

# MySQL Workbench and InnoDB GIS

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# MySQL Workbench

# MySQL Workbench

- MySQLの管理/開発支援ツール
- Windows 7 and newer (32 and 64bits)
- Mac (Snow Leopard and newer)
- Linux (Ubuntu, Fedora, Oracle Linux or sources)
- Latest version 6.2 **New**
- MySQL 5.1以降に対応



# MySQL Workbench

- Free/Open Source Community Edition
- Commercial Edition

GUI for Online Backup, Audit, DBDoc etc

Included with commercial MySQL Editions

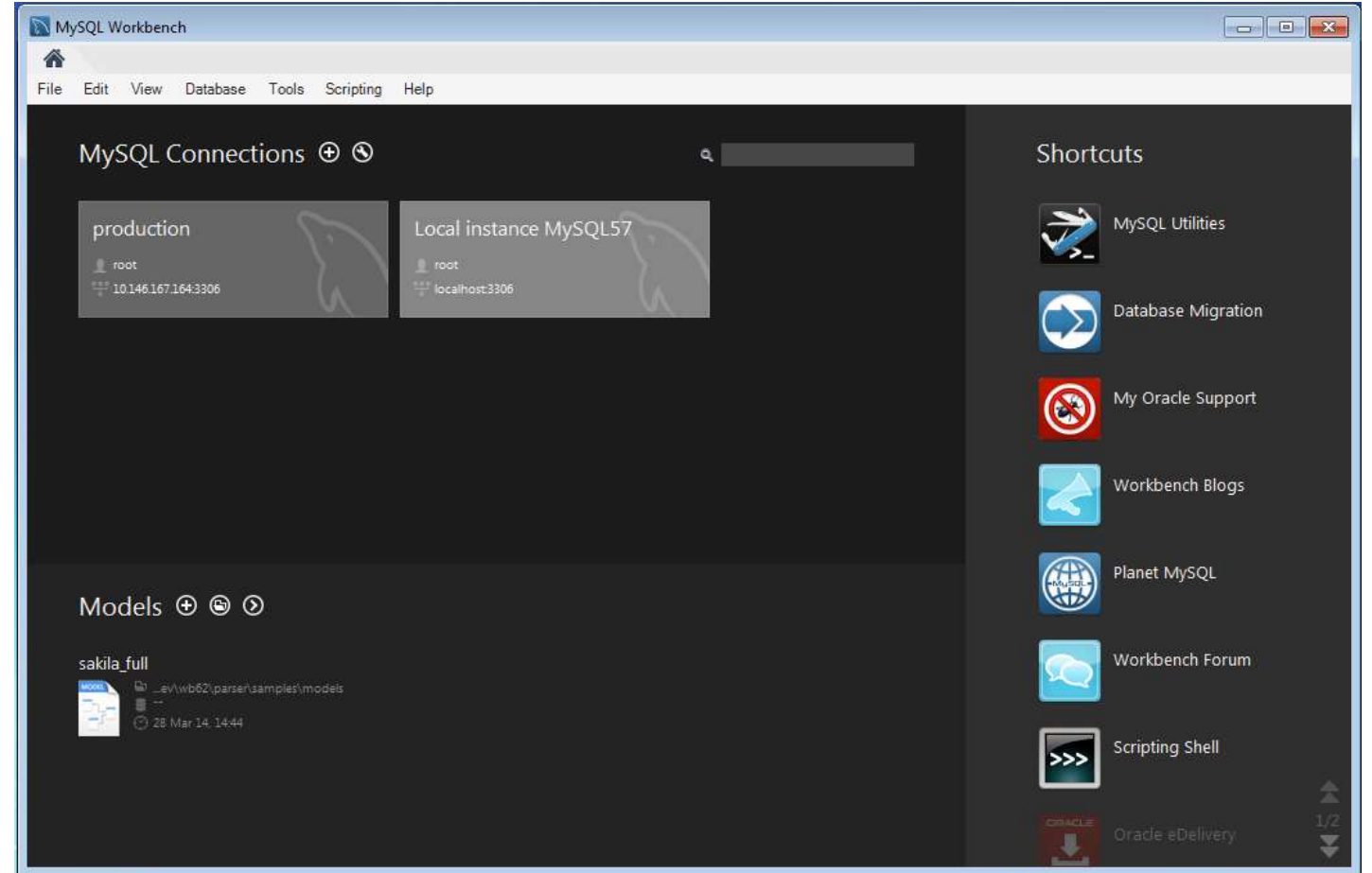
- <http://dev.mysql.com/downloads/workbench/>





# MySQL Workbench

- 管理
- 開発支援
- データモデリング
- マイグレーション



# MySQL Workbench – 管理

- Server Status
- Start/Stop
- Connections
- Accounts
- Dump/Import
- Logs
- Configuration
- Performance Reports

The screenshot shows the MySQL Workbench interface for the 'Local instance MySQL57'. The window title is 'MySQL Workbench' and the connection name is 'Local instance MySQL57'. The interface is divided into several sections:

- MANAGEMENT:** Server Status (selected), Client Connections, Users and Privileges, Status and System Variables, Data Export, Data Import/Restore.
- INSTANCE:** Startup / Shutdown, Server Logs, Options File.
- PERFORMANCE:** Dashboard, Performance Reports, Performance Schema Setup.
- MySQL ENTERPRISE:** Audit Inspector, Online Backup, Restore.

The main area displays server details:

- Host: ALKOJIMA-US
- Socket: mysql
- Port: 3306
- Version: 5.7.4-m14 MySQL Community Server (GPL)
- Compiled For: Win64 (x86\_64)
- Configuration File: C:\ProgramData\MySQL\MySQL Server 5.7\my.ini
- Running Since: Mon Sep 15 11:53:03 2014 (7 days 4h 38m)

A 'Refresh' button is located below the server details.

**Available Server Features:**

Performance Schema:	<input checked="" type="radio"/> On	SSL Availability:	<input type="radio"/> Off
Thread Pool:	<input type="radio"/> n/a	Windows Authentication:	<input type="radio"/> Off
Memcached Plugin:	<input type="radio"/> n/a	Password Validation:	<input type="radio"/> n/a
Semisync Replication Plugin:	<input type="radio"/> n/a	Audit Log:	<input type="radio"/> n/a

