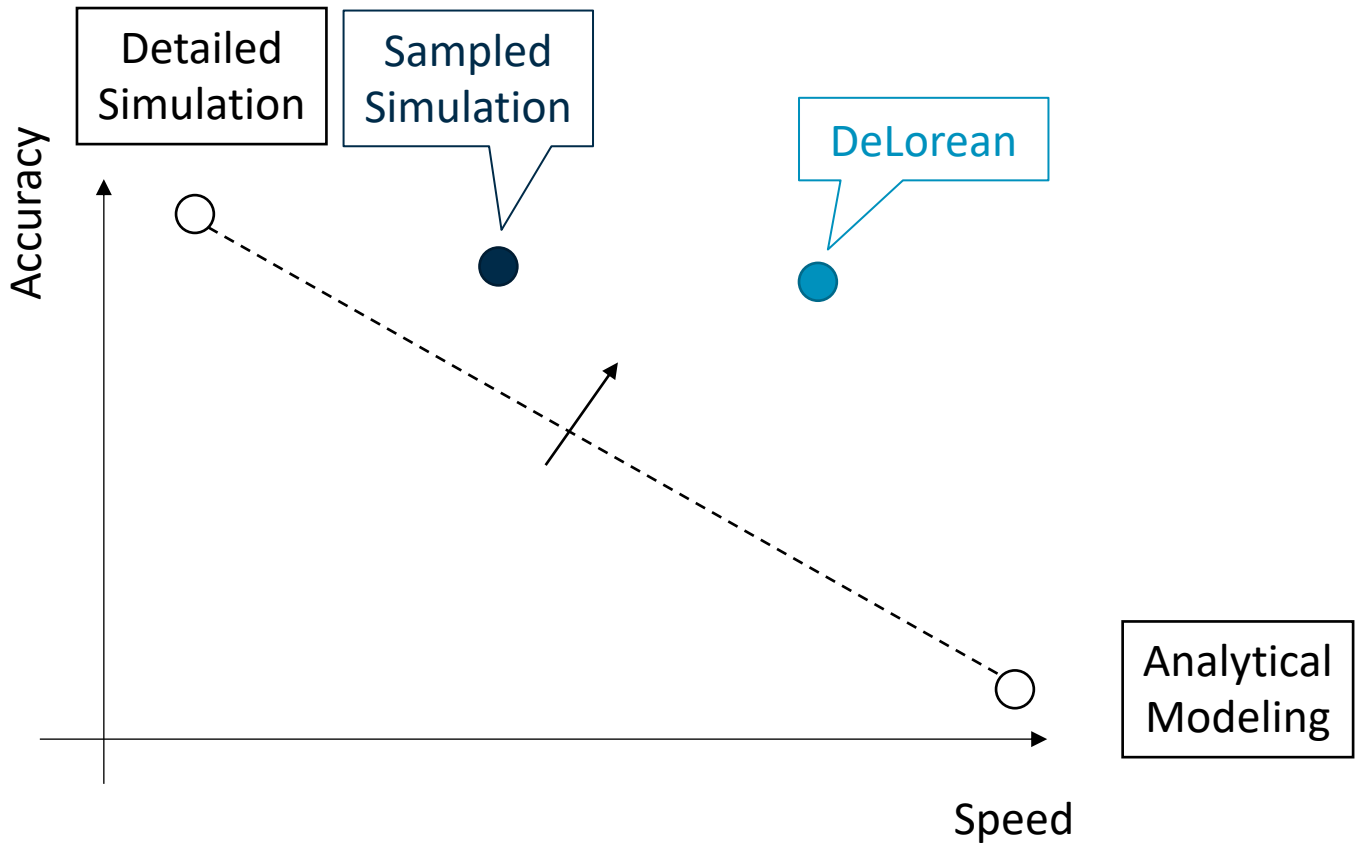
Accuracy/Speed Trade-off



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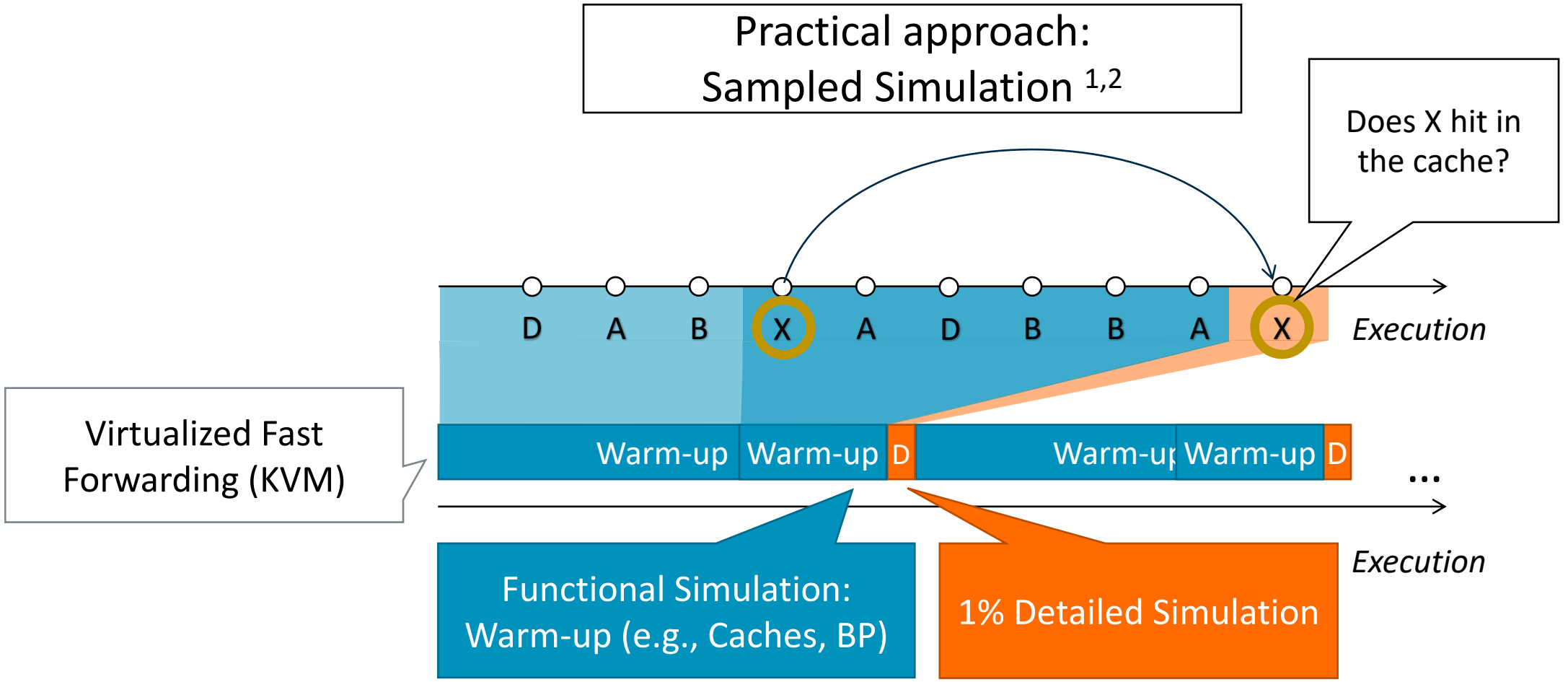
Sampled Simulation



[1] SMARTS: Accelerating Microarchitecture Simulation via Rigorous Statistical Sampling. Wunderlich et al. ISCA 2003

