Need for Speed: MySQL Indexing

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Oli Sennhauser

Senior MySQL Consultant at FromDual GmbH

oli.sennhauser@fromdual.com

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- FromDual provides neutral and independent:
  - Consulting for MySQL, Percona Server, MariaDB
  - Support for all MySQL and Galera Cluster
  - Remote-DBA Services
  - MySQL Training
- Oracle Silver Partner (OPN)

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MySQL and Indexing

- **MySQL documentation says:**

  The best way to improve the performance of `SELECT` operations is to create indexes on one or more of the columns that are tested in the query.

- **Great! But:**

  Unnecessary indexes waste space and waste time to determine which indexes to use. You must find the right balance to achieve fast queries using the optimal set of indexes.

- **... hmm so we have to think a bit... :-(**

What is an Index?

- Adams, Douglas: The Hitchhiker's Guide to the Galaxy?

- Sennhauser, Oli, Uster?

52 WAG-WEE © DIALLING CODES :—FOR FULL PARTICULARS SEE PAGES 7 and 8

Waghorne A. R,
Hohneswch Sandford Mill rd.....Cheltenham 4517
Waghorne Bros,Btchrs,346 High st.....Cheltenham 2956
Waghorne D. E,12 Pittville villas.....Cheltenham 3594
Waghorne Frank,Btchr,4 Tivoli bldgs...Cheltenham 3419
Waghorne & Evans,Motr Engrs,
Shurdington rd.....Cheltenham 3211
Waghorne Mrs. M. A,
1 Oxford villas London rd.....Cheltenham 2411
Waghorne Wallace,
Beulah lo 82 Prestbury rd.....Cheltenham 3596
Wagner Mrs. O. H,Spencer cottage
Cirencester rd Minchinhampton....Brimscombe 170
Wagon & Horses Hotel,Hucclecote....Gloucester 614211
Wagon Repairs Ltd,India rd.....★Gloucester 2225
Lydney.....Lydney 73
Waine W. O,Tramgr,Fountain st.....Nailsworth 83
Waite Mrs. A. E,Church hig Highnam...Gloucester 3819
Waite A. P,29 Derby rd.....★Gloucester 3301
Waite Eric,Dntl Srgn,9 Imperial sq....Cheltenham 2988
Waite & Son,Jwlrs,349 High st.....Cheltenham 2891
Waite T. Wilfred,Engelberg.....©Cleeve Hill 72
Wake Mrs.H,10 Imperial sq.....Cheltenham 5140
Wake H. B. L,Newick ho Sandford rd...Cheltenham 4162
Wakefield H. E,13 Park pl.....Cheltenham 4583
Wakefield Mrs. L,10 Church st.....Cheltenham 4532
Wakefield Miss M. C,
Camperdown St Stephens rd.....Cheltenham 3407
Wakefield Mrs. M. E,Spring Hill cb....Nailsworth 105
Wakefield & Son,Tlrs,Market pl.....Cirencester 119
Wakefield Thomas,Church farm.....Northleach 49
Wakeford E. E,Plmbr, Hot-Water Fttr,
Sidney parade.....Gloucester 2952
Walden F,Btchr,26 Dyer st.....Cirencester 191
Wales Sydney,
Hyde Tyeing Minchinhampton....Brimscombe 130
Wales Sydney,Queens Minchinhampton..Brimscombe 201
Walford Miss K. M,
Royal Well villa Chapel walk.....Cheltenham 3958
Walford S. T,Upbill 189 Leckhampton rd.Cheltenham 2839
Walker Mrs. A,Sub Postmistress PO.....Cutkerton 1
Walker A. A,Church ho Naunton.....Guiting Power 29
Walker A. J,Bkr,Comfortar,17 Long st...Wotton-u-E 123
Walker A. W,Btchr,Kemerton nr Tewkesbury Bredon 6
Walker Mrs. C. F,The Mount.....Amberley 43
Walker Col. C. W. G,Manor ho.....South Cerney 10
Walker & Co's Strs Ltd,Grcrs,George st....Stroud 125
Walker & Co.'s Strs,Castle st.....Cirencester 84
Walker E. W, Berry Wormington.....Toddington 2
Walker Mrs. Gavin,7 Queens parade....Cheltenham 4967
Walker George N,Norton ct Glouste.....Twigworth 64
Walker G. S,Hardwicke ho.....Bredon 7
Walker Harry,High st garMinchinhampto Brimscombe 73
Walker H. C,Greentrees Hatherley rd...Cheltenham 4962
Walker H. J,St Briavels Stores.....St. Briavels 29
Walker Lt-Col. H. S,Greenfields..Bourton-on-the-W 21
Walker J,Genl Strs,
Cheltenham rd Gloucester.....©Churchdown 357
Walker James,
Honeyacre Uhlswood Cheltenham..Shurdington 71
Walker James (Goldsmith & Silversmith) Ltd,
48 Promenade.....Cheltenham 3427
Walker Miss,F.R.S,Dunkirk ho.....Amberley 131
Walker R. W,
The Hawthorns Church rd.....Cheltenham 5090
Walker Thos. H,Underhill.....Dursley 159
Walker T. Lawson,Frnr,
Pool fm Acton Beauchamp Worcs.Fromes Hill 17
Walker W. C. & Son,Bkrs,Grcrs,
Chedworth.....Fossebridge 18
Walker W. J,Buscot Wick.....Lechlade 63
Wallis Mrs. M,Avonside.....Tewkesbury 20
Wallis Miss M. J. E,
Sunnyside Bussage Stroud.....Brimscombe 150
Walpamur Co. Ltd. The,Commercial rd..Gloucester 3411
Walters Rev. F. E,
Minsterworth vicarage Gloucester..Minsterworth 32
Walters J. T. & Co,Drprs,5 High st.....Ledbury 141
Walters & Son,Bkrs, Cnfctnrs,
Cotswold cafe.....Dursley 35
Waltham C,Btchr,5 Suffolk par.....Cheltenham 2151
Wallis G. Allan,
Waltham Watch Depot,14 King sq....Gloucester 3753
Walton E. L,The Northend Northgate st.Gloucester 356011
Walton J. Ltd,Fruit Mchts,
G.W.R. Goods yard.....Longhope 65
Walton Mrs. M,The Moorend Much Cowarne,
Bronyard.....Stirtn Grandison 14
Walton S. A,Frir,19 Russell st.....Stroud 382
Walwin,Glmst,47 Southgate st.....Gloucester 2844
Waiwin Mrs,Sunnymede Upton lane....Gloucester 6143
Wankiyn Mrs. W. L,
The Little Manor Charlton Kings...Cheltenham 3910