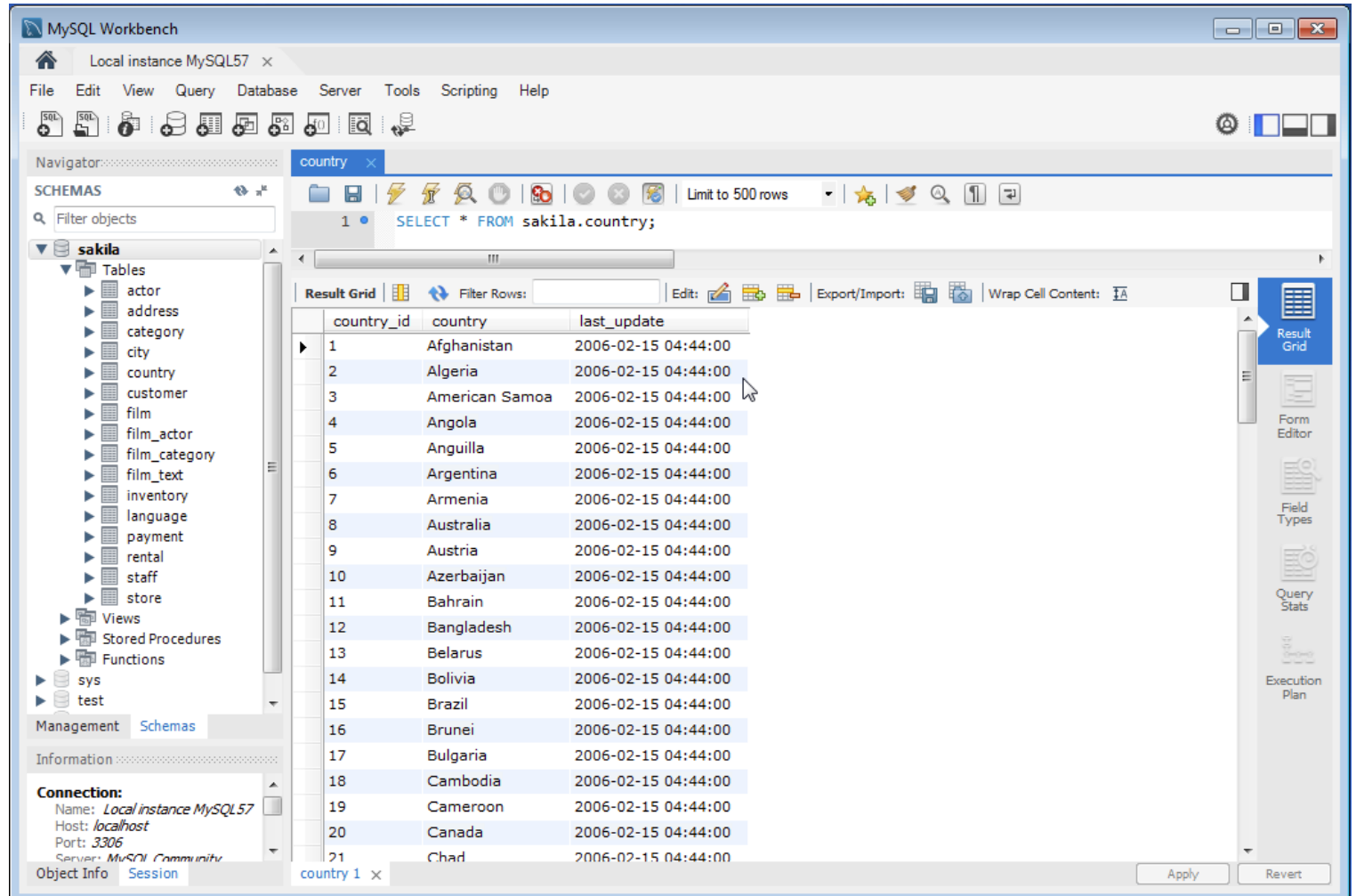
**Server Directories:**

- Base Directory: C:\Program Files\MySQL\MySQL Server 5.7\
- Data Directory: C:\ProgramData\MySQL\MySQL Server 5.7\data\
- Disk Space in Data Dir: 12.00 GB of 326.00 GB available
- Plugins Directory: C:\Program Files\MySQL\MySQL Server 5.7\lib\plugin\
- Tmp Directory: C:\Windows\SERVIC~2\NETWOR~1\AppData\Local\Temp
- Error Log:  On, .\ALKOJIMA-US.err
- General Log:  Off

The right sidebar shows performance metrics: Server Status (Running), CPU (---), Traffic (---), Selects per Second (---), and InnoDB Reads per Second (---).

# MySQL Workbench – 開発支援: SQL Editor

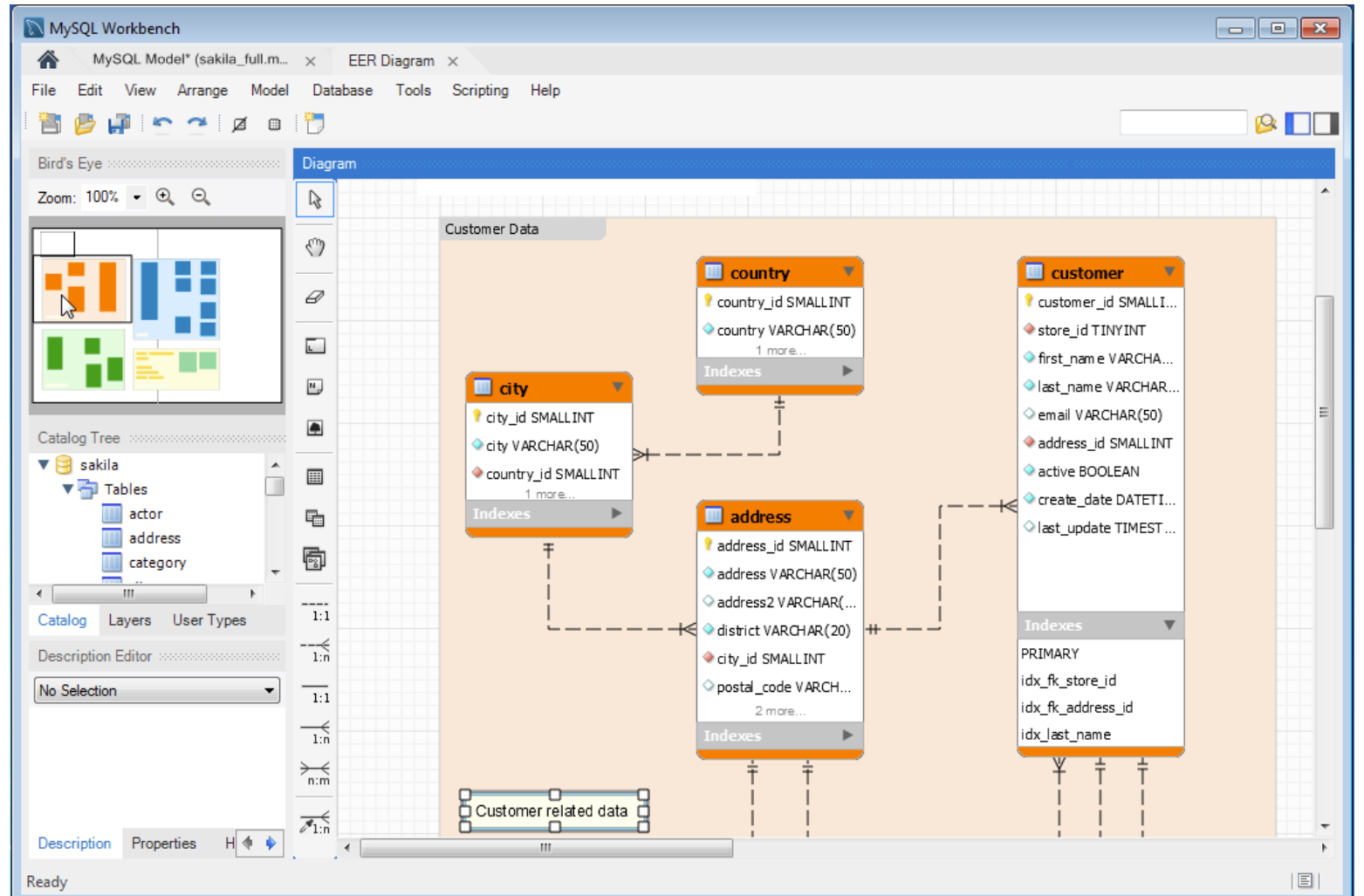
- Browse Databases
- View/Edit Data
- Run Queries and Scripts
- Create/Alter Objects (online)
- Query Optimization (Visual Explain etc)