[2] Full Speed Ahead: Detailed Architectural Simulation at Near-Native Speed. Sandberg et al. IISWC 2015

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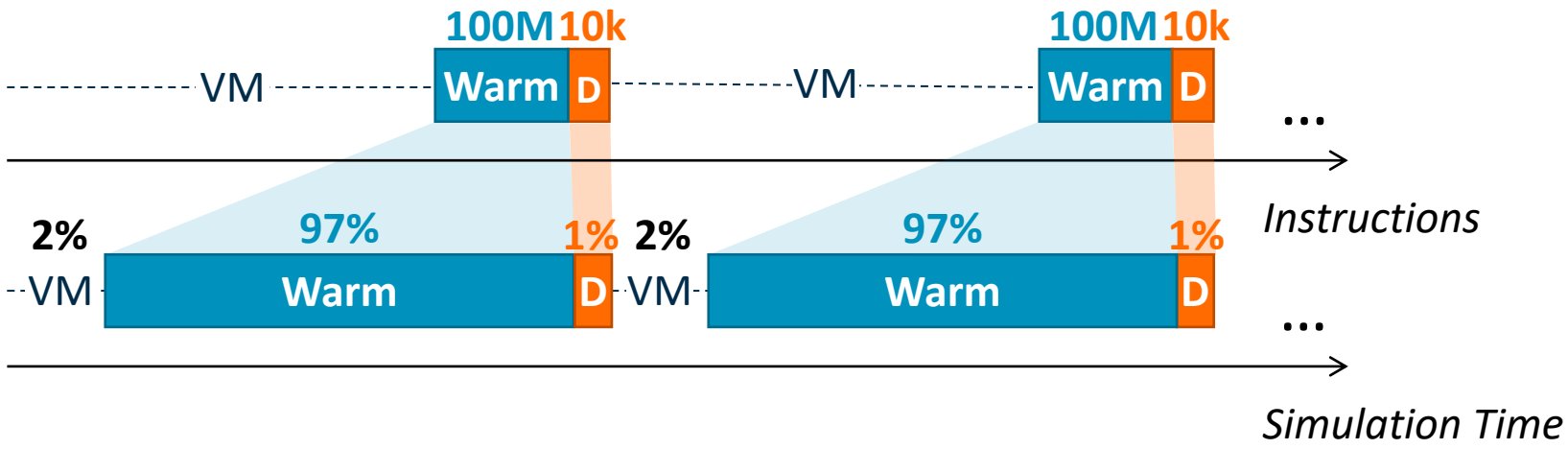
Sampled Simulation Bottleneck



