Locality of (p)reference

Some thoughts about MySQL consulting issues

Oli Sennhauser
Senior Consultant
osennhauser@mysql.com

ToC

- Locality of (p)reference
- commit_demo.pl (performance test/numbers)
- InnoDB information (discussion)
- RAM disk
- MySQL variables (discussion)
- MyISAM log
- MySQL Visual Explain

Locality of (p)reference

- In theory: We should not care how data are stored internally.
- In practice: It is sometimes good to know!
- Why?
- 2 examples from the last 9 months:
  - wind mills
  - vehicle tracking for parcel delivery

Example 1

- Several 100 wind mills
- 50 measured values per wind mill
- Every 5-15 minutes
- Up to 10 years
- Dozens of GB of data
- Record size up to 2k!

- Search pattern: Give me value x from wind mill #13 in this time range!

Example 2

- Several 100 vehicles
- 24 h/d
- Every 2 min position
- Status/position per vehicle, later per parcel!!!
- Dozens of GB of data
- Record size 400 bytes

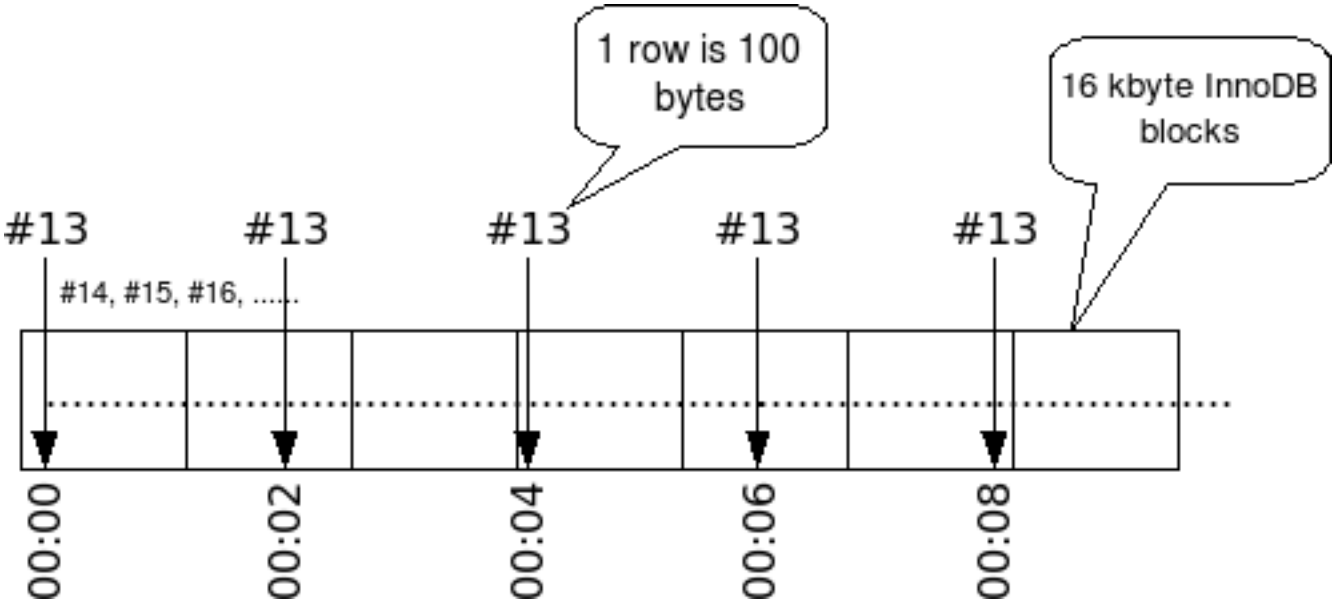
- Search pattern: Give me all positions of vehicle #13 from the last 24 hours.

Locality of Reference

- These 2 examples have one behaviour in common:
- Delivery of data is completely different than search pattern.
  - Usually data are delivered sorted by time and also (more or less) retrieved by time.
  - In this cases time has a secondary influence!
- But what happens???

Locality of Reference

- Block size is 16k/4k
- PK is AUTO_INCREMENT



- Synthecial PK are sometimes dangerous!

Locality of Reference

- What to do???

- PK on (vehicle_id, ts) for example or
- PK on (windmill_id, data, ts)

- Can be up to 100 times more efficient (not necessarily faster)

- What about MyISAM?
- What about Falcon? (Mail from Ann can be provided).

