Лабораторная работа №3

Характеристики системы:

MacBook Pro (Mid 2014)
Processor 2.8 GHz Intel Core i5 (2 cores)
Memory 8 GB 1600 MHz DDR3

Cache:

```
hw.cachelinesize: 64
hw.l1icachesize: 32768
hw.l1dcachesize: 32768
hw.l2cachesize: 262144
hw.l3cachesize: 3145728
machdep.cpu.cache.linesize: 64
machdep.cpu.cache.L2_associativity: 8
machdep.cpu.cache.size: 256
```

Сравнение результатов собственного анализатора и valgrind:

Был написан собственный анализатор с двумя моделями вытеснения: самой давно использованной кеш-линии (Custom Oldest) и случайной кеш-линии (Custom Random).
В собственном анализаторе использовались следующие параметры:

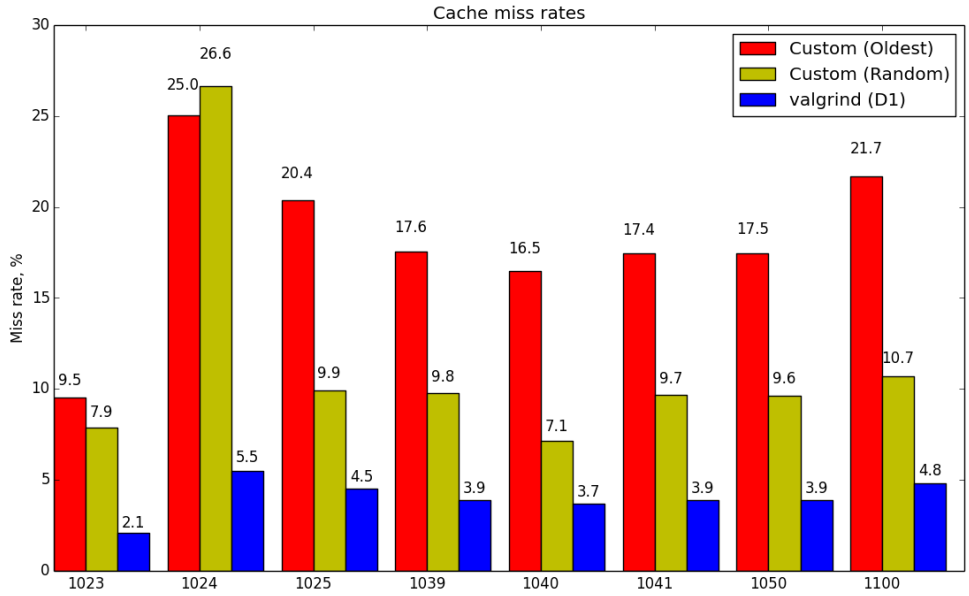
```
    cacheLineSize = 64;
    cacheSize = 65536;
    cacheChannelsCount = 8;
```

Для cachegrind использовались следующие параметры: `--I1=65536,8,64 --D1=65536,8,64`
В сравнении в качестве предсказанного процента кеш-промахов использовался процент промахов в кеше данных 1-го уровняе D1 (valgrind D1) .
Кол-во кэш промахов было рассчитано для следующих n: 1023, 1024, 1025, 1039, 1040, 1041, 1050, 1100.

Наблюдения следующие:

- в модели Custom Oldest процент промахов примерно в 2 раза больше, чем в модели Custom Random для всех рассмотренных n, кроме 1023 и 1024
- в модели Custom Oldest процент промахов примерно в 4-5 больше, чем предсказанный утилитой cachegrind
- во всех 3х вычислених наблюдается скачок процента промахов на n=1024, и не наблюдается скачок на n=1040 и n=1041, что соответствует нашим прошлым наблюдениям о значительном замедлении вычислений на n=1024.

Ниже приведено сравнение всех 3х вариантов подсчёта кеш-промахов:



Результаты собственного анализатора:

