

3.

OBJECT_TYPE	OBJECT_SCHEMA	OBJECT_NAME	ENABLED	TIMED
EVENT	mysql	%	NO	NO
EVENT	performance_schema	%	NO	NO
EVENT	information_schema	%	NO	NO
EVENT	%	%	YES	YES
FUNCTION	mysql	%	NO	NO
FUNCTION	performance_schema	%	NO	NO
FUNCTION	information_schema	%	NO	NO
FUNCTION	%	%	YES	YES
PROCEDURE	mysql	%	NO	NO
PROCEDURE	performance_schema	%	NO	NO
PROCEDURE	information_schema	%	NO	NO
PROCEDURE	%	%	YES	YES
TABLE	mysql	%	NO	NO
TABLE	performance_schema	%	NO	NO
TABLE	information_schema	%	NO	NO
TABLE	%	%	YES	YES
TRIGGER	mysql	%	NO	NO
TRIGGER	performance_schema	%	NO	NO
TRIGGER	information_schema	%	NO	NO
TRIGGER	%	%	YES	YES
EVENT	baseball	%	YES	YES
EVENT	baseball_pkfk	%	YES	YES

a)

```
select count(playerID) from Master where birthYear is null or birthYear = ""  
                                or birthMonth is null or birthMonth = ""  
                                or birthDay is null or birthDay = "";
```

**Without any index:**

```
[mysql> show indexes in master;  
Empty set (0.00 sec)
```

**First experiment:**

```
timer_start = 2670250977689000000  
timer_end = 2670250989851000000  
timer_wait = 12162000000
```

**Second experiment:**

```
timer_start = 2670348410393000000  
timer_end = 2670348422958000000  
timer_wait = 12565000000
```

**Third experiment:**

```
timer_start = 2670525774194000000  
timer_end = 2670525787571000000  
timer_wait = 13377000000
```

**Fourth experiment:**

```
timer_start = 2670550071715000000  
timer_end = 2670550084205000000  
timer_wait = 12490000000
```

**Fifth experiment:**

```
timer_start = 2670555884274000000  
timer_end = 2670555896913000000  
timer_wait = 12639000000
```

```
average = 12646600000 picoseconds = 12646.6 microseconds  
min = 12162000000 picoseconds = 12162 microseconds  
max = 13377000000 picoseconds = 13377 microseconds
```

### **With primary key:**

```
mysql> show index in master;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Master |          0 | PRIMARY |          1 | playerID   |      A      |       18582 |        NULL |    YES  |    YES | BTREE     |          |           | YES     |      NULL   |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
1 row in set (0.01 sec)
```

### **First experiment:**

```
timer_start = 2675058847276000000
timer_end = 2675058855635000000
timer_wait = 8359000000
```

### **Second experiment:**

```
timer_start = 2675062205187000000
timer_end = 2675062213872000000
timer_wait = 8685000000
```

### **Third experiment:**

```
timer_start = 2675063213317000000
timer_end = 2675063221973000000
timer_wait = 8656000000
```

### **Fourth experiment:**

```
timer_start = 2675064631861000000
timer_end = 2675064640297000000
timer_wait = 8436000000
```

### **Fifth experiment:**

```
timer_start = 2675088920187000000
timer_end = 2675088929092000000
timer_wait = 8905000000
```

```
average = 8608200000 picoseconds = 8608.2 microseconds
min = 8359000000 picoseconds = 8359 microseconds
max = 8905000000 picoseconds = 8905 microseconds
```

**With index:**

```
mysql> SHOW INDEXES IN Master;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Master |          1 | birthYear |          1 | birthYear |      A |       167 |        NULL |    YES | BTREE |           |           |           | YES | NULL |
| Master |          1 | birthMonth |         1 | birthMonth |      A |        13 |        NULL |    YES | BTREE |           |           |           | YES | NULL |
| Master |          1 | birthDay |          1 | birthDay |      A |        32 |        NULL |    YES | BTREE |           |           |           | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3 rows in set (0.01 sec)
```