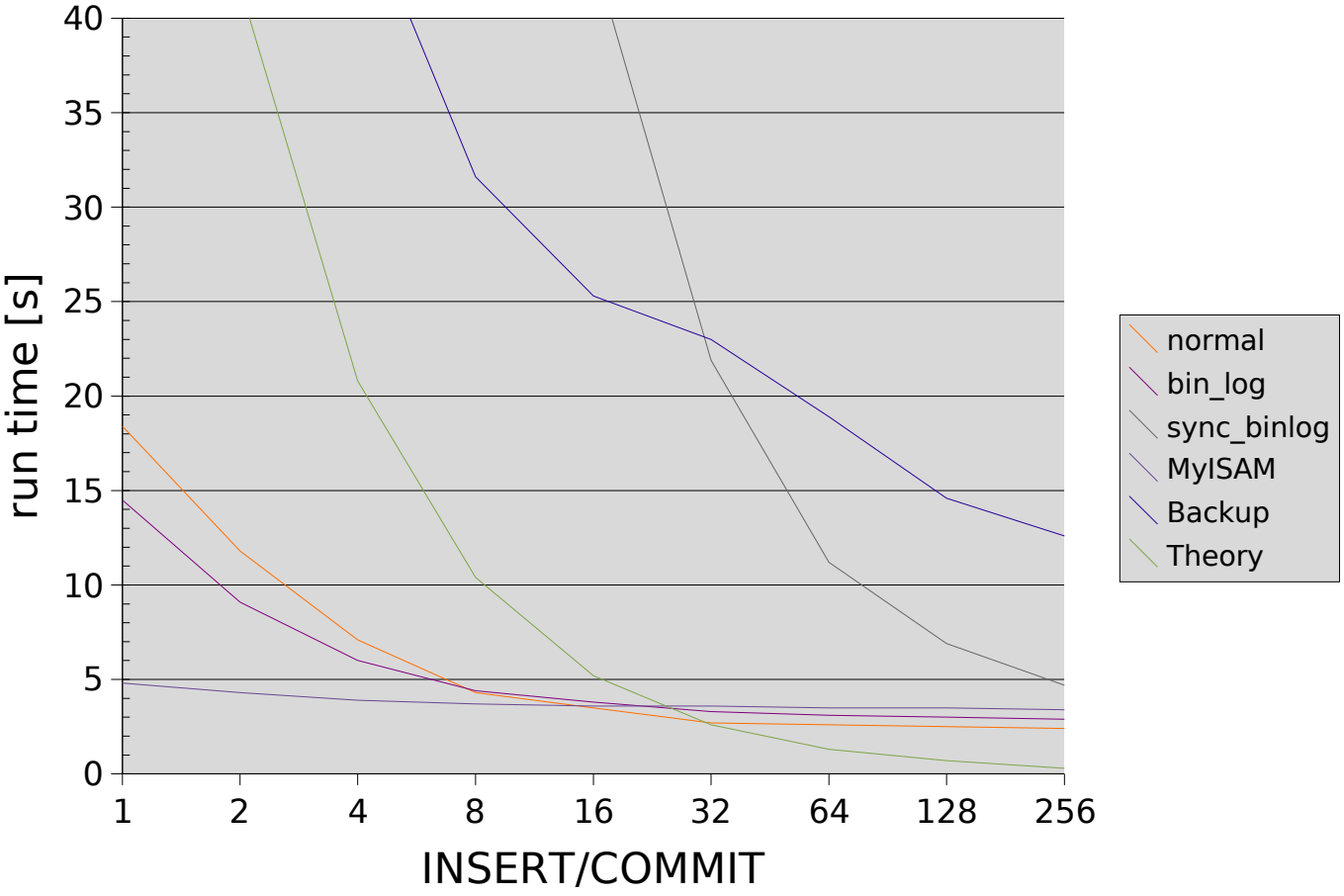
commit_demo.pl

- Little ugly script to test your I/O system:
  http://www.shinguz.ch/MySQL/consulting_tools.html
- What it does:
  INSERT -> COMMIT -> INSERT -> COMMIT -> ...
- The idea behind it
- How to call:

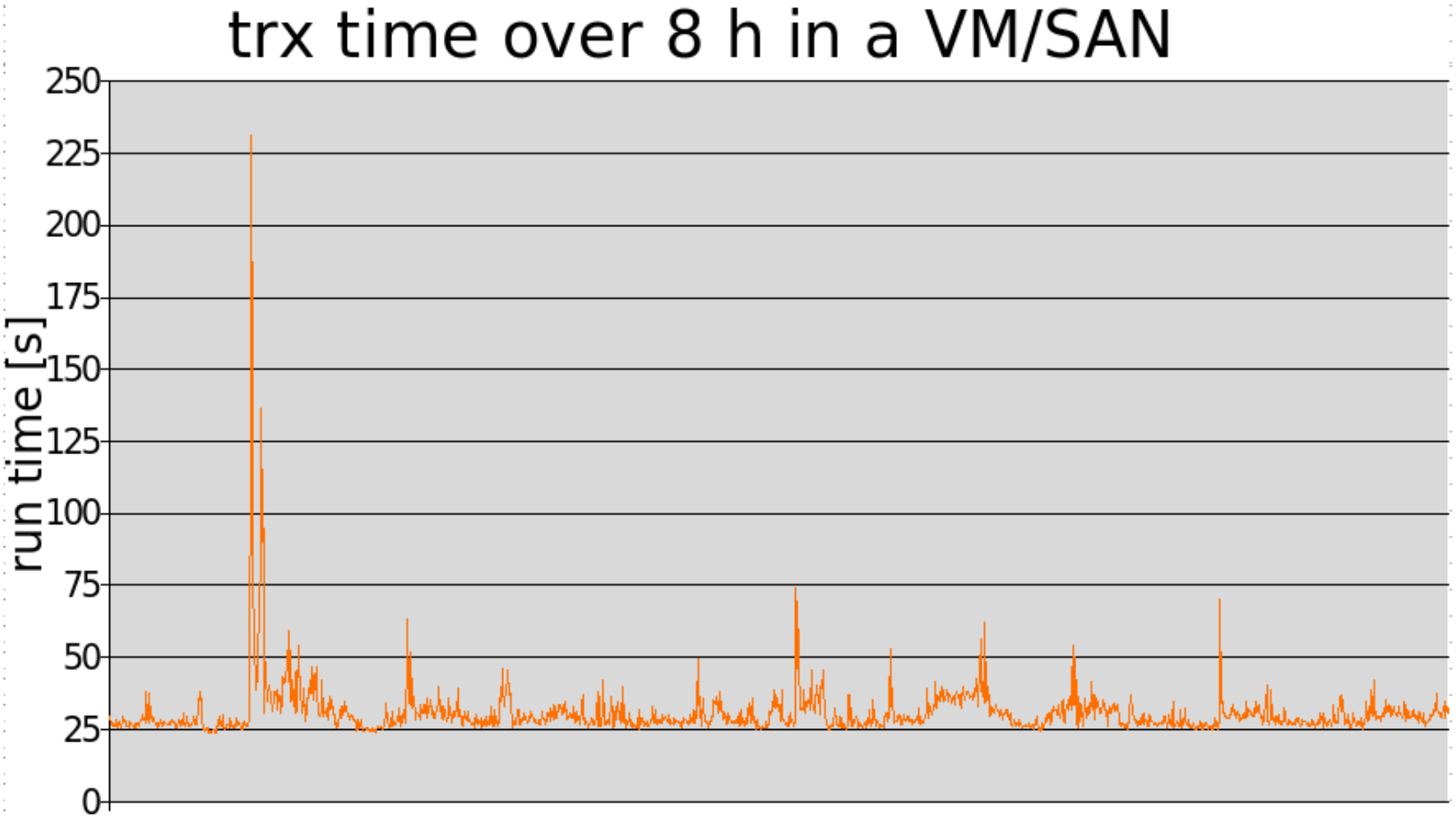
```
./commit_demo.pl -u root -c
./commit_demo.pl -u root -i <n>
./commit_demo.pl -u root -c
```

- Does NOT work with 6.0 :-(
- Lit: http://www.shinguz.ch/MySQL/transaction_performance.pdf

commit_demo.pl



commit_demo.pl



commit_demo.pl

Time [s]	trx [ms/trx]	trx [trx/s]	theorie [ms/trx]	Comment
12.3	1.2	833	8.3	Laptop, with good disk cache
27.2	2.7	370	2.5	SAN with up to 2000 I/O per second
41.0	4.1	244	4.0	Baseline for the following test
42.2	4.2	238	4.0	With DRBD, 2.5% slower
157.0	15.7	64	4.0	with XFS, badly configured?
86.4	8.6	116	8.0	With binary logging
565.0	56.5	18	8.0	sync_binlog=1!!!

