Explaining the

MySQL EXPLAIN

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OTN South America Tour
July 2011

ORACLE TECHNOLOGY NETWORK

ORACLE ACE Director

Ecuador Oracle Users Group

EffectiveMySQL.com - Its all about **Performance** and **Scalability**

AGENDA

- EXPLAIN syntax options
- How to read QEP
- QEP examples
- MySQL optimizer limitations

PURPOSE

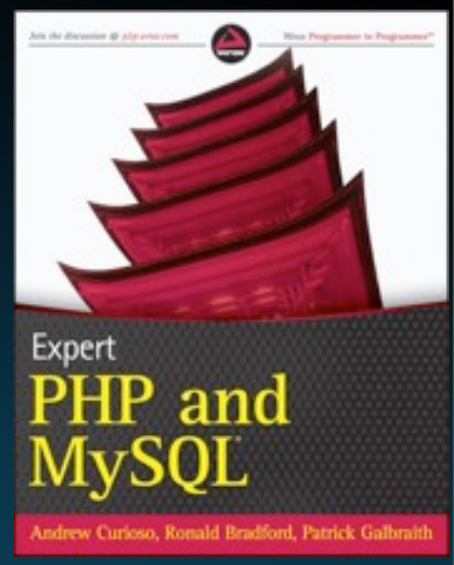
EXPLAIN is used for

- Determine Query Execution Plan (QEP)
- Understand MySQL optimizer
- Identify information needed for tuning
- Not providing tuning recommendations

ABOUT THE AUTHOR

RONALD BRADFORD

- 2011 - All time top blog contributor to Planet MySQL
- 2010 - Published Author of Expert PHP & MySQL
- 2010 - Oracle ACE Director (first in MySQL)
- 2009 - MySQL community member of the year



- 22 years of RDBMS experience, 12 years with MySQL
  - MySQL Inc (2006-2008)
  - Oracle Corporation (1996-1999)
- Provide independent consulting - Available NOW

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MYSQL QEP

- Cost Based Optimizer
- No pinning
- Few hints
- Calculated every SQL execution
- Except Query Cache

SYNTAX

- EXPLAIN SELECT ...
  - EXPLAIN PARTITIONS ...
  - EXPLAIN EXTENDED ...

- Does not support UPDATE,DELETE

SUPPORT COMMANDS

- SHOW CREATE TABLE
- SHOW INDEXES
- SHOW TABLE STATUS
- INFORMATION_SCHEMA
- SHOW VARIABLES
- SHOW STATUS

EXPLAIN USAGE

- Does not execute query

BUT

- May execute portions

WARNING !!!

EXPLAIN

EXAMPLE

```
mysql> EXPLAIN SELECT * FROM proposal WHERE post_id=16102176;
+----+-------------+----------+------+---------------+------+---------+------+--------+-------------+
| id | select_type | table    | type | possible_keys | key  | key_len | ref  | rows   | Extra       |
+----+-------------+----------+------+---------------+------+---------+------+--------+-------------+
|  1 | SIMPLE      | proposal | ALL  | NULL          | NULL | NULL    | NULL | 787126 | Using where |
+----+-------------+----------+------+---------------+------+---------+------+--------+-------------+
```

MYSQL CLIENT

- Statement terminator
  - ;
  - \G

EXPLAIN

EXAMPLE

```
mysql> EXPLAIN SELECT * FROM inventory
    -> WHERE item_id = 16102176\G
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: inventory
         type: ref
possible_keys: item_id
          key: item_id
      key_len: 4
          ref: const
         rows: 1
        Extra:
```

ATTRIBUTES

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ATTRIBUTES

- id
- select_type
- table
- type
- possible_keys
- key
- key_len
- ref
- rows
- Extra

```
mysql> EXPLAIN SELECT * FROM invento
    -> WHERE item_id = 16102176\G
*************************** 1. row **
           id: 1
  select_type: SIMPLE
        table: inventory
         type: ref
possible_keys: item_id
          key: item_id
      key_len: 4
          ref: const
         rows: 1
        Extra:
```

ESSENTIAL

EXAMPLE

- id
- select_type
- table
- type
- possible_keys
- **key**
- key_len
- ref
- **rows**
- Extra

```
mysql> EXPLAIN SELECT * FROM invento
    -> WHERE item_id = 16102176\G
*************************** 1. row ***
           id: 1
  select_type: SIMPLE
        table: inventory
         type: ref
possible_keys: item_id
          key: item_id
      key_len: 4
          ref: const
         rows: 1
        Extra:
```