Wanswell Call Office,PO.....Sharpness 013
Warburton Mrs. E. M. T,
121 Cheltenham rd.....Cirencester 491
WAR DEPARTMENT—
Recruiting Office,353 High st.....Cheltenham 4193
Recruiting Office,The Barracks....Gloucester 2993
Ward A. D,Bank Agnt,etc,
Bank chambers High st.....Northleach 45
Ward Mrs. Addleton,Beechworth lawn..Cheltenham 2637
Ward Mrs. A. G,
Treelands 130 Leckhampton rd.....Cheltenham 2273
Ward R. L. Ltd,Drprs, Frnshrs,High st★Cheltenham 5165
Ward E. L,2 Hatherley Court rd.....Cheltenham 4215
Ward R. T. & Son,Coal Mchts,G.W.R. wharf.Stroud 199
Ward Capt. F. G,
Hillfrede Barnwood rd.....Gloucester 3885
Ward Miss F. M,Southcote Kemerton.....Overbury 28
Ward Geo. W,Bldr,
Buckstone Oakland av.....Cheltenham 3543
Ward H. Waltman,Srgn,
Chipping manor.....Wotton-u-E 14
Ward J. E, 1,Gambles End.....©Cleeve Hill 105
Ward & Woodman,Chmnds,Eastgate st...Gloucester 2825
Warden Mrs. Ellary,Swan cottage.....Much Marcle 15
Warden Capt. St. L. S,
Midland Bank Flat,1 Montpellier Ter.Cheltenham 3479
Wardon Mrs. M,Fosse Wold.....Stow-on-the-Wold 102
Wardle-Smith J. H,
Winstone Cove Cirencester.....Miserden 28
Ware E. P,Frnr,Sudgrove farm Stroud...Miserden 24
Ware Maj.-Gen. Sir Fabian,Dhsl cottage..Amberley 63
Ware G. S,Hide Market Northgate st....Gloucester 2531
Wares Private Hotel,Suffolk sq.....Cheltenham 2663
Wargent H,Parkhold cottage.....Trumpet 78
Wargent H. H,Garage Ashperto.....Trumpet 45
Wargent & Sons,Engrs,CanonFrome Stirtn Grandison 2
Warman Mrs. W,Woodlands.....Stroud 8
Warman W. & Son,Solrs,1 Rowcroft.....Stroud 17
Warn J,The Rivers.....Dursley 65
Warner A,Frnr,Highfield farm.....Tetbury 7291
Warner A. E. F,Btchr,Frnr,Lawn Longfrd Gloucester 2694
Warner Bros,Motr Engrs,Twyning green....Bredon 23
Warner Maj. C. A. S,
Little Rissington manor....Bourton-on-the-W 49
Warner C. T,Garage,113 High st.....Tewkesbury 8
Warner F. The Cottage.....©Churchdown 253
Warner E,Haulier,Snow farm Ashcch..Tewkesbury 27
Warner R. S,Southwick.....Tewkesbury 206
Watkin W. R,Stroud rd.....Gloucester 3850
Watkins Mrs. A,Frogmore Little dean..Cinderford 2127
Watkins C. W,Fairoaks Hollybush,...Bromesberrow 42
Watkins E. L,Manor farm Longdon...Birtsmorton 28
Watkins Fred (Iron Ore Mines),Coleford....Coleford 200
Watkins H. B,Commn Agnt,
Montalgne Woodside.....Broam 13
Watkins L. G,Baker,
The Bakery Ashperton Ledbury.....Trumpet 46
Watkins Maurice S,Bldr, Undtkr,
Wintles hill.....Westbury-on-S 36
Watkins R. J,Yarleton farm.....Longhope 66
Watkins T. J,Hitchfield.....Longhope 56
Watkins W. A,Haulage & Coal,
Frampton-on-Severn.....Saul 79
Watkins W. H,Grcr,7 High st.....Cheltenham 4161
Watney Lady Margaret,
Wilmstrp park Fairford Glos. Coin St. Aldwyns 40
Watson A. H,6 Cirencester rd.....Cheltenham 3155
Watson Rev. C. E,Churchfields lo Rodboro...Stroud 157
Watson Col. C. H,Del Rey ho.....Cheltenham 3734
Watson Mrs. Edgar,5 Suffolk mans.....Cheltenham 3869
Watson G. E,8 Gadshill rd Charlton Kings Cheltenham 3193
Watson Mrs. G. R,Wyneide.....St. Briavels 39
Watson M. T,Chmst,Rowcroft Pharmacy..Stroud 49
Watson R. E,Comm Agnt,
Commercial st.....Cinderford 3100
Watson R. S,High Elms Prestbury.....Cheltenham 7154
Watson W. E,Foothill Salperton.....Guiting Power 70
Watson W. G,146 Old Bath rd.....Cheltenham 3340
Watson W. S. J,Pen Moel Park rd.....Stroud 519
Watson's Soft Furnishings,3 Clarence st.Cheltenham 3898
Watt-Smyth Mrs,
Orchard cottage Woodmancote.....©Cleeve Hill 41
Watts Mrs. B. A,Moor fm MorefonValmce....Saul 14
Watts Charles,Outfitter,148A High st....Cheltenham 4624
Watts Major R. M,
The Bungalow Middle Lyplatt.....Stroud 629
Watts (Factors) Ltd,Genl Fctrs,High st...★Lydney 92
Watts F. E,Frnr,Elm farm Ilmore.....Hardwicke 1344
Watts H. F,Elstcr Engr,Park rd.....Nailsworth 238
Watts John H,The Rocklands.....Lydney 134
Watts J. S. & Son,Irnmgrs,Broam.....Broam 15
Watts L. J,Bldr,Kings hill.....Dursley 164
Watts W. D,Rosemount.....Lydney 129
Watts W. & Son, Haldrsrs,
Montpellier walk.....Cheltenham 3348
Waugh Evelyn,Piers et Stonebcombe....Dursley 250
Waylen C. W,Rosedene 356 Old Bath rd.Cheltenham 3451
Wayte W. J,Gayton Greenhills rd.....Cheltenham 3644
Wear L. R,34 Vicarage rd.....Gloucester 3762
Weare E. R,4 Oxford st.....Lydney 159
Wearne Rev. E. C,Barnsley, Cirencester.....Bibury 40
Weaver Mrs. A. M. M,
Spring cottage Llandogo.....St. Briavels 82
Weaver George & Sons,Fruit, Corn,
Castlemorton.....Bromesberrow 26
Weaver H.PO Berrow.....Bromesberrow 20
Weaver Mrs. J. Y,
The Plough Upper Oddington.Stow-on-the-W 134
Weaver Nurse,2 Berkeley vls Pittville..Cheltenham 2829
Weavers Stores,Grcrs,
Church st Charlton Kings.....Cheltenham 3446
Webb Mrs. A. E,21 Alexander rd.....Gloucester 3247
Webb Bros,Domestic Engrs,Belmont rd....Stroud 290
Webb Bros. Ltd, Brick, Tile Mfrs,
Battledown works.....★Cheltenham 3001
Coal Mchts,14 Promenade.....★Cheltenham 3001
Colliery Agnts,Battledown works.★Cheltenham 3001
Webb S. S,Station gar Charlton Kings..Cheltenham 3747