InnoDB information (discussion)

- SHOW GLOBAL STATUS LIKE 'InnoDB%';
- SHOW ENGINE INNODB STATUS\G
- OK. But what does it mean to me?
- Let's start with a rough architecture picture:

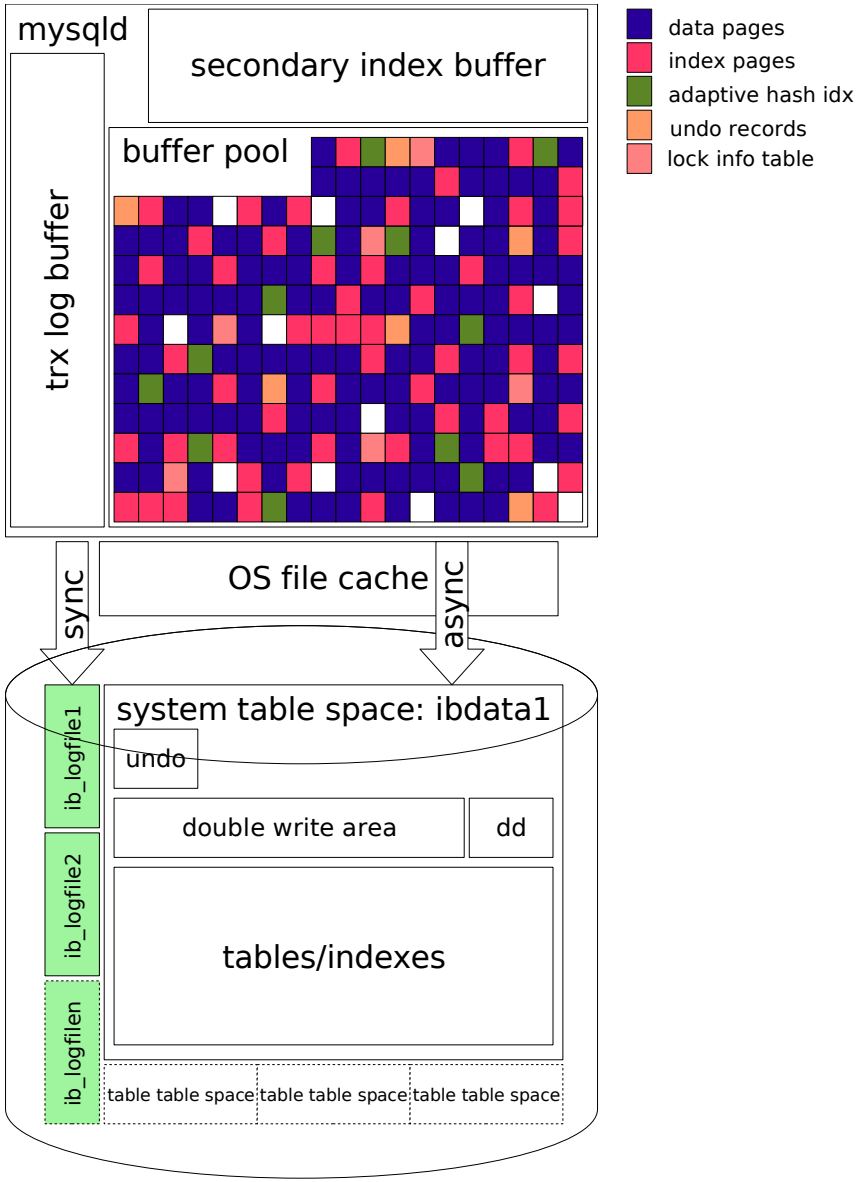
InnoDB architecture

- SHOW STATUS;

```
Innodb_buffer_pool_%
Innodb_data_%
Innodb_dblwr_%
Innodb_log_%
Innodb_os_log_%
Innodb_pages_%
Innodb_row_lock_%
Innodb_rows_%
```

- SHOW INNODB STATUS;

```
SEMAPHORES
TRANSACTIONS
FILE I/O
INSERT BUFFER AND
  ADAPTIVE HASH INDEX
LOG
BUFFER POOL AND MEMORY
ROW OPERATIONS
```



