Playing with Geometry/Spatial Data Types in MySQL

In this tutorial, we are going to understand how to store and use spatial data types like coordinates and objects. But, we will mainly focus on Points (2D Cartesian Coordinate) and Geographic Locations (Geodetic Coordinates)

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(courtesy of **pexels.com**)

Imagine that you are trying to develop an application that helps people find restaurants, pubs, bars and other hangout places near them. In nutshell, this will be a location discovery platform.

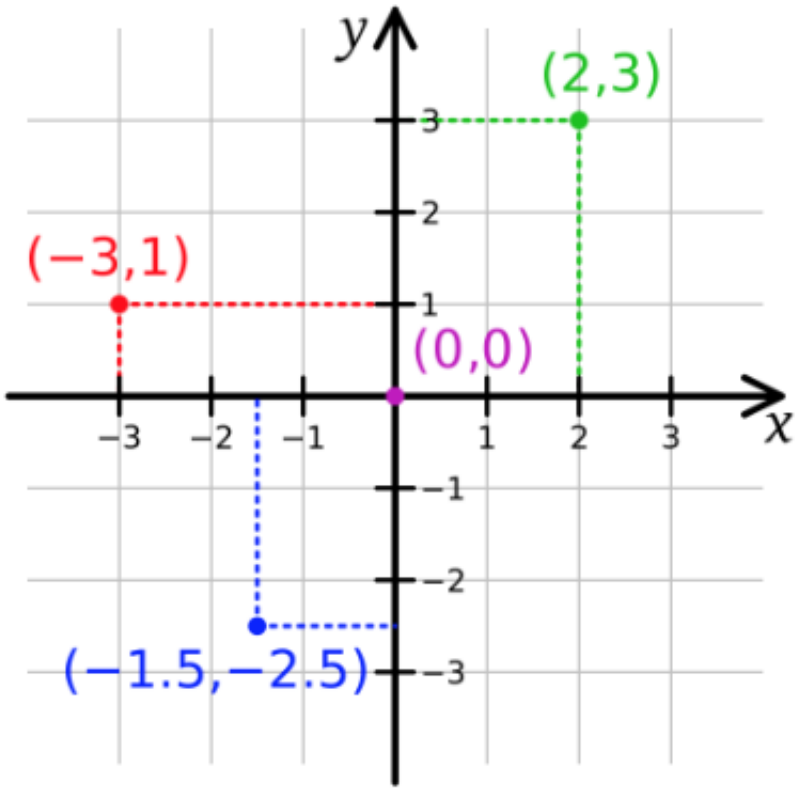
Looking from a backend perspective, we would be needing to store geographic data of these locations like **Latitude** and **Longitude**. Then we would need to write functions that calculate the distance between the user and the location (*to show how far the location is from him/her*). Using the same function, we can design an algorithm that finds closest places near to the user or within a given radius from him/her.

There are many tutorials and study material on the internet that helps you solve this problem by using simple data types like `float` for **latitude** and **longitude** and MySQL's capability to create internal **procedures**/**functions** to calculate & search locations. But in this tutorial, we are going to talk about MySQL's built-in **spatial data types**.

> *This tutorial assumes that you have the latest **MySQL**/**MariaDB** version installed on your system and you are using **InnoDB** as your default database engine. All the tests in this tutorial are performed using **MySQL** Server Version **8.0.13** and **InnoDB** version **8.0.13**. To Check MySQL version, use command `mysql --version` and same for InnoDB can be achived by loging into the MySQL database and execute query `SHOW VARIABLES LIKE "innodb_version";`*

OGC or **Open Geospatial Consortium** is a non-profit organization consisting of many individuals, companies, and organizations that set the standard **OpenGIS** for open geospatial content and services. MySQL is one of the databases that follow a subset of this standard. You can read about OGC from **opengeospatial.org**.

Let's start by understanding some theory about the coordinate system. We are mainly focusing on a 2-dimensional coordinate system. Initially, we will focus on an **infinite flat cartesian coordinate system**.



(courtesy of Wikipedia)

On the left, you can see an infinite **2D** flat *unitless* surface where a point is represented like `P(x,y)` where `x` is the distance of a point **P** from the **origin**(0,0) on the **x-axis** while `y` is the distance from the origin(0,0) on the **y-axis**. Hence, if we know `x, y` of a point, we can locate it on the coordinate surface.

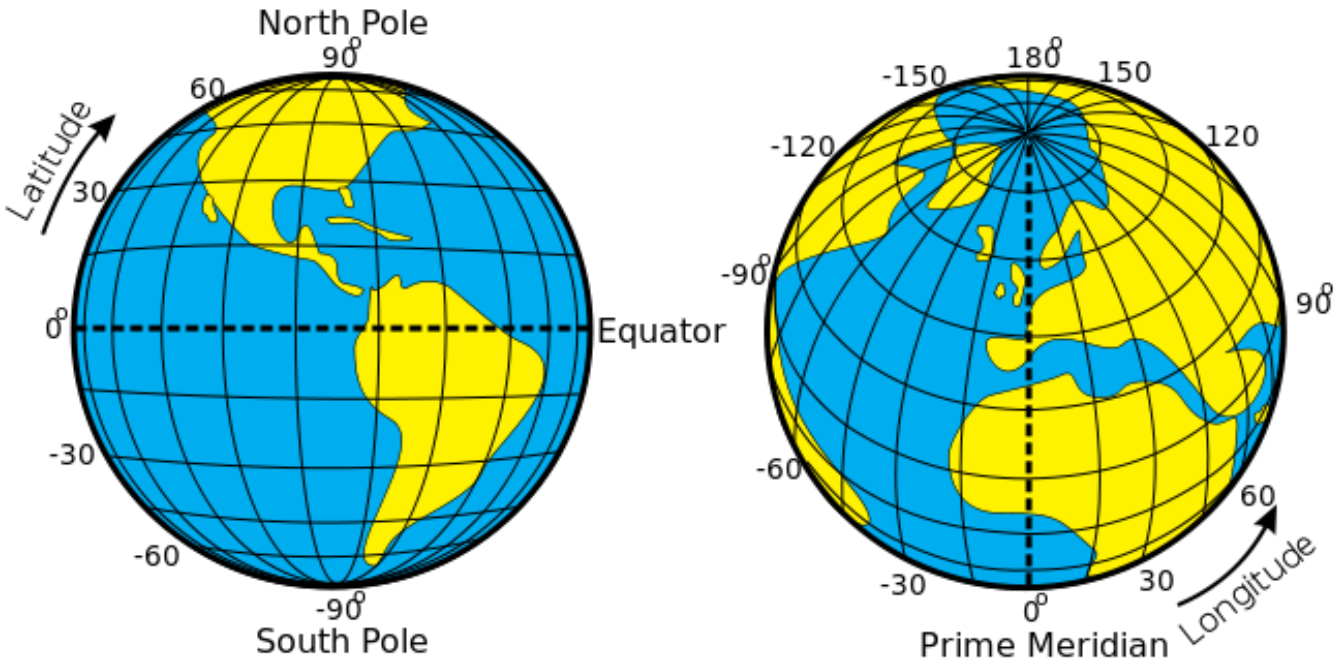
The distance of a point from the origin is calculated using **Pythagoras theorem.** If we consider the point in **green color**, using Pythagoras theorem, we can calculate its distance from the origin to be the **square root of the sum of the squares of the `2` and `3`**.

If you want to calculate the **distance between two points**, you can shift the origin to any one point and measure the distance from it. If we had to find **points inside a circle** (*whose center is at the origin*), we have to calculate the distance of each point and check if it is less than or equal to equal to the radius of the circle

> *I am assuming you understand basic math and geometry and I don't need to explain 2D cartesian coordiante system in formulae.*

For **Spherical Surface**, like **Planet Earth**, things are not as simple as a 2-dimensional surface. We follow the **geodetic reference system** for mapping locations on the surface of the planet. In a nutshell, the geodetic reference system

is based on **longitude** and **latitude** value.



(Courtesy of Wikimedia Commons)

Latitude of a location *(point)* on the globe (*sphere*) is the number of degrees it is from the equator (*when measured along the axis of rotation of the Earth*). **Longitude** of a location on the globe is the number of degrees it is from the **prime meridian** (*when measured along the equator*). Both Latitude and Longitude are measured from the center of the Earth. You can read more about the **Geographic Coordinate System** on Wikipedia.

The maximum value of the Latitude is 90° while the minimum is -90°. Similarly, the maximum value of longitude is 180° while the minimum is -180°.

> *As we know, Earth isn't exactly a sphere but it is an ellipsoid. But for the sake of simplicity, we are going to assume it is a simple sphere of constant uniform radius. Later, towards the ending of this tutorial, we are going to talk about some of the issues with MySQL regarding this same exact problem.*

Moving on, the **0° Latitude** line goes through the equator of the planet dividing the globe into northern and southern hemispheres. The **0° Longitude line** AKA **international prime meridian**, however, goes through **British Royal Observatory** in **Greenwich**, England.

Finding the distance between two locations (points) on the globe (sphere) is not as easy as it was in the 2D coordinate system. In this case, we need to use **Haversine formula** which is used to find the distance between two points on the sphere using **latitude, longitude of the points** and **radius of the sphere**. We can use the same formula to find the shortest distance between two locations on the globe. **geeksforgeeks.com** has provided some simple code snippets in different languages to calculate the distance between two places on the Earth based on Haversine formula, you can check it out from **here.**

> ⚠️ *But the important fact to remember here is that Haversine formula is for a sphere and as we know, that's not the case for the Earth. Hence, this can lead to some error which might not be acceptable for precision measurements.*

So far, we have seen two coordinate systems, **flat** and **spherical**. There can be many coordinate systems based on the shape, location of the origin or how distance is measured from an origin. Hence a point on a surface can have a different meaning based on in which coordinate system it lies. Hence saying P(x,y) is just not enough.

Therefore, we need an extra identifier associated with point signature. This is where **SRID** comes into the picture. **SRID** or **Coordinate Reference System Identifier** is the unique **integer** associated with a coordinate system proposed by OGC. MySQL databased comes with more than **5000** of such coordinate systems which you can check using below query

```
SELECT `srs_name`, `srs_id`
FROM INFORMATION_SCHEMA.ST_SPATIAL_REFERENCE_SYSTEMS
```

OGC has provided two formats for creating a spatial object like Point, Line, Polygon etc. They are **WKT** (*well-known text*) and **WKB** (well-known binary). **WKT** for a point is 2D cartesian coordinates is as simple as **string** "**POINT(X, Y)"** where X and Y are axial distances from the origin. While in spherical coordinate system X and Y of **POINT(X, Y)** is **latitude** and **longitude** value respectively. WKB is the binary representation of WKB, which will cover in upcoming topics in this tutorial. Read more about WKT, WKB specifications for

different geometries from **here**.

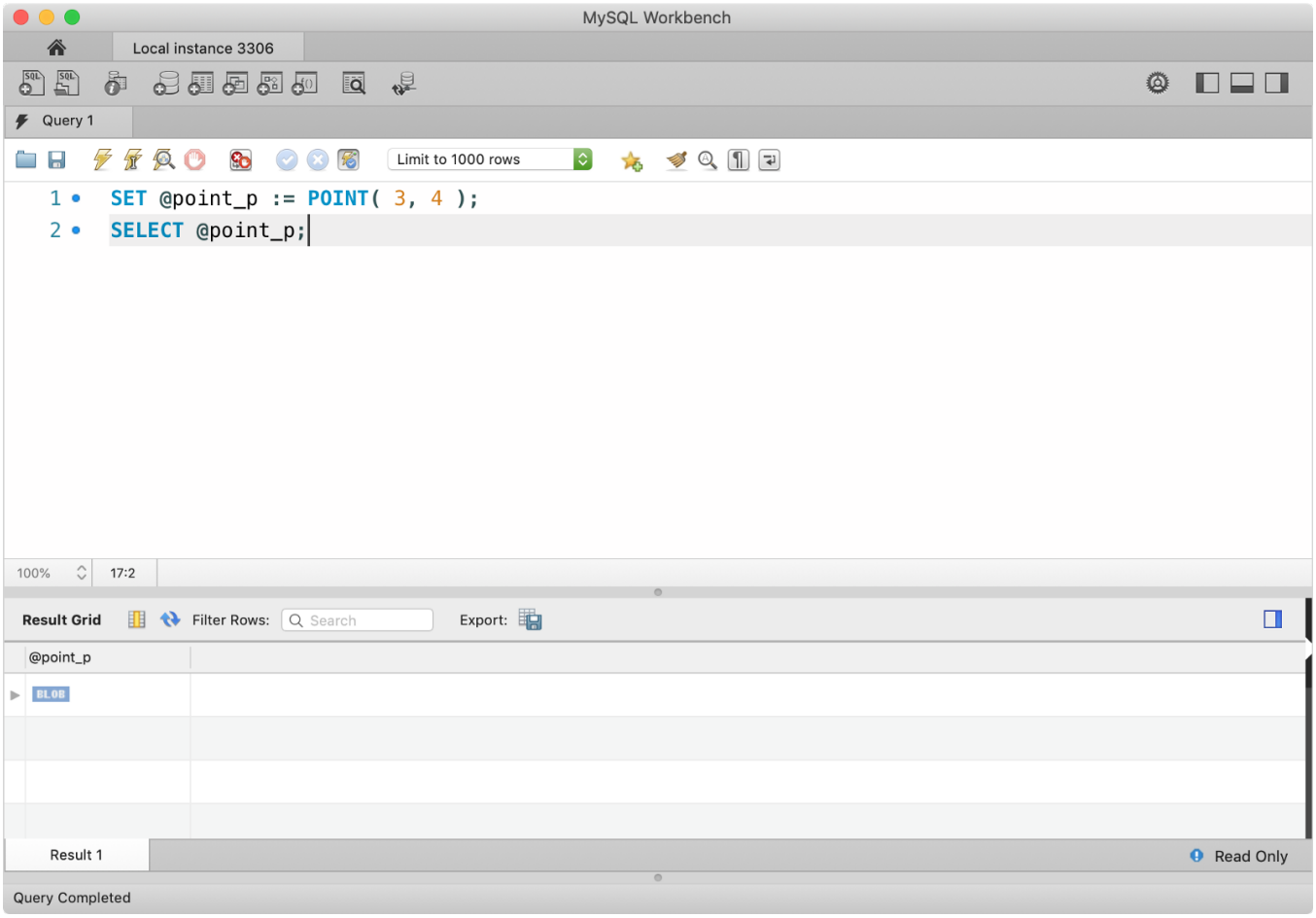
Cartesian Coordinate System

Alright, enough with the theory. Let's now dive into the MySQL world and execute some queries to see things in real life. Initially, we will focus on the **2D cartesian coordinate system**.

SRID associated with the 2D cartesian coordinate system is **0**. This is default SRID associated with the `POINT` built-in function in MySQL.