Cache warmup
97% of simulation time

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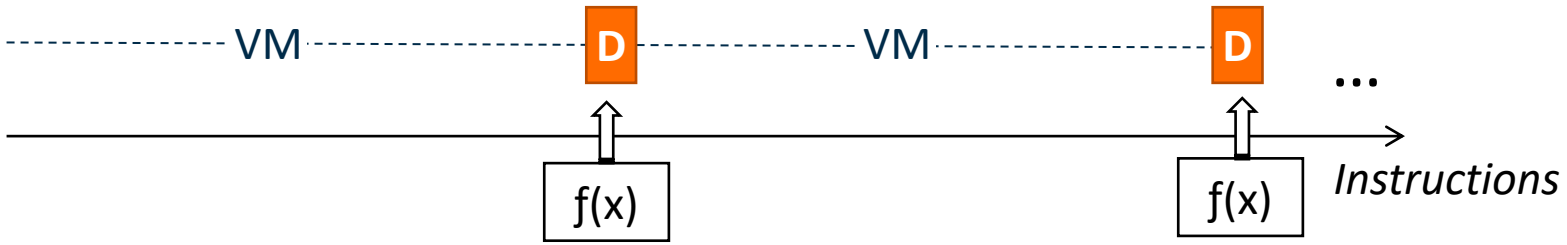
Goal: Eliminate Traditional Cache Warm-up



Feasible simulation for systems w/ large caches

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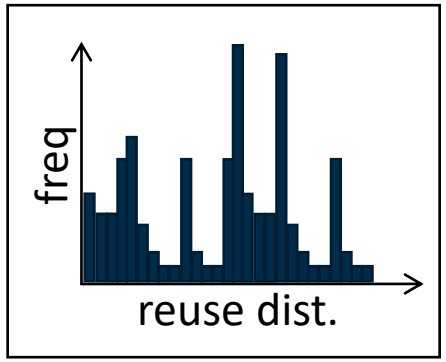
But how?

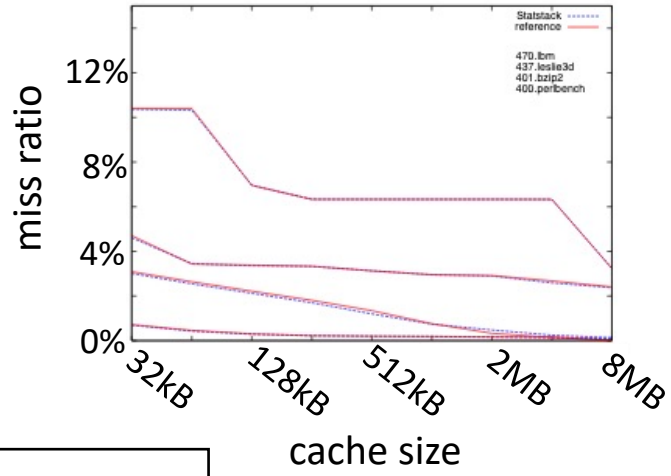
Statistical Cache Modeling

Input:
memory reuse



Cache Model

Output:
miss ratio=ƒ(cache size)



StatStack[1], StatCache[2], etc:

- **Sparse** input
- 20% overhead on native execution

[1] StatStack: Efficient modeling of LRU caches. Eklöv and Hagersten. ISPASS 2010.

[2] StatCache: A Probabilistic Approach to Efficient and Accurate Data Locality Analysis. Berg and Hagersten. ISPASS 2004.

