

Online Model Swapping for Architectural Simulation

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What is Online Model Swapping?

Online Model Swapping consists of

1. **Monitoring** the behavior of simulation components
2. **Training** simple statistical models based on the behavior of those components
3. **Swapping** out the simulation's components with the simpler statistical models

We want to do this so that we can potentially **speed up** simulations for which we don't need full detail for some or all of the components.

The Punchy Results

This work is a proof-of-concept, *but* we have made significant progress towards our goal of creating a simulator that can perform online model swapping. In this work, we have two big results:

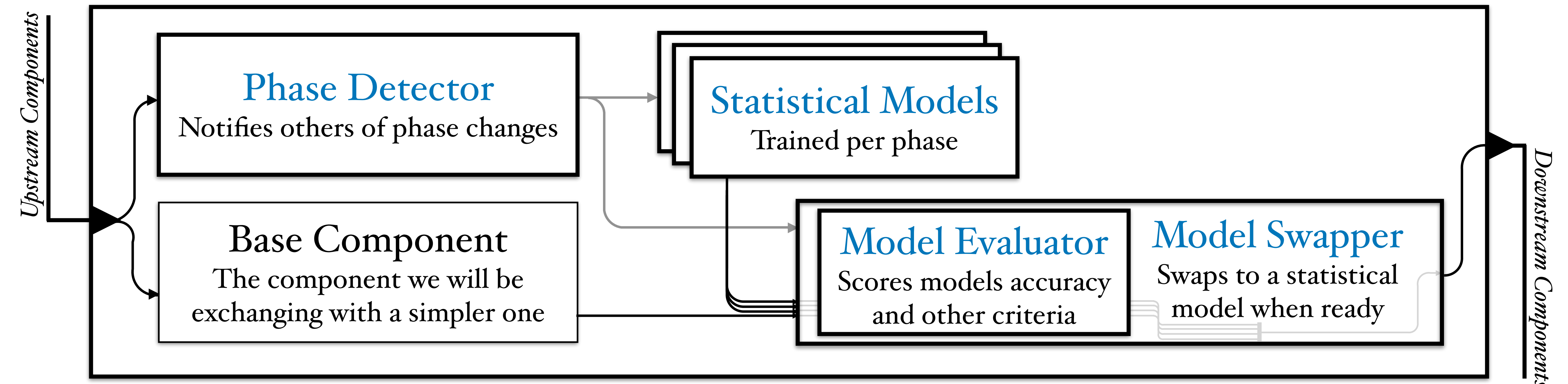
1. We **have designed a framework** for implementing model swapping with many types of components
2. We have demonstrated that **model swapping works** by implementing our framework to swap out the L1 cache component with statistical models that give only an **8% error in simulated cycle count while being used for over 90% of the simulation**

Next Steps

1. Add more statistical models (e.g. **RNNs**)
2. Integrate into **SST**

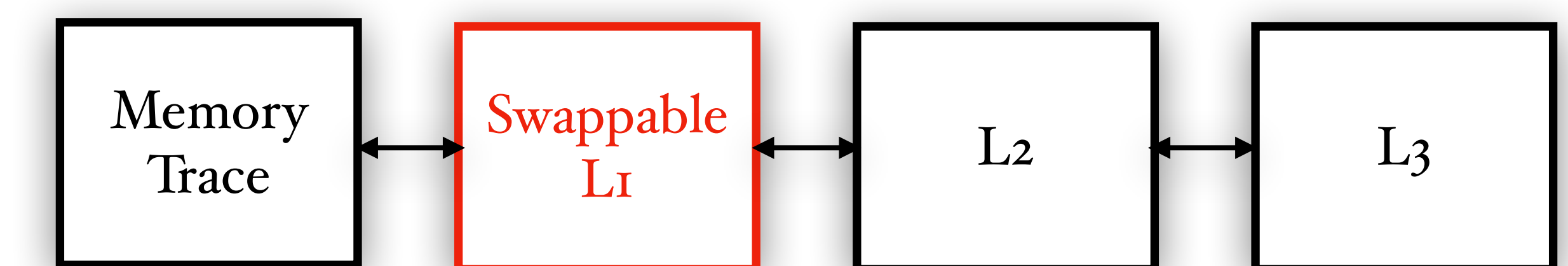
This work was completed in part during an internship at Arm Research. This work used the Hive cluster, which is supported by the National Science Foundation under grant number 1828187.