What is an Index technically?

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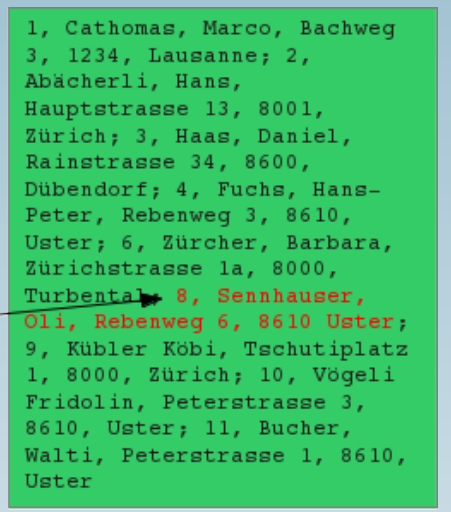
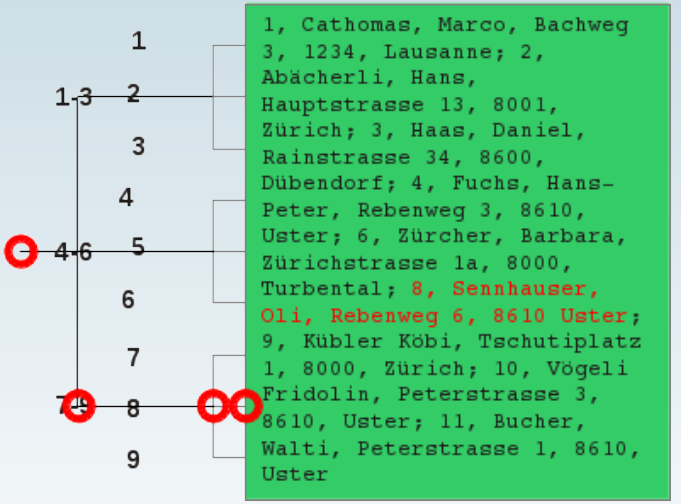




MySQL uses indexes:

- To enforce uniqueness (`PRIMARY KEY`, `UNIQUE KEY`)
- To fast access and filter rows (`WHERE`)
- To perform joins fast (`JOIN`)
- To find `MIN()` and `MAX()` values
- For sorting and grouping (`ORDER BY`, `GROUP BY`)
- To avoid joins by using covering indexes
- To enforce `FOREIGN KEY` Constraints (`FOREIGN KEY`)

WHERE clause 1


```
SELECT *
  FROM customers
 WHERE name = 'No
```

```
SHOW CREATE TABLE customers\G

CREATE TABLE `customers` (
  `customer_id` smallint(5) unsigned
, `name` varchar(64) DEFAULT NULL
  PRIMARY KEY (`customer_id`)
```

```
EXPLAIN
SELECT *
  FROM customers
 WHERE name = 'No Clue of MySQL LLC';

+----------+------+---------------+------+-------+-------------+
| table    | type | possible_keys | key  | rows  | Extra       |
+----------+------+---------------+------+-------+-------------+
| customers | ALL  | NULL          | NULL | 31978 | Using where |
+----------+------+---------------+------+-------+-------------+
```

How to create and Index?


```
ALTER TABLE …
```

- `ADD PRIMARY KEY (id);`
- `ADD UNIQUE KEY (uuid);`
- `ADD FOREIGN KEY (customer_id) REFERENCES customers (customer_id);`
- `ADD INDEX (last_name, first_name);`
- `ADD INDEX pre_ind (hash(8));`
- `ADD FULLTEXT INDEX (last_name, first_name);`

WHERE clause 2


```
ALTER TABLE customers
  ADD INDEX (name);
```

Gain: 20 ms → 5 ms

```
s` (
nt(5) unsigned
EFAULT NULL
er_id`)
, KEY `name` (`name`)
)
```

```
+----------+------+---------------+------+---------+-------+------+
| table    | type | possible_keys | key  | key_len | ref   | rows |
+----------+------+---------------+------+---------+-------+------+
| customers | ref  | name          | name | 67      | const |    1 |
+----------+------+---------------+------+---------+-------+------+
```

JOIN clause


```
EXPLAIN SELECT *
  FROM customers AS c
  JOIN orders AS o ON c.customer_id = o.customer_id
 WHERE c.name = 'No Clue of MySQL LLC';
+-------+------+---------------+------+---------+------+---------+
| table | type | po                                  | rows    |
+-------+------+---            ---+---            ---+---------+
| c     | ref  | PR                                ast |       1 |
| o     | ALL  | NU                                LL  | 1045105 |
+-------+------+---            ---+---            ---+---------+
```

Gain: 450 ms → 6 ms

```
ALTER TABLE orders
  ADD INDEX (customer_id);
```

```
+-------+------+---------------+-------------+---------+---------------+------+
| table | type | possible_keys | key         | key_len | ref           | rows |
+-------+------+---------------+-------------+---------+---------------+------+
| c     | ref  | PRIMARY,name  | name        | 67      | const         |    1 |
| o     | ref  | customer_id   | customer_id | 3       | c.customer_id |    8 |
+-------+------+---------------+-------------+---------+---------------+------+
```

For sorting/grouping tables

ORDER BY, GROUP BY

```
EXPLAIN SELECT *
  FROM contacts AS c
 WHERE last_name = 'Sennhauser'
 ORDER BY last_name, first_name;
+------+------+---
| table | type | ke
+------+------+---
| c     | ref  | la
+------+------+---
                                                  ----------------+
                                                                  |
                                                  ----------------+
                                                  ; Using filesort |
                                                  ----------------+
```

Gain: 20 ms → 7 ms

```
ALTER TABLE contacts
  ADD INDEX (last_name, first_name);
```

```
+----------+------+-------------+------+--------------------------+
| table    | type | key         | rows | Extra                    |
+----------+------+-------------+------+--------------------------+
| contacts | ref  | last_name_2 | 1561 | Using where; Using index |
+----------+------+-------------+------+--------------------------+
```

Covering Indexes


```
EXPLAIN
SELECT customer_id, amount
  FROM orders AS o
 WHERE customer_id = 59349;
+-------+------+-------------+------+-------+
| table | type
+-------+-----
| o     | ref
+-------+-----
```