# MySQL Workbench – モデリング

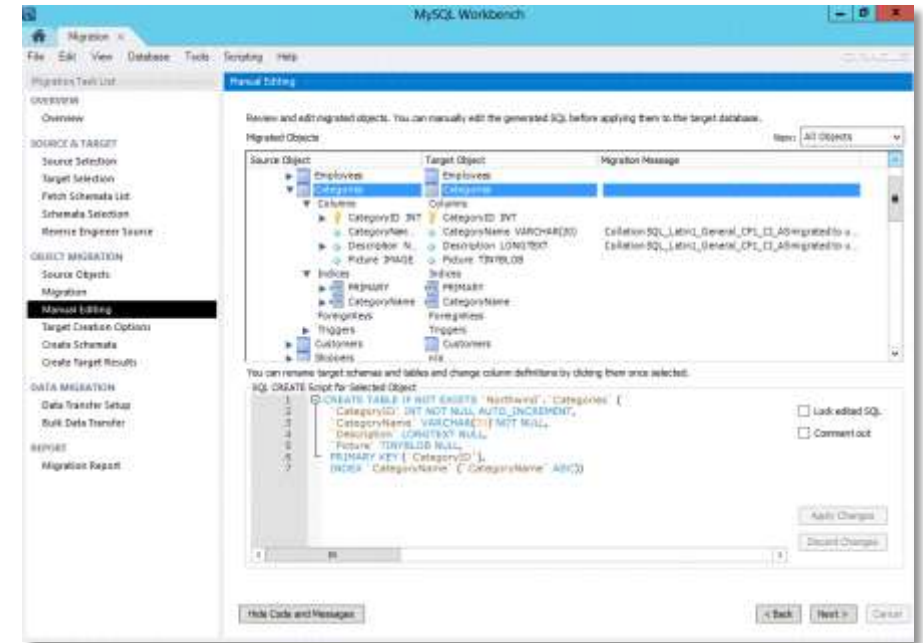
- Visually model database schemas
- Reverse engineer existing databases
- Generate SQL code from diagram
- Synchronize



# MySQL Workbench 6.2

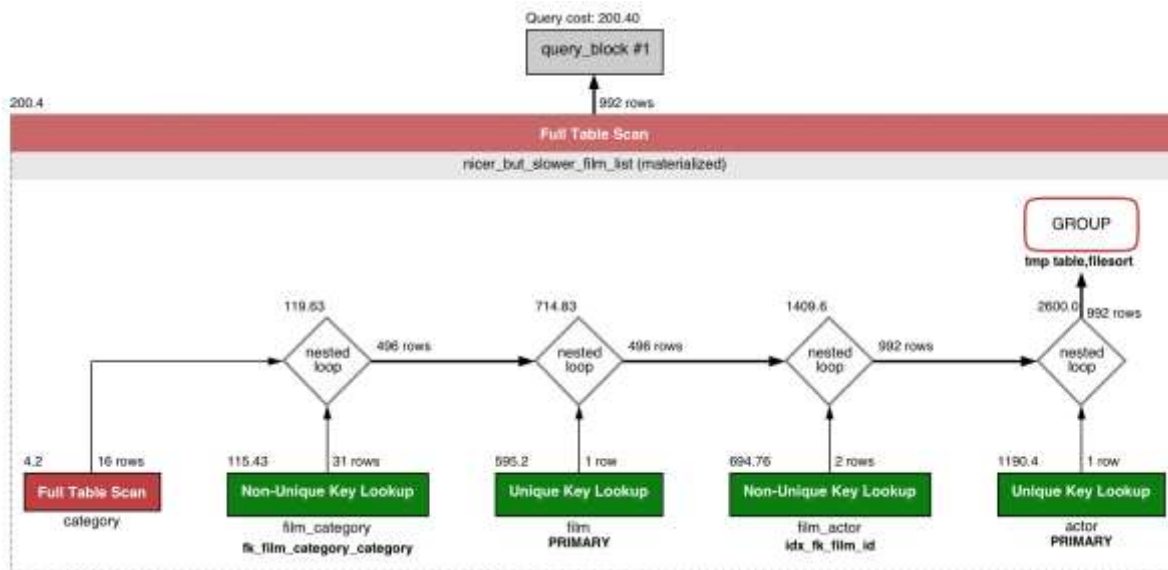


- Fabric対応
  - Fabricノードの追加、構成確認、接続
- Performance Dashboard
  - パフォーマンススキーマのレポートとグラフ
- Visual Explain
- GIS Viewer
- マイグレーション
  - **New** Microsoft Access
  - Microsoft SQL Server, Sybase, PostgreSQL



# MySQL 5.7: Optimizer - JSON EXPLAINへのコスト情報追加

- JSON EXPLAINを拡張
  - 出力可能なコスト情報を全て表示
  - MySQL WorkbenchのVisual Explainにも表示



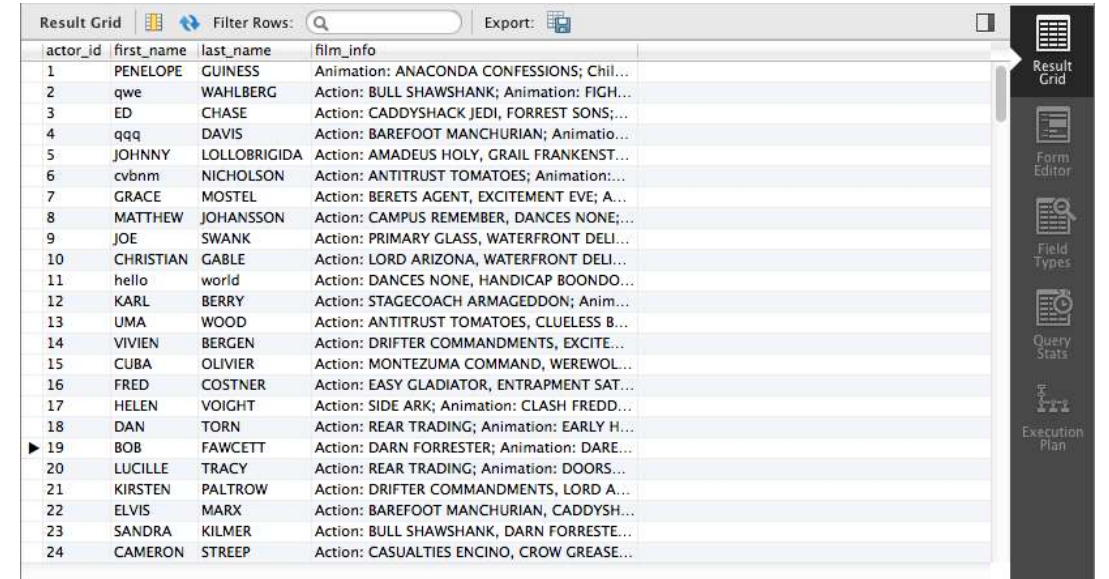
```
{  
  "query_block": {  
    "select_id": 1,  
    "cost_info": {  
      "query_cost": "200.40"  
    },  
    "table": {  
      "table_name": "nicer_but_slower_film_list",  
      "access_type": "ALL",  
      "rows_examined_per_scan": 992,  
      "rows_produced_per_join": 992,  
      "filtered": 100,  
      "cost_info": {  
        "read_cost": "2.00",  
        "eval_cost": "198.40",  
        "prefix_cost": "200.40",  
        "data_read_per_join": "852K"  
      },  
      "used_columns": [  
        "FID",  
        "title",  
        "description",  
        "category",  
        "price",  
        "length",  
        "rating",  
        "actors"  
      ],  
      ...  
    }  
  }  
}
```

# スキーマとデータをMySQLへマイグレーション

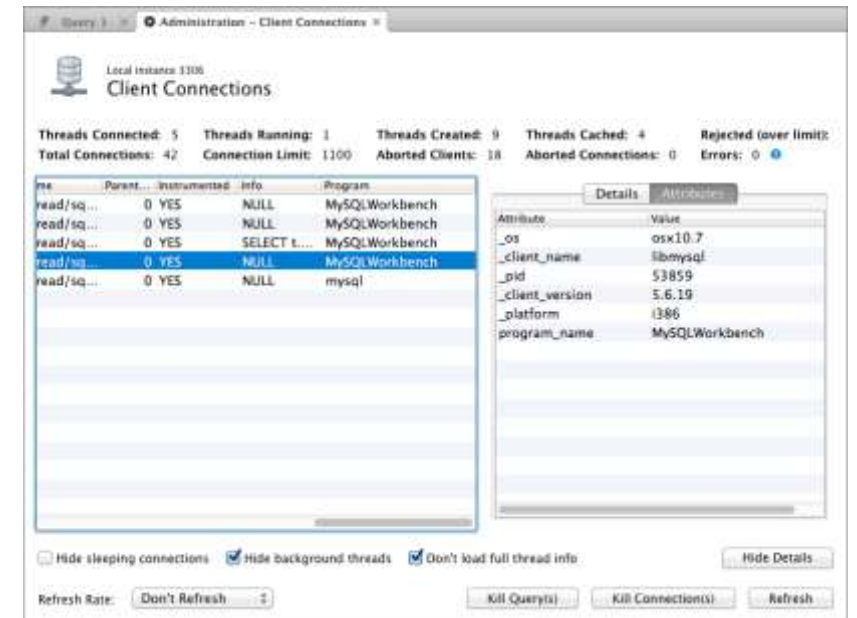
- MS SQL Server
  - 2000
  - 2005
  - 2008
  - 2012
- MS Access New in WB 6.2
- Sybase ASE
- Sybase SQL Anywhere
- PostgreSQL
- SQLite
- Generic
- MySQL