Result 1: A Model Swapping Framework

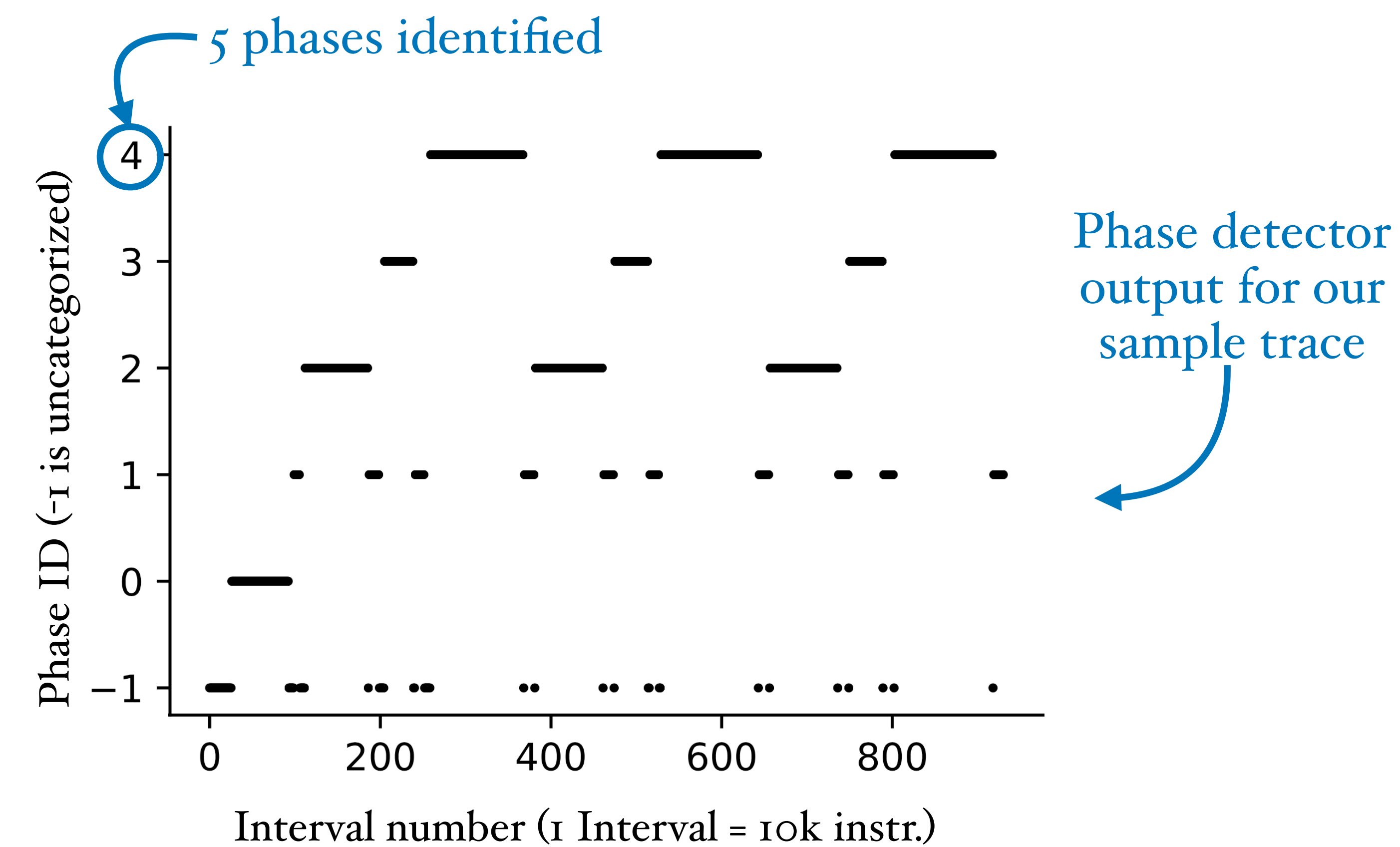


Result 2: Implementation: Swapping the L1 Cache

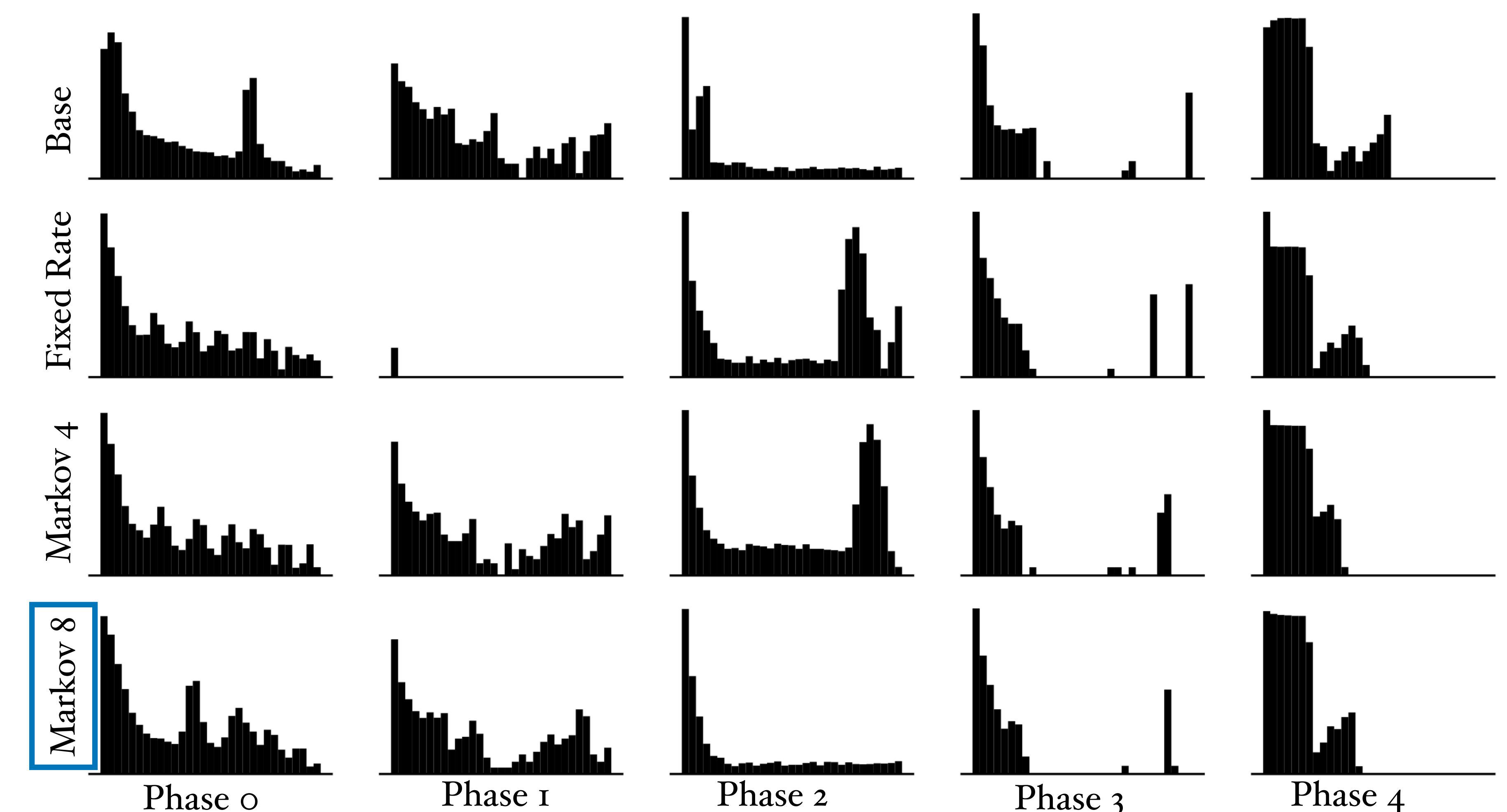
The sve-cachesim simulator, with our model swapping



1. Our working set-based phase detector running on the Meabo benchmark



3. The locality of references entering the L2



2. The accuracy of our three models on the 5 different phases in the trace

	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4
Fixed Rate	0.67	0.99	0.70	0.53	0.74
Markov 4	0.68	0.98	0.71	0.62	0.82
Markov 8	0.73	0.99	0.88	0.69	0.93

How well do the models predict L1 hits?

Do our models break the rest of the system?

4. The effect of swapping on other stats

	L1 Hits	L2 Hits	L3 Hits	Cycles
Base	7.60E+06	7.78E+05	2.53E+05	1.37E+08
Fixed Rate	-0.07%	54.11%	-71.11%	-27.91%
Markov 4	-0.19%	46.10%	-52.14%	-23.13%
Markov 8	0.07%	10.12%	-4.65%	-7.99%