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1 General Overview

The program first reads in the flags from the command line, and verifies them for correctness. Then it creates an array of structs to track the statistics of each inputted tracefile. Next, it creates a hash table for use as the page table, allocate memory for virtual memory. Then it reads all the references from files by calling readRefsFromFiles. It flushes the TLB if necessary, and then performs the necessary additions/lookups by calling addToMemory. Once computation has been completed, it displays it and performs cleanup for termination of the program.

2 How Simulator is Efficient and Scalable

2.1 fileIO.c

1. In line 54 it reads in the entire (4 * Quantum) bytes, rather than reading in 4 bytes quantum times. This removed a significant bottle neck in our code

2.2 memory.c

1. traceFileTracker is a "poor man's hash table" indexed by PID, that allows statistics to be tracked for each tracefile in constant time
2. On line 122 frameBuffer is a hash table used to store pointers to the current nodes in virtualMemory. Giving us near constant time access to seek the nodes.

3. We are tracking the last PID and last page number to determine automatically if the page is already in the TLB, and therefore do not need to search the TLB linearly. These are checked for before any searching is done

2.3 In General

1. We tried to minimize iteration as much as possible by having all arrays index on PID or some uniquely identifiable variable to ensure constant time lookup of data
2. We wrote tests found in the /tests folder to ensure our modules were working as intended
3. We maintained separate .c and .h files for each major functionality that are highly independent to ensure that code was easily debuggable and optimized
4. TLB, all pageTables and virtualMemory are all represented as doubly linked list. This means that we can dynamically allocate all storage and only use up as much memory as we need at any given time and no more.

3 Testing

3.1 Test Suite

- Run "make test" to run the following test suite:
time ./tvm379 1024 128 g 100 800 f heapsort-trace.bin quicksort-trace.bin
time ./tvm379 1024 128 g 100 800 l heapsort-trace.bin quicksort-trace.bin
time ./tvm379 1024 128 g 100 80 f heapsort-trace.bin quicksort-trace.bin
time ./tvm379 1024 128 g 100 80 l heapsort-trace.bin quicksort-trace.bin
time ./tvm379 1024 128 g 100 800 f heapsort-trace.bin
time ./tvm379 1024 128 g 100 800 l heapsort-trace.bin
time ./tvm379 1024 128 g 100 80 f heapsort-trace.bin
time ./tvm379 1024 128 g 100 80 l heapsort-trace.bin
time ./tvm379 1024 128 g 100 800 f quicksort-trace.bin
time ./tvm379 1024 128 g 100 800 l quicksort-trace.bin

```

time ./tvm379 1024 128 g 100 80 f quicksort-trace.bin
time ./tvm379 1024 128 g 100 80 l quicksort-trace.bin
time ./tvm379 65536 256 g 100 1000000 l heapsort-trace.bin quicksort-
trace.bin quicksort-trace.bin heapsort-trace.bin quicksort-trace.bin
time ./tvm379 16 8 g 10 1 l heapsort-trace.bin quicksort-trace.bin
quicksort-trace.bin heapsort-trace.bin quicksort-trace.bin
time ./tvm379 65536 256 g 100 1000000 f heapsort-trace.bin quicksort-
trace.bin quicksort-trace.bin heapsort-trace.bin quicksort-trace.bin
time ./tvm379 16 8 g 10 1 f heapsort-trace.bin quicksort-trace.bin
quicksort-trace.bin heapsort-trace.bin quicksort-trace.bin
time ./tvm379 65536 256 p 100 1000000 l heapsort-trace.bin quicksort-
trace.bin quicksort-trace.bin heapsort-trace.bin quicksort-trace.bin
time ./tvm379 16 8 p 10 1 l heapsort-trace.bin quicksort-trace.bin
quicksort-trace.bin heapsort-trace.bin quicksort-trace.bin
time ./tvm379 65536 256 p 100 1000000 f heapsort-trace.bin quicksort-
trace.bin quicksort-trace.bin heapsort-trace.bin quicksort-trace.bin
time ./tvm379 16 8 p 10 1 f heapsort-trace.bin quicksort-trace.bin
quicksort-trace.bin heapsort-trace.bin quicksort-trace.bin

```

3.2 Results

* Test Machine Specifications

- All tests were run on a 2015 MBP
- Processor: 2.7Gh Intel Core i5
- Memory 8Gb 1867 Mhz DDR3

* Samples output

```

time ./tvm379 1024 128 g 100 800 f heapsort-trace.bin quicksort-trace.bin

39823095  93244  92593  711.398810
41154468  6872  6723  84.640971
          7.25 real          7.09 user          0.13 sys

time ./tvm379 1024 128 g 100 800 l heapsort-trace.bin quicksort-trace.bin

