

Week#4 Effect of page size on performance

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1. INTRODUCTION

Load the TPC-C data with different page sizes and run the benchmark on MySQL. Then observe how the performance changes over time.

2. METHODS

For this experiment, I want to know the TPC-C performance such as the number of transactions completed per minute(TpmC). Also I want to know the IOPS and hit ratio variation over time. We can change page size by editing my.cnf file. Also we can get various performance information by starting MySQL server and running the TPC-C test. We can observe values by commanding 'iostat', and 'show engine innodb status;'.

3. Performance Evaluation

3.1 Experimental Setup

System setup:

Type	Specification
OS	Ubuntu 20.04.3 LTS
CPU	Intel® Core™ i3-9100F CPU @ 3.60GHz
Memory	16GB
Kernel	5.11.0-27-generic
Data Device	Western Digital WD Blue 500GB
Log Device	Western Digital WD Blue 500GB

Benchmark setup:

Type	Configuration
DB size	700MB (7 warehouse)
Buffer Pool Size	210MB (30% of DB size)
Benchmark Tool	tpcc-mysql
Runtime	1200s
Connections	8

3.2 Experimental Results

Page size = 4KB, progress: 100 seconds / 1200 seconds

```
Dictionary memory allocated 157263
Buffer pool size      65536
Free buffers          0
Database pages        62496
Old database pages    23050
Modified db pages     35864
Pending reads         2
Pending writes: LRU 0, flush list 5, single page
Pages made young 31121, not young 218096
0.00 youngs/s, 0.00 non-youngs/s
Pages read 58873, created 175530, written 215537
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 990 / 1000, young-making rate 42 / 1000
Pages read ahead 0.00/s, evicted without access 0
m read ahead 0.00/s
LRU len: 62496, unzip_LRU len: 0
I/O sum[30168]:cur[281], unzip sum[0]:cur[0]
```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	265.00	1.04	0.00	0.00	0.94	4.00	264.00
scd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
100, trx: 605, 95%: 134.073, 99%: 275.419, max_rt: 376.028, 605|329.127, 60|71.322, 61|635.522, 61|528.049
```

Page size = 4KB, progress: 400 seconds / 1200 seconds

```
Buffer pool size      65536
Free buffers          40
Database pages        60922
Old database pages    22471
Modified db pages     44727
Pending reads         2
Pending writes: LRU 62, flush list 0, single page
Pages made young 104659, not young 624892
0.00 youngs/s, 0.00 non-youngs/s
Pages read 151024, created 184725, written 317802
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making rate 32 / 1000
Pages read ahead 0.00/s, evicted without access 0
m read ahead 0.00/s
LRU len: 60922, unzip_LRU len: 0
```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	386.00	1.51	0.00	0.00	0.94	4.00	312.00
scd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

400, trx: 571, 95%: 199.160, 99%: 327.933, max_rt: 440.086, 569|273.431, 56|186.939, 56|617.623, 57|397.730

Page size = 4KB, progress: 800 seconds / 1200 seconds

```

Dictionary memory allocated 157263
Buffer pool size      65536
Free buffers          174
Database pages        60731
Old database pages    22398
Modified db pages     44930
Pending reads         0
Pending writes: LRU 94, flush list 0, single-page writes 0
Pages made young 205086, not young 1151807
0.00 youngs/s, 0.00 non-youngs/s
Pages read 269994, created 196324, written 0
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making rate 0 / 1000
Pages read ahead 0.00/s, evicted without access 0
m read ahead 0.00/s
LRU len: 60731, unzip_LRU len: 0
I/O sum[30312]:cur[473], unzip sum[0]:cur[0]

```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	249.00	0.97	0.00	0.00	1.13	4.00	266.00
scd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

800, trx: 574, 95%: 171.681, 99%: 298.425, max_rt: 553.578, 576|339.820, 58|196.704, 58|421.635, 59|518.735

Page size = 4KB, progress: 1100 seconds / 1200 seconds