Ниже приведен output, сгенерированный приложенным кодом. “rewrite option” указывает на модель кэша (“oldest” – вытеснение самой давно использованной кэш-линии, “random” – вытеснение случайной кэш-линии).

```
n: 1023
rewrite option: oldest
9.54621%
timeSimple: 460.777

n: 1023
rewrite option: random
7.89376%
timeSimple: 416.257

n: 1024
rewrite option: oldest
25.0228%
timeSimple: 518.736

n: 1024
rewrite option: random
26.6176%
timeSimple: 530.528

n: 1025
rewrite option: oldest
20.3883%
```

```
timeSimple: 462.72

n: 1025
rewrite option: random
9.90435%
timeSimple: 423.581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n: 1039
rewrite option: oldest
17.5539%
timeSimple: 537.15

n: 1039
rewrite option: random
9.75134%
timeSimple: 505.998

n: 1040
rewrite option: oldest
16.4547%
timeSimple: 558.15

n: 1040
rewrite option: random
7.14779%
timeSimple: 482.425

n: 1041
rewrite option: oldest
17.4263%
timeSimple: 555.916

n: 1041
rewrite option: random
9.65698%
timeSimple: 562.665


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n: 1050
rewrite option: oldest
17.4637%
timeSimple: 674.132

n: 1050
rewrite option: random
9.63427%
timeSimple: 521.514

n: 1100
```

```
rewrite option: oldest
21.6959%
timeSimple: 622.582

n: 1100
rewrite option: random
10.681%
timeSimple: 552.366
```

Результаты valgrind:

Ниже приведён output valgrind, сгенерированный выполнением следующих команд:

```
valgrind --tool=cachegrind --I1=65536,8,64 --D1=65536,8,64 ./cache
1023
valgrind --tool=cachegrind --I1=65536,8,64 --D1=65536,8,64 ./cache
1024
valgrind --tool=cachegrind --I1=65536,8,64 --D1=65536,8,64 ./cache
1025
valgrind --tool=cachegrind --I1=65536,8,64 --D1=65536,8,64 ./cache
1039
valgrind --tool=cachegrind --I1=65536,8,64 --D1=65536,8,64 ./cache
1040
valgrind --tool=cachegrind --I1=65536,8,64 --D1=65536,8,64 ./cache
1041
valgrind --tool=cachegrind --I1=65536,8,64 --D1=65536,8,64 ./cache
1050
valgrind --tool=cachegrind --I1=65536,8,64 --D1=65536,8,64 ./cache
1100
```

```
==28003== Cachegrind, a cache and branch-prediction profiler
==28003== Copyright (C) 2002-2015, and GNU GPL'd, by Nicholas
Nethercote et al.
==28003== Using Valgrind-3.12.0.SVN and LibVEX; rerun with -h for
copyright info
==28003== Command: ./cache 1023
==28003==
--28003-- warning: L3 cache found, using its data for the LL
simulation.
n = 1023
timeSimple: 291.317
==28003==
==28003== I   refs:      28,072,421,402
==28003== I1  misses:             3,387
==28003== LLi misses:             3,040
==28003== I1  miss rate:           0.00%
==28003== LLi miss rate:           0.00%
==28003==
==28003== D   refs:      21,560,797,292  (19,346,791,243 rd   +
```

```
2,214,006,049 wr)
==28003== D1  misses:       411,922,660  (   411,724,509 rd   +
198,151 wr)
==28003== LLd misses:        67,164,558  (    66,966,806 rd   +
197,752 wr)
==28003== D1  miss rate:            1.9% (           2.1%     +
0.0%  )
==28003== LLd miss rate:            0.3% (           0.3%     +
0.0%  )
==28003==
==28003== LL refs:          411,926,047  (   411,727,896 rd   +
198,151 wr)
==28003== LL misses:         67,167,598  (    66,969,846 rd   +
197,752 wr)
==28003== LL miss rate:             0.1% (           0.1%     +
0.0%  )
==28166== Cachegrind, a cache and branch-prediction profiler
==28166== Copyright (C) 2002-2015, and GNU GPL'd, by Nicholas
Nethercote et al.
==28166== Using Valgrind-3.12.0.SVN and LibVEX; rerun with -h for
copyright info
==28166== Command: ./cache 1024
==28166==
--28166-- warning: L3 cache found, using its data for the LL
simulation.
n = 1024
timeSimple: 377.261
==28166==
==28166== I   refs:      28,154,577,249
==28166== I1  misses:             3,393
==28166== LLi misses:             3,013
==28166== I1  miss rate:           0.00%
==28166== LLi miss rate:           0.00%
==28166==
==28166== D   refs:      21,623,936,841  (19,403,504,328 rd   +
2,220,432,513 wr)
==28166== D1  misses:     1,075,132,025  ( 1,074,933,471 rd   +
198,554 wr)
==28166== LLd misses:     1,075,036,396  ( 1,074,838,251 rd   +
198,145 wr)
==28166== D1  miss rate:            5.0% (           5.5%     +
0.0%  )
==28166== LLd miss rate:            5.0% (           5.5%     +
0.0%  )
==28166==
==28166== LL refs:        1,075,135,418  ( 1,074,936,864 rd   +
198,554 wr)
==28166== LL misses:      1,075,039,409  ( 1,074,841,264 rd   +
198,145 wr)
==28166== LL miss rate:             2.2% (           2.3%     +
0.0%  )
==28177== Cachegrind, a cache and branch-prediction profiler
==28177== Copyright (C) 2002-2015, and GNU GPL'd, by Nicholas
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```