Innodb_buffer_pool%

```
    Innodb_buffer_pool_pages_dirty
  + Innodb_buffer_pool_pages_clean
  ------------------------------
  Innodb_buffer_pool_pages_data
+ Innodb_buffer_pool_pages_free
+ Innodb_buffer_pool_pages_misc
  ------------------------------
= Innodb_buffer_pool_pages_total
  ==============================

Innodb_buffer_pool_pages_flushed
Innodb_buffer_pool_pages_latched

Innodb_buffer_pool_read_ahead_rnd
Innodb_buffer_pool_read_ahead_seq

Innodb_buffer_pool_read_requests
Innodb_buffer_pool_reads
Innodb_buffer_pool_write_requests

Innodb_buffer_pool_wait_free
```

```
----------------------
BUFFER POOL AND MEMORY
----------------------
Total memory allocated 18415432;
in additional pool allocated 859008
Dictionary memory allocated 20888
Buffer pool size   512
Free buffers       493
Database pages     19
Modified db pages  0
Pending reads 0
Pending writes: LRU 0,
flush list 0,
single page 0
Pages read 19,
created 0,
written 0
0.32 reads/s,
0.00 creates/s,
0.00 writes/s
Buffer pool hit rate 754 / 1000
```

Innodb_data%

```
Innodb_data_fsyncs
Innodb_data_pending_fsyncs
Innodb_data_pending_reads
Innodb_data_pending_writes
Innodb_data_read
Innodb_data_reads
Innodb_data_writes
Innodb_data_written
```

???

Innodb_dblwr%

Innodb_dblwr_pages_written
Innodb_dblwr_writes

???

Innodb_[os_]log%

```
Innodb_log_waits
Innodb_log_write_requests
Innodb_log_writes

Innodb_os_log_fsyncs
Innodb_os_log_pending_fsyncs
Innodb_os_log_pending_writes
Innodb_os_log_written
```

```
LOG
---
Log sequence number 0 46409
Log flushed up to   0 46409
Last checkpoint at  0 46409
0 pending log writes,
0 pending chkp writes
8 log i/o's done,
0.14 log i/o's/second

Pending normal aio reads: 0,
aio writes: 0,
ibuf aio reads: 0,
log i/o's: 0,
sync i/o's: 0
Pending flushes (fsync) log: 0;
buffer pool: 0
```

Innodb_pages%

```
Innodb_page_size
Innodb_pages_created
Innodb_pages_read
Innodb_pages_written
```

???

Innodb_row_lock%

```
Innodb_row_lock_current_waits
Innodb_row_lock_time_max

  Innodb_row_lock_time_avg
* Innodb_row_lock_waits
  ------------------------
= Innodb_row_lock_time
```

???

Innodb_rows%

```
Innodb_rows_deleted
Innodb_rows_inserted
Innodb_rows_read
Innodb_rows_updated
```

```
ROW OPERATIONS
--------------
0 queries inside InnoDB,
0 queries in queue
1 read views open inside InnoDB
Main thread process no. 7924,
id 3004103568,
state: waiting for server activity
Number of rows inserted 0,
updated 0,
deleted 0,
read 0
0.00 inserts/s,
0.00 updates/s,
0.00 deletes/s,
0.00 reads/s
```

SEMAPHORES

???

```
SEMAPHORES
----------
OS WAIT ARRAY INFO:
reservation count 2,
signal count 2
Mutex spin waits 0,
rounds 0,
OS waits 0
RW-shared spins 4,
OS waits 2;
RW-excl spins 1,
OS waits 0
```

TRANSACTIONS

???

```
TRANSACTIONS
------------
Trx id counter 0 1280
Purge done for trx's n:o < 0 0
undo n:o < 0 0
History list length 0
Total number of lock structs
in row lock hash table 0

LIST OF TRANSACTIONS
FOR EACH SESSION:
---TRANSACTION 0 0, not started,
process no 7924,
OS thread id 3032894352
MySQL thread id 2,
query id 4 localhost root
show engine innodb status
```

FILE I/O

???

```
FILE I/O
--------
I/O thread 0 state:
waiting for i/o request
(insert buffer thread)
I/O thread 1 state:
waiting for i/o request
(log thread)
I/O thread 2 state:
waiting for i/o request
(read thread)
I/O thread 3 state:
waiting for i/o request
(write thread)

Pending normal aio reads: 0,
aio writes: 0,
ibuf aio reads: 0, log i/o's: 0,
sync i/o's: 0
Pending flushes (fsync) log: 0;
buffer pool: 0
25 OS file reads, 3 OS file writes,
3 OS fsyncs
0.42 reads/s, 100433 avg bytes/read,
0.05 writes/s, 0.05 fsyncs/s
```

INSERT BUFFER AND ADAPTIVE HASH INDEX

???

```
INSERT BUFFER AND
ADAPTIVE HASH INDEX
-------------------
Ibuf: size 1,
free list len 0,
seg size 2,
0 inserts,
0 merged recs,
0 merges

Hash table size 34679,
used cells 0,
node heap has 0 buffer(s)
0.00 hash searches/s,
0.31 non-hash searches/s
```