```

Buffer pool size 65536
Free buffers 47
Database pages 60862
Old database pages 22446
Modified db pages 45040
Pending reads 2
Pending writes: LRU 47, flush list 0, single page
Pages made young 279478, not young 1531866
0.00 young/s, 0.00 non-young/s
Pages read 356670, created 204391, written 566294
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making rate 36 / 1000
Pages read ahead 0.00/s, evicted without access 0
m read ahead 0.00/s
LRU len: 60862, unzip_LRU len: 0
I/O sum[31981]:cur[529], unzip sum[0]:cur[0]

```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	156.00	0.67	8.00	4.88	1.13	4.38	125.00
scd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```

1100, trx: 546, 95%: 213.164, 99%: 321.037, max_rt: 398.448, 550|271.137, 56|88.102, 55|507.652, 56|421.704

```

Page size = 4KB

```

[transaction percentage]
  Payment: 43.48% (>=43.0%) [OK]
  Order-Status: 4.35% (>= 4.0%) [OK]
  Delivery: 4.35% (>= 4.0%) [OK]
  Stock-Level: 4.35% (>= 4.0%) [OK]
[response time (at least 90% passed)]
  New-Order: 0.13% [NG] *
  Payment: 5.52% [NG] *
  Order-Status: 9.40% [NG] *
  Delivery: 1.00% [NG] *
  Stock-Level: 0.04% [NG] *

<TpmC>
3517.600 TpmC

```

Page size = 8KB, progress: 100 seconds / 1200 seconds

```

Free buffers          104
Database pages        30905
Old database pages    11390
Modified db pages     23640
Pending reads         2
Pending writes: LRU 59, flush list 0, single pa
Pages made young 29774, not young 179038
0.00 youngs/s, 0.00 non-youngs/s
Pages read 48552, created 84186, written 125356
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making r
ot 27 / 1000
Pages read ahead 0.00/s, evicted without access
m read ahead 0.00/s
LRU len: 30905, unzip_LRU len: 0
I/O sum[24713]:cur[17], unzip sum[0]:cur[0]

```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	285.00	2.23	0.00	0.00	1.03	8.00	285.00
scd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
100, trx: 609, 95%: 151.444, 99%: 268.179, max_rt: 409.014, 608|302.853, 61|86.940, 60|759.292, 61|307.799
```

Page size = 8KB, progress: 400 seconds / 1200 seconds

```

Total large memory allocated 281280512
Dictionary memory allocated 157263
Buffer pool size    32768
Free buffers        34
Database pages      30393
Old database pages  11200
Modified db pages   23555
Pending reads       3
Pending writes: LRU 104, flush list 0, single pag
Pages made young 104281, not young 479959
0.00 youngs/s, 0.00 non-youngs/s
Pages read 128783, created 88723, written 213184
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making rat
ot 27 / 1000
Pages read ahead 0.00/s, evicted without access 0
m read ahead 0.00/s
LRU len: 30393, unzip_LRU len: 0
I/O sum[28851]:cur[294], unzip sum[0]:cur[0]

```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	277.00	2.16	0.00	0.00	0.96	8.00	165.00
scd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
400, trx: 523, 95%: 178.280, 99%: 311.010, max_rt: 586.116, 523|174.414, 51|88.261, 52|497.336, 53|522.023
```

Page size = 8KB, progress: 800 seconds / 1200 seconds

```
Total large memory allocated 281280512
Dictionary memory allocated 157263
Buffer pool size 32768
Free buffers 38
Database pages 30385
Old database pages 11197
Modified db pages 23570
Pending reads 2
Pending writes: LRU 11, flush list 0, single page
Pages made young 212535, not young 912195
0.00 youngs/s, 0.00 non-youngs/s
Pages read 243595, created 94808, written 338354
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making rate
ot 27 / 1000
Pages read ahead 0.00/s, evicted without access 0
m read ahead 0.00/s
LRU len: 30385, unzip_LRU len: 0
I/O sum[29791]:cur[137], unzip sum[0]:cur[0]
```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	298.00	2.33	0.00	0.00	1.27	8.00	464.00
sdd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
800, trx: 565, 95%: 196.026, 99%: 345.569, max_rt: 640.796, 565|193.608, 56|144.708, 57|357.473, 56|473.362
```

Page size = 8KB, progress: 1100 seconds / 1200 seconds

