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Class: CS 1550 - Operating Systems
Professor: Professor John Misurda
Project: Assignment 3 - VM Simulator
Website: http://people.cs.pitt.edu/~jmisurda/teaching/cs1550/2151/cs1550-2151-project3.htm

Files in directory:

vmsim.py
argparse.py
argparse.pyc
README.pdf

Some comments about the program:

- The project is written in python. Therefore to run it, type the command:

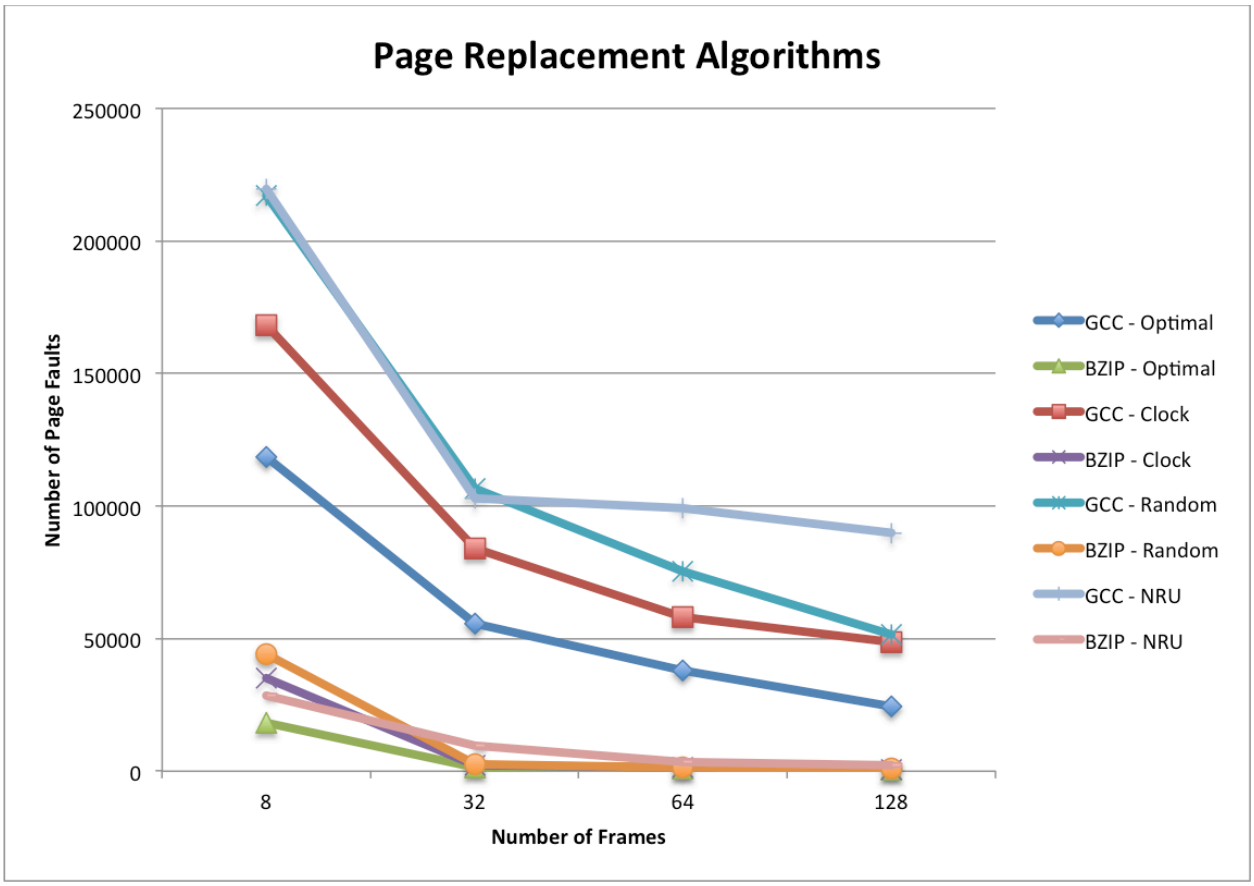
python vmsim.py –n <numframes> -a <opt|clock|nru|rand> [-r <refresh>] <tracefile>

from the directory that vmsim.py is in.

- Because the version of python on thot.cs.pitt.edu is Python2.6 and not Python2.7 or later, I had to manually include the argparse module. This is the sole purpose of the two files, argparse.py and argparse.pyc. They are necessary for vmsim.py to run.
- The project is fairly commented, but if you have problems with my algorithms, email me at the email above.