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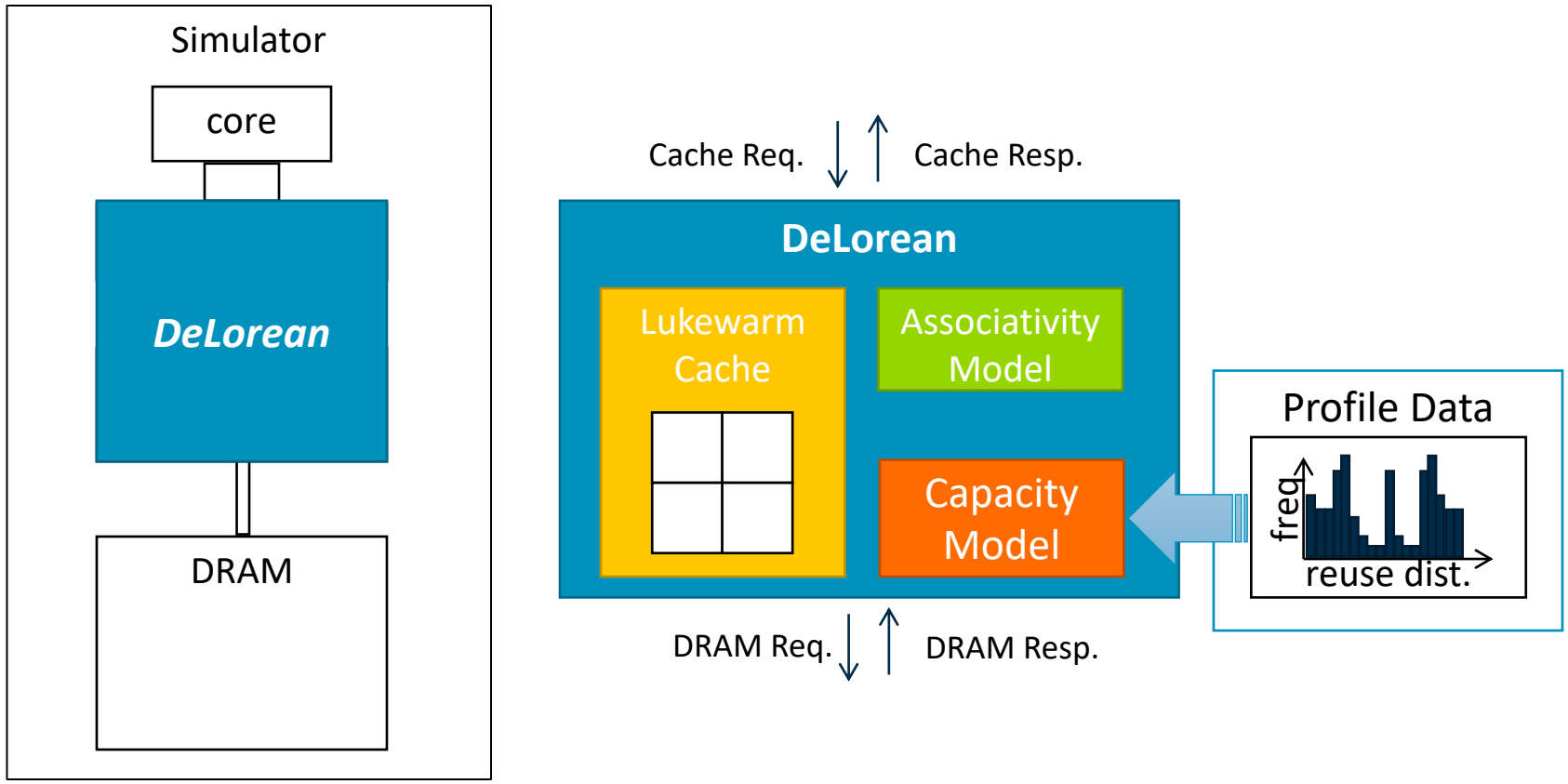
DeLorean Overview



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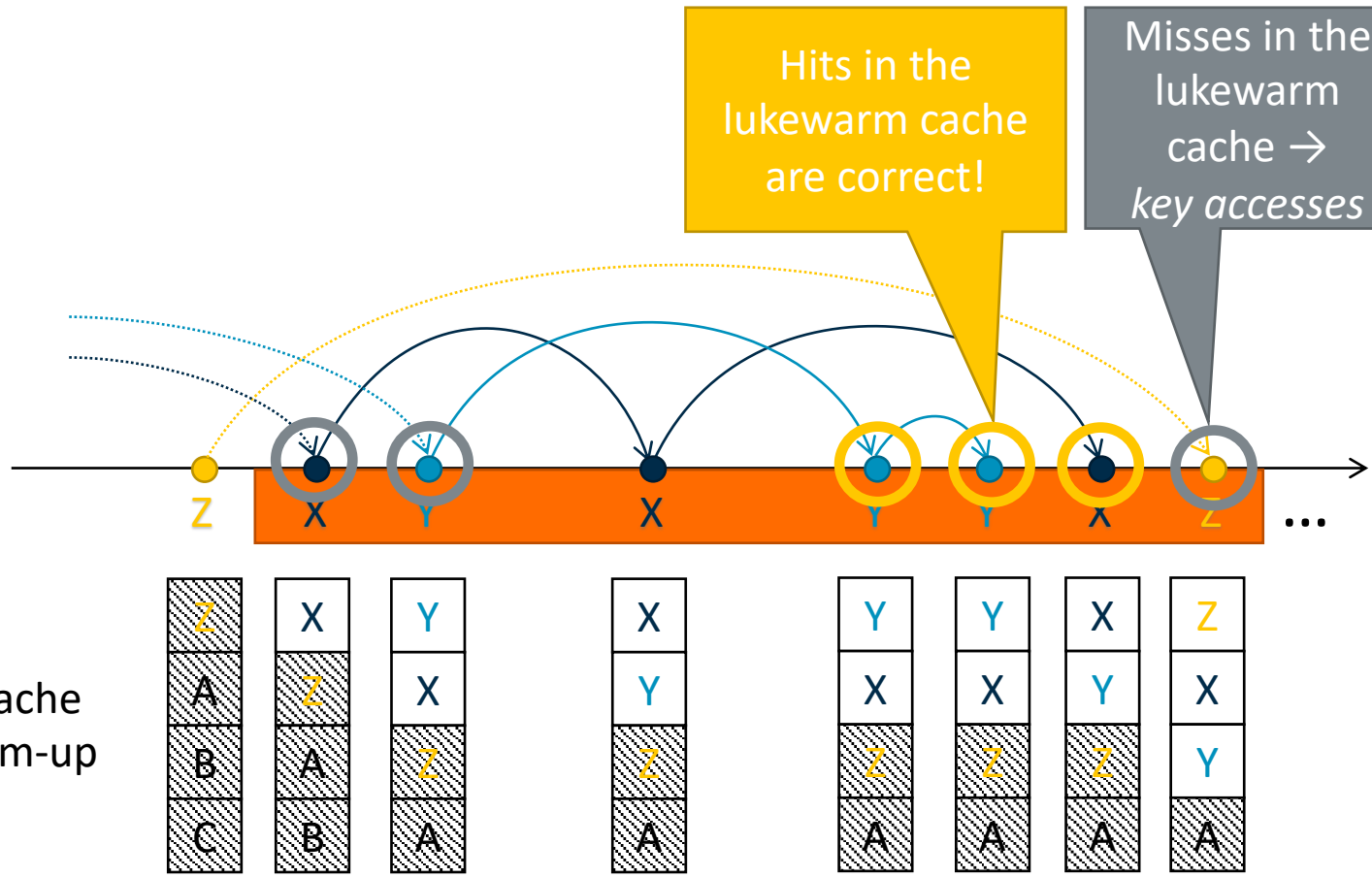
The Lukewarm Cache