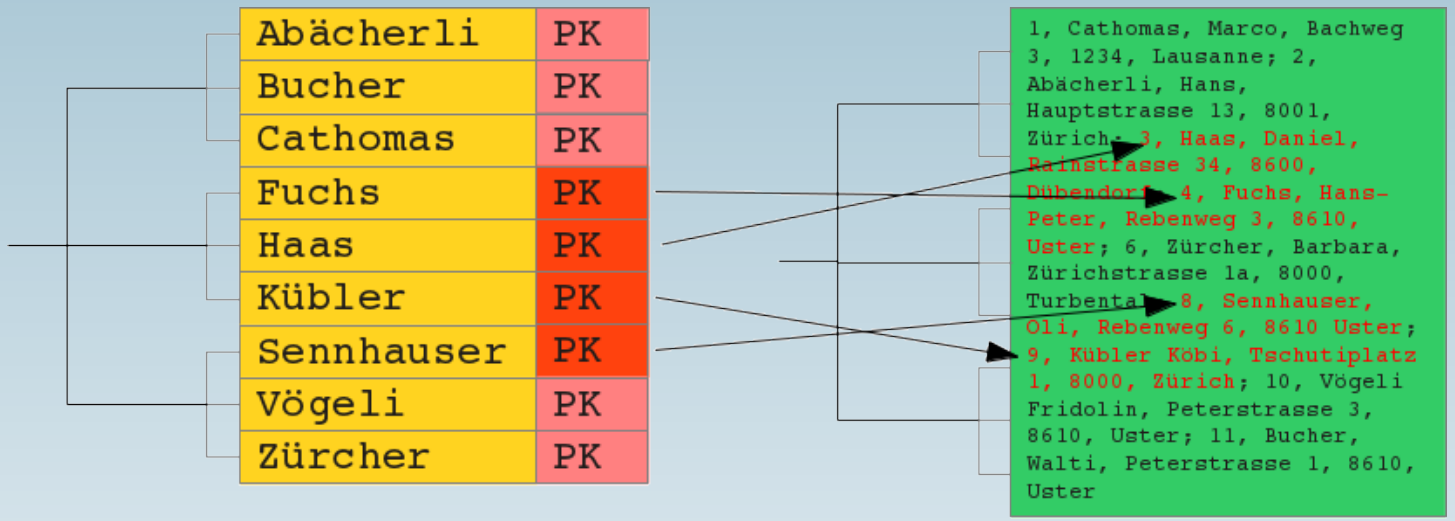
So what?

```
ALTER TABLE orders
  ADD INDEX (customer_id, amount);
```

```
+-------+------+--------------+------+-------------+
| table | type | key          | rows | Extra       |
+-------+------+--------------+------+-------------+
| o     | ref  | customer_id_2 |   15 | Using index |
+-------+------+--------------+------+-------------+
```

Benefit of Covering Indexes

- Why are Covering Indexes beneficial



How-to find missing indexes?

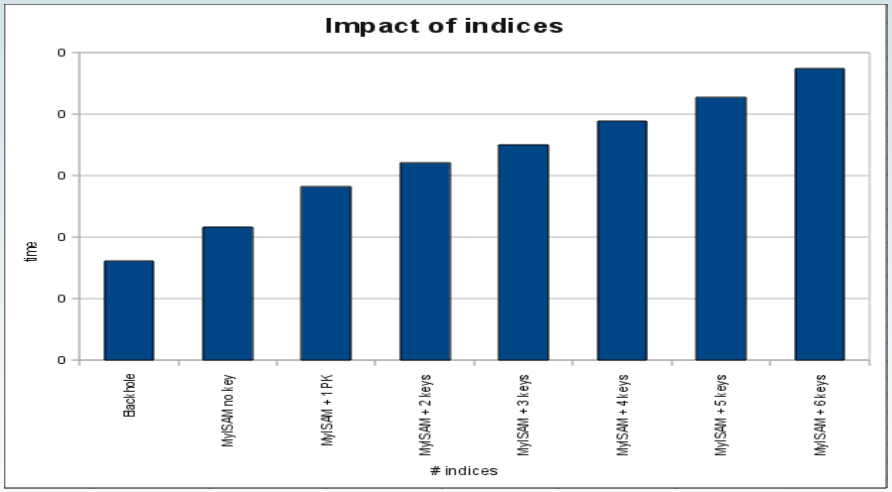
- ER Diagram? :-(
  - Most of them rely to you business logic...
- How-to FIND?
- Slow Query Log
- MySQL Variables:
- Since v5.1 on-line!

```
+-------------------------------+----------+
| Variable_name                 | Value    |
+-------------------------------+----------+
| log_queries_not_using_indexes | ON       |
| long_query_time               | 0.250000 |
| min_examined_row_limit        | 100      |
| slow_query_log                | ON       |
| slow_query_log_file           | slow.log |
+-------------------------------+----------+
```

Indexes are not only good

- Indexes use space (Disk, hot data in RAM!)
- Indexes use time to maintain (CPU, RAM, I/O)
- Optimizer needs time to determine which indexes to use.
- Sometimes optimizer is completely confused and does wrong decisions if too many (similar) indexes are there.

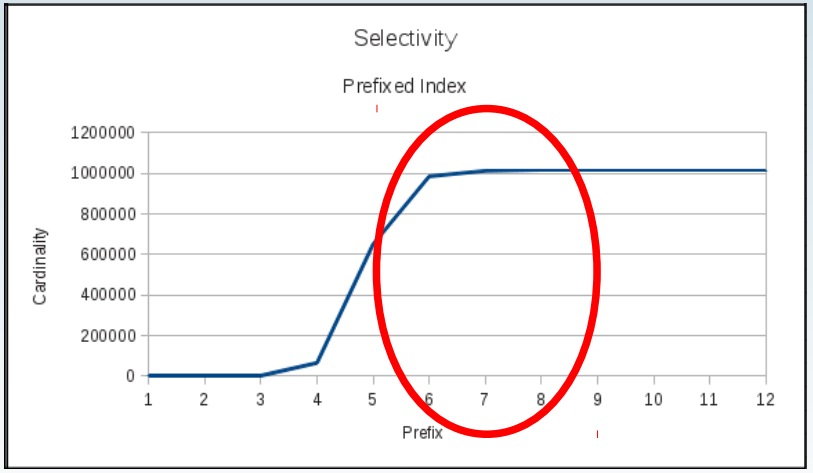
→ *You must find the right balance to achieve fast queries using the optimal set of indexes.*



Smaller indexes faster queries

- Better fit into memory (less I/O)
- Higher data density (rows/block)
- Less CPU cycles (to crawl through)
- Prefixed indexes:

```
ADD INDEX pre_ind (hash(8));
```