Results from the program:

As seen in the chart below, there was a pretty strong difference between the bzip.trace file provided and the gcc.trace file provided. From the gcc.trace file, it is pretty easy to conclude that the closest algorithm to optimal is clock. The bzip.trace file is a little less conclusive. From the charts, we notice that the clock algorithm is the most optimal for 32 frames, 64 frames, and 128 frames. However, at 8 frames NRU provided the most optimal algorithm with a refresh every 75 cycles. From this evidence, I still conclude that the Clock algorithm is the most optimal algorithm overall and therefore is the algorithm I would choose to implement in a real OS.


Page Replacement Algorithms
250000
200000
150000
100000
50000
0
Number of Page Faults
8
32
64
128
Number of Frames
GCC - Optimal
BZIP - Optimal
GCC - Clock
BZIP - Clock
GCC - Random
BZIP - Random
GCC - NRU
BZIP - NRU

Optimal Page Replacement Algorithm Chart

	8 frames		32 frames		64 frames		128 frames	
Trace:	gcc	bzip	gcc	bzip	gcc	bzip	gcc	bzip
# page faults	118480	18251	55802	1330	38050	821	24391	497
# writes to disk	15031	7580	8274	460	5738	283	3968	137

Raw data for Optimal Page Replacement Algorithm

GCC.TRACE :

```
Number of frames : 8
Total memory access: 1000000
Total page faults: 118480
Total writes to disk: 15031

Number of frames : 32
Total memory access: 1000000
Total page faults: 55802
Total writes to disk: 8274

Number of frames : 64
Total memory access: 1000000
Total page faults: 38050
Total writes to disk: 5730

Number of frames : 128
Total memory access: 1000000
Total page faults: 24391
Total writes to disk: 3968
```

BZIP.TRACE:

```
Number of frames : 8
Total memory access: 1000000
Total page faults: 18251
Total writes to disk: 7580

Number of frames : 32
Total memory access: 1000000
Total page faults: 1330
Total writes to disk: 460

Number of frames : 64
Total memory access: 1000000
Total page faults: 821
Total writes to disk: 283

Number of frames : 128
Total memory access: 1000000
Total page faults: 497
Total writes to disk: 137
```

Clock Page Replacement Algorithm

	8 frames		32 frames		64 frames		128 frames	
Trace:	gcc	bzip	gcc	bzip	gcc	bzip	gcc	bzip
# page faults	168290	34926	83859	2119	57952	1280	48716	787
# writes to disk	22848	12155	11522	701	8682	419	6846	231

Raw data for Clock Page Replacement Algorithm :

GCC.TRACE

```
Number of frames : 8
Total memory access: 1000000
Total page faults: 168290
Total writes to disk: 22848

Number of frames : 32
Total memory access: 1000000
Total page faults: 83859
Total writes to disk: 11522

Number of frames : 64
Total memory access: 1000000
Total page faults: 57952
Total writes to disk: 8682

Number of frames : 128
Total memory access: 1000000
Total page faults: 40716
Total writes to disk: 6046
```

BZIP.TRACE

```
Number of frames : 8
Total memory access: 1000000
Total page faults: 34926
Total writes to disk: 12155

Number of frames : 32
Total memory access: 1000000
Total page faults: 2119
Total writes to disk: 701

Number of frames : 64
Total memory access: 1000000
Total page faults: 1280
Total writes to disk: 419

Number of frames : 128
Total memory access: 1000000
Total page faults: 787
Total writes to disk: 231
```

Random Page Replacement Algorithm

	8 frames		32 frames		64 frames		128 frames	
Trace:	gcc	bzip	gcc	bzip	gcc	bzip	gcc	bzip
# page faults	217074	44297	106683	2621	75195	1591	51528	900
# writes to disk	37386	16481	17347	873	12250	563	8631	30

Raw Data for Random Page Replacement Algorithm

GCC.TRACE

```
Number of frames : 8
Total memory access: 1000000
Total page faults: 217074
Total writes to disk: 37386

Number of frames : 32
Total memory access: 1000000
Total page faults: 106683
Total writes to disk: 17347

Number of frames : 64
Total memory access: 1000000
Total page faults: 75195
Total writes to disk: 12250

Number of frames : 128
Total memory access: 1000000
Total page faults: 51528
Total writes to disk: 8631
```