Do we need to statistically model every memory instruction?



f(x)

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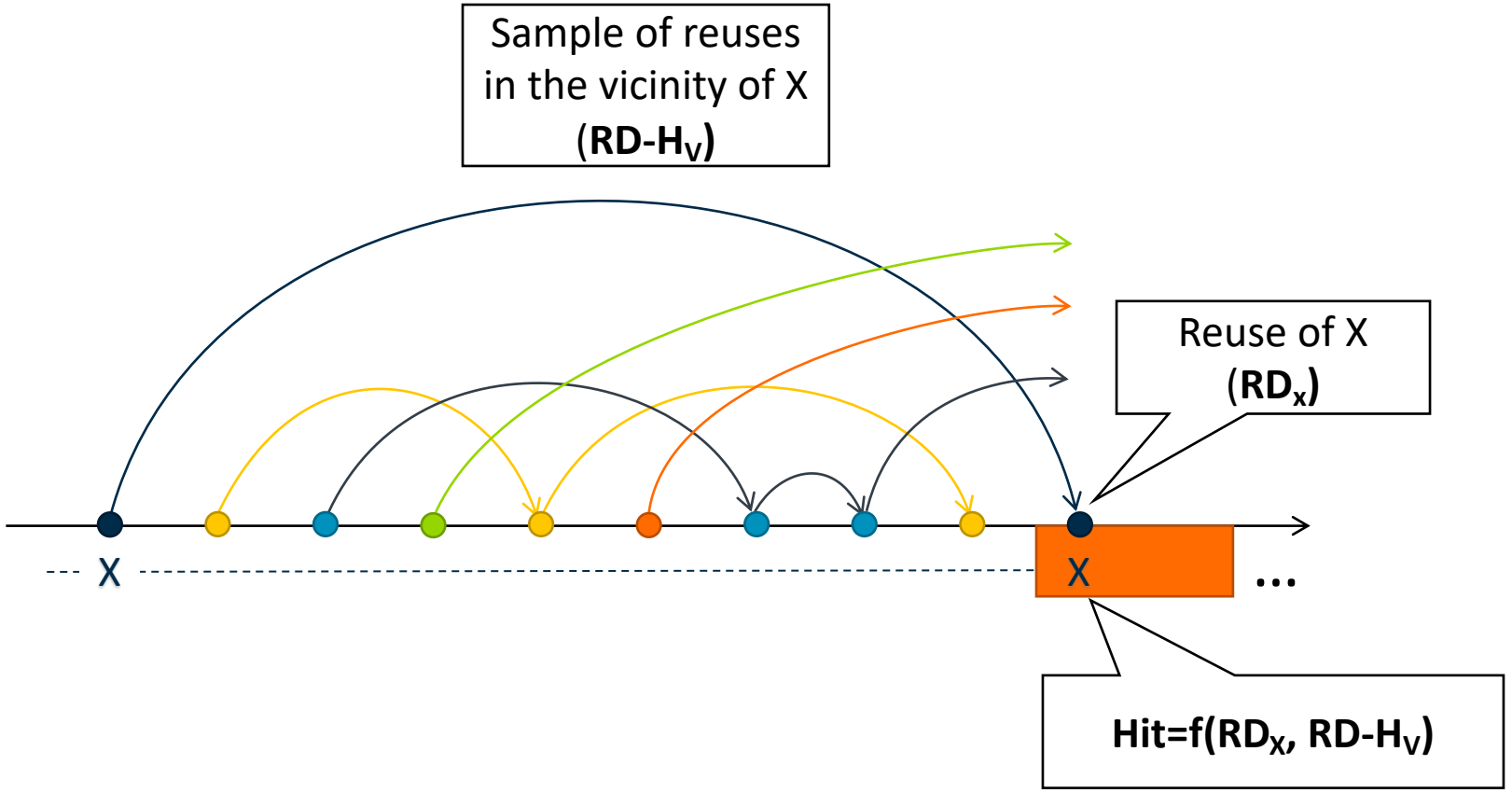
Capacity Model: StatStack