Avoid indexes

- Avoid redundant (and thus unnecessary) indexes
- How does it happen?
  - Developer 1: Creates a Foreign Key constraint → done
  - Developer 2: Ouu! Query is slow → Oli told me to create an index! → done
  - Developer 3: Ouu! Query is slow → Developer 2 is stupid! → Create and index → done
- Frameworks vs. Developer
- Upgrade process vs. Developer

- Avoid indexes which are not used / needed

How to find such indexes?


```
SHOW CREATE TABLE ...\G
```

```
mysqldump --no-data > structure_dump.sql
```

- Since MySQL 5.6: PERFORMANCE_SCHEMA
  - Percona Server / MariaDB: Userstats
  - http://fromdual.com/mysql-performance-schema-hints

```
SELECT object_schema, object_name, index_name
  FROM performance_schema.table_io_waits_summary_by_index_usage
 WHERE index_name IS NOT NULL
   AND count_star = 0
 ORDER BY object_schema, object_name;
```

Avoid partial redundant indexes

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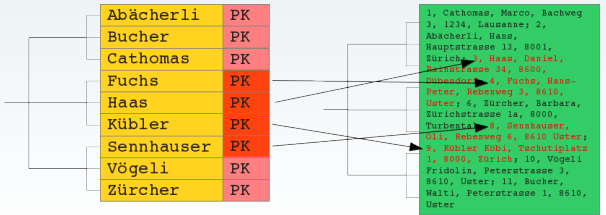
- `INDEX (city, last_name, first_name)`
- ~~`INDEX (city, last_name)`~~
- ~~`INDEX (city)`~~
- `INDEX (last_name, city)` ???
- `INDEX (first_name, last_name)` !!!

Bad selectivity

- Remove indexes with bad selectivity (~= low cardinality)
- Candidates are:
  - `status`
  - `gender`
  - `active`
- How to find if field has bad selectivity?

  Indexes (and Joins) are expensive!!!
- Break even between 15% and 66%
- Lets see if the MySQL optimizer knows about it... :-)

```
SELECT status, COUNT(*)
  FROM orders
 GROUP BY status;

+--------+--------+
| status | cnt    |
+--------+--------+
|      0 | 393216 |
|      1 | 262144 |
|      2 |     12 |
|      3 |     36 |
|      4 |     24 |
|      5 |      4 |
|      6 |      8 |
+--------+--------+
```



Optimizer is wrong!


```
SELECT * FROM orders WHERE status = 2;
+--------+------+---------------+--------+------+
| table  | type | possible_keys | key    | rows |
+--------+------+---------------+--------+------+
| orders | ref  | status        | status |   12 |
+--------+------+---------------+--------+------+
```

```
SELECT * FROM orders WHERE status = 0;
1.43 s
+--------+------+---------------+--------+--------+
| table  | type | possible_keys | key    | rows   |
+--------+------+---------------+--------+--------+
| orders | ref  | status        | status | 327469 |
+--------+------+---------------+--------+--------+
```

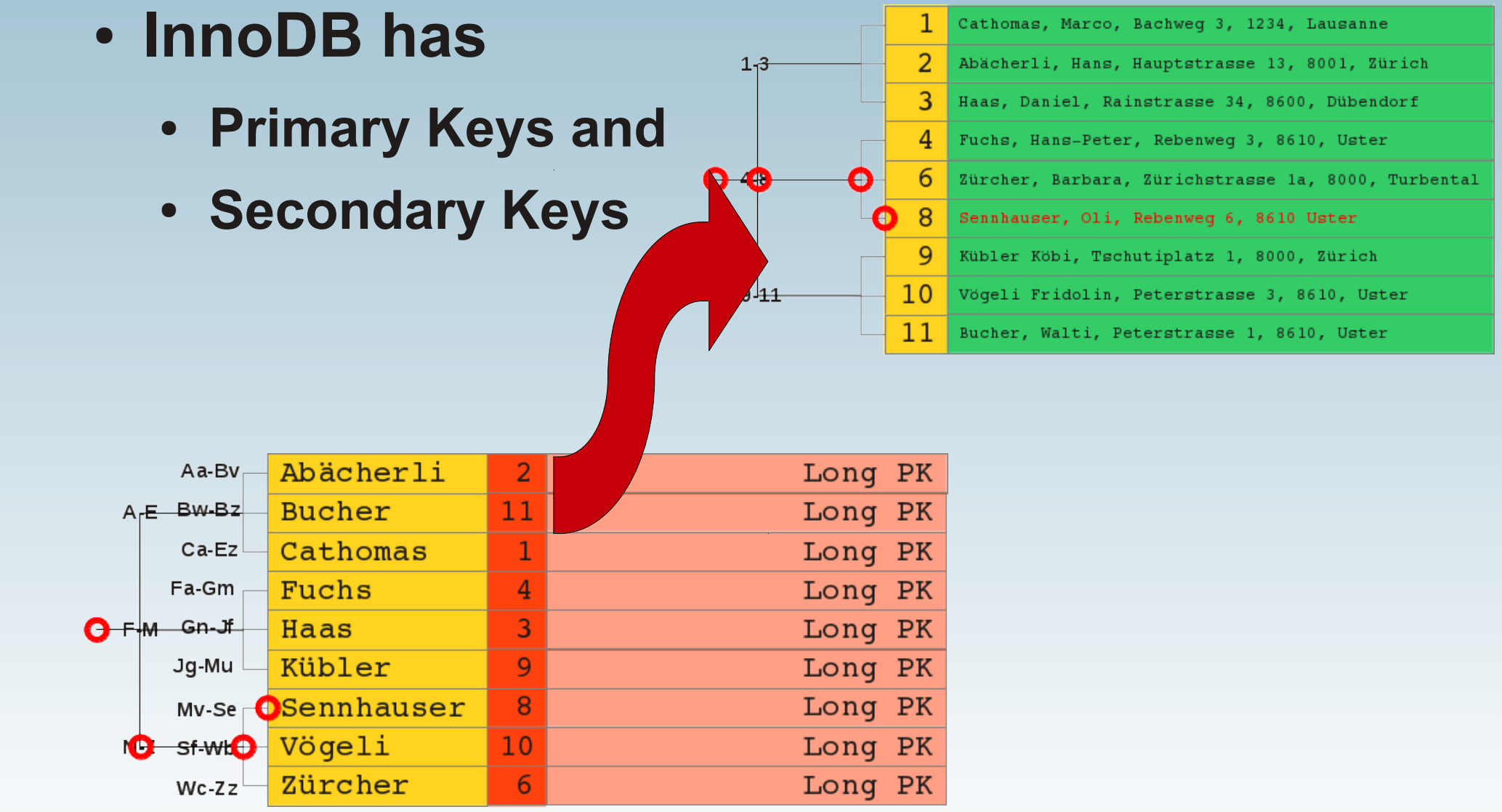
```
SELECT status, COUNT(*)
  FROM orders
 GROUP BY status;

+--------+--------+
| status | cnt    |
+--------+--------+
|      0 | 393216 |
|      1 | 262144 |
|      2 |     12 |
|      3 |     36 |
|      4 |     24 |
|      5 |      4 |
|      6 |      8 |
+--------+--------+
```

```
SELECT * FROM orders IGNORE INDEX (STATUS) WHERE status = 0;
0.44 s
+--------+------+-
| table  | type | p
+--------+------+-
| orders | ALL  | N
+--------+------+-
```