ESSENTIAL

EXAMPLE

- id
- select_type
- table
- type
- possible_keys
- **key**
- key_len
- ref
- **rows**
- Extra

```
mysql> EXPLAIN SELECT * FROM invento
    -> WHERE item_id = 16102176\G
*************************** 1. row ***
           id: 1
  select_type: SIMPLE
        table: inventory
         type: ref
possible_keys: item_id
          key: item_id
      key_len: 4
          ref: const
         rows: 1
        Extra:
```

ESSENTIAL

EXAMPLE

- id
- select_type
- table
- type
- possible_keys
- **key**
- key_len
- ref
- **rows**
- Extra

```
mysql> EXPLAIN SELECT * FROM invento
    -> WHERE item_id = 16102176\G
*************************** 1. row **
           id: 1
  select_type: SIMPLE
        table: inventory
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 787338
        Extra: Using where
```

ESSENTIAL

EXAMPLE

- id
- select_type
- table
- type
- possible_keys
- **key**
- key_len
- ref
- **rows**
- Extra

```
mysql> EXPLAIN SELECT * FROM invento
    -> WHERE item_id = 16102176\G
*************************** 1. row **
           id: 1
  select_type: SIMPLE
        table: inventory
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 787338
        Extra: Using where
```

key

- Identify index to be used
- Generally only one per table (*)

- Associated elements
  - possible_keys
  - key_len

```
           id: 1
  select_type: SIMPLE
        table: invento
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 787338
        Extra: Using w
```

key

EXAMPLE

```
mysql> EXPLAIN SELECT * FROM inventory
    -> WHERE item_id = 16102176\G
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: inventory
         type: ref
possible_keys: item_id
          key: item_id
      key_len: 4
          ref: const
         rows: 1
        Extra:
```

key

MERGE INDEX EXAMPLE

```
mysql> EXPLAIN SELECT id FROM users
    -> WHERE first = 'west' OR last='west'\G
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: users
         type: index_merge
possible_keys: first,last
          key: first,last
      key_len: 22,22
          ref: NULL
         rows: 2
        Extra: Using union(first,last); Using where
```

```
CREATE TABLE `users` (
  `id` int(10) unsigned NOT NULL AU
  `first` varchar(20) NOT NULL,
  `last` varchar(20) NOT NULL,
  `username` varchar(20) NOT NULL,
  `last_login` timestamp NOT NULL D
  PRIMARY KEY (`id`),
  KEY `first` (`first`),
  KEY `last` (`last`),
  KEY `username` (`username`) ...
```

possible_keys

- Indexes the optimizer considered
  - Why was no index used?
  - Too many is not good
- Associated elements
  - key

```
           id: 1
  select_type: SIMPLE
        table: inventc
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 787338
        Extra: Using w
```

possible_keys

EXAMPLE

```
+----+-------------+-------+-------+---------------+---------+---------+------+------+----------------+
| id | select_type | table | type  | possible_keys | key     | key_len | ref  | rows | Extra          |
+----+-------------+-------+-------+---------------+---------+---------+------+------+----------------+
|  1 | SIMPLE      | c     | const | PRIMARY       | PRIMARY | 4       | const |    1 | Using filesort |
|  1 | SIMPLE      | i     | ALL   | customer_id   | NULL    | NULL    | NULL  |    7 | Using where    |
+----+-------------+-------+-------+---------------+---------+---------+------+------+----------------+
```

```
+----+-------------+-------+-------+---------------+-------------+---------+-------+------+-------------+
| id | select_type | table | type  | possible_keys | key         | key_len | ref   | rows | Extra       |
+----+-------------+-------+-------+---------------+-------------+---------+-------+------+-------------+
|  1 | SIMPLE      | c     | const | PRIMARY       | PRIMARY     | 4       | const |    1 |             |
|  1 | SIMPLE      | i     | ref   | customer_id   | customer_id | 4       | const |    5 | Using where |
+----+-------------+-------+-------+---------------+-------------+---------+-------+------+-------------+
```

possible_keys

EXAMPLE

```
+----+-------------+-------+-------+---------------+---------+---------+------+------+----------------+
| id | select_type | table | type  | possible_keys | key     | key_len | ref  | rows | Extra          |
+----+-------------+-------+-------+---------------+---------+---------+------+------+----------------+
|  1 | SIMPLE      | c     | const | PRIMARY       | PRIMARY | 4       | const |    1 | Using filesort |
|  1 | SIMPLE      | i     | ALL   | customer_id   | NULL    | NULL    | NULL  |    7 | Using where    |
+----+-------------+-------+-------+---------------+---------+---------+------+------+----------------+
```

```
+----+-------------+-------+-------+---------------+-------------+---------+-------+------+-------------+
| id | select_type | table | type  | possible_keys | key         | key_len | ref   | rows | Extra       |
+----+-------------+-------+-------+---------------+-------------+---------+-------+------+-------------+
|  1 | SIMPLE      | c     | const | PRIMARY       | PRIMARY     | 4       | const |    1 |             |
|  1 | SIMPLE      | i     | ref   | customer_id   | customer_id | 4       | const |    5 | Using where |
+----+-------------+-------+-------+---------------+-------------+---------+-------+------+-------------+
```