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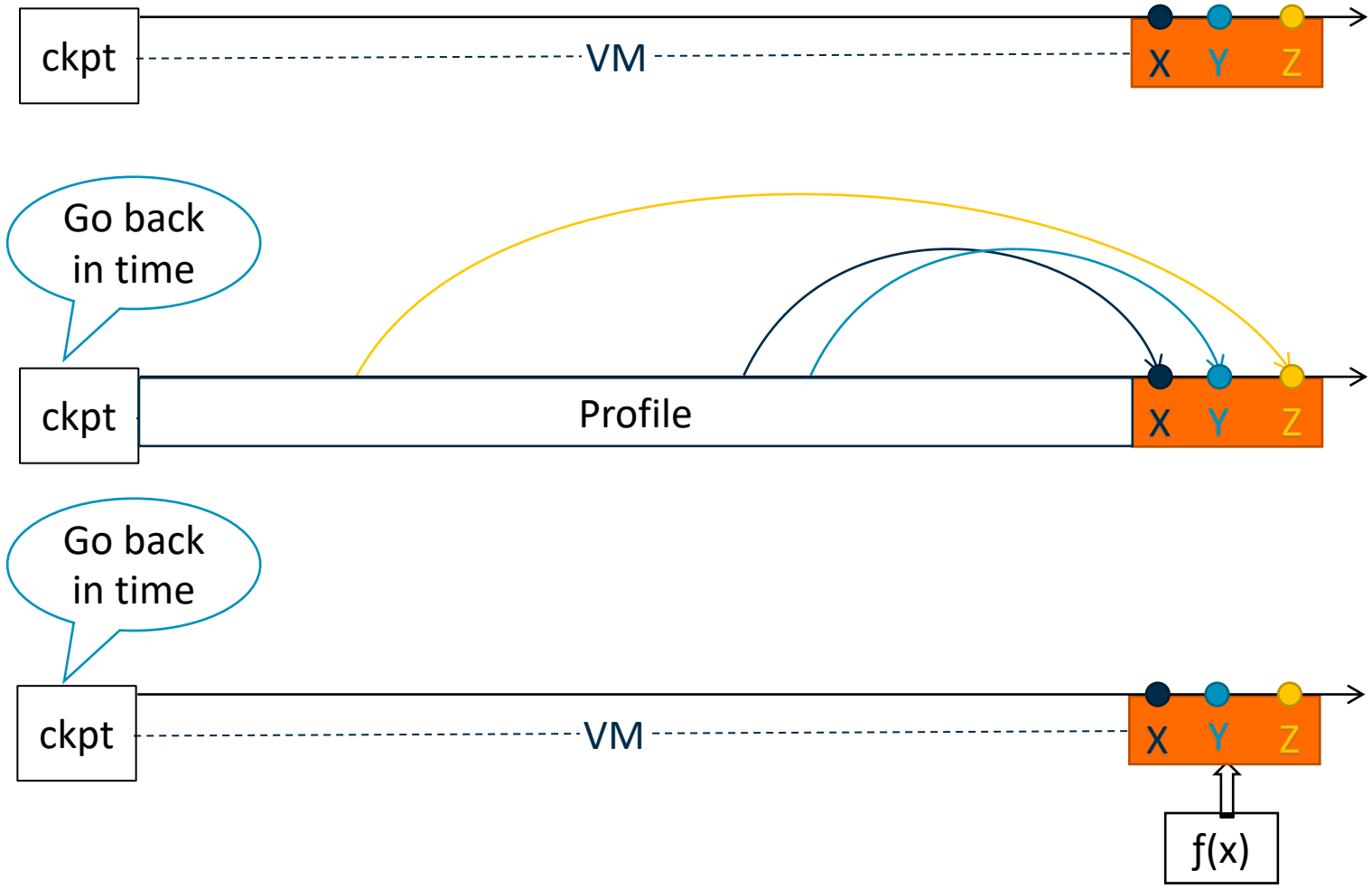
Time Traveling