5.6.12 (after analyze table)

InnoDB PK and SK

- InnoDB has
  - Primary Keys and
  - Secondary Keys



Clustered Index

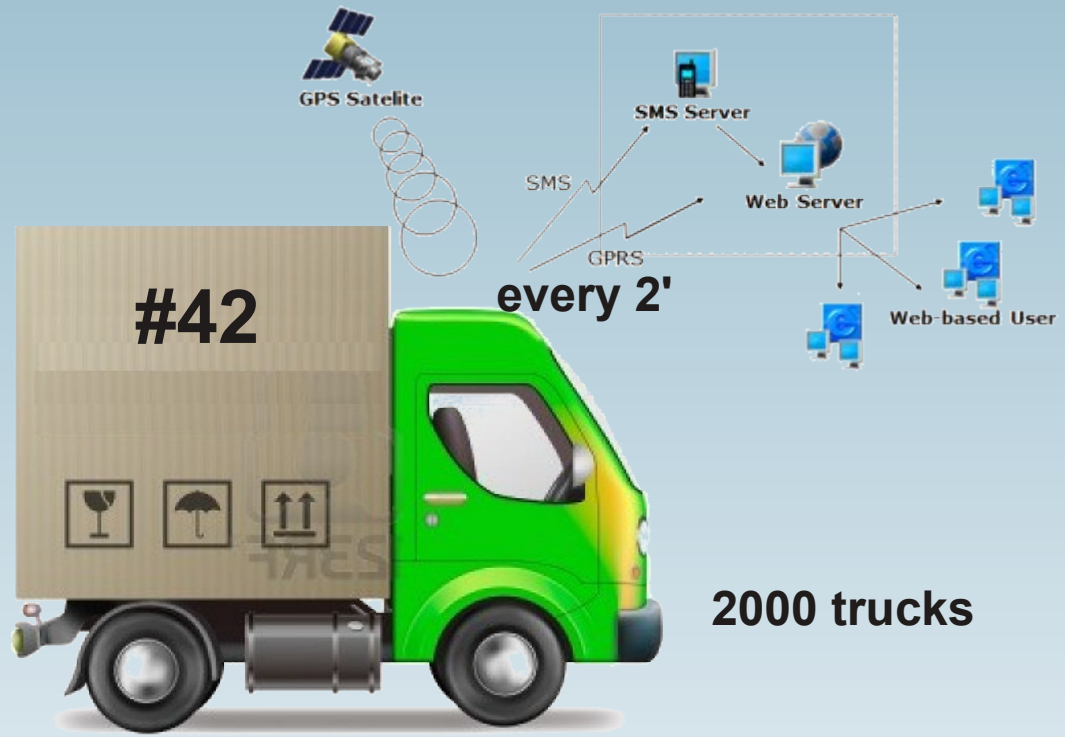
- InnoDB: Data = Leaf of Primary Key
  - We call this an Index Clustered Table (IOT)

    → Data are sorted like PK (key is sorted)!

