

Simulation Assignments.

240C Winter 2022

1 Cache Replacement Policy

In this homework, you will explore the state of the art replacement policies for LLC using the 2nd Cache Replacement Championship infrastructure and workloads. You can find the winners source code and slides on the website ([click here](#)).

Infrastructure is ChampSim base. Go to the Champsim Github for the current development head of the Champsim source. The following dropbox link contains the set of SPEC2006 and CloudSuite traces used for the competition. Due to bandwidth constraints on the Dropbox account (250GB/day), please limit how many traces you download at a time.

2 Deliverable

For your homework, choose two winner replacement policies. Deliver the following:

1. Summarize the ideas of three winners of the Replacement Policy contest at a high level.
2. Choose two replacement policies. For each policy, list all the meta-data, including details such as the length of histories, etc. Explain the key design of those policies *e.g.* update strategy, etc.
3. Reproduce their main results. Plot main graphs and report the reproduced result error (e.g., the difference between your measured MPKI and MPKI reported in the paper).
4. Explore the design space of each design, for at least "two" main parameters. Explain why you picked those parameters, and plot the performance numbers as you vary those parameters.
5. Analyze your observation from step 4 e.g., explain why the performance is increasing or decreasing, or any particular gap in the curves or sharp changes.
6. By varying the first order size structures kept for each replacement policy, show how each performs using a different hardware budget. Analyze your observations.
7. Compare the constraints on area of replacement policy for Last-Level-Cache with prefetcher for Instruction Cache by (1) comparing the size of I-Cache and LLC, (2)

list the overhead budget range in KB for LLC replacement policies you examined, and (3) report what percentage of LLC size are the overheads. (4) Compute the same percentage for instruction prefetchers overheads from assignment I.

8. Compare the constraints on latency of replacement policy for Last-Level-Cache with prefetcher for Instruction Cache. List three operations (computations or accesses to structures) used in the LLC replacement policies that are not tolerable in front-end processor, explain why.
9. I expect your report for this assignment to be at least "five" pages of IEEE or ACM conference paper format (with references). While you don't have to, I recommend you use Latex! Word produces horrible, unprofessional looking output. Only upload a report pdf to Canvas. Upload your code to a GitHub repository and include a link to it in your report. Include a section in your report on how to run your code, or any instructions required for the TA to reproduce your results. Refer to any modifications you made to ChampSim simulator and where your design exploration codes/scripts are located in the repository. If you have changed the baseline used in the replacement policy Championship, please list and explain.
10. Discuss even small capabilities you incorporated to the infrastructure, i.e. interfaces for the design space exploration in your report. It can go under methodology or your code description section, or a little bit of both. Basically, in your report, you get the chance to try to sell what you already developed, e.g., explain here are the minimal features you added so far and validated, and how you designed it to be scalable where other features can be added for broader design exploration. Explain the limitations.
11. Note, you can iterate through the Assignment I and polish your experiments through one of the following: Repeat the Assignment I evaluations with a larger set of traces, or repeat the evaluations with finer space exploration if you haven't done yet. Report the new results and compare them with old results. Analyse the observations. You can recover up to 60-70% of lost points regarding a low number of examined traces or limited space exploration dimensions/granularity if this iteration satisfies the missed results. You can discuss with your instructor with specific feedback on how to improve your assignment 1 experiments. If you have updates for your first assignment, bind both reports (assignment I and II into one and submit one pdf)
12. **Submit your report by Feb 11, 2022 at 11:59 PM on Canvas under HW2.**