```
==28177== Using Valgrind-3.12.0.SVN and LibVEX; rerun with -h for
copyright info
==28177== Command: ./cache 1025
==28177==
--28177-- warning: L3 cache found, using its data for the LL
simulation.
n = 1025
timeSimple: 324.884
==28177==
==28177== I   refs:      28,236,891,584
==28177== I1  misses:             3,369
==28177== LLi misses:             3,013
==28177== I1  miss rate:           0.00%
==28177== LLi miss rate:           0.00%
==28177==
==28177== D   refs:      21,687,199,123  (19,460,327,903 rd   +
2,226,871,220 wr)
==28177== D1  misses:       880,676,183  (   880,477,245 rd   +
198,938 wr)
==28177== LLd misses:        67,542,295  (    67,343,756 rd   +
198,539 wr)
==28177== D1  miss rate:            4.1% (           4.5%     +
0.0%  )
==28177== LLd miss rate:            0.3% (           0.3%     +
0.0%  )
==28177==
==28177== LL refs:          880,679,552  (   880,480,614 rd   +
198,938 wr)
==28177== LL misses:         67,545,308  (    67,346,769 rd   +
198,539 wr)
==28177== LL miss rate:             0.1% (           0.1%     +
0.0%  )
==28189== Cachegrind, a cache and branch-prediction profiler
==28189== Copyright (C) 2002-2015, and GNU GPL'd, by Nicholas
Nethercote et al.
==28189== Using Valgrind-3.12.0.SVN and LibVEX; rerun with -h for
copyright info
==28189== Command: ./cache 1039
==28189==
--28189-- warning: L3 cache found, using its data for the LL
simulation.
n = 1039
timeSimple: 222.364
==28189==
==28189== I   refs:      29,406,251,410
==28189== I1  misses:             3,391
==28189== LLi misses:             3,043
==28189== I1  miss rate:           0.00%
==28189== LLi miss rate:           0.00%
==28189==
==28189== D   refs:      22,585,880,119  (20,267,551,021 rd   +
2,318,329,098 wr)
==28189== D1  misses:       790,342,497  (   790,138,148 rd   +
204,349 wr)
```

```
==28189== LLd misses:        70,359,068  (    70,155,117 rd   +
203,951 wr)
==28189== D1  miss rate:            3.5% (           3.9%     +
0.0%  )
==28189== LLd miss rate:            0.3% (           0.3%     +
0.0%  )
==28189==
==28189== LL refs:          790,345,888  (   790,141,539 rd   +
204,349 wr)
==28189== LL misses:         70,362,111  (    70,158,160 rd   +
203,951 wr)
==28189== LL miss rate:             0.1% (           0.1%     +
0.0%  )
==28199== Cachegrind, a cache and branch-prediction profiler
==28199== Copyright (C) 2002-2015, and GNU GPL'd, by Nicholas
Nethercote et al.
==28199== Using Valgrind-3.12.0.SVN and LibVEX; rerun with -h for
copyright info
==28199== Command: ./cache 1040
==28199==
--28199-- warning: L3 cache found, using its data for the LL
simulation.
n = 1040
timeSimple: 209.248
==28199==
==28199== I   refs:      29,490,989,486
==28199== I1  misses:             3,378
==28199== LLi misses:             3,010
==28199== I1  miss rate:           0.00%
==28199== LLi miss rate:           0.00%
==28199==
==28199== D   refs:      22,651,004,346  (20,326,048,571 rd   +
2,324,955,775 wr)
==28199== D1  misses:       744,262,722  (   744,058,011 rd   +
204,711 wr)
==28199== LLd misses:        70,577,977  (    70,373,658 rd   +
204,319 wr)
==28199== D1  miss rate:            3.3% (           3.7%     +
0.0%  )
==28199== LLd miss rate:            0.3% (           0.3%     +
0.0%  )
==28199==
==28199== LL refs:          744,266,100  (   744,061,389 rd   +
204,711 wr)
==28199== LL misses:         70,580,987  (    70,376,668 rd   +
204,319 wr)
==28199== LL miss rate:             0.1% (           0.1%     +
0.0%  )
==28212== Cachegrind, a cache and branch-prediction profiler
==28212== Copyright (C) 2002-2015, and GNU GPL'd, by Nicholas
Nethercote et al.
==28212== Using Valgrind-3.12.0.SVN and LibVEX; rerun with -h for
copyright info
==28212== Command: ./cache 1041
```