**First experiment:**

```
timer_start = 2675743402738000000
timer_end = 2675743404700000000
timer_wait = 1962000000
```

**Second experiment:**

```
timer_start = 2675744157658000000
timer_end = 2675744159643000000
timer_wait = 1985000000
```

**Third experiment:**

```
timer_start = 2675744805937000000
timer_end = 2675744807899000000
timer_wait = 1962000000
```

**Fourth experiment:**

```
timer_start = 2675745461413000000
timer_end = 2675745463393000000
timer_wait = 1980000000
```

**Fifth experiment:**

```
timer_start = 2675746079171000000
timer_end = 2675746081219000000
timer_wait = 2048000000
```

```
average = 1987400000 picoseconds = 1987.4 microseconds
min = 1962000000 picoseconds = 1962 microseconds
max = 2048000000 picoseconds = 2048 microseconds
```

b)

```
select playerID,sum(salary) as totalPay from Salaries
      left outer join Appearances using (playerID,yearID,teamID)
      left outer join Managers using (playerID,yearID,teamID)
          where G is null and
                G_all is null
      group by playerID
      order by totalPay desc
      limit 3;
```

**Without any index:**

```
[mysql> SHOW INDEXES IN salaries;
Empty set (0.00 sec)

[mysql> SHOW INDEXES IN appearances;
Empty set (0.00 sec)

[mysql> SHOW INDEXES IN managers;
Empty set (0.00 sec)
```

**First experiment:**

```
timer_start = 2676497028819000000
timer_end = 2676497340486000000
timer_wait = 311667000000
```

**Second experiment:**

```
timer_start = 2676496057829000000
timer_end = 2676496379061000000
timer_wait = 321232000000
```

**Third experiment:**

```
timer_start = 2676495180931000000
timer_end = 2676495491202000000
timer_wait = 310271000000
```

**Fourth experiment:**

```
timer_start = 2676494271010000000
timer_end = 2676494588133000000
timer_wait = 317123000000
```

**Fifth experiment:**

```
timer_start = 2676493302192000000
timer_end = 2676493625012000000
timer_wait = 322820000000
```

```
average = 316622600000 picoseconds = 316622.6 microseconds
min = 310271000000 picoseconds = 310271 microseconds
max = 322820000000 picoseconds = 322820 microseconds
```

## With primary key:

```
mysql> show indexes in salaries;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| salaries | 0 | PRIMARY | 1 | yearID | A | 31 | NULL | NULL | BTREE | | YES | NULL |
| salaries | 0 | PRIMARY | 2 | teamID | A | 943 | NULL | NULL | BTREE | | YES | NULL |
| salaries | 0 | PRIMARY | 3 | playerID | A | 26648 | NULL | NULL | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3 rows in set (0.00 sec)

mysql> show indexes in managers;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| managers | 0 | PRIMARY | 1 | playerID | A | 698 | NULL | NULL | BTREE | | YES | NULL |
| managers | 0 | PRIMARY | 2 | yearID | A | 3385 | NULL | NULL | BTREE | | YES | NULL |
| managers | 0 | PRIMARY | 3 | inseason | A | 3436 | NULL | NULL | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3 rows in set (0.01 sec)

mysql> show indexes in appearances;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| appearances | 0 | PRIMARY | 1 | yearID | A | 145 | NULL | NULL | BTREE | | YES | NULL |
| appearances | 0 | PRIMARY | 2 | teamID | A | 2714 | NULL | NULL | BTREE | | YES | NULL |
| appearances | 0 | PRIMARY | 3 | playerID | A | 162183 | NULL | NULL | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3 rows in set (0.01 sec)
```

## First experiment:

```
timer_start = 2677709783933000000
timer_end = 2677709869826000000
timer_wait = 85893000000
```

## Second experiment:

```
timer_start = 2677708600213000000
timer_end = 2677708680463000000
timer_wait = 80250000000
```

## Third experiment:

```
timer_start = 2677708079932000000
timer_end = 2677708162571000000
timer_wait = 82639000000
```

## Fourth experiment:

```
timer_start = 2677707513975000000
timer_end = 2677707594072000000
timer_wait = 80097000000
```