# MySQL Workbench 6.2 その他の改善点

- Query Results Panelの改善
- SQLスクリプトの実行
  - サイズの大きなSQLファイルを読み込まずに直接実行
- スニペットの共有
  - よく使うSQL文を共有して使用
- メタデータ・ロック・ブラウザー
- クライアント・コネクション・ブラウザーの改善
  - OS, プログラム, クライアントバージョン等の詳細情報を表示
- など



actor_id	first_name	last_name	film_info
1	PENELOPE	GUINNESS	Animation: ANACONDA CONFESSIONS; Chil...
2	qwe	WAHLBERG	Action: BULL SHAWSHANK; Animation: FIGH...
3	ED	CHASE	Action: CADDYSHACK JEDI, FORREST SONS;...
4	qqq	DAVIS	Action: BAREFOOT MANCHURIAN; Animatio...
5	JOHNNY	LOLLOBRIGIDA	Action: AMADEUS HOLY, GRAIL FRANKENST...
6	cvbnm	NICHOLSON	Action: ANTITRUST TOMATOES; Animation:...
7	GRACE	MOSTEL	Action: BERETS AGENT, EXCITEMENT EVE; A...
8	MATTHEW	JOHANSSON	Action: CAMPUS REMEMBER, DANCES NONE;...
9	JOE	SWANK	Action: PRIMARY GLASS, WATERFRONT DELI...
10	CHRISTIAN	GABLE	Action: LORD ARIZONA, WATERFRONT DELI...
11	hello	world	Action: DANCES NONE, HANDICAP BOONDO...
12	KARL	BERRY	Action: STAGECOACH ARMAGEDDON; Anim...
13	UMA	WOOD	Action: ANTITRUST TOMATOES, CLUELESS B...
14	VIVIEN	BERGEN	Action: DRIFTER COMMANDMENTS, EXCITE...
15	CUBA	OLIVIER	Action: MONTEZUMA COMMAND, WEREWOL...
16	FRED	COSTNER	Action: EASY GLADIATOR, ENTRAPMENT SAT...
17	HELEN	VOIGHT	Action: SIDE ARK; Animation: CLASH FREDD...
18	DAN	TORN	Action: REAR TRADING; Animation: EARLY H...
19	BOB	FAWCETT	Action: DARN FORRESTER; Animation: DARE...
20	LUCILLE	TRACY	Action: REAR TRADING; Animation: DOORS...
21	KIRSTEN	PALTROW	Action: DRIFTER COMMANDMENTS, LORD A...
22	ELVIS	MARX	Action: BAREFOOT MANCHURIAN, CADDYSH...
23	SANDRA	KILMER	Action: BULL SHAWSHANK, DARN FORRESTE...
24	CAMERON	STREEP	Action: CASUALTIES ENCINO, CROW GREASE...



Threads Connected	Threads Running	Threads Created	Threads Cached	Rejected (over limit)
5	1	9	4	

Param	Instrumented	Info	Program
read/sq...	0 YES	NULL	MySQLWorkbench
read/sq...	0 YES	NULL	MySQLWorkbench
read/sq...	0 YES	SELECT L...	MySQLWorkbench
read/sq...	0 YES	NULL	MySQLWorkbench
read/sq...	0 YES	NULL	mysql

Attribute	Value
_os	osx10.7
_client_name	libmysql
_pid	53859
_client_version	5.6.19
_platform	i386
program_name	MySQLWorkbench

# "Spatial Viewer" and "Geometry Viewer"

- New in Workbench 6.2

Form Editor | Navigate: 1 / 178 | Edit: | View Geometry as WKT

OGR\_FID: 1

SHAPE2: POLYGON ((61.210817091725744 35.65007233309225,62.230651483005886 35.270663967422294,62.98466230657661 35.404040839167621,63.193538445900352 35.857165635718914,63.98289594915871 36.007957465146603,64.546479119733903 36.312073269184268,64.746105177677407 37.111817735333304,65.588947788357842 37.305216783185642,65.745630731066825 37.661164048812068,66.217384881459338 37.39379018813392,66.51860680528867 37.362784328758792,67.075782098259623 37.356143907209287,67.829999627559516 37.144994004864685,68.135562371701389 37.023115139304309,68.859445835245936 37.344335842430596,69.196272820924378 37.151143500307427,69.518785434857961 37.60899669041342,70.116578403610333 37.588222764632093,70.270574171840138 37.735164699854025,70.376304152309302 38.138305901027522,70.806820509732887,38.486281643216415,71.348131137900265 38.138305901027522,70.806820509732887,38.486281643216415,71.348131137900265))

Scalerank: 1

Featurecla: Admin-0 country

Labelrank: 3.000000

Sovereignt: Afghanistan

Sov\_a3: AFG

Adm0\_dif: 0.000000

borders2 1 | Apply | Revert

Query 1 | borders2 | Limit to 1000 rows

1 | SELECT \* FROM gis\_test.borders2:

100% | 1:1 | Spatial View | Projection: Robinson | Tool: | Zoom: | Reset: | Jump To:

Layer | Source

Grid | borders2

SHAPE2 | borders2

Lat: 79d53' 9.96"S  
Lon: 87d 5'50.96"W

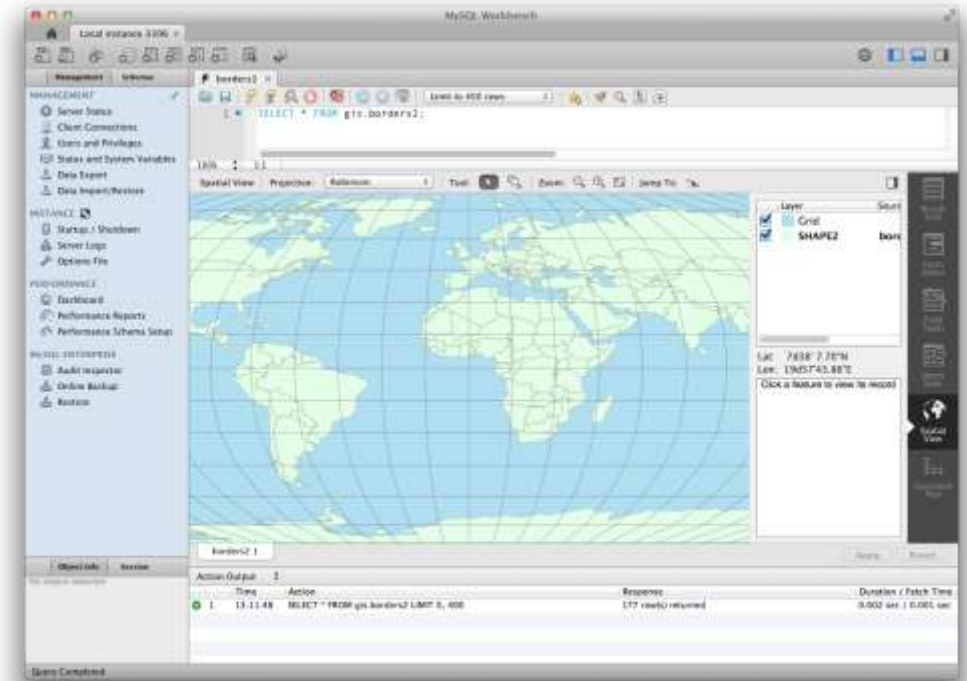
OGR\_FID: 23  
SHAPE2: ...  
scalerank: 1  
featurecla: Admin-0 country  
labelrank: 2.000000  
sovereignt: Brazil  
sov\_a3: BRA  
adm0\_dif: 0.000000  
level: 2.000000  
type: Sovereign country  
admin: Brazil  
adm0\_a3: BRA  
geou\_dif: 0.000000  
geounit: Brazil

borders2 1 | Apply | Revert



# MySQL 5.7: GIS - Boost.Geometryとの統合

- 独自コードの置き換え
  - 空間図形情報の計算
  - 空間図形情報の分析
- OGC(Open Geospatial Consortium)準拠
  - パフォーマンスの向上
- Boost.Geometryによる効果
  - エキスパートとの交流
  - 非常に活発なコミュニティ
- Boost.Geometryへのコントリビュートも



