**Mem size: 50**

Simpleloop:

RAND:

Hit count: 7298

Miss count: 2990

Clean evictions: 139

Dirty evictions: 2801

Hit rate: 70.9370

Miss rate: 29.0630

FIFO:

Hit count: 7304

Miss count: 2984

Clean evictions: 132

Dirty evictions: 2802

Hit rate: 70.9953

Miss rate: 29.0047

CLOCK:

Hit count: 7484

Miss count: 2804

Clean evictions: 72

Dirty evictions: 2682

Hit rate: 72.7449

Miss rate: 27.2551

LRU:

Hit count: 7505

Miss count: 2783

Clean evictions: 67

Dirty evictions: 2666

Hit rate: 72.9491

Miss rate: 27.0509

OPT:

Hit count: 7619

Miss count: 2669

Clean evictions: 18

Dirty evictions: 2601

Hit rate: 74.0572

Miss rate: 25.9428

Matmul:

RAND:

Hit count: 1892150

Miss count: 995842

Clean evictions: 478284

Dirty evictions: 517508

Hit rate: 65.5178

Miss rate: 34.4822

FIFO:

Hit count: 1760714

Miss count: 1127278

Clean evictions: 541687

Dirty evictions: 585541

Hit rate: 60.9667

Miss rate: 39.0333

CLOCK:

Hit count: 1846735

Miss count: 1041257

Clean evictions: 520112

Dirty evictions: 521095

Hit rate: 63.9453

Miss rate: 36.0547

LRU:

Hit count: 1846765

Miss count: 1041227

Clean evictions: 520102

Dirty evictions: 521075

Hit rate: 63.9463

Miss rate: 36.0537

OPT:

Hit count: 2300535

Miss count: 587457

Clean evictions: 293415

Dirty evictions: 293992

Hit rate: 79.6586

Miss rate: 20.3414

Blocked:

RAND:

Hit count: 2409652

Miss count: 8516

Clean evictions: 3116

Dirty evictions: 5350

Hit rate: 99.6478

Miss rate: 0.3522

FIFO:

Hit count: 2411656

Miss count: 6512

Clean evictions: 2123

Dirty evictions: 4339

Hit rate: 99.7307

Miss rate: 0.2693

CLOCK:

Hit count: 2412906

Miss count: 5262

Clean evictions: 1468

Dirty evictions: 3744

Hit rate: 99.7824

Miss rate: 0.2176

LRU:

Hit count: 2412951

Miss count: 5217

Clean evictions: 1434

Dirty evictions: 3733

Hit rate: 99.7843

Miss rate: 0.2157

OPT:

Hit count: 2414459

Miss count: 3709

Clean evictions: 1321

Dirty evictions: 2338

Hit rate: 99.8466

Miss rate: 0.1534

Freq5:

RAND:

Hit count: 391621

Miss count: 826

Clean evictions: 293

Dirty evictions: 483

Hit rate: 99.7895

Miss rate: 0.2105

FIFO:

Hit count: 391608

Miss count: 839

Clean evictions: 291

Dirty evictions: 498

Hit rate: 99.7862

Miss rate: 0.2138

CLOCK:

Hit count: 391841

Miss count: 606

Clean evictions: 199

Dirty evictions: 357

Hit rate: 99.8456

Miss rate: 0.1544

LRU:

Hit count: 391908

Miss count: 539

Clean evictions: 181

Dirty evictions: 308

Hit rate: 99.8627

Miss rate: 0.1373

OPT:

Hit count: 392153

Miss count: 294

Clean evictions: 70

Dirty evictions: 174

Hit rate: 99.9251

Miss rate: 0.0749

**Mem Size: 100**

Simpleloop:

RAND:

Hit count: 7509

Miss count: 2779

Clean evictions: 37

Dirty evictions: 2642

Hit rate: 72.9879

Miss rate: 27.0121

FIFO:

Hit count: 7530

Miss count: 2758

Clean evictions: 33

Dirty evictions: 2625

Hit rate: 73.1921

Miss rate: 26.8079

CLOCK:

Hit count: 7600

Miss count: 2688

Clean evictions: 4

Dirty evictions: 2584

Hit rate: 73.8725

Miss rate: 26.1275

LRU:

Hit count: 7602

Miss count: 2686

Clean evictions: 2

Dirty evictions: 2584

Hit rate: 73.8919

Miss rate: 26.1081

OPT:

Hit count: 7644

Miss count: 2644

Clean evictions: 0

Dirty evictions: 2544

Hit rate: 74.3002

Miss rate: 25.6998

Matmul:

RAND:

Hit count: 2564985

Miss count: 323007

Clean evictions: 157906

Dirty evictions: 165001

Hit rate: 88.8155

Miss rate: 11.1845

FIFO:

Hit count: 1804445

Miss count: 1083547

Clean evictions: 530672

Dirty evictions: 552775

Hit rate: 62.4810

Miss rate: 37.5190

CLOCK:

Hit count: 1846883

Miss count: 1041109

Clean evictions: 520031

Dirty evictions: 520978

Hit rate: 63.9504

Miss rate: 36.0496

LRU:

Hit count: 1881535

Miss count: 1006457

Clean evictions: 502791

Dirty evictions: 503566

Hit rate: 65.1503

Miss rate: 34.8497

OPT:

Hit count: 2795193

Miss count: 92799

Clean evictions: 46006

Dirty evictions: 46693

Hit rate: 96.7867

Miss rate: 3.2133

Blocked:

RAND:

Hit count: 2412871

Miss count: 5297

Clean evictions: 1857

Dirty evictions: 3340

Hit rate: 99.7809

Miss rate: 0.2191

FIFO:

Hit count: 2413829

Miss count: 4339

Clean evictions: 1398

Dirty evictions: 2841

Hit rate: 99.8206

Miss rate: 0.1794

CLOCK:

Hit count: 2414144

Miss count: 4024

Clean evictions: 1334

Dirty evictions: 2590

Hit rate: 99.8336

Miss rate: 0.1664

LRU:

Hit count: 2414381

Miss count: 3787

Clean evictions: 1328

Dirty evictions: 2359

Hit rate: 99.8434

Miss rate: 0.1566

OPT:

Hit count: 2415157

Miss count: 3011

Clean evictions: 1044

Dirty evictions: 1867

Hit rate: 99.8755

Miss rate: 0.1245

Freq5:

RAND:

Hit count: 392182

Miss count: 265

Clean evictions: 31

Dirty evictions: 134

Hit rate: 99.9325

Miss rate: 0.0675

FIFO:

Hit count: 392199

Miss count: 248

Clean evictions: 15

Dirty evictions: 133

Hit rate: 99.9368

Miss rate: 0.0632

CLOCK:

Hit count: 392253

Miss count: 194

Clean evictions: 2

Dirty evictions: 92

Hit rate: 99.9506

Miss rate: 0.0494

LRU:

Hit count: 392257

Miss count: 190

Clean evictions: 2

Dirty evictions: 88

Hit rate: 99.9516

Miss rate: 0.0484

OPT:

Hit count: 392284

Miss count: 163

Clean evictions: 0

Dirty evictions: 63

Hit rate: 99.9585

Miss rate: 0.0415

**Mem size: 150**

Simpleloop:

RAND:

Hit count: 7574

Miss count: 2714

Clean evictions: 9

Dirty evictions: 2555

Hit rate: 73.6198

Miss rate: 26.3802

FIFO:

Hit count: 7570

Miss count: 2718

Clean evictions: 8

Dirty evictions: 2560

Hit rate: 73.5809

Miss rate: 26.4191

CLOCK:

Hit count: 7601

Miss count: 2687

Clean evictions: 0

Dirty evictions: 2537

Hit rate: 73.8822

Miss rate: 26.1178

LRU:

Hit count: 7604

Miss count: 2684

Clean evictions: 0

Dirty evictions: 2534

Hit rate: 73.9114

Miss rate: 26.0886

OPT:

Hit count: 7644

Miss count: 2644

Clean evictions: 0

Dirty evictions: 2494

Hit rate: 74.3002

Miss rate: 25.6998

Matmul:

RAND:

Hit count: 2791617

Miss count: 96375

Clean evictions: 47094

Dirty evictions: 49131

Hit rate: 96.6629

Miss rate: 3.3371

FIFO:

Hit count: 2853581

Miss count: 34411

Clean evictions: 16665

Dirty evictions: 17596

Hit rate: 98.8085

Miss rate: 1.1915

CLOCK:

Hit count: 2854779

Miss count: 33213

Clean evictions: 16134

Dirty evictions: 16929

Hit rate: 98.8500

Miss rate: 1.1500

LRU:

Hit count: 2855104

Miss count: 32888

Clean evictions: 16018

Dirty evictions: 16720

Hit rate: 98.8612

Miss rate: 1.1388

OPT:

Hit count: 2861376

Miss count: 26616

Clean evictions: 12926

Dirty evictions: 13540

Hit rate: 99.0784

Miss rate: 0.9216

Blocked:

RAND:

Hit count: 2413848

Miss count: 4320

Clean evictions: 1517

Dirty evictions: 2653

Hit rate: 99.8214

Miss rate: 0.1786

FIFO:

Hit count: 2413941

Miss count: 4227

Clean evictions: 1366

Dirty evictions: 2711

Hit rate: 99.8252

Miss rate: 0.1748

CLOCK:

Hit count: 2414232

Miss count: 3936

Clean evictions: 1326

Dirty evictions: 2460

Hit rate: 99.8372

Miss rate: 0.1628

LRU:

Hit count: 2414398

Miss count: 3770

Clean evictions: 1318

Dirty evictions: 2302

Hit rate: 99.8441

Miss rate: 0.1559

OPT:

Hit count: 2415640

Miss count: 2528

Clean evictions: 827

Dirty evictions: 1551

Hit rate: 99.8955

Miss rate: 0.1045

Freq5:

RAND:

Hit count: 392273

Miss count: 174

Clean evictions: 0

Dirty evictions: 24

Hit rate: 99.9557

Miss rate: 0.0443

FIFO:

Hit count: 392268

Miss count: 179

Clean evictions: 0

Dirty evictions: 29

Hit rate: 99.9544

Miss rate: 0.0456

CLOCK:

Hit count: 392281

Miss count: 166

Clean evictions: 0

Dirty evictions: 16

Hit rate: 99.9577

Miss rate: 0.0423

LRU:

Hit count: 392284

Miss count: 163

Clean evictions: 0

Dirty evictions: 13

Hit rate: 99.9585

Miss rate: 0.0415

OPT:

Hit count: 392284

Miss count: 163

Clean evictions: 0

Dirty evictions: 13

Hit rate: 99.9585

Miss rate: 0.0415

**Mem size: 200**

Simpleloop:

RAND:

Hit count: 7570

Miss count: 2718

Clean evictions: 8

Dirty evictions: 2510

Hit rate: 73.5809

Miss rate: 26.4191

FIFO:

Hit count: 7578

Miss count: 2710

Clean evictions: 6

Dirty evictions: 2504

Hit rate: 73.6586

Miss rate: 26.3414

CLOCK:

Hit count: 7603

Miss count: 2685

Clean evictions: 0

Dirty evictions: 2485

Hit rate: 73.9016

Miss rate: 26.0984

LRU:

Hit count: 7604

Miss count: 2684

Clean evictions: 0

Dirty evictions: 2484

Hit rate: 73.9114

Miss rate: 26.0886

OPT:

Hit count: 7644

Miss count: 2644

Clean evictions: 0

Dirty evictions: 2444

Hit rate: 74.3002

Miss rate: 25.6998

Matmul:

RAND:

Hit count: 2831327

Miss count: 56665

Clean evictions: 27598

Dirty evictions: 28867

Hit rate: 98.0379

Miss rate: 1.9621

FIFO:

Hit count: 2854102

Miss count: 33890

Clean evictions: 16250

Dirty evictions: 17440

Hit rate: 98.8265

Miss rate: 1.1735

CLOCK:

Hit count: 2855088

Miss count: 32904

Clean evictions: 15988

Dirty evictions: 16716

Hit rate: 98.8607

Miss rate: 1.1393

LRU:

Hit count: 2855115

Miss count: 32877

Clean evictions: 15985

Dirty evictions: 16692

Hit rate: 98.8616

Miss rate: 1.1384

OPT:

Hit count: 2868726

Miss count: 19266

Clean evictions: 9240

Dirty evictions: 9826

Hit rate: 99.3329

Miss rate: 0.6671

Blocked:

RAND:

Hit count: 2414315

Miss count: 3853

Clean evictions: 1329

Dirty evictions: 2324

Hit rate: 99.8407

Miss rate: 0.1593

FIFO:

Hit count: 2414993

Miss count: 3175

Clean evictions: 1001

Dirty evictions: 1974

Hit rate: 99.8687

Miss rate: 0.1313

CLOCK:

Hit count: 2414978

Miss count: 3190

Clean evictions: 1065

Dirty evictions: 1925

Hit rate: 99.8681

Miss rate: 0.1319

LRU:

Hit count: 2414471

Miss count: 3697

Clean evictions: 1281

Dirty evictions: 2216

Hit rate: 99.8471

Miss rate: 0.1529

OPT:

Hit count: 2415890

Miss count: 2278

Clean evictions: 655

Dirty evictions: 1423

Hit rate: 99.9058

Miss rate: 0.0942

Freq5:

RAND:

Hit count: 392284

Miss count: 163

Clean evictions: 0

Dirty evictions: 0

Hit rate: 99.9585

Miss rate: 0.0415

FIFO:

Hit count: 392284

Miss count: 163

Clean evictions: 0

Dirty evictions: 0

Hit rate: 99.9585

Miss rate: 0.0415

CLOCK:

Hit count: 392284

Miss count: 163

Clean evictions: 0

Dirty evictions: 0

Hit rate: 99.9585

Miss rate: 0.0415

LRU:

Hit count: 392284

Miss count: 163

Clean evictions: 0

Dirty evictions: 0

Hit rate: 99.9585

Miss rate: 0.0415

OPT:

Hit count: 392284

Miss count: 163

Clean evictions: 0

Dirty evictions: 0

Hit rate: 99.9585

Miss rate: 0.0415

My program:

The program I chose was an old csc209 program. Briefly, it forks into multiple processes of the users choice and each process reads a .dat filled with genetic code and counts the substrings of length 5 (also known as 5-mers in bioinformatics). These counts are then piped back to the parent where the parent aggregates all counts into one histogram. I thought this one might be interesting because the program forks into multiple processes, given that this simulation is to simulate page translation I thought it might beinteresting to see how it might behave when multiple processes are accessing the memory concurrently.

It doesn’t seem all that interesting for memsize=200, probably because for the sake of time I drastically cut down on the size of the .dat files so the trace files would be made faster. Even though a DNA substring of length 5 can create 4^5 combinations, the program only recorded 163 of those combinations, so it only used 163 slots in the histogram and thus memsize was more than enough to carry everything and no evictions were needed.

Comparing algos:

As predicted, the algorithms ordered from worst to best is: FIFO, CLOCK, LRU, OPT. But the time used to execute from worst to best is: OPT, LRU, CLOCK, FIFO. Some other interesting things to note is that LRU and clock on some occasions (mostly when the memsize is small) perform virtually the same, with LRU being slightly better by a negligible amount. Another interesting thing to note is beladys anomaly clearly being shown in the FIFO algorithm on simpleloop: it seems that even though you increase the mem size the number of hits can drastically increase (from 50 to 100 memsize) but also hardly increase at all (from 150 to 200 memsize). The hit rate also does not increase that much from FIFO to LRU in a single memsize but OPT has a huge increase in performance with matmul with memsize =50 and 100. It would seem that temporal locality played a major role in LRU, CLOCK and OPT doing better than the simple FIFO algorithm, by determining time of reference those algorithms performed better, but the incrase in performance varies.

LRU analysis:

The LRU hit rate increases as memory increases. This is probably due to temporal locality: by adding more memory we can store more pages and get a more accurate picture of the current state of memory and make a better choice of which to predict. (e.g if I had memsize = 50 and memsize=200 I could probably make a better decision on who to evict if I had memsize=200 as I have more pages to work with). Again, LRU does better than FIFO and CLOCK, which is not surprising: FIFO only does well in very specific conditions and CLOCK approximates LRU. There seems to be a large jump in hit rate from memsize =100 to memsize=150, this could be due to the nature of matmul itself. If I had to make an educated guess, I would say that it may have something to do with loading large matrices, it’s entirely possible that memsize =50 or 100 isn’t large enough for the size of the matrices being multiplied so a lot of misses and evictions occur, while memsize = 150+ is enough room to store the matrices so far less swapping is needed and any references to the matrix will already be in memory.