## Fifth experiment:

```
timer_start = 2677706907731000000
timer_end = 2677706988923000000
timer_wait = 81192000000
```

```
average = 82014200000 picoseconds = 82014.2 microseconds
min = 80097000000 picoseconds = 80097 microseconds
max = 85893000000 picoseconds = 85893 microseconds
```

### With primary key and foreign key:

```

+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Managers | 0 | PRIMARY | 1 | playerID | A | 698 | NULL | NULL | BTREE | | YES | NULL | |
| Managers | 0 | PRIMARY | 2 | yearID | A | 3386 | NULL | NULL | BTREE | | YES | NULL |
| Managers | 0 | PRIMARY | 3 | inSeason | A | 3436 | NULL | NULL | BTREE | | YES | NULL |
| Managers | 1 | yearID | 1 | yearID | A | 146 | NULL | NULL | BTREE | | YES | NULL |
| Managers | 1 | yearID | 2 | lgID | A | 276 | NULL | NULL | YES | BTREE | | YES | NULL |
| Managers | 1 | yearID | 3 | teamID | A | 2835 | NULL | NULL | YES | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
6 rows in set (0.01 sec)

mysql> show index in appearances;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Appearances | 0 | PRIMARY | 1 | yearID | A | 147 | NULL | NULL | BTREE | | YES | NULL | |
| Appearances | 0 | PRIMARY | 2 | teamID | A | 2679 | NULL | NULL | BTREE | | YES | NULL |
| Appearances | 0 | PRIMARY | 3 | playerID | A | 10780 | NULL | NULL | BTREE | | YES | NULL |
| Appearances | 1 | playerID | 1 | playerID | A | 19298 | NULL | NULL | BTREE | | YES | NULL |
| Appearances | 1 | yearID | 1 | yearID | A | 147 | NULL | NULL | BTREE | | YES | NULL |
| Appearances | 1 | yearID | 2 | lgID | A | 279 | NULL | NULL | YES | BTREE | | YES | NULL |
| Appearances | 1 | yearID | 3 | teamID | A | 3835 | NULL | NULL | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
7 rows in set (0.01 sec)

mysql> show index in salaries;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Salaries | 0 | PRIMARY | 1 | teamID | A | 0 | NULL | NULL | BTREE | | YES | NULL |
| Salaries | 0 | PRIMARY | 2 | yearID | A | 0 | NULL | NULL | BTREE | | YES | NULL |
| Salaries | 0 | PRIMARY | 3 | playerID | A | 0 | NULL | NULL | BTREE | | YES | NULL |
| Salaries | 1 | playerID | 1 | playerID | A | 0 | NULL | NULL | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
4 rows in set (0.01 sec)

```

### First experiment:

```

timer_start = 2679589034687000000
timer_end = 2679589124798000000
timer_wait = 90111000000

```

### Second experiment:

```

timer_start = 2679588291542000000
timer_end = 2679588379969000000
timer_wait = 88427000000

```

### Third experiment:

```

timer_start = 2679587375741000000
timer_end = 2679587466515000000
timer_wait = 90774000000

```

### Fourth experiment:

```

timer_start = 2679586831826000000
timer_end = 2679586921074000000
timer_wait = 89248000000

```

### Fifth experiment:

```

timer_start = 2679586235626000000
timer_end = 2679586327892000000
timer_wait = 92266000000

```

```

average = 90165200000 picoseconds = 90165.2 microseconds
min = 88427000000 picoseconds = 88427 microseconds
max = 92266000000 picoseconds = 92266 microseconds