A woman with long brown hair and glasses, wearing a brown leather jacket and a blue patterned scarf, is sitting at a wooden table. She is holding a black smartphone to her ear with her right hand and looking down at a large open book or document on the table with her left hand. The background is a bright, modern interior with large windows and a person sitting at another table in the distance.

# Common Terms and Concepts

# Standards Organizations

- Open Geospatial Consortium (OGC)
  - Set and maintain the ISO SQL standards for GIS
    - Also many others: transformations, markup languages (KML, GML, etc.), presentation, ...
- European Petroleum Survey Group (EPSG)
  - An authority for things such as coordinate reference systems
    - CRS/EPSGID/SRID
  - Now part of the OGC
- Environmental Systems Research Institute
  - A commercial company that is a de-facto standard
    - Creators of the very popular Shapefile (.shp) format
    - Creators of the very popular ArcGIS software



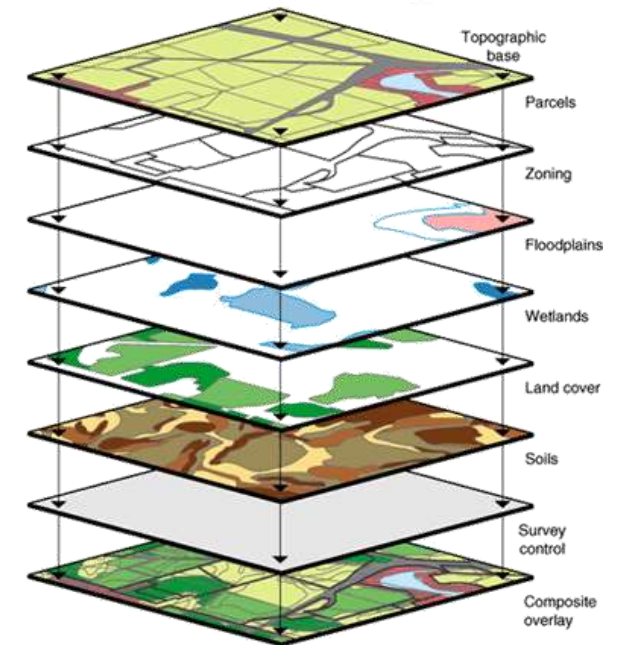
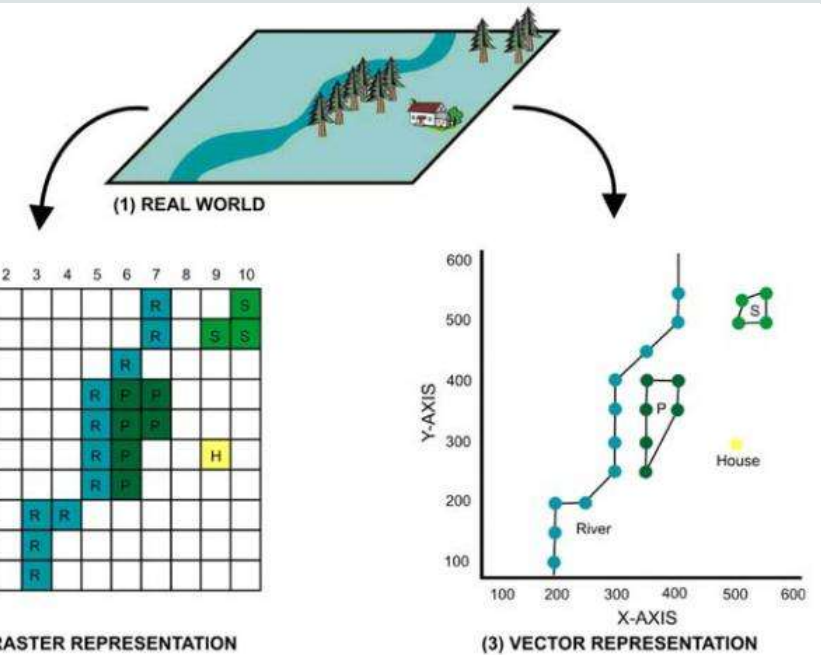
# Common Terms

- Coordinates
  - $x,y,z$  coordinates in planar space (4D is m or measure)
  - MySQL currently only supports 2D ( $x,y$ ) coordinates
- Projection
  - Allows a spheroidal surface to be represented in planar format
  - Necessary for creating “flat” or 2D maps from locations on a spheroid
- Coordinate reference system (CRS/SRS/EPSGID/SRID)
  - Defines where a POINT—represented by a longitude and latitude coordinate pair—is located on the physical earth and defines its relationship to other POINTs
  - Also used for calculating distances



# Data Formats

- Vector
  - Points, lines, and polygons
  - Position (x,y,z) is relative in a coordinate system
  - Generally used by database servers
  - Includes .Shp, .OSM, .KML, .GeoJSON, ...
- Raster
  - Cells in a grid matrix, tied to an anchor (e.g. the {1,1} cell)
  - Generally used in aerial, satellite, and other imagery
  - Includes .tiff, .jpg, .gif, and other pixel based formats





# Data Sources

- Free
  - OpenStreetMap
  - Governments and NGOs
  - Universities (UCGIS) and other non-profits
- Commercial / Non-free
  - Data Depot, Geography Network, Land Info, Macon, NEXRAIN, SPOT image, ...
- Custom
  - Geoencoding from various sources, such as user generated images and GPS data
    - Most media today is automatically geotagged: tweets, photos, Facebook posts, ...
  - Create custom maps using ArcGIS, QGIS, GRASS, ...





# Migrating Data

- The OSGeo project
  - Geospatial Data Abstraction Library (GDAL/OGR)
    - Import data from various vector formats
    - Convert raster based data to vector format
- ESRI
  - ArcGIS
    - ArcSDE geodatabase abstraction layer for interfacing directly with database servers
    - Convert data between various file formats
- Open Street Map
  - Perl (OsmDB.pm) and Java (Osmosis) tools for importing OSM data



A woman with long brown hair and glasses is sitting at a wooden table in a cafe. She is wearing a brown leather jacket over a blue patterned scarf. She is holding a black smartphone to her ear with her left hand and looking down at a newspaper or magazine on the table with her right hand. The background is a bright, modern cafe with large windows and other people sitting at tables.