```
Database pages 30195
Old database pages 11126
Modified db pages 23533
Pending reads 1
Pending writes: LRU 102, flush list 0, single page
Pages made young 339257, not young 1343964
0.00 youngs/s, 0.00 non-youngs/s
Pages read 354228, created 100129, written 462720
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 994 / 1000, young-making rate
ot 25 / 1000
Pages read ahead 0.00/s, evicted without access 0
m read ahead 0.00/s
LRU len: 30195, unzip_LRU len: 0
I/O sum[27836]:cur[313], unzip sum[0]:cur[0]
```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	1150, t
loop0	0.00	0.00	0.00	0.00	0.00	0.00	1160, t
loop1	0.00	0.00	0.00	0.00	0.00	0.00	1170, t
loop2	0.00	0.00	0.00	0.00	0.00	0.00	1180, t
loop3	0.00	0.00	0.00	0.00	0.00	0.00	
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	186.00	1.45	0.00	0.00	1.02	8.00	232.00
sdd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
1100, trx: 691, 95%: 122.888, 99%: 181.348, max_rt: 388.044, 693|219.785, 69|67.681, 69|359.132, 69|239.616
```

Page size = 8KB

```
<Constraint Check> (all must be [OK])
[transaction percentage]
  Payment: 43.48% (>=43.0%) [OK]
  Order-Status: 4.35% (>= 4.0%) [OK]
  Delivery: 4.35% (>= 4.0%) [OK]
  Stock-Level: 4.35% (>= 4.0%) [OK]
[response time (at least 90% passed)]
  New-Order: 0.14% [NG] *
  Payment: 6.67% [NG] *
  Order-Status: 9.26% [NG] *
  Delivery: 1.78% [NG] *
  Stock-Level: 0.05% [NG] *

<TpmC>
3897.750 TpmC
```

Page size = 16KB, progress: 100 seconds / 1200 seconds

```
Free buffers      63
Database pages    15440
Old database pages 5681
Modified db pages 12004
Pending reads     1
Pending writes: LRU 95, flush list 0, single page 0
Pages made young 41669, not young 179276
0.00 youngs/s, 0.00 non-youngs/s
Pages read 42890, created 41714, written 78885
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making rate 0.00 / 1000
not 22 / 1000
Pages read ahead 0.00/s, evicted without access 0.00/s
m read ahead 0.00/s
LRU len: 15440, unzip_LRU len: 0
I/O sum[26678]:cur[200], unzip sum[0]:cur[0]
```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	281.00	4.39	0.00	0.00	1.04	16.00	171.00
sdd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
100, trx: 607, 95%: 150.901, 99%: 239.775, max_rt: 429.738, 603|400.882, 60|91.701, 61|600.079, 61|462.250
```

Page size = 16KB, progress: 400 seconds / 1200 seconds


```

Total large memory allocated 274857984
Dictionary memory allocated 157263
Buffer pool size 16384
Free buffers 41
Database pages 15289
Old database pages 5624
Modified db pages 11862
Pending reads 1
Pending writes: LRU 0, flush list 102, single page 0
Pages made young 171641, not young 472793
0.00 youngs/s, 0.00 non-youngs/s
Pages read 135179, created 44273, written 167974
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making rate 11
not 24 / 1000
Pages read ahead 0.00/s, evicted without access 0.00/
m read ahead 0.00/s
LRU len: 15289, unzip_LRU len: 0
I/O sum[27840]:cur[460], unzip sum[0]:cur[0]

```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	174.00	2.72	0.00	0.00	1.22	16.00	266.00
sdd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
400, trx: 660, 95%: 169.536, 99%: 285.065, max_rt: 447.389, 661|465.797, 66|138.072, 66|417.231, 66|379.715
```