rows

- Estimated number of table rows (*)
- Associated elements
- key

```
           id: 1
  select_type: SIMPLE
        table: invento
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 787338
        Extra: Using w
```

key_len

- Amount of index used (*)
- Associated elements
- Extra = Using Index

```
           id: 1
  select_type: SIMPLE
        table: invento
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 787338
        Extra: Using w
```

key_len

EXAMPLE

```
mysql> EXPLAIN SELECT user_id,balance,created
    -> FROM accounts
    -> WHERE id = 42\G
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: accounts
         type: const
possible_keys: PRIMARY
          key: PRIMARY
      key_len: 8
          ref: const
         rows: 1
        Extra:
```

```
CREATE TABLE `accounts` (
  `id` BIGINT NOT NULL AUTO_INCREMEN
...
PRIMARY KEY (id)
...
```

key_len with varchar

EXAMPLE

```
mysql> EXPLAIN SELECT *
    -> FROM categories
    -> WHERE name LIKE 'NCAA%';

*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: categories
         type: range
possible_keys: name
          key: name
      key_len: 32
          ref: NULL
         rows: 6
        Extra: Using where
```

```
CREATE TABLE categories (
  id int NOT NULL AUTO_INCREMENT,
  name VARCHAR(30) NOT NULL,
...
  INDEX (name)
...
```

key_len with utf8

EXAMPLE

```
mysql> EXPLAIN SELECT *
    -> FROM categories
    -> WHERE name LIKE 'NCAA%';

*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: categories
         type: range
possible_keys: name
          key: name
      key_len: 92
          ref: NULL
         rows: 6
        Extra: Using where
```

```
CREATE TABLE `categories` (
  `id` int(4) NOT NULL AUTO_INCREMEN
  `name` VARCHAR(30) NOT NULL,
...
  INDEX (name)
) ... DEFAULT CHARSET=utf8
```

key_len

CALCULATIONS

- TINYINT - 1 byte
- SMALLINT - 2 bytes
- INT - 4 bytes
- BIGINT - 8 bytes
- DATE - 3 bytes
- TIMESTAMP - 4 bytes
- DATETIME - 8 bytes
- CHAR(n) - n bytes
- VARCHAR(n) - n bytes
- NULL + 1 byte
- VARCHAR + 2 bytes
- Character set x [1-3] bytes

key_len EXAMPLE

(1) (3)

```
mysql> EXPLAIN SELECT ID, post_title FROM wp_posts WHERE post_type='post' and post_date > '2010-06-01';
+----+-------------+----------+------+------------------+------------------+---------+-------+------+-------------+
| id | select_type | table    | type | possible_keys    | key              | key_len | ref   | rows | Extra       |
+----+-------------+----------+------+------------------+------------------+---------+-------+------+-------------+
|  1 | SIMPLE      | wp_posts | ref  | type_status_date | type_status_date | 62      | const | 1132 | Using where |
+----+-------------+----------+------+------------------+------------------+---------+-------+------+-------------+
```

```
CREATE TABLE `wp_posts` (
...
  `post_date` datetime NOT NULL DEFAULT '0000-00-00 00:00:00',
  `post_status` varchar(20) NOT NULL DEFAULT 'publish',
  `post_type` varchar(20) NOT NULL DEFAULT 'post',
...
  PRIMARY KEY (`ID`),
  KEY `type_status_date` (`post_type`,`post_status`,`post_date`,`ID`),
) DEFAULT CHARSET=utf8
```

(1) (2) (3) (4)

62 + 62 + 8 + 8

key_len EXAMPLE

(1) (3)

```
mysql> EXPLAIN SELECT ID, post_title FROM wp_posts WHERE post_type='post' and post_date > '2010-06-01';
+----+-------------+----------+------+-------------------+-------------------+---------+------+------+-------------+
| id | select_type | table    | type | possible_keys     | key               | key_len | ref  | rows | Extra       |
+----+-------------+----------+------+-------------------+-------------------+---------+------+------+-------------+
|  1 | SIMPLE      | wp_posts | ref  | type_status_date | type_status_date | 62      | const | 1132 | Using where |
+----+-------------+----------+------+-------------------+-------------------+---------+------+------+-------------+
```