# What's New in MySQL 5.7

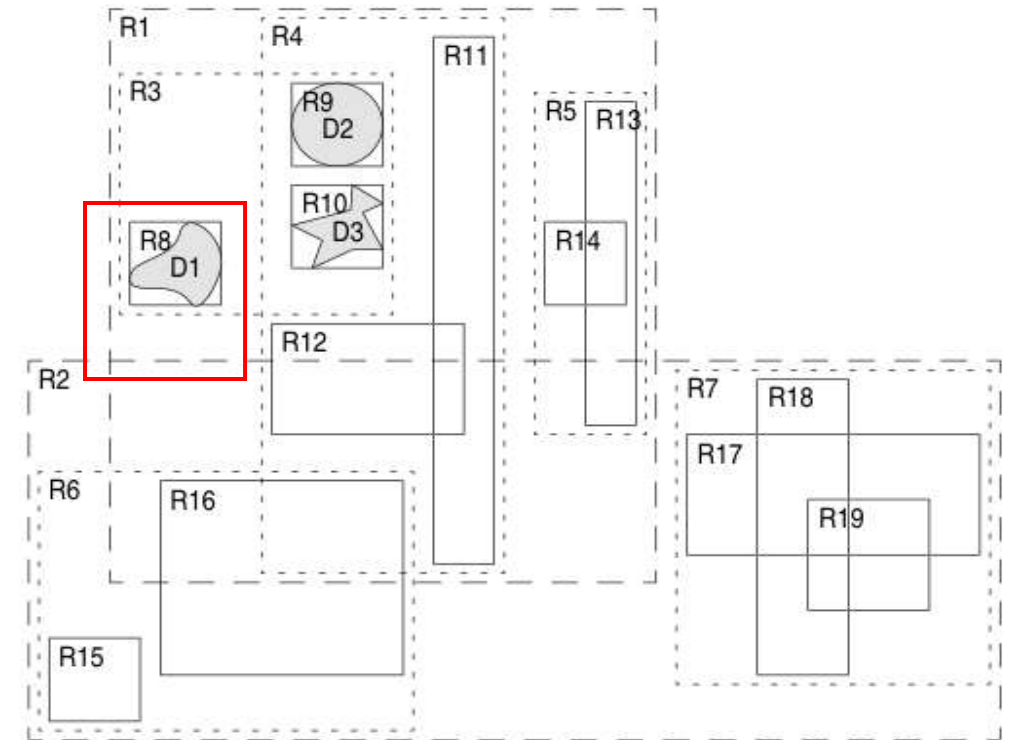
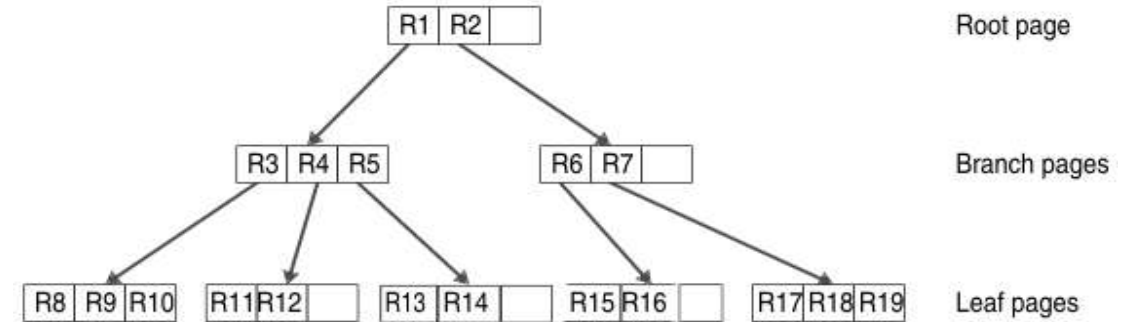
# Boost.Geometryとの統合

- 独自コードの置き換え
  - 空間図形情報の計算
  - 空間図形情報の分析
- OGC(Open Geospatial Consortium)準拠
  - パフォーマンスの向上
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# Spatial Indexes for InnoDB

- R-tree based
  - トランザクションサポート
  - ファントムリードを防ぐロック
  - レコードは最小のbounding box (境界線)を含む
  - 現時点では2Dデータのみをサポート
    - 3Dデータのサポートも計画中
  - historical spatial index DDL をサポート



# Additional Features

- GeoHash
  - B-tree indexes on the generated hash values
  - Quick lookups for exact matches
  - Not very accurate for proximity searches
- GeoJSON
- Additional functions
  - ST\_IsValid(), ST\_IsSimple(), ...
- Limited SRID support



GeoJSON Example

```
{
  "type": "Feature",
  "geometry": {
    "type": "Point",
    "coordinates": [125.6, 10.1]
  },
  "properties": {
    "name": "Dinagat Islands"
  }
}
```



A woman with long brown hair and glasses, wearing a brown leather jacket and a blue patterned scarf, is sitting at a wooden table in a cafe. She is talking on a black mobile phone held to her left ear and looking down at an open newspaper on the table. The background is a bright, modern cafe with large windows and other people sitting at tables.

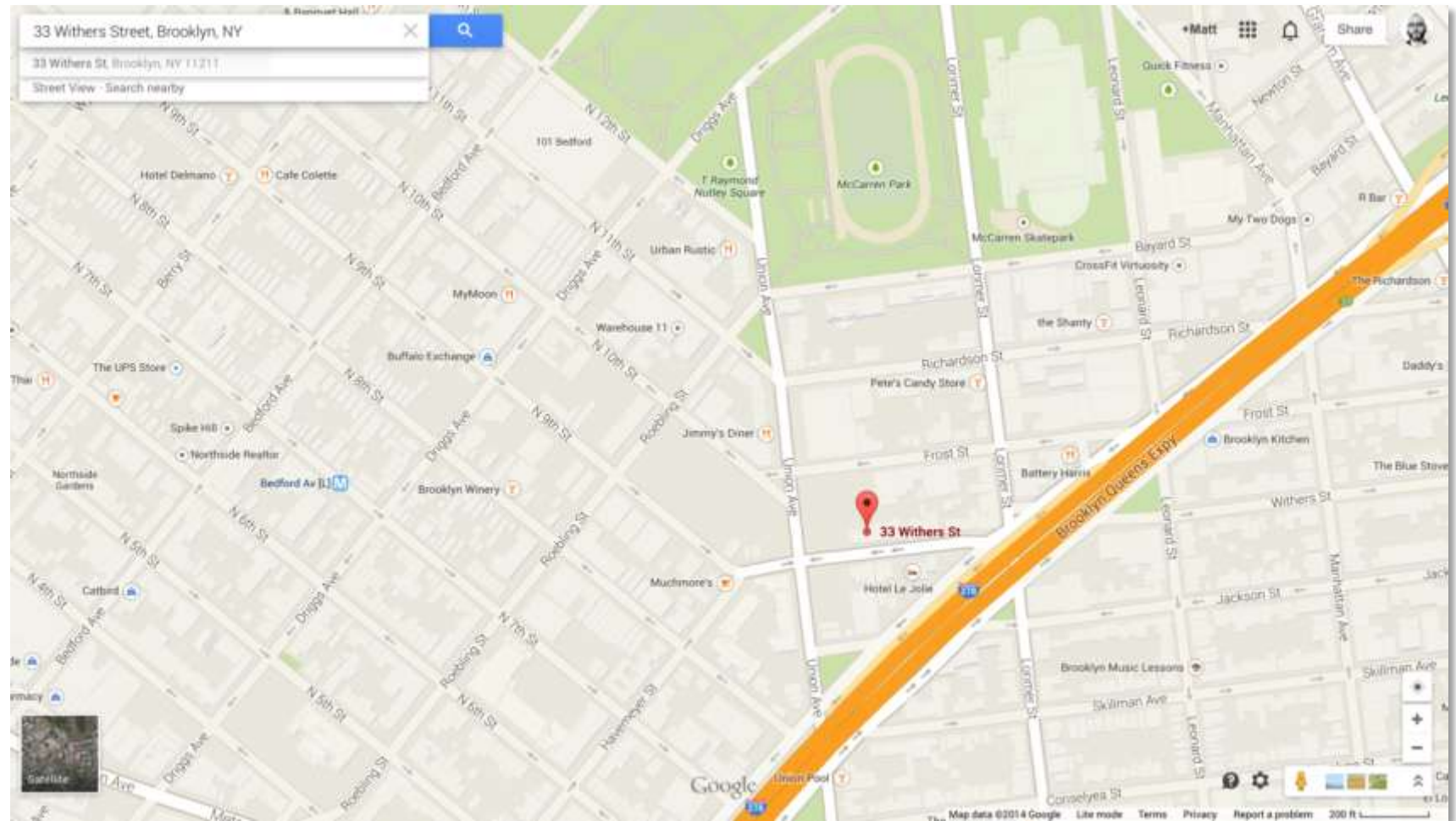
# Some Real World Examples



# A Starting Point

- My old apartment in Brooklyn, NY
  - 33 Withers Street Brooklyn, NY 11211
  - POINT(<LONG>,<LAT>)
    - **-73.951353,40.716914**

<https://www.google.com/maps/place/33+Withers+St,+Brooklyn,+NY+11211/@40.7169144,-73.9513538>



# The Application Use Case

- I'm hungry and in the mood for Thai food
  - What Thai restaurants are around me?
  - What's the closest one?
  - Can I see the menu, contact info, yelp ratings, etc.?
  - How would I get there?