```
==28212==
--28212-- warning: L3 cache found, using its data for the LL
simulation.
n = 1041
timeSimple: 211.324
==28212==
==28212== I   refs:      29,575,890,274
==28212== I1  misses:             3,369
==28212== LLi misses:             3,013
==28212== I1  miss rate:           0.00%
==28212== LLi miss rate:           0.00%
==28212==
==28212== D   refs:      22,716,254,134  (20,384,658,954 rd   +
2,331,595,180 wr)
==28212== D1  misses:       789,320,977  (   789,115,860 rd   +
205,117 wr)
==28212== LLd misses:        70,749,553  (    70,544,830 rd   +
204,723 wr)
==28212== D1  miss rate:            3.5% (            3.9%     +
0.0%  )
==28212== LLd miss rate:            0.3% (            0.3%     +
0.0%  )
==28212==
==28212== LL refs:          789,324,346  (   789,119,229 rd   +
205,117 wr)
==28212== LL misses:         70,752,566  (    70,547,843 rd   +
204,723 wr)
==28212== LL miss rate:             0.1% (            0.1%     +
0.0%  )
==28218== Cachegrind, a cache and branch-prediction profiler
==28218== Copyright (C) 2002-2015, and GNU GPL'd, by Nicholas
Nethercote et al.
==28218== Using Valgrind-3.12.0.SVN and LibVEX; rerun with -h for
copyright info
==28218== Command: ./cache 1050
==28218==
--28218-- warning: L3 cache found, using its data for the LL
simulation.
n = 1050
timeSimple: 206.452
==28218==
==28218== I   refs:      30,347,351,961
==28218== I1  misses:             3,365
==28218== LLi misses:             3,009
==28218== I1  miss rate:           0.00%
==28218== LLi miss rate:           0.00%
==28218==
==28218== D   refs:      23,309,150,602  (20,917,230,688 rd   +
2,391,919,914 wr)
==28218== D1  misses:       811,982,603  (   811,773,962 rd   +
208,641 wr)
==28218== LLd misses:        72,611,562  (    72,403,313 rd   +
208,249 wr)
==28218== D1  miss rate:            3.5% (            3.9%     +
```

```
0.0%  )
==28218== LLd miss rate:            0.3% (           0.3%     +
0.0%  )
==28218==
==28218== LL refs:          811,985,968  (   811,777,327 rd   +
208,641 wr)
==28218== LL misses:         72,614,571  (    72,406,322 rd   +
208,249 wr)
==28218== LL miss rate:             0.1% (           0.1%     +
0.0%  )
==28226== Cachegrind, a cache and branch-prediction profiler
==28226== Copyright (C) 2002-2015, and GNU GPL'd, by Nicholas
Nethercote et al.
==28226== Using Valgrind-3.12.0.SVN and LibVEX; rerun with -h for
copyright info
==28226== Command: ./cache 1100
==28226==
--28226-- warning: L3 cache found, using its data for the LL
simulation.
n = 1100
timeSimple: 235.023
==28226==
==28226== I   refs:      34,878,650,980
==28226== I1  misses:             3,380
==28226== LLi misses:             3,040
==28226== I1  miss rate:           0.00%
==28226== LLi miss rate:           0.00%
==28226==
==28226== D   refs:      26,791,702,528  (24,045,614,440 rd   +
2,746,088,088 wr)
==28226== D1  misses:     1,157,547,290  ( 1,157,318,498 rd   +
228,792 wr)
==28226== LLd misses:        83,477,939  (    83,249,544 rd   +
228,395 wr)
==28226== D1  miss rate:            4.3% (           4.8%     +
0.0%  )
==28226== LLd miss rate:            0.3% (           0.3%     +
0.0%  )
==28226==
==28226== LL refs:        1,157,550,670  ( 1,157,321,878 rd   +
228,792 wr)
==28226== LL misses:         83,480,979  (    83,252,584 rd   +
228,395 wr)
==28226== LL miss rate:             0.1% (           0.1%     +
0.0%  )
```