(1) (2) (3)

```
mysql> EXPLAIN SELECT ID, post_title FROM wp_posts WHERE post_type='post' AND post_status='publish' AND post_date >
'2010-06-01';
+----+-------------+----------+-------+-------------------+-------------------+---------+------+------+-------------+
| id | select_type | table    | type  | possible_keys     | key               | key_len | ref  | rows | Extra       |
+----+-------------+----------+-------+-------------------+-------------------+---------+------+------+-------------+
|  1 | SIMPLE      | wp_posts | range | type_status_date | type_status_date | 132     | NULL |    1 | Using where |
+----+-------------+----------+-------+-------------------+-------------------+---------+------+------+-------------+
```

```
CREATE TABLE `wp_posts` (
...
  `post_date` datetime NOT NULL DEFAULT '0000-00-00 00:00:00',
  `post_status` varchar(20) NOT NULL DEFAULT 'publish',
  `post_type` varchar(20) NOT NULL DEFAULT 'post',
...
  PRIMARY KEY (`ID`),
  KEY `type_status_date` (`post_type`,`post_status`,`post_date`,`ID`),
) DEFAULT CHARSET=utf8
```

(1) (2) (3) (4)

62 + 62 + 8 + 8

select_type

- SIMPLE
- PRIMARY
- SUBQUERY
- DERIVED
- UNION

```
           id: 1
  select_type: SIMPLE
        table: invento
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 787338
        Extra: Using w
```

select_type

- SIMPLE
- PRIMARY
- SUBQUERY
- DERIVED
- UNION
- DEPENDENT UNION
- UNION RESULT
- UNCACHEABLE QUERY
- UNCACHEABLE UNION

```
           id: 1
  select_type: SIMPLE
        table: invento
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 787338
        Extra: Using w
```

select_type

EXAMPLE

```
mysql> EXPLAIN SELECT MAX(id) FROM (SELECT id FROM users WHERE first = 'west') c;
+----+-------------+-----------+------+---------------+-------+---------+------+------+-------------+
| id | select_type | table     | type | possible_keys | key   | key_len | ref  | rows | Extra       |
+----+-------------+-----------+------+---------------+-------+---------+------+------+-------------+
|  1 | PRIMARY     | <derived2>| ALL  | NULL          | NULL  | NULL    | NULL |    2 |             |
|  2 | DERIVED     | users     | ref  | first         | first | 22      |      |    1 | Using where |
+----+-------------+-----------+------+---------------+-------+---------+------+------+-------------+

mysql> EXPLAIN SELECT p.* FROM parent p WHERE p.val LIKE 'a%'
    -> UNION
    -> SELECT p.* FROM parent p WHERE p.id > 5;
+----+--------------+-----------+-------+---------------+-----+---------+------+------+-------------+
| id | select_type  | table     | type  | possible_keys | key | key_len | ref  | rows | Extra       |
+----+--------------+-----------+-------+---------------+-----+---------+------+------+-------------+
|  1 | PRIMARY      | p         | range | val           | val | 12      | NULL |    1 | Using where |
|  2 | UNION        | p         | ALL   | PRIMARY       | NULL| NULL    | NULL |    8 | Using where |
| NULL | UNION RESULT | <union1,2> | ALL | NULL          | NULL| NULL    | NULL | NULL |             |
+----+--------------+-----------+-------+---------------+-----+---------+------+------+-------------+
```

select_type

EXAMPLE

```
mysql> EXPLAIN SELECT MAX(id) FROM (SELECT id FROM users WHERE first = 'west') c;
+----+-------------+-----------+------+---------------+-------+---------+------+------+-------------+
| id | select_type | table     | type | possible_keys | key   | key_len | ref  | rows | Extra       |
+----+-------------+-----------+------+---------------+-------+---------+------+------+-------------+
|  1 | PRIMARY     | <derived2>| ALL  | NULL          | NULL  | NULL    | NULL |    2 |             |
|  2 | DERIVED     | users     | ref  | first         | first | 22      |      |    1 | Using where |
+----+-------------+-----------+------+---------------+-------+---------+------+------+-------------+

mysql> EXPLAIN SELECT p.* FROM parent p WHERE p.val LIKE 'a%'
    -> UNION
    -> SELECT p.* FROM parent p WHERE p.id > 5;
+----+--------------+-----------+-------+---------------+------+---------+------+------+-------------+
| id | select_type  | table     | type  | possible_keys | key  | key_len | ref  | rows | Extra       |
+----+--------------+-----------+-------+---------------+------+---------+------+------+-------------+
|  1 | PRIMARY      | p         | range | val           | val  | 12      | NULL |    1 | Using where |
|  2 | UNION        | p         | ALL   | PRIMARY       | NULL | NULL    | NULL |    8 | Using where |
| NULL | UNION RESULT | <union1,2> | ALL | NULL          | NULL | NULL    | NULL | NULL |             |
+----+--------------+-----------+-------+---------------+------+---------+------+------+-------------+
```