```

## With index:

```
mysql> show index in appearances;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| appearances | 1 | pvt | 1 | playerID | A | 19827 | NULL | NULL | BTREE | YES | NULL | |
| appearances | 1 | pvt | 2 | yearID | A | 95548 | NULL | NULL | BTREE | YES | NULL |
| appearances | 1 | pvt | 3 | teamID | A | 162349 | NULL | NULL | BTREE | YES | NULL |
| appearances | 1 | G_all | 1 | G_all | A | 165 | NULL | NULL | YES | BTREE | YES | NULL |
| appearances | 1 | playerid | 1 | playerID | A | 18856 | NULL | NULL | BTREE | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
5 rows in set (0.00 sec)

mysql> show index in managers;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| managers | 1 | pvt | 1 | playerID | A | 698 | NULL | NULL | BTREE | YES | NULL | |
| managers | 1 | pvt | 2 | yearID | A | 3385 | NULL | NULL | BTREE | YES | NULL |
| managers | 1 | pvt | 3 | teamID | A | 340 | NULL | NULL | YES | BTREE | YES | NULL |
| managers | 1 | G | 1 | G | A | 165 | NULL | NULL | YES | BTREE | YES | NULL |
| managers | 1 | playerid | 1 | playerID | A | 698 | NULL | NULL | BTREE | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
5 rows in set (0.01 sec)

mysql> show index in salaries;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| salaries | 1 | pvt | 1 | playerID | A | 5155 | NULL | NULL | BTREE | YES | NULL |
| salaries | 1 | pvt | 2 | yearID | A | 26112 | NULL | NULL | BTREE | YES | NULL |
| salaries | 1 | pvt | 3 | teamID | A | 26112 | NULL | NULL | BTREE | YES | NULL |
| salaries | 1 | playerid | 1 | playerID | A | 5155 | NULL | NULL | BTREE | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

## First experiment:

```
timer_start = 2689287400445000000
timer_end = 2689287505777000000
timer_wait = 105332000000
```

## Second experiment:

```
timer_start = 2689287016687000000
timer_end = 2689287124894000000
timer_wait = 108207000000
```

## Third experiment:

```
timer_start = 2689286667599000000
timer_end = 2689286773869000000
timer_wait = 106270000000
```

## Fourth experiment:

```
timer_start = 2689286336748000000
timer_end = 2689286440624000000
timer_wait = 103876000000
```

## Fifth experiment:

```
timer_start = 2689285988301000000
timer_end = 2689286092579000000
timer_wait = 104278000000
```

```
average = 105592600000 picoseconds = 105592.6 microseconds
min = 103876000000 picoseconds = 103876 microseconds
max = 108207000000 picoseconds = 108207 microseconds
```

c)

```
select nameFirst, nameLast, max(RBI) from Batting  
      inner join Master using (playerID)  
     where HR = 0 limit 1;
```

**Without any index:**

```
[mysql> show index in master;  
Empty set (0.00 sec)  
  
[mysql> show index in batting;  
Empty set (0.00 sec)
```

**First experiment:**

```
timer_start = 2683521168869000000  
timer_end = 2683521322099000000  
timer_wait = 153230000000
```

**Second experiment:**

```
timer_start = 2683520522006000000  
timer_end = 2683520676959000000  
timer_wait = 154953000000
```

**Third experiment:**

```
timer_start = 2683519868334000000  
timer_end = 2683520022897000000  
timer_wait = 154563000000
```

**Fourth experiment:**

```
timer_start = 2683519259727000000  
timer_end = 2683519417296000000  
timer_wait = 157569000000
```

**Fifth experiment:**

```
timer_start = 2683518577026000000  
timer_end = 2683518734890000000  
timer_wait = 157864000000
```

```
average = 155635800000 picoseconds = 155635.8 microseconds  
min = 153230000000 picoseconds = 153230 microseconds  
max = 157864000000 picoseconds = 157864 microseconds
```

### With primary key:

```
mysql> show index in master;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| master |          0 | PRIMARY |          1 | playerID |      A |     18912 |       NULL |    NULL |    BTREE |           |           | YES |      NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
1 row in set (0.00 sec)

mysql> show index in batting;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| batting |          0 | PRIMARY |          1 | playerID |      A |     18813 |       NULL |    NULL |    BTREE |           |           | YES |      NULL |
| batting |          0 | PRIMARY |          2 | yearID   |      A |      94313 |       NULL |    NULL |    BTREE |           |           | YES |      NULL |
| batting |          0 | PRIMARY |          3 | stint     |      A |     102667 |       NULL |    NULL |    BTREE |           |           | YES |      NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3 rows in set (0.00 sec)
```

### First experiment:

```
timer_start = 268390954034400000
timer_end = 2683909667638000000
timer_wait = 127294000000
```

### Second experiment:

```
timer_start = 2683908961224000000
timer_end = 2683909090418000000
timer_wait = 129194000000
```

### Third experiment:

```
timer_start = 2683908381386000000
timer_end = 2683908515736000000
timer_wait = 134350000000
```

### Fourth experiment:

```
timer_start = 2683907772178000000
timer_end = 2683907901779000000
timer_wait = 129601000000
```

### Fifth experiment:

```
timer_start = 2683907151329000000
timer_end = 2683907282132000000
timer_wait = 130803000000
```

```
average = 130248400000 picoseconds = 130248.4 microseconds
min = 127294000000 picoseconds = 127294 microseconds
max = 134350000000 picoseconds = 134350 microseconds
```

### With primary key and foreign key:

```
mysql> show index in master;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Master |          0 | PRIMARY |           1 | playerID |      A |       18582 |        NULL |     NULL |    BTREE |           |           | YES |      NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
1 row in set (0.00 sec)

mysql> show index in batting;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Batting |          0 | PRIMARY |           1 | playerID |      A |       17636 |        NULL |     NULL |    BTREE |           |           | YES |      NULL |
| Batting |          0 | PRIMARY |           2 | yearID |      A |       99949 |        NULL |     NULL |    BTREE |           |           | YES |      NULL |
| Batting |          0 | PRIMARY |           3 | stl |      A |      186300 |        NULL |     NULL |    BTREE |           |           | YES |      NULL |
| Batting |          1 | yearID |           1 | yearID |      A |        147 |        NULL |     NULL |    BTREE |           |           | YES |      NULL |
| Batting |          1 | yearID |           2 | lgid |      A |        266 |        NULL |     YES |    BTREE |           |           | YES |      NULL |
| Batting |          1 | yearID |           3 | teamID |      A |       2915 |        NULL |     YES |    BTREE |           |           | YES |      NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

### First experiment:

```
timer_start = 2684181067740000000
timer_end = 2684181206596000000
timer_wait = 138856000000
```

### Second experiment:

```
timer_start = 2684180234504000000
timer_end = 2684180372019000000
timer_wait = 137515000000
```

### Third experiment:

```
timer_start = 2684179424129000000
timer_end = 2684179573309000000
timer_wait = 149180000000
```

### Fourth experiment:

```
timer_start = 2684178604558000000
timer_end = 2684178744235000000
timer_wait = 139677000000
```

### Fifth experiment:

```
timer_start = 2684177815742000000
timer_end = 2684177959049000000
timer_wait = 143307000000
```

```
average = 141707000000 picoseconds = 141707 microseconds
min = 137515000000 picoseconds = 137515 microseconds
max = 149180000000 picoseconds = 149180 microseconds
```

### **With index:**

```
mysql> show index in master;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| master | 1 | playerID | 1 | playerID | A | 19024 | NULL | NULL | BTREE | YES | YES | YES | NULL |
| master | 1 | name | 1 | nameFirst | A | 2352 | NULL | NULL | BTREE | YES | YES | YES | NULL |
| master | 1 | name | 2 | nameLast | A | 18482 | NULL | NULL | BTREE | YES | YES | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3 rows in set (0.00 sec)

mysql> show index in batting;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| batting | 1 | playerID | 1 | playerID | A | 19888 | NULL | NULL | BTREE | YES | YES | YES | NULL |
| batting | 1 | HR | 1 | HR | A | 38 | NULL | NULL | BTREE | YES | YES | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
2 rows in set (0.00 sec)
```

### **First experiment:**

```
timer_start = 2684799712959000000
timer_end = 2684799713174000000
timer_wait = 215000000
```

### **Second experiment:**

```
timer_start = 2684799200257000000
timer_end = 2684799200467000000
timer_wait = 210000000
```