    → PK influences Locality of data (physical location)
- `AUTO_INCREMENT` ~= sorting by time!
- Good for many things
  - where hot data = recent data
- Bad for time series
  - Where hot data = per item data

Example: InnoDB

A_I	ts	v_id	xpos	ypos	...
1	17:30	#42	x,	y,	...
2	17:30	#43	x,	y,	...
3	17:30	#44	x,	y,	...
	...				
2001	17:32	#42	x,	y,	...
2002	17:32	#43	x,	y,	...
2003	17:32	#44	x,	y,	...



Q1: Δ in rows? ~ 2000 rows
A1: 1 row ~ 100 byte
Q2: Δ in bytes? ~ 200 kbyte
Q3: Default InnoDB block size? default: 16 kbyte
Q4: Avg. # of rows of car #42 in 1 InnoDB block? ~ 1
A2: 3 d and 720 pt/d → ~2000 pt ~ 2000 rec ~ 2000 blk
Q5: How long will this take and why (32 Mbyte)?
~ 2000 IOPS ~ 10s random read!!!
S: All in RAM or strong I/O system or …?

over the last 3 days

InnoDB PK safes the day!

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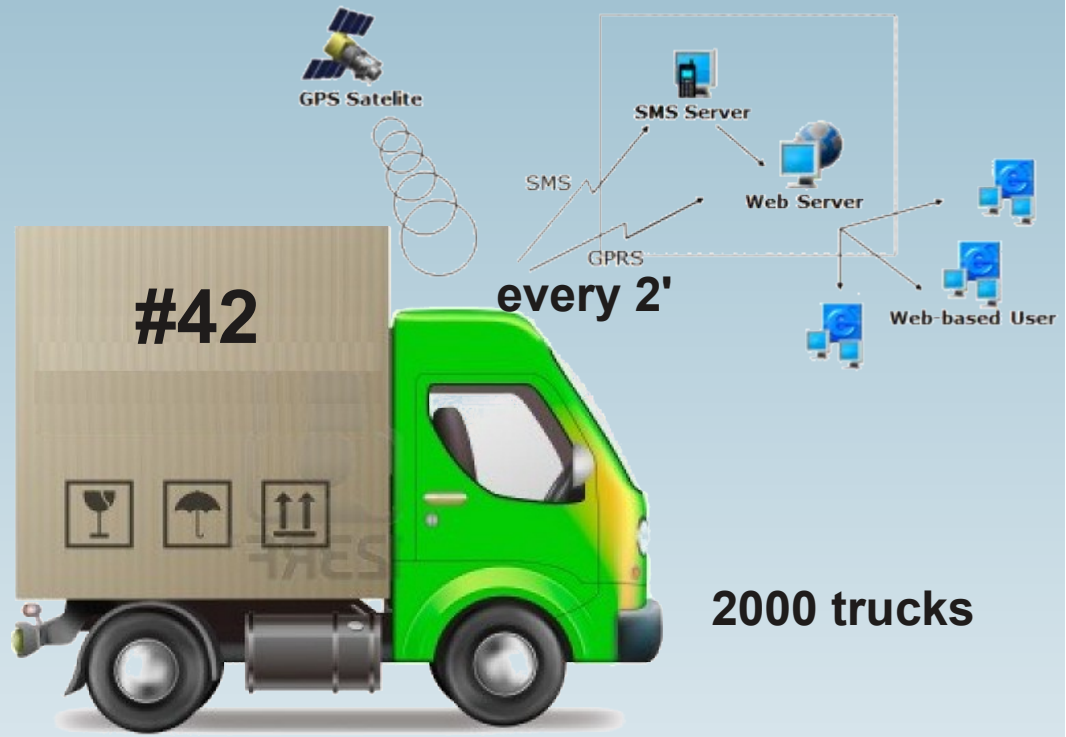
```
ts v_id xpos ypos ...

17:30 #42 x, y, ...
17:32 #42 x, y, ...
17:34 #42 x, y, ...
          ...
17:30 #43 x, y, ...
17:32 #43 x, y, ...
17:34 #43 x, y, ...

          ...
17:30 #44 x, y, ...
```



Q1: Avg. # of rows of car #42 in 1 InnoDB block? ~ 120
A1: 3 d and 720 pt/d → ~2000 pt ~ 2000 rec ~ 20 blk
Q2: How long will this take and why (320 kbyte)?
~ 1-2 IOPS ~ 10-20 ms sequential read!
S: Wow f=50 faster! Any drawbacks?

over the last 3 days

Index hints

- MySQL optimizer is sometimes wrong!
  - We have to help (= hint) him...
- Index hints are:
  - `USE INDEX (ind1, ind2)`
    - Only consider these indexes
  - `FORCE INDEX (ind3)`
    - Use this index without considering anything else
  - `IGNORE INDEX (ind1, ind3)`
    - Do NOT consider these indexes but everything else
- Hints should be used only as a last resort

MySQL Variables

- MySQL variables influencing index use
  - MyISAM: `key_buffer_size`
  - InnoDB: `innodb_buffer_pool_size` / `innodb_buffer_pool_instances`
- InnoDB Change Buffer
  - `innodb_change_buffer_max_size`
  - `innodb_change_buffering`
- Adaptive Hash Index (AHI)
- MySQL 5.6.3 / 5.5.14 index length 767 → 3072 bytes
  - `innodb_large_prefix`

Q & A

Questions ?

Discussion?

We have time for some face-to-face talks...

- **FromDual provides neutral and independent:**
  - **Consulting**
  - **Remote-DBA**
  - **Support for MySQL, Galera, Percona Server and MariaDB**
  - **Training**

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