2 represents id

1,2 represents id

select_type

EXAMPLE

```
mysql> EXPLAIN SELECT p.* FROM parent p WHERE p.id NOT IN (SELECT c.parent_id FROM child c);
+----+--------------------+-------+----------------+--------------+----------+---------+------+------+-------------+
| id | select_type        | table | type           | possible_keys | key      | key_len | ref  | rows | Extra       |
+----+--------------------+-------+----------------+--------------+----------+---------+------+------+-------------+
|  1 | PRIMARY            | p     | ALL            | NULL         | NULL     | NULL    | NULL |    7 | Using where |
|  2 | DEPENDENT SUBQUERY | c     | index_subquery | parent_id    | parent_id | 4       | func |    2 | Using index |
+----+--------------------+-------+----------------+--------------+----------+---------+------+------+-------------+

mysql> EXPLAIN SELECT p.* FROM parent p LEFT JOIN child c ON p.id = c.parent_id WHERE c.child_id IS NULL;
+----+-------------+-------+------+---------------+----------+---------+------+------+-------------------------+
| id | select_type | table | type | possible_keys | key      | key_len | ref  | rows | Extra                   |
+----+-------------+-------+------+---------------+----------+---------+------+------+-------------------------+
|  1 | SIMPLE      | p     | ALL  | NULL          | NULL     | NULL    | NULL |    7 |                         |
|  1 | SIMPLE      | c     | ref  | parent_id     | parent_id | 4       | p.id |    2 | Using where; Not exists |
+----+-------------+-------+------+---------------+----------+---------+------+------+-------------------------+

mysql> EXPLAIN SELECT p.* FROM parent p WHERE  NOT EXISTS (SELECT parent_id FROM child c WHERE c.parent_id = p.id);
+----+--------------------+-------+------+---------------+----------+---------+------+------+-------------+
| id | select_type        | table | type | possible_keys | key      | key_len | ref  | rows | Extra       |
+----+--------------------+-------+------+---------------+----------+---------+------+------+-------------+
|  1 | PRIMARY            | p     | ALL  | NULL          | NULL     | NULL    | NULL |    7 | Using where |
|  2 | DEPENDENT SUBQUERY | c     | ref  | parent_id     | parent_id | 4       | p.id |    2 | Using index |
+----+--------------------+-------+------+---------------+----------+---------+------+------+-------------+
```

select_type EXAMPLE

3 ways to get same query results

```
mysql> EXPLAIN SELECT p.* FROM parent p WHERE p.id NOT IN (SELECT c.parent_id FROM child c);
+----+--------------------+-------+----------------+-------------+----------+---------+------+------+-------------+
| id | select_type        | table | type           | possible_keys | key      | key_len | ref  | rows | Extra       |
+----+--------------------+-------+----------------+-------------+----------+---------+------+------+-------------+
|  1 | PRIMARY            | p     | ALL            | NULL          | NULL     | NULL    | NULL |    7 | Using where |
|  2 | DEPENDENT SUBQUERY | c     | index_subquery | parent_id     | parent_id | 4       | func |    2 | Using index |
+----+--------------------+-------+----------------+-------------+----------+---------+------+------+-------------+

mysql> EXPLAIN SELECT p.* FROM parent p LEFT JOIN child c ON p.id = c.parent_id WHERE c.child_id IS NULL;
+----+-------------+-------+------+---------------+----------+---------+------+------+-------------------------+
| id | select_type | table | type | possible_keys | key      | key_len | ref  | rows | Extra                   |
+----+-------------+-------+------+---------------+----------+---------+------+------+-------------------------+
|  1 | SIMPLE      | p     | ALL  | NULL          | NULL     | NULL    | NULL |    7 |                         |
|  1 | SIMPLE      | c     | ref  | parent_id     | parent_id | 4       | p.id |    2 | Using where; Not exists |
+----+-------------+-------+------+---------------+----------+---------+------+------+-------------------------+

mysql> EXPLAIN SELECT p.* FROM parent p WHERE  NOT EXISTS (SELECT parent_id FROM child c WHERE c.parent_id = p.id);
+----+--------------------+-------+------+---------------+----------+---------+------+------+-------------+
| id | select_type        | table | type | possible_keys | key      | key_len | ref  | rows | Extra       |
+----+--------------------+-------+------+---------------+----------+---------+------+------+-------------+
|  1 | PRIMARY            | p     | ALL  | NULL          | NULL     | NULL    | NULL |    7 | Using where |
|  2 | DEPENDENT SUBQUERY | c     | ref  | parent_id     | parent_id | 4       | p.id |    2 | Using index |
+----+--------------------+-------+------+---------------+----------+---------+------+------+-------------+
```

Which query is best?