BZIP.TRACE

```
Number of frames : 8
Total memory access: 1000000
Total page faults: 44297
Total writes to disk: 16481

Number of frames : 32
Total memory access: 1000000
Total page faults: 2621
Total writes to disk: 873

Number of frames : 64
Total memory access: 1000000
Total page faults: 1591
Total writes to disk: 563

Number of frames : 128
Total memory access: 1000000
Total page faults: 900
Total writes to disk: 30
```

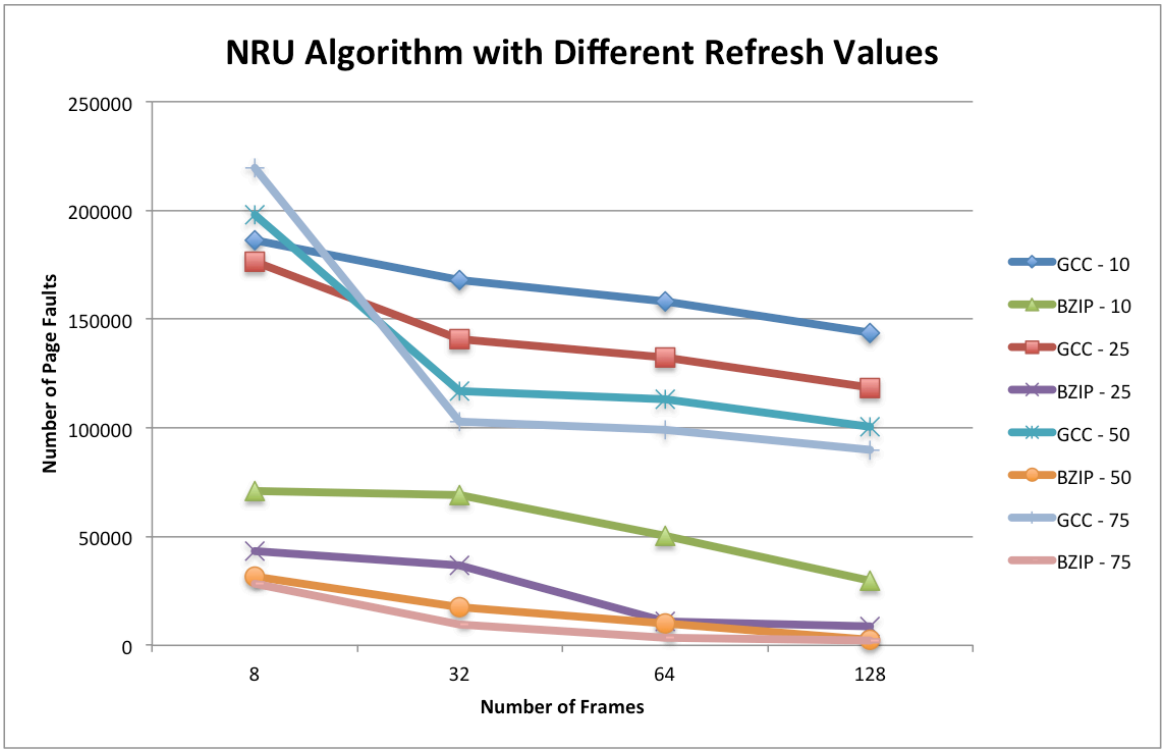
NRU Page Replacement Algorithm

Refresh = 10								
	8 frames		32 frames		64 frames		128 frames	
Tracefile	Gcc	Bzip	Gcc	Bzip	Gcc	Bzip	Gcc	Bzip
# page faults	186053	70835	167753	69036	158085	50557	143778	29548
# writes to disk	17488	12249	12688	12864	11118	3200	10448	82

Refresh = 25								
	8 frames		32 frames		64 frames		128 frames	
Tracefile	Gcc	Bzip	Gcc	Bzip	Gcc	Bzip	Gcc	Bzip
# page faults	176341	43322	140922	36578	132364	11049	118543	8720
# writes to disk	19021	6857	11083	5008	10278	568	9334	69

Refresh = 50								
	8 frames		32 frames		64 frames		128 frames	
Tracefile	Gcc	Bzip	Gcc	Bzip	Gcc	Bzip	Gcc	Bzip
# page faults	197881	31503	117062	17636	113027	10019	100474	2374
# writes to disk	18938	7547	10122	2227	9676	1663	8440	86

Refresh = 75								
	8 frames		32 frames		64 frames		128 frames	
Tracefile	Gcc	Bzip	Gcc	Bzip	Gcc	Bzip	Gcc	Bzip
# page faults	219676	28431	102998	9796	99008	3515	89911	2220
# writes to disk	18388	7855	9636	2753	9158	570	8278	69



From this graph of the Refresh values, I determined that the best refresh value to use is 75 cycles. This is clearly noticed in the graph because 75 cycles provided the lowest page fault values for both the bzip.trace file and the gcc.trace file.