### **Third experiment:**

```
timer_start = 2684798677155000000
timer_end = 2684798677367000000
timer_wait = 212000000
```

### **Fourth experiment:**

```
timer_start = 2684798130838000000
timer_end = 2684798131054000000
timer_wait = 216000000
```

### **Fifth experiment:**

```
timer_start = 2684797590021000000
timer_end = 2684797590233000000
timer_wait = 212000000
```

```
average = 213000000 picoseconds = 213 microseconds
min = 210000000 picoseconds = 210 microseconds
max = 216000000 picoseconds = 216 microseconds
```

Other combination of index:

```
mysql> show index in master;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| master | 1 | playerID | 1 | playerID | A | 19024 | NULL | NULL | YES | BTREE | | YES | NULL |
| master | 1 | name | 1 | nameFirst | A | 2352 | NULL | NULL | YES | BTREE | | YES | NULL |
| master | 1 | name | 2 | nameLast | A | 18482 | NULL | NULL | YES | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3 rows in set (0.01 sec)

mysql> show index in batting;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| batting | 1 | HR | 1 | HR | A | 38 | NULL | NULL | YES | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
1 row in set (0.00 sec)
```

2685050470764000000	2685050709228000000	238464000000
EMENT		
2685051269375000000	2685051467430000000	198055000000
EMENT		
2685052051009000000	2685052250205000000	199196000000
EMENT		
2685052762862000000	2685052956345000000	193483000000
EMENT		
2685053498088000000	2685053692988000000	194900000000
EMENT		
2685054174166000000	2685054367108000000	192942000000

```
mysql> show index in master;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| master | 1 | playerID | 1 | playerID | A | 19024 | NULL | NULL | YES | BTREE | | YES | NULL |
| master | 1 | name | 1 | nameFirst | A | 2352 | NULL | NULL | YES | BTREE | | YES | NULL |
| master | 1 | name | 2 | nameLast | A | 18482 | NULL | NULL | YES | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3 rows in set (0.00 sec)

mysql> show index in batting;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| batting | 1 | playerID | 1 | playerID | A | 19080 | NULL | NULL | YES | BTREE | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
1 row in set (0.00 sec)
```

2685194168249000000	2685194356700000000	188451000000
EMENT		
2685195559205000000	2685195746354000000	187149000000
EMENT		
2685196362095000000	2685196556044000000	193949000000
EMENT		
2685197153074000000	2685197340371000000	187297000000
EMENT		
2685197939996000000	2685198131574000000	191578000000

```

mysql> show index in master;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| master | 1 | name | 1 | nameFirst | A | 2352 | NULL | NULL | YES | BTREE | | | YES | NULL |
| master | 1 | name | 2 | nameLast | A | 18482 | NULL | NULL | YES | BTREE | | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
2 rows in set (0.00 sec)

mysql> show index in batting;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| batting | 1 | playerID | 1 | playerID | A | 19080 | NULL | NULL | YES | BTREE | | | YES | NULL |
| batting | 1 | HR | 1 | HR | A | 38 | NULL | NULL | YES | BTREE | | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
2 rows in set (0.00 sec)

```

2685297008388000000	2685297008592000000	204000000	
MENT			
2685297632392000000	2685297632598000000	206000000	
MENT			
2685298142305000000	2685298142505000000	200000000	
MENT			
2685298621269000000	2685298621475000000	206000000	
MENT			
2685299171327000000	2685299171529000000	202000000	
MENT			
2685299690203000000	2685299690403000000	200000000	

```

mysql> show index in master;
Empty set (0.00 sec)

mysql> show index in batting;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Table | Non_unique | Key_name | Seq_in_index | Column_name | Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment | Index_comment | Visible | Expression |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| batting | 1 | playerID | 1 | playerID | A | 19080 | NULL | NULL | YES | BTREE | | | YES | NULL |
| batting | 1 | HR | 1 | HR | A | 38 | NULL | NULL | YES | BTREE | | | YES | NULL |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
2 rows in set (0.00 sec)