Extra

Most Common

- Using where
- Using temporary
- Using filesort
- Using index **GOOD**
- Using join buffer

```
           id: 1
  select_type: SIMPLE
        table: invento
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 787338
        Extra: Using w
```

Extra - Using temporary

- Internal Table (MEMORY based)
- Can have multiple per query
- To Disk Impact
  - TEXT/BLOB
  - Size

http://forge.mysql.com/wiki/Overview_of_query_execution_and_use_of_temp_tables

Extra - Using filesort

- ORDER BY
  - Can be CPU intensive

- Is order via DB necessary?
- Can you leverage an index?

Extra - Using filesort

EXAMPLE

```
EXPLAIN
SELECT   i.invoice_date, i.customer_id, i.invoice_total, c.company, c.state
FROM     invoice i INNER JOIN customer c USING (customer_id)
WHERE    i.customer_id = 42
ORDER BY i.invoice_date;

+-------+------+---------------+-------------+---------+-------+------+----------------+
| table | type | possible_keys | key         | key_len | ref   | rows | Extra          |
+-------+------+---------------+-------------+---------+-------+------+----------------+
| c     | const | PRIMARY       | PRIMARY     | 4       | const |    1 | Using filesort |
| i     | ref   | customer_id   | customer_id | 4       | const |    5 | Using where    |
+-------+------+---------------+-------------+---------+-------+------+----------------+


CREATE TABLE invoice(
  invoice_id  INT UNSIGNED NOT NULL AUTO_INCREMENT,
  invoice_date DATE NOT NULL,
  customer_id  INT UNSIGNED NOT NULL,
  invoice_total DECIMAL(10,2) NOT NULL,
  PRIMARY KEY(invoice_id),
  KEY (customer_id)
) ENGINE=InnoDB;
```

Extra - Using filesort

EXAMPLE

```
EXPLAIN
SELECT   i.invoice_date, i.customer_id, i.invoice_total, c.company, c.state
FROM     invoice i INNER JOIN customer c USING (customer_id)
WHERE    i.customer_id = 42
ORDER BY i.invoice_date;
```

```
+-------+------+---------------+-------------+---------+-------+------+----------------+
| table | type | possible_keys | key         | key_len | ref   | rows | Extra          |
+-------+------+---------------+-------------+---------+-------+------+----------------+
| c     | const | PRIMARY       | PRIMARY     | 4       | const |    1 | Using filesort |
| i     | ref   | customer_id   | customer_id | 4       | const |    5 | Using where    |
+-------+------+---------------+-------------+---------+-------+------+----------------+
```

```
CREATE TABLE invoice(
  invoice_id  INT UNSIGNED NOT NULL AUTO_INCREMENT,
  invoice_date DATE NOT NULL,
  customer_id  INT UNSIGNED NOT NULL,
  invoice_total DECIMAL(10,2) NOT NULL,
  PRIMARY KEY(invoice_id),
  KEY (customer_id, invoice_date)
) ENGINE=InnoDB;
```

Extra - Using index

- Does not mean using index
- Means using ONLY THE INDEX

- Additional Presentation

Improving Performance with Better Indexes

EffectiveMySQL.com - Its all about **Performance** and **Scalability**

Extra - Using index

EXAMPLE

id	select_t	tab	key	key_	id	select_t	tab	key	key_	Extra
1	PRIMARY	c	statu	1	1	PRIMARY	c	adver	4	Using where
1	PRIMARY	e	PRIMA	4	1	PRIMARY	e	**statu**	**1**	Using where; **Using index**
1	PRIMARY	g	campa	4	1	PRIMARY	g	campa	4	Using where
10	DEPENDEN	crb	id_ca	**4**	10	DEPENDEN	crb	id_ca	**66**	Using where
9	DEPENDEN	csb	pub_s	98	9	DEPENDEN	csb	pub_s	98	Using where
8	DEPENDEN	arb	id_ad	**4**	8	DEPENDEN	arb	id_ad	**26**	Using where
7	DEPENDEN	asb	pub_s	**34**	7	DEPENDEN	asb	**id_ad**	**40**	Using where; **Using index**
6	DEPENDEN	pm	id_adr	**4**	6	DEPENDEN	pm	id_adr	**12**	Using index
5	DEPENDEN	tgv	searc	**4**	5	DEPENDEN	tgv	searc	**10**	Using where; **Using index**
4	DEPENDEN	st	id_sc	4	4	DEPENDEN	st	id_sc	4	Using where; **Using index**
4	DEPENDEN	t	PRIMA	4	4	DEPENDEN	t	PRIMA	4	Using where
3	DEPENDEN	k2	keywo	302	3	DEPENDEN	k2	keywo	302	Using where; **Using index**
3	DEPENDEN	gk2	PRIMA	100	3	DEPENDEN	gk2	PRIMA	100	Using where
2	DEPENDEN	k1	keywo	302	2	DEPENDEN	k1	keywo	302	Using where; **Using index**
2	DEPENDEN	gk1	PRIMA	100	2	DEPENDEN	gk1	PRIMA	100	Using where

