caching

A project that simulates different cache replacement policies such as least recently used (lru) and adaptive replacement cache (acr). The simulations are done on real application caching traces.

Building

To build the project, do:

```
make
```

Tests

To run all the tests, do:

```
make test
```

If the tests are taking too long to run, and you want to run them in parallel, do:

```
make test -j
```

The tests completed in about 4 minutes on `general.asu.edu`.

Input

Sample input is in the `trace` directory. The format is:

- starting block: the starting block of the cache request.
- number of blocks: the number of blocks starting from the starting block. This simulates the concept of locality.
- ignore
- request number: The request number; think line counter.

Theses fields are reflected in the `trace_line` struct in `main.c`.

```
typedef struct {
  int starting_block;
  int number_of_blocks;
  int ignore;
  int request_number;
} trace_line;
```

Output

A sample output file is included `output.txt`. The format is:

- file: the trace file used to generate the line of output.
- capacity: the capacity of the cache in pages; ex: `32768 = (16*1024*1024)/512`.
- algo: the replacement algorithm (lru or acr).
- requests: the total number of requests to the cache.
- hits: the total number of cache hits.
- ratio: the ratio `hits/requests`.

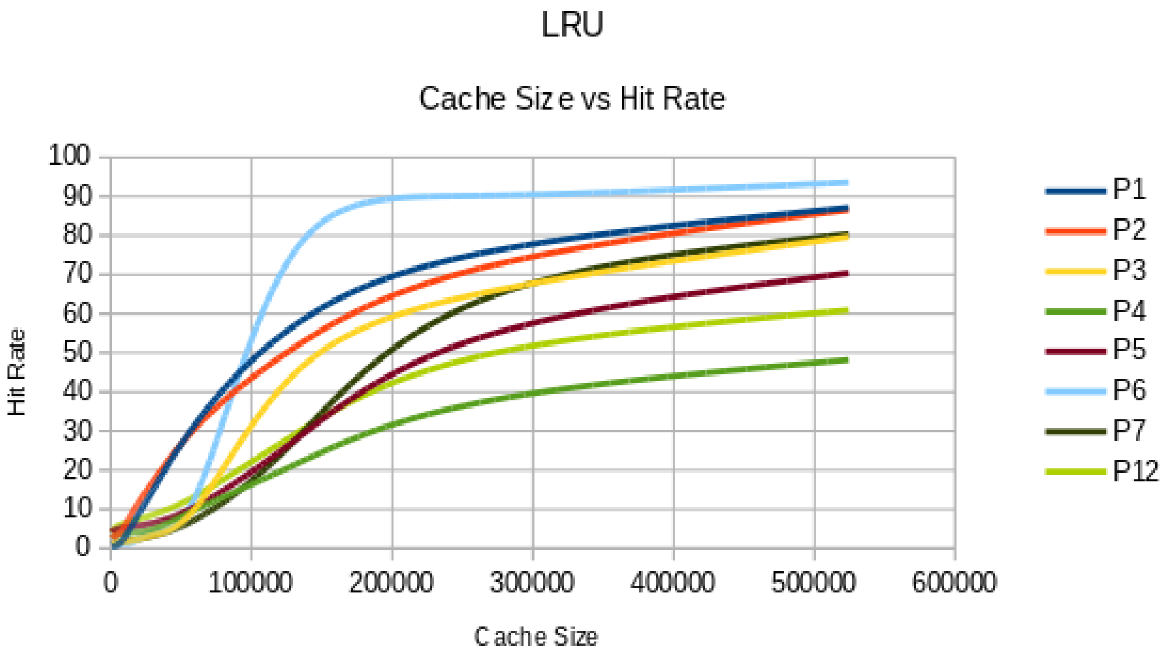
Details

Below are some implementation details for the cache replacement algorithms implemented in this project.

LRU

To calculate the lru for the input trace files, I needed to maintain an ordering of the recently accessed pages. To do this I used a doubly linked list (implemented in `list.h` and `list.c`). However, a linked list has linear search time. To improves search, I used a map (implemented in `map.h` and `map.c`) to have practically constant time search of the linked list.

The following plot summarizes the results from the lru simulation:

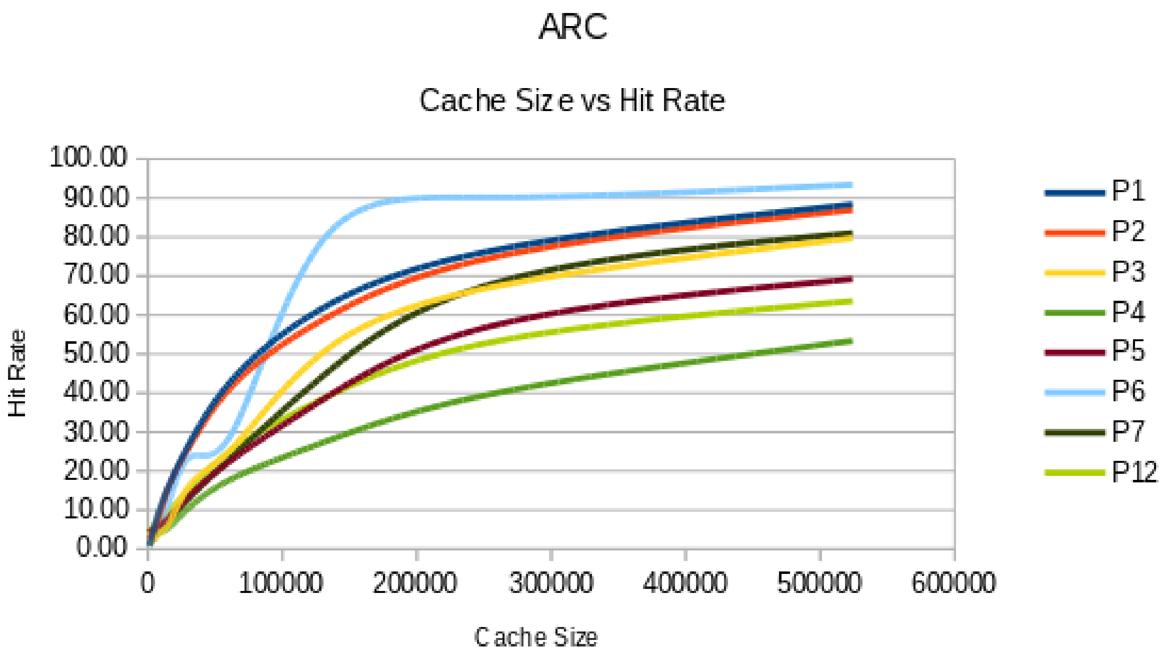


For all of the provided trace files, as the size of the cache increases, The hit rate also increases. However, it does so at a decreasing rate.

ARC

To simulate the arc cache replacement policy, I used the same data structures as the lru. However, I used four lists (t1, t2, b1, b2) as described in the arc algorithm and two maps (pages, ghosts) to keep track of pages in the cache, and pages which are in the ghost cache. My implementation is exactly as described in the research paper.

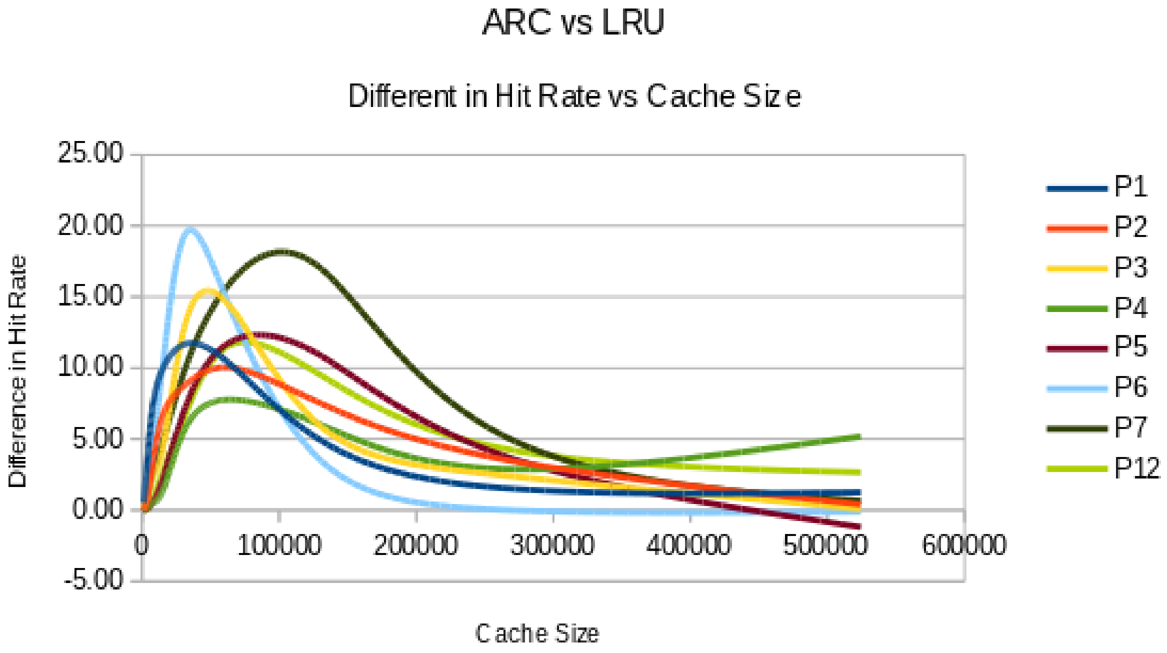
The following plot summarizes the results from the arc simulation:



Similar to lru, as the cache size increases, so does the hit rate. Again, it does so at a decreasing rate.

Comparison

After simulating both algorithms, I compared both algorithms hit rates and plotted the difference in the following graph.



Interestingly, as the cache size increases, the difference between both algorithms seems to decrease. This suggests that as the cache size increases arc and lru perform similarly.