# Getting Some Data In

- Download a NYC OSM extract:
  - <http://osm-extracted-metros.s3.amazonaws.com/new-york.osm.bz2>
- Import the data using a customized OsmDB.pm Perl module
  - <http://wiki.openstreetmap.org/wiki/OsmDB.pm> (original)
  - <https://www.dropbox.com/s/l17vj3wf9y13tee/osmdb-scripts.tar.gz> (customized)
    - Creates a Geometry column named 'geom'
    - Creates a spatial index on the 'geom' column



```
mysql -e "create database nyosm"  
bunzip2 new-york.osm.bz2  
./bulkDB.pl new-york.osm nyosm
```

# The Generated Schema

- <http://wiki.openstreetmap.org/wiki/Elements>

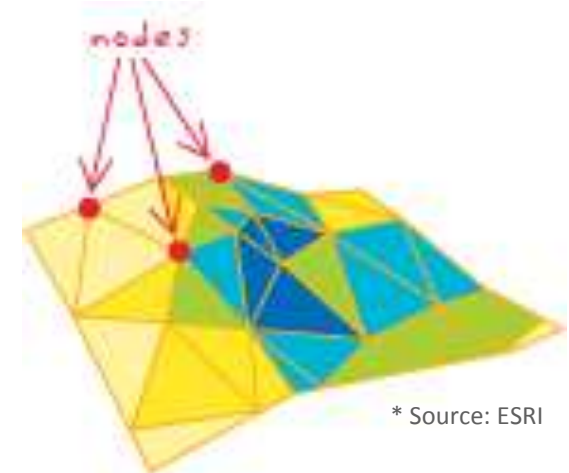
```
mysql> show tables;
+-----+
| Tables_in_nyosm |
+-----+
| nodes            |
| nodetags         |
| relationmembers |
| relations        |
| relationtags    |
| waynodes        |
| ways            |
| waytags         |
+-----+
```

- We'll focus on nodes and nodetags for our examples
- Nodes
  - A point or location
- Nodetags
  - Metadata about each location
  - X name/value pairs



# De-normalizing the Tag Data

- Greatly simplify our query
- Allow for the use of a full-text index
  - Also improves performance
- Mimic better schema created by osm2pgsql
  - [http://wiki.openstreetmap.org/wiki/Osm2pgsql/schema#planet\\_osm\\_nodes](http://wiki.openstreetmap.org/wiki/Osm2pgsql/schema#planet_osm_nodes)



```
mysql> alter table nodes add column tags text, add fulltext index(tags);
mysql> update nodes set tags=(SELECT group_concat(concat(k, "=", v) SEPARATOR
';') from nodetags where nodetags.id=nodes.id group by nodes.id);
```



# Final Nodes Table

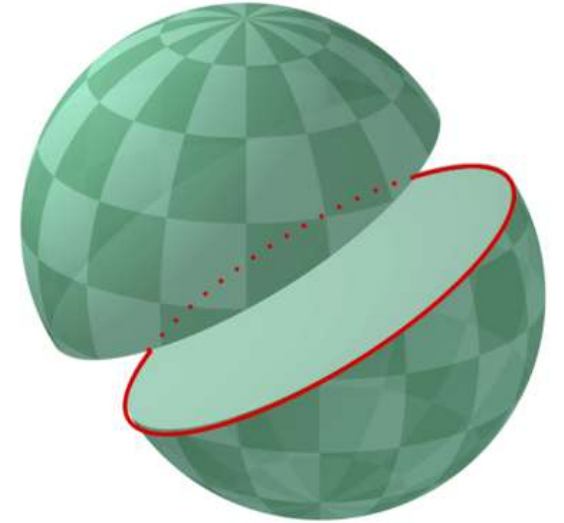
```
mysql> show create table nodes\G
***** 1. row *****
      Table: nodes
Create Table: CREATE TABLE `nodes` (
  `id` bigint(20) DEFAULT NULL,
  `geom` geometry NOT NULL,
  `user` varchar(50) DEFAULT NULL,
  `version` int(11) DEFAULT NULL,
  `timestamp` varchar(20) DEFAULT NULL,
  `uid` int(11) DEFAULT NULL,
  `changeset` int(11) DEFAULT NULL,
  `tags` text,
  UNIQUE KEY `i_nodeids` (`id`),
  SPATIAL KEY `i_geomidx` (`geom`),
  FULLTEXT KEY `tags` (`tags`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1
```





# Creating a Distance Calculation Function

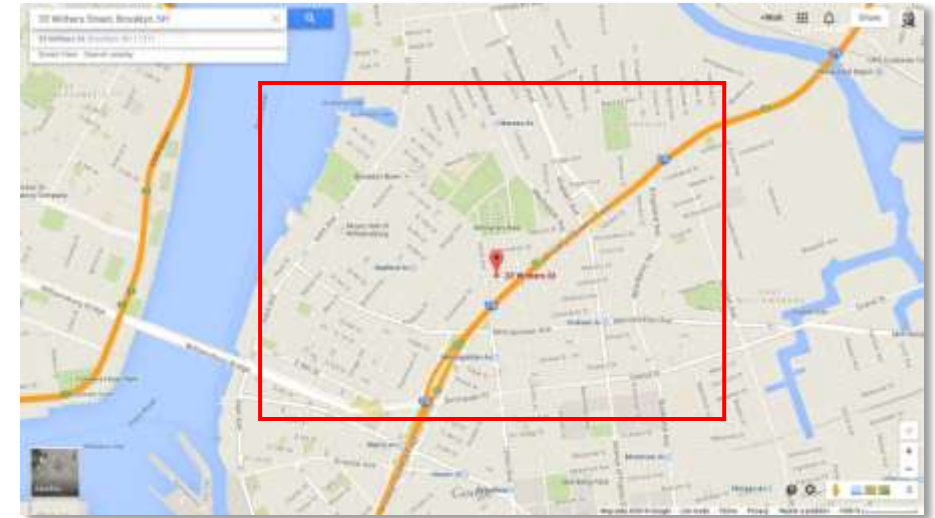
- Various great circle (orthodrome) distance formulas
  - Haversine, Spherical Law of Cosines (my choice), ...
  - [http://en.wikipedia.org/wiki/Great-circle\\_distance](http://en.wikipedia.org/wiki/Great-circle_distance)
  - Necessary for calculating distances between two Geometries
    - Need goes away when we support Geography and/or Projections (ST\_Transform)



```
mysql> CREATE FUNCTION slc (lat1 double, lon1 double, lat2 double, lon2 double)
RETURNS double
RETURN 6371 * acos(cos(radians(lat1)) * cos(radians(lat2)) * cos(radians(lon2)
- radians(lon1)) + sin(radians(lat1)) * sin(radians(lat2)));
```

# Creating a Bounding Box For Our Search

- Utilize the r-tree index by limiting area
  - Easy with future spatial reference systems support
    - WGS84 or SRID 4326 being the most common
  - Need to use some additional geographic formulas
    - <http://www.movable-type.co.uk/scripts/latlong.html>
    - Need should go away with full SRID support



```
${origlon} = -73.951368
${origlat} = 40.716743
${lon1} = ${origlon} + (${distance_in_km}/abs(cos(radians(${origlat}))*111))
${lat1} = ${origlat} + (${distance_in_km}/111)
${lon2} = ${origlon} - (${distance_in_km}/abs(cos(radians(${origlat}))*111))
${lat2} = ${origlat} - (${distance_in_km}/111)
```