Record key accesses
Misses in the Lukewarm Cache

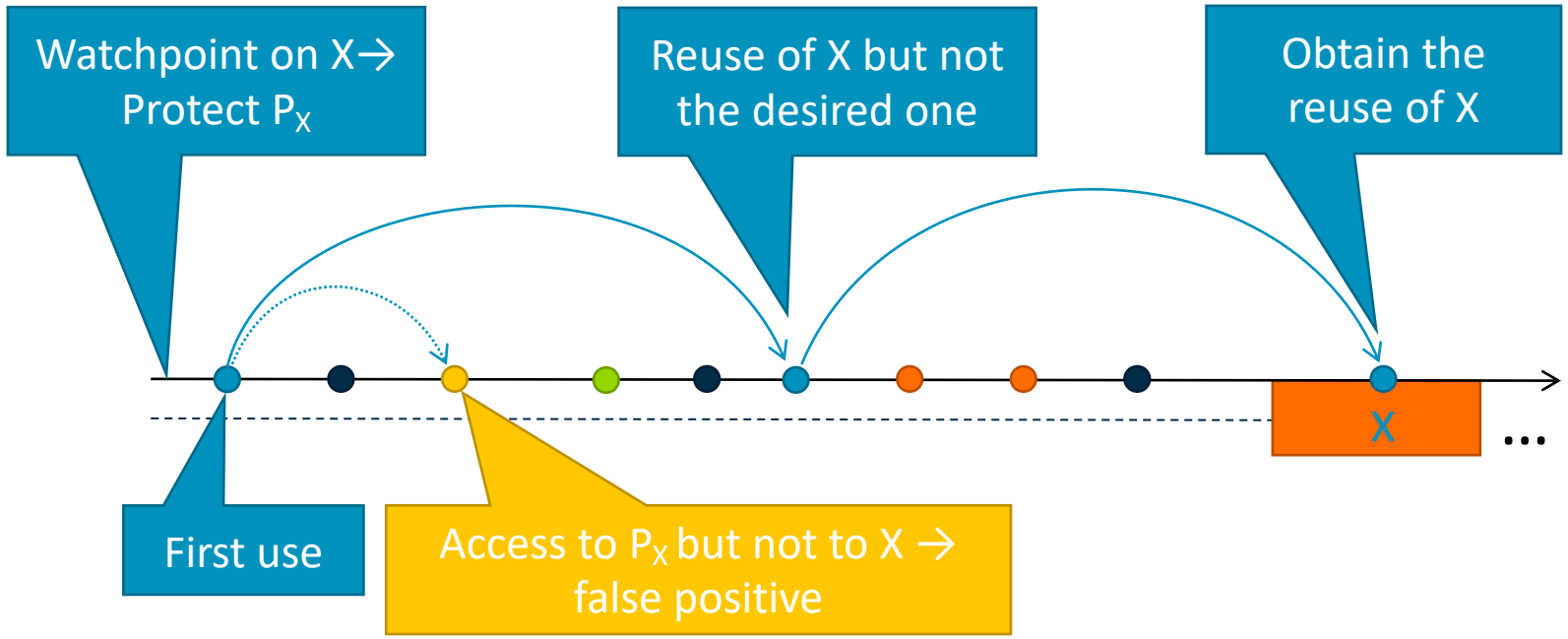
Obtain reuses for key accesses

Detailed simulation and directed cache warming



Directed Reuse Profiling

Obtain reuses for the key accesses while executing in KVM



Avoid false positives for efficient reuse collection

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Time Traveling

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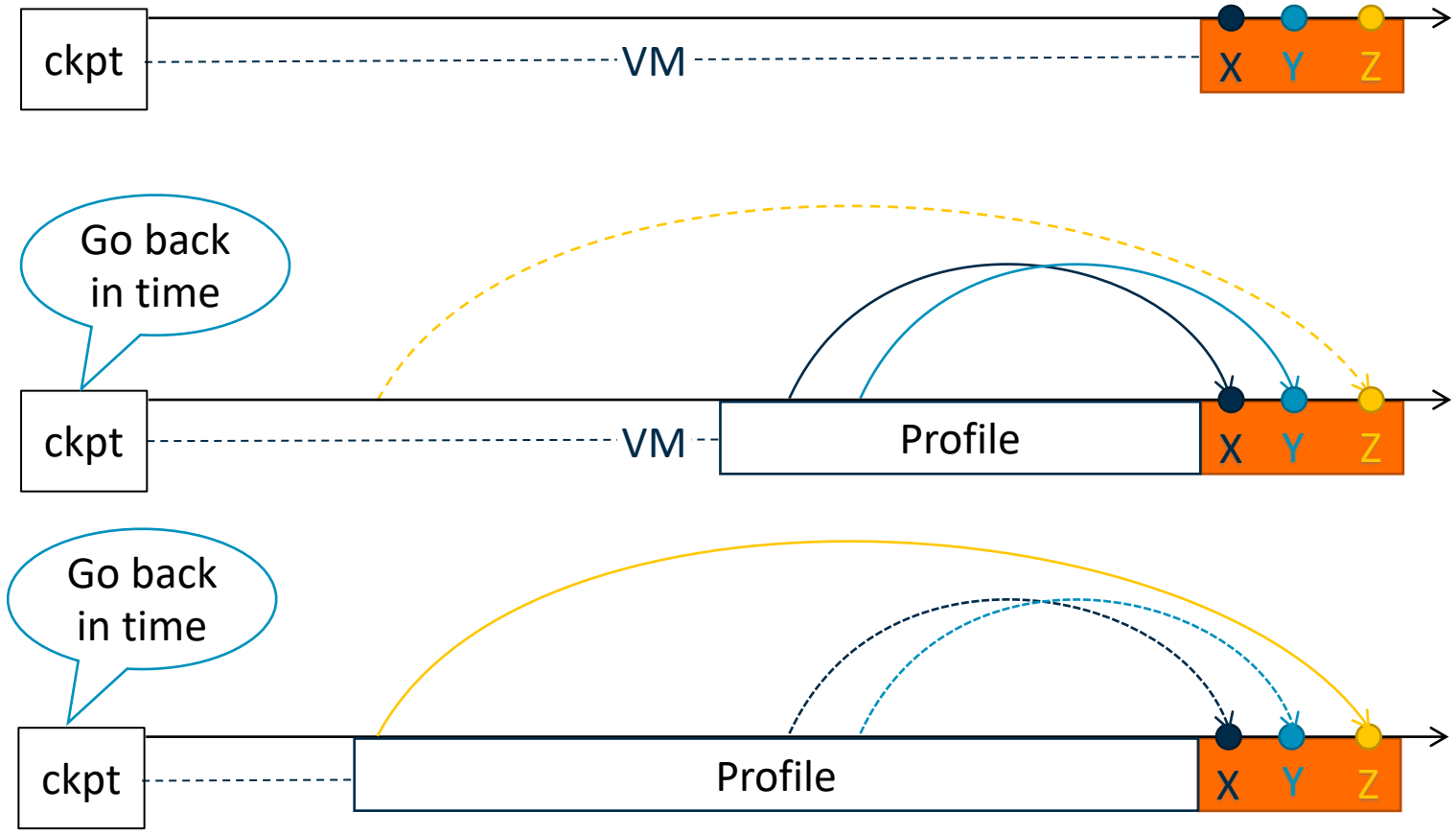

Repeat until reuses for all key accesses are found.
Explorer-n+1 is not always needed!