Raw data for NRU Page Replacement Algorithm

REFRESH = 10

GCC.TRACE

```
Number of frames : 8
Total memory access: 1000000
Total page faults: 186053
Total writes to disk: 17488

Number of frames : 32
Total memory access: 1000000
Total page faults: 167753
Total writes to disk: 12680

Number of frames : 64
Total memory access: 1000000
Total page faults: 158085
Total writes to disk: 11118

Number of frames : 128
Total memory access: 1000000
Total page faults: 143778
Total writes to disk: 10448
```

```
Number of frames : 8
Total memory access: 1000000
Total page faults: 70835
Total writes to disk: 12249

Number of frames : 32
Total memory access: 1000000
Total page faults: 69036
Total writes to disk: 12864

Number of frames : 64
Total memory access: 1000000
Total page faults: 50557
Total writes to disk: 3200

Number of frames : 128
Total memory access: 1000000
Total page faults: 29548
Total writes to disk: 82
```

BZIP.TRACE

REFRESH = 25

GCC.TRACE

```
Number of frames : 8
Total memory access: 1000000
Total page faults: 176341
Total writes to disk: 19021
```

```
Number of frames : 32
Total memory access: 1000000
Total page faults: 140922
Total writes to disk: 11083
```

Number of frames : 64
Total memory access: 1000000
Total page faults: 132364
Total writes to disk: 10278

Number of frames : 128
Total memory access: 1000000
Total page faults: 118543
Total writes to disk: 9334

BZIP.TRACE

Number of frames : 8
Total memory access: 1000000
Total page faults: 43322
Total writes to disk: 6857

Number of frames : 32
Total memory access: 1000000
Total page faults: 36578
Total writes to disk: 5008

Number of frames : 64
Total memory access: 1000000
Total page faults: 11049
Total writes to disk: 568

Number of frames : 128
Total memory access: 1000000
Total page faults: 8720
Total writes to disk: 69

REFRESH = 50

GCC.TRACE

Number of frames : 8
Total memory access: 1000000
Total page faults: 197881
Total writes to disk: 18938

Number of frames : 32
Total memory access: 1000000
Total page faults: 117062
Total writes to disk: 10122

Number of frames : 64
Total memory access: 1000000
Total page faults: 113027
Total writes to disk: 9676

Number of frames : 128
Total memory access: 1000000
Total page faults: 100474
Total writes to disk: 8440

BZIP.TRACE

Number of frames : 8
Total memory access: 1000000
Total page faults: 31503
Total writes to disk: 7547

Number of frames : 32
Total memory access: 1000000
Total page faults: 17636
Total writes to disk: 2227

Number of frames : 64
Total memory access: 1000000
Total page faults: 10019
Total writes to disk: 1663

Number of frames : 128
Total memory access: 1000000
Total page faults: 2374
Total writes to disk: 86

REFRESH = 75

GCC.TRACE

Number of frames : 8
Total memory access: 1000000
Total page faults: 219676
Total writes to disk: 18388

Number of frames : 32
Total memory access: 1000000
Total page faults: 102998
Total writes to disk: 9636

Number of frames : 64
Total memory access: 1000000
Total page faults: 99008
Total writes to disk: 9158

Number of frames : 128
Total memory access: 1000000
Total page faults: 89911
Total writes to disk: 8278

BZIP.TRACE

Number of frames : 8
Total memory access: 1000000
Total page faults: 28431
Total writes to disk: 7855

Number of frames : 32
Total memory access: 1000000
Total page faults: 9796
Total writes to disk: 2753

Number of frames : 64
Total memory access: 1000000
Total page faults: 3515
Total writes to disk: 570

Number of frames : 128
Total memory access: 1000000
Total page faults: 2220
Total writes to disk: 69