RAM disks (I)

- ORDER BY, GROUP BY, DISTINCT --> temp tables
  - bigger than:
  - BLOB/TEXT

```
tmp_table_size      = 32M
max_heap_table_size = 16M
```

- Will be written into:

```
tmpdir              =  /tmp/
```

- Can be seen in:

```
Created_tmp_disk_tables  0
Created_tmp_tables      20
```

RAM disk (II)

- Both counters are increased!
- Solutions?
  - Change your statement/requirements
  - Optimize your Query
  - Reduce size of result set
  - Avoid BLOB/TEXT
- And if you cannot?

--> Use a RAM disk!

RAM disk (III)

- RAM disk is a disk in RAM :-) --> So you need much RAM (8 Gbyte on 32-bit systems?)!
- Can use your SWAP (we do not want that)!
- More info: /usr/src/linux/Documentation/filesystems

```
# cat /proc/filesystems
# mount tmpfs -t tmpfs /mnt -o size=100m
# mount
```

- Bug in 5.0.4x!!! :-(

MySQL variables (discussion)

- Customers have very often misconfigured my.cnf
- My postulate: use the DEFAULT and adapt 3 things:
  - key_buffer_size
  - innodb_buffer_pool_size
  - innodb_log_file_size
- That's it! Other changes only after detailed tests!
- What is you opinion?

MyISAM log

- There is a log for MyISAM!
  I did not know that! :-(
- enable in my.cnf

```
log-isam = myisam.log
```

- cat myisam.log: :-(

```
+�./mysql/host.MYI+�
+�+�+�./mysql/user.MYI+�
+�+�+�./mysql/db.MYI+�
+�+�+�+�+�+�+�+�+�+�+!./mysql/time_zone_leap_second.MYI+�
+�+�+▒./mysql/time_zone_name.MYI+�
+�+�+�./mysql/time_zone.MYI+�
  +�%./mysql/time_zone_transition_type.MYI
+�  ./mysql/time_zone_transition.MYI+�
+�+�+�+�+�+�+./mysql/tables_priv.MYI+�
+�+�+▒./mysql/columns_priv.MYI+�
```

MyISAM log

- myisamlog myisam.log

```
Commands    Used count    Errors    Recover errors
open                15         0                 0
write                8         0                 0
update               1         0                 0
close                8         0                 0
extra               93         0                 0
Total              125         0                 0
```

- myisamlog -? --> help
- myisamlog -vvv
- myisamlog -i

```
User time 0.00, System time 0.00
Maximum resident set size 0, Integral resident set size 0
Non-physical pagefaults 519, Physical pagefaults 0, Swaps 0
Blocks in 0 out 0, Messages in 0 out 0, Signals 0
Voluntary context switches 1, Involuntary context switches 8
```

MySQL visual explain

- http://mysqltoolkit.sourceforge.net/

```
EXPLAIN
SELECT i.number, l.answer
  FROM poll_item i
  JOIN poll_item_l l ON (l.poll_id = i.poll_id
                     AND l.number = i.number)
WHERE i.poll_id = '4'
  AND l.language_id = '2'
ORDER BY i.number ASC;
```

```
+----+--------+-----+--------+----------+---------+-------+-----------+------+--------------------------+
| id | select | tab | type   | pos_keys | key     | k_len | ref       | rows | Extra                    |
+----+--------+-----+--------+----------+---------+-------+-----------+------+--------------------------+
|  1 | SIMPLE | i   | ref    | PRIMARY  | PRIMARY | 2     | const     |    5 | Using where; Using index |
|  1 | SIMPLE | l   | eq_ref | PRIMARY  | PRIMARY | 5     | const,... |    1 | Using where              |
+----+--------+-----+--------+----------+---------+-------+-----------+------+--------------------------+
```

MySQL visual explain

- http://mysqltoolkit.sourceforge.net/

```
./mysql-visual-explain test.exp

JOIN
+- Filter with WHERE
|  +- Bookmark lookup
|     +- Table
|     |  table           l
|     |  possible_keys   PRIMARY
|     +- Unique index lookup
|        key             l->PRIMARY
|        possible_keys   PRIMARY
|        key_len         5
|        ref             const,topodb.i.number,const
|        rows            1
+- Filter with WHERE
   +- Index lookup
      key             i->PRIMARY
      possible_keys   PRIMARY
      key_len         2
      ref             const
      rows            5
```