Extra - Using index

EXAMPLE

Executed 25-30 thousand queries per second

id	select_t	tab	key	key_
1	PRIMARY	c	statu	1
1	PRIMARY	e	PRIMA	4
1	PRIMARY	g	campa	4
10	DEPENDEN	crb	id_ca	**4**
9	DEPENDEN	csb	pub_s	98
8	DEPENDEN	arb	id_ad	**4**
7	DEPENDEN	asb	pub_s	**34**
6	DEPENDEN	pm	id_adr	**4**
5	DEPENDEN	tgv	searc	**4**
4	DEPENDEN	st	id_sc	4
4	DEPENDEN	t	PRIMA	4
3	DEPENDEN	k2	keywo	302
3	DEPENDEN	gk2	PRIMA	100
2	DEPENDEN	k1	keywo	302
2	DEPENDEN	gk1	PRIMA	100

Before was 175ms

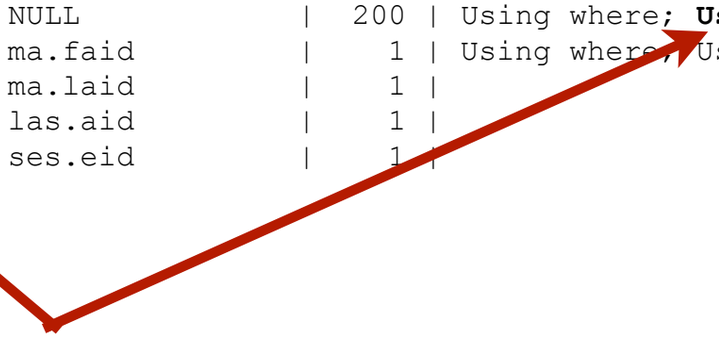
id	select_t	tab	key	key_	Extra
1	PRIMARY	c	adver	4	Using where
1	PRIMARY	e	**statu**	**1**	Using where; **Using index**
1	PRIMARY	g	campa	4	Using where
10	DEPENDEN	crb	id_ca	**66**	Using where
9	DEPENDEN	csb	pub_s	98	Using where
8	DEPENDEN	arb	id_ad	**26**	Using where
7	DEPENDEN	asb	**id_ad**	**40**	Using where; **Using index**
6	DEPENDEN	pm	id_adr	**12**	Using index
5	DEPENDEN	tgv	searc	**10**	Using where; **Using index**
4	DEPENDEN	st	id_sc	4	Using where; **Using index**
4	DEPENDEN	t	PRIMA	4	Using where
3	DEPENDEN	k2	keywo	302	Using where; **Using index**
3	DEPENDEN	gk2	PRIMA	100	Using where
2	DEPENDEN	k1	keywo	302	Using where; **Using index**
2	DEPENDEN	gk1	PRIMA	100	Using where

After was 5ms

Extra - Using join buffer

EXAMPLE

id	select_type	table	type	possible_keys	key	key_len	ref	rows	Extra
1	SIMPLE	fs	ref	PRIMARY,sts	sts	768	const	21	Using where; Using temporary; U
1	SIMPLE	fsu	ref	PRIMARY,d,sid	sid	4	fs.sid	21	Using where
1	SIMPLE	fes	ref	sasi,eid,sid,sues,suid	sues	8	fsi.suid,fs.sid	26	
1	SIMPLE	ma	ALL	masi	**NULL**	NULL	NULL	200	Using where; **Using join buffer**
1	SIMPLE	fas	eq_ref	PRIMARY	PRIMARY	4	ma.faid	1	Using where; Using index
1	SIMPLE	las	eq_ref	PRIMARY,asai	PRIMARY	4	ma.laid	1	
1	SIMPLE	la	eq_ref	PRIMARY	PRIMARY	4	las.aid	1	
1	SIMPLE	fp	eq_ref	PRIMARY	PRIMARY	4	ses.eid	1	