```

2685396014531000000	2685396184216000000	169685000000	
EMENT			
2685396546463000000	2685396715298000000	168835000000	
EMENT			
2685397114032000000	2685397280618000000	166586000000	
EMENT			
2685397641430000000	2685397806797000000	165367000000	
EMENT			
2685398936563000000	2685399103191000000	166628000000	

### **Conclusion:**

```
select count(playerID) from Master where birthYear is null or birthYear = ""  
                                or birthMonth is null or birthMonth = ""  
                                or birthDay is null or birthDay = "";
```

#### **Without any index:**

average = 12646600000 picoseconds = 12646.6 microseconds  
min = 12162000000 picoseconds = 12162 microseconds  
max = 13377000000 picoseconds = 13377 microseconds

#### **With primary key:**

average = 8608200000 picoseconds = 8608.2 microseconds  
min = 8359000000 picoseconds = 8359 microseconds  
max = 8905000000 picoseconds = 8905 microseconds

#### **With index:**

average = 1987400000 picoseconds = 1987.4 microseconds  
min = 1962000000 picoseconds = 1962 microseconds  
max = 2048000000 picoseconds = 2048 microseconds

```
select playerID,sum(salary) as totalPay from Salaries  
      left outer join Appearances using (playerID,yearID,teamID)  
      left outer join Managers using (playerID,yearID,teamID)  
          where G is null and  
                G_all is null  
group by playerID  
order by totalPay desc  
limit 3;
```

#### **Without any index:**

average = 316622600000 picoseconds = 316622.6 microseconds  
min = 310271000000 picoseconds = 310271 microseconds  
max = 322820000000 picoseconds = 322820 microseconds

#### **With primary key:**

average = 82014200000 picoseconds = 82014.2 microseconds  
min = 80097000000 picoseconds = 80097 microseconds  
max = 85893000000 picoseconds = 85893 microseconds

#### **With primary key and foreign key:**

average = 90165200000 picoseconds = 90165.2 microseconds  
min = 88427000000 picoseconds = 88427 microseconds  
max = 92266000000 picoseconds = 92266 microseconds

#### **With index:**

average = 105592600000 picoseconds = 105592.6 microseconds

```
min = 103876000000 picoseconds = 103876 microseconds
max = 108207000000 picoseconds = 108207 microseconds

select nameFirst, nameLast, max(RBI) from Batting
      inner join Master using (playerID)
      where HR = 0 limit 1;
```

**Without any index:**

```
average = 155635800000 picoseconds = 155635.8 microseconds
min = 153230000000 picoseconds = 153230 microseconds
max = 157864000000 picoseconds = 157864 microseconds
```

**With primary key:**

```
average = 130248400000 picoseconds = 130248.4 microseconds
min = 127294000000 picoseconds = 127294 microseconds
max = 134350000000 picoseconds = 134350 microseconds
```

**With primary key and foreign key:**

```
average = 141707000000 picoseconds = 141707 microseconds
min = 137515000000 picoseconds = 137515 microseconds
max = 149180000000 picoseconds = 149180 microseconds
```

**With index:**

```
average = 213000000 picoseconds = 213 microseconds
min = 210000000 picoseconds = 210 microseconds
max = 216000000 picoseconds = 216 microseconds
```

```

+-----+
| white_win_fraction |
+-----+
|          0.4989 |
+-----+
1 row in set (0.01 sec)

+-----+
| average_moves_white_win |
+-----+
|          57.7589 |
+-----+
1 row in set (0.01 sec)

+-----+
| average_moves_black_win |
+-----+
|          60.7270 |
+-----+
1 row in set (0.01 sec)

+-----+
| pawn_move_fraction |
+-----+
|          0.9584 |
+-----+
1 row in set (0.00 sec)

```

Only involve those games that move knights or bishops or rooks.

**white moves before moving knights:**  
**2.4154663021764273**

**white moves before moving bishops:**  
**4.124159830643027**

**white moves before moving rooks:**  
**15.303969805216688**

**black moves before moving knights:**  
**2.5332033308738273**

**black moves before moving bishops:**  
**4.5941958757335914**

**black moves before moving rooks:**  
**15.540441935705926**