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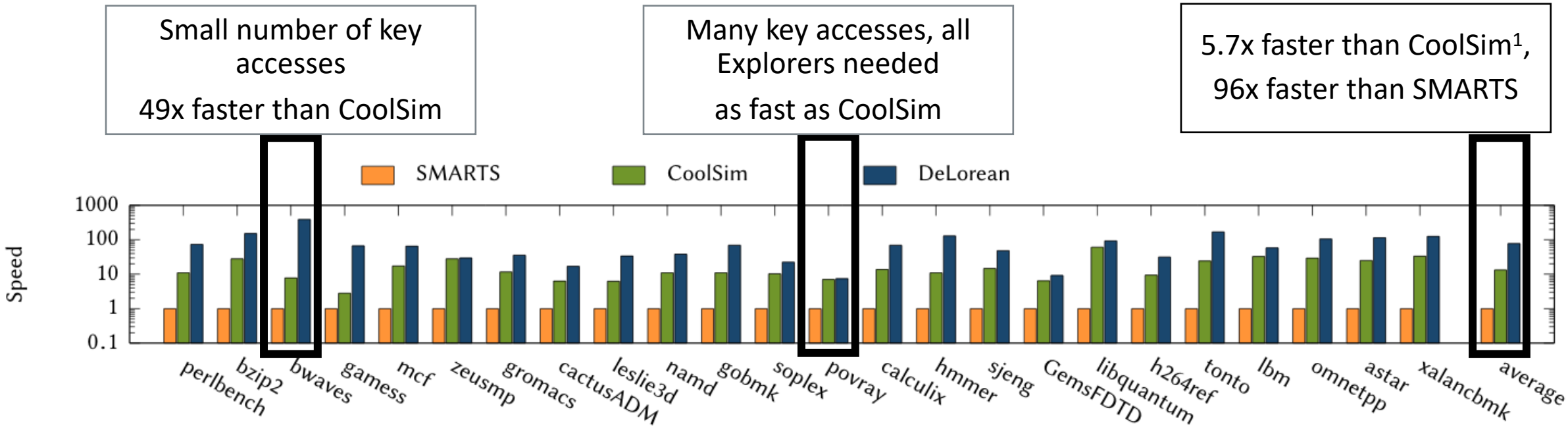
Results: Speed



[1] CoolSim: Statistical Techniques to Replace Cache Warming with Efficient, Virtualized Profiling. Nikoleris et al. SAMOS 2016

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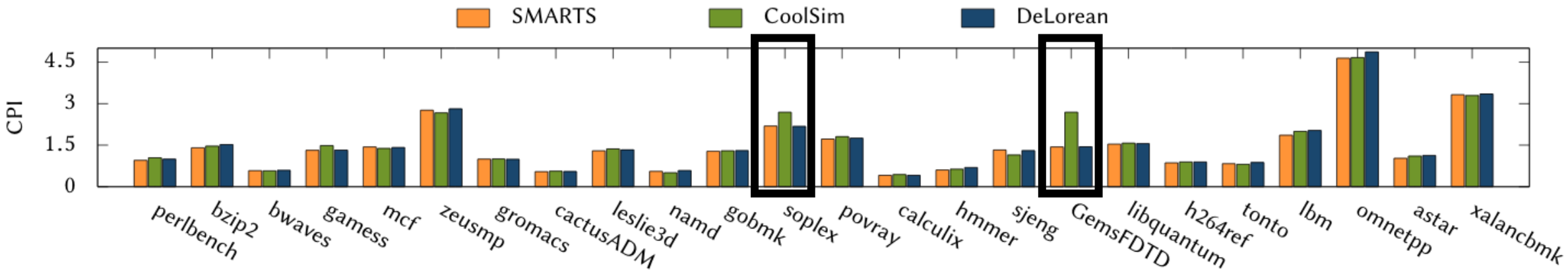
Results: Accuracy

Average error 3.5%



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Conclusion

- Multi-pass approach to identify and capture key memory reuses
  - Time Traveling: Exploits **near-native fast-forwarding** (**KVM**)
  - Targets memory reuse of **key accesses**
- Simulation speed
  - 96x faster than SMARTS
- Accuracy - 3% error on average
- Check the paper for more
  - Multicore simulation
  - Replacement policies
- Code publicly available at:
  - github.com/delorean-sim

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Thank You
Danke
Merci
谢谢
ありがとう
Gracias
Kiitos
감사합니다
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