Page size = 16KB, progress: 800 seconds / 1200 seconds

```

Buffer pool size 16384
Free buffers 69
Database pages 15243
Old database pages 5607
Modified db pages 11901
Pending reads 1
Pending writes: LRU 97, flush list 0, single page 0
Pages made young 329547, not young 828377
0.00 youngs/s, 0.00 non-youngs/s
Pages read 247689, created 47607, written 276236
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making rate 1
not 24 / 1000
Pages read ahead 0.00/s, evicted without access 0.00/
m read ahead 0.00/s
LRU len: 15243, unzip_LRU len: 0
I/O sum[28321]:cur[468], unzip sum[0]:cur[0]

```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	221.00	3.45	0.00	0.00	1.03	16.00	146.00
sdd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
800, trx: 583, 95%: 154.975, 99%: 254.797, max rt: 587.743, 588|181.848, 58|98.999, 58|336.972, 59|483.456
```


Page size = 16KB, progress: 1100 seconds / 1200 seconds

```
Total large memory allocated 274857984
Dictionary memory allocated 157263
Buffer pool size 16384
Free buffers 60
Database pages 15218
Old database pages 5600
Modified db pages 11721
Pending reads 1
Pending writes: LRU 66, flush list 0, single page 0
Pages made young 479295, not young 1148619
0.00 young/s, 0.00 non-young/s
Pages read 348356, created 50477, written 372588
0.00 reads/s, 0.00 creates/s, 0.00 writes/s
Buffer pool hit rate 993 / 1000, young-making rate 0.00 / 1000
not 23 / 1000
Pages read ahead 0.00/s, evicted without access 0.00/s
m read ahead 0.00/s
LRU len: 15218, unzip_LRU len: 0
I/O sum[27744]:cur[395], unzip sum[0]:cur[0]
```

Device	r/s	rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s
loop0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loop5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sda	207.00	3.23	0.00	0.00	1.09	16.00	275.00
sdd0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
1100, trx: 670, 95%: 139.060, 99%: 273.448, max_rt: 375.905, 668|288.831, 67|57.149, 66|425.853, 66|294.795
```

Page size = 16KB

```
<Constraint Check> (all must be [OK])
[transaction percentage]
  Payment: 43.48% (>=43.0%) [OK]
  Order-Status: 4.35% (>= 4.0%) [OK]
  Delivery: 4.35% (>= 4.0%) [OK]
  Stock-Level: 4.35% (>= 4.0%) [OK]
[response time (at least 90% passed)]
  New-Order: 0.16% [NG] *
  Payment: 7.74% [NG] *
  Order-Status: 10.28% [NG] *
  Delivery: 2.82% [NG] *
  Stock-Level: 0.03% [NG] *

<TpmC>
3757.900 TpmC
```

IOPS) As page size goes bigger, read per second and write per second both decrease a little bit. And no matter the page size, IOPS rises at the beginning and then decreases towards the end of the measure time.

Buffer hit ratio) First, when page size is 4KB and progressed 100 seconds, hit ratio starts with 990/1000. Then it rises to 993/1000 over time and this degree is kept continuously.

TpmC) 3517-> 3897 -> 3757 TpmC
(4KB) (8KB) (16KB)

I think TpmC should increase as the page size get bigger. In case of 16KB, the result accidentally came out wrong.

Transaction throughput)		100s	400s	800s	1100s
Page size	4KB	605	569	576	550
	8KB	608	523	565	693
	16KB	603	661	588	668

Throughputs are all similar no matter the page size.

4. Conclusion

For this experiment, I noticed a detail performance change with page size.

5. REFERENCES

[1] <https://github.com/meeeejin/SWE3033-F2021/tree/main/week-4>