# Calculating the Results

- Our final query, searching within **~ 10km** radius



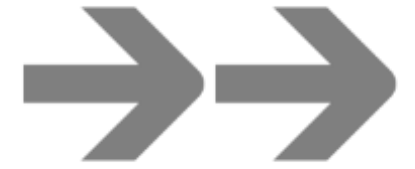
```
mysql> SELECT id,  
s1c(40.716743, -73.951368, y(geom), x(geom))*1000 as distance_in_meters,  
tags, ST_AsText(geom)  
FROM nodes  
WHERE ST_Contains(ST_Envelope(linestring(point((-73.951368+(10/111)),  
(40.716743+(10/111))), point((-73.951368-(10/111)), (40.716743-(10/111))))),  
geom)  
AND match(tags) against ("+thai +restaurant" IN BOOLEAN MODE)  
ORDER BY distance_in_meters¥G
```



# Examining the Results

```
***** 1. row *****
      id: 888976948
distance_in_meters: 614.4973960877276
      tags: addr:street=Bedford Avenue;amenity=restaurant;name=Tai
Thai;addr:housenumber=206;phone=7185995556
      astext(geom): POINT(-73.958637 40.717174)
***** 2. row *****
      id: 2178443635
distance_in_meters: 2780.87697408101
      tags: microbrewery=no;website=http://www.onemorethai.net/;name=One
More Thai;amenity=restaurant;opening_hours=12:00-22:30;cuisine=thai;phone=(212)
228-8858
      astext(geom): POINT(-73.983871 40.7210541)
***** 3. row *****
...

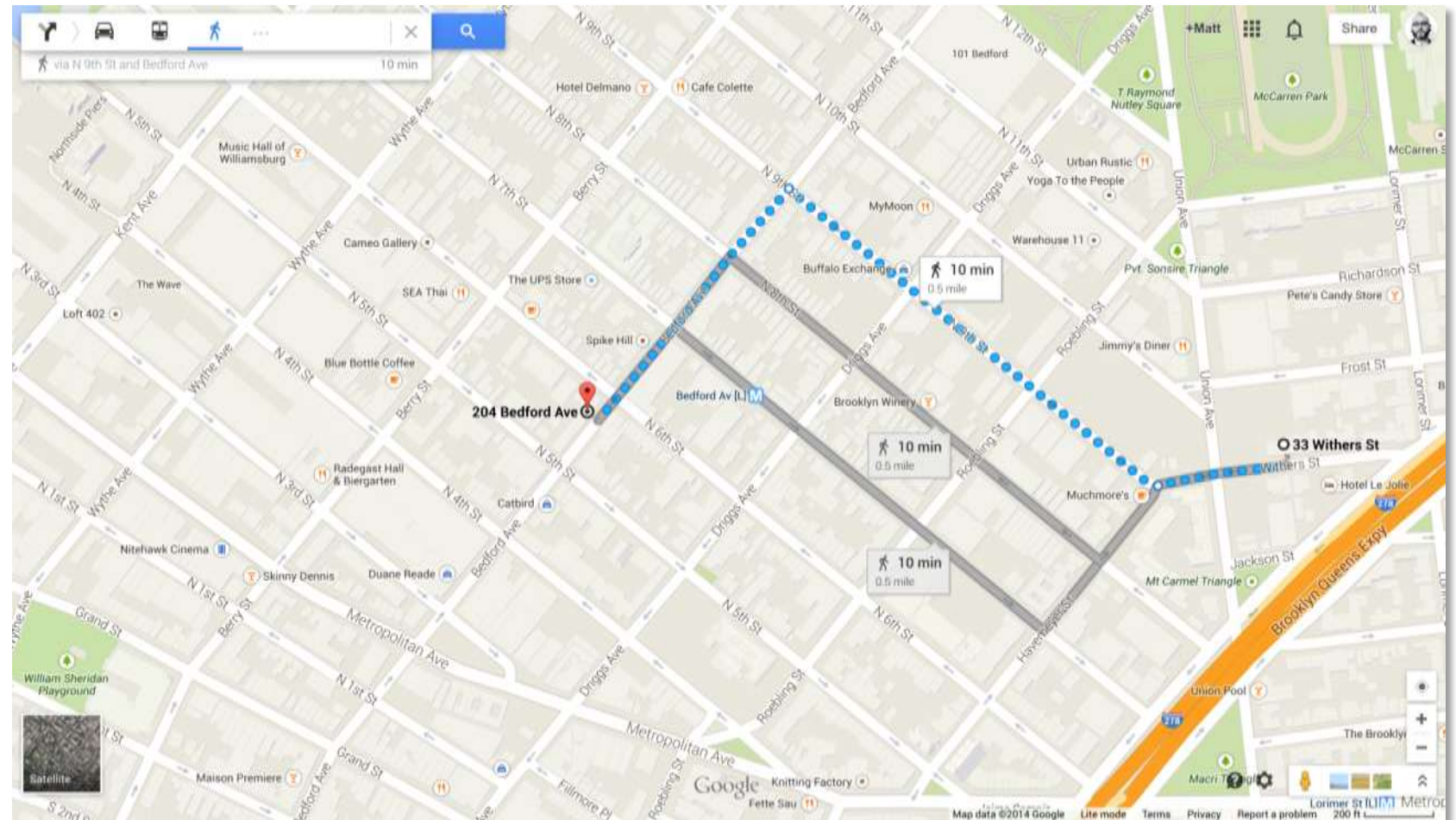
```



# Mapping the Results

- From my old place
  - -73.951353,40.716914
- To Tai Thai
  - -73.958637,40.717174
- Maps APIs
  - Google, Bing, Apple, ...

<https://www.google.com/maps/dir/40.716914,+73.951353/40.717174,+73.958637>



# 参考情報

- MySQL 5.7 and GIS, an Example  
<http://mysqlserverteam.com/mysql-5-7-and-gis-an-example/>
- Importing Raster Based Spatial Data into MySQL 5.7  
<http://mysqlserverteam.com/importing-raster-based-spatial-data-into-mysql-5-7/>
- MySQL GIS: Boost.Geometry
  - <http://mysqlserverteam.com/making-use-of-boost-geometry-in-mysql-gis/>
  - <http://mysqlserverteam.com/why-boost-geometry-in-mysql/>
  - <http://mysqlserverteam.com/building-mysql-with-boost/>
- MySQL GIS: InnoDB R-Tree
  - <http://mysqlserverteam.com/innodb-spatial-indexes-in-5-7-4-lab-release/>



A woman with long brown hair and glasses is sitting at a wooden table in a cafe. She is wearing a brown leather jacket over a blue patterned scarf. She is holding a black smartphone to her ear with her left hand and looking down at a newspaper or magazine on the table with her right hand. The background is a bright, modern cafe with large windows and other people sitting at tables.

# What's Next for MySQL GIS

# Storage Enhancements

- R-tree enhancements
  - 3D support
- Improved storage
  - Fixed length storage when possible
  - Transparent compression
  - Improved BLOB handling
- Concurrency improvements



# Geography

- Geography types
- Geography functions
- Makes distance calculations very accurate
  - Simple `ST_Distance()` call for value in meters



# Additional Features

- Projections
  - ST\_Transform()
- 3D and Geodetic support
- OGC standard Information\_Schema metadata
- Spatial reference system support
  - Starting with WGS84 (SRID 4326)
- Additional performance optimizations
- What else would **you** like to see?
  - Let us know!



# Appendix : Additional Resources

- Manual
  - <http://dev.mysql.com/doc/refman/5.7/en/spatial-extensions.html>
- Community forum
  - <http://forums.mysql.com/list.php?23>
- Boost.Geometry
  - <http://www.boost.org/libs/geometry>
- Report GIS bugs and submit feature requests
  - <http://bugs.mysql.com/>



Thank You!



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