```

```

39824870 56404 55726 718.726178
41154596 7205 7083 77.313509
          11.68 real          10.86 user          0.36 sys

time ./tvm379 1024 128 g 100 80 f heapsort-trace.bin quicksort-trace.bin

39190505 1978395 1978325 73.814592
41108915 59985 59975 6.188825
          6.01 real          5.55 user          0.24 sys

time ./tvm379 1024 128 g 100 80 l heapsort-trace.bin quicksort-trace.bin

39458465 1710435 1710365 73.555660
41152298 16602 16592 6.406009
          7.37 real          7.01 user          0.20 sys

time ./tvm379 1024 128 g 100 800 f heapsort-trace.bin

39766376 58011 57211 792.036306
          6.27 real          6.06 user          0.11 sys

time ./tvm379 1024 128 g 100 800 l heapsort-trace.bin

39767413 45821 45021 792.056215
          8.27 real          8.16 user          0.08 sys

time ./tvm379 1024 128 g 100 80 f heapsort-trace.bin

39138944 1956456 1956376 79.921258
          4.09 real          4.00 user          0.07 sys

time ./tvm379 1024 128 g 100 80 l heapsort-trace.bin

39407989 1687411 1687331 79.923227
          5.20 real          4.87 user          0.13 sys

time ./tvm379 1024 128 g 100 800 f quicksort-trace.bin

41163636 1798 998 792.050524
          1.18 real          1.08 user          0.07 sys

```

```
time ./tvm379 1024 128 g 100 800 l quicksort-trace.bin
```

```
41163635 1792 992 792.070397
          2.70 real          2.19 user          0.16 sys
```

```
time ./tvm379 1024 128 g 100 80 f quicksort-trace.bin
```

```
41162782 6118 6038 79.921399
          1.37 real          1.15 user          0.10 sys
```

```
time ./tvm379 1024 128 g 100 80 l quicksort-trace.bin
```

```
41162832 6068 5988 79.923364
          3.39 real          2.46 user          0.18 sys
```

```
time ./tvm379 65536 256 g 100 1000000 l heapsort-trace.bin quicksort-trace.bin quicksort-trace.bin
```

```
41168883 17 0 16.808974
41168884 16 0 15.808974
41168884 16 0 15.808974
41168884 16 0 15.808974
41168884 16 0 15.808974
          11.40 real          10.67 user          0.38 sys
```

```
time ./tvm379 16 8 g 10 1 l heapsort-trace.bin quicksort-trace.bin quicksort-trace.bin
```

```
0 41168890 41168890 0.900000
0 41168890 41168890 0.900000
0 41168890 41168890 0.900000
0 41168890 41168890 0.900000
0 41168890 41168889 0.900000
          94.20 real          91.14 user          1.01 sys
```

```
time ./tvm379 65536 256 g 100 1000000 f heapsort-trace.bin quicksort-trace.bin quicksort-trace.bin
```

```
41168883 17 0 16.808971
41168884 16 0 15.808974
41168884 16 0 15.808974
```

```

41168884 16 0 15.808974
41168884 16 0 15.808974
          6.77 real          5.62 user          0.44 sys

```

```
time ./tvm379 16 8 g 10 1 f heapsort-trace.bin quicksort-trace.bin quicksort-trace.bin
```

```

21874890 19294000 19294000 0.900000
17247294 23921596 23921596 0.900000
17247294 23921596 23921596 0.900000
21874887 19294003 19294003 0.900000
17247294 23921596 23921595 0.900000
          53.28 real          51.84 user          0.70 sys

```

```
time ./tvm379 65536 256 p 100 1000000 l heapsort-trace.bin quicksort-trace.bin quicksort-trace.bin
```

```

38996139 17 0 16.808974
40511616 16 0 15.808974
40511616 16 0 15.808974
38996141 16 0 15.808974
40511616 16 0 15.808974
          12.81 real          12.31 user          0.33 sys

```

```
time ./tvm379 16 8 p 10 1 l heapsort-trace.bin quicksort-trace.bin quicksort-trace.bin
```

```

0 41168890 41168890 0.900000
0 41168890 41168890 0.900000
0 41168890 41168890 0.900000
0 41168890 41168890 0.900000
0 41168890 41168889 0.900000
          104.13 real          99.27 user          1.31 sys

```

```
time ./tvm379 65536 256 p 100 1000000 f heapsort-trace.bin quicksort-trace.bin quicksort-trace.bin
```

```

38996140 17 0 16.808971
40511616 16 0 15.808974
40511616 16 0 15.808974
38996141 16 0 15.808974
40511616 16 0 15.808974
          6.92 real          6.65 user          0.24 sys

```

```
time ./tvm379 16 8 p 10 1 f heapsort-trace.bin quicksort-trace.bin quicksort-trace.bin
```

```
21874890 19294000 19294000 0.900000  
17247294 23921596 23921596 0.900000  
17247294 23921596 23921596 0.900000  
21874887 19294003 19294003 0.900000  
17247294 23921596 23921595 0.900000
```

```
56.96 real 56.09 user 0.50 sys
```