Extra - Using join buffer

EXAMPLE

id	select_type	table	type	possible_keys	key	key_len	ref	rows	Extra
1	SIMPLE	fs	ref	PRIMARY,sts	sts	768	const	21	Using where; Using temporary; U
1	SIMPLE	fsu	ref	PRIMARY,d,sid	sid	4	fs.sid	21	Using where
1	SIMPLE	fes	ref	sasi,eid,sid,sues,suid	sues	8	fsi.suid,fs.sid	26	
1	SIMPLE	ma	ALL	masi	**NULL**	NULL	NULL	200	Using where; **Using join buffer**
1	SIMPLE	fas	eq_ref	PRIMARY	PRIMARY	4	ma.faid	1	Using where; Using index
1	SIMPLE	las	eq_ref	PRIMARY,asai	PRIMARY	4	ma.laid	1	
1	SIMPLE	la	eq_ref	PRIMARY	PRIMARY	4	las.aid	1	
1	SIMPLE	fp	eq_ref	PRIMARY	PRIMARY	4	ses.eid	1	

No index can be satisfied for join condition.
i.e. full table scan

Extra cont.

Less common

- Impossible WHERE ...
- Distinct
- Not exists
- Select tables optimized away

Extra

EXAMPLE

```
mysql> EXPLAIN SELECT COUNT(*) FROM (SELECT id FROM users WHERE first = 'west') c
*************************** 1. row ***************************
           id: 1
  select_type: PRIMARY
        table: NULL
         type: NULL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: NULL
        Extra: Select tables optimized away
*************************** 2. row ***************************
           id: 2
  select_type: DERIVED
        table: users
         type: ref
possible_keys: first
          key: first
      key_len: 22
          ref:
         rows: 1
```

Extra cont.

Merge Indexes

- Using sort_union(...)
- Using union(...)
- Using intersect(...)

SYNTAX

- EXPLAIN SELECT ...
  - EXPLAIN PARTITIONS ...
  - EXPLAIN EXTENDED ...

- Does not support UPDATE,DELETE

EXPLAIN PARTITIONS

EXAMPLE

```
   mysql> EXPLAIN PARTITIONS SELECT * from audit_log WHERE yr in
   (2011,2012)\G
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: audit_log
   partitions: p2,p3
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 2
        Extra: Using where
```

EXPLAIN EXTENDED

EXAMPLE

```
    mysql> EXPLAIN EXTENDED select t1.name from test1 t1 INNER JOIN test2 t2 USING(uid)\G
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: t1
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 1
     filtered: 100.00
        Extra:
*************************** 2. row ***************************
           id: 1
  select_type: SIMPLE
        table: t2
         type: eq_ref
possible_keys: PRIMARY
          key: PRIMARY
      key_len: 98
          ref: func
         rows: 1
     filtered: 100.00
        Extra: Using where; Using index
2 rows in set, 1 warning (0.00 sec)
```

EXPLAIN EXTENDED

EXAMPLE

```
mysql> EXPLAIN EXTENDED select t1.name from test1 t1 INNER JOIN
test2 t2 USING(uid)\G


mysql> SHOW WARNINGS\G
*************************** 1. row ***************************
  Level: Note
   Code: 1003
Message: select `book`.`t1`.`name` AS `name` from `book`.`test1`
`t1` join `book`.`test2` `t2` where (convert(`book`.`t1`.`uid` using
utf8) = `book`.`t2`.`uid`)
```

INDEX HINTS

- USE INDEX
- IGNORE INDEX
- FORCE INDEX
- FOR
- JOIN | ORDER BY | GROUP BY

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INDEX HINTS

- USE INDEX
- IGNORE INDEX
- FORCE INDEX

Can specify multiple indexes

- FOR
- JOIN | ORDER BY | GROUP BY

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SELECT HINTS

- STRAIGHT_JOIN
  - Defines order of tables in QEP
- HIGH_PRIORITY
- Certain engines (*)

SELECT HINTS

- SQL_CACHE
- SQL_NO_CACHE
- SQL_CALC_FOUND_ROWS
- SQL_BIG_RESULT
- SQL_SMALL_RESULT
- SQL_BUFFER_RESULT

SQL_CALC_FOUND_ROWS

EXAMPLE

```
SELECT id,username FROM users WHERE last LIKE 'w%' LIMIT 10;
..
+--------+----------+
10 rows in set (0.00 sec)


SELECT SQL_CALC_FOUND_ROWS id,username FROM users
WHERE last LIKE 'w%' LIMIT 10;
SELECT FOUND_ROWS();
...
10 rows in set (8.81 sec)

mysql> SELECT FOUND_ROWS();
+---------------+
| FOUND_ROWS()  |
+---------------+
|          1671 |
+---------------+
1 row in set (0.02 sec)
```

Conclusion

EffectiveMySQL.com - Its all about **Performance** and **Scalability**

CONCLUSION

- Essential tool for SQL analysis
- Not the only information you need

- Other Presentations
  - Understanding MySQL Indexes
  - Improving Performance with Better Indexes

Emacs

Ronald Bradford

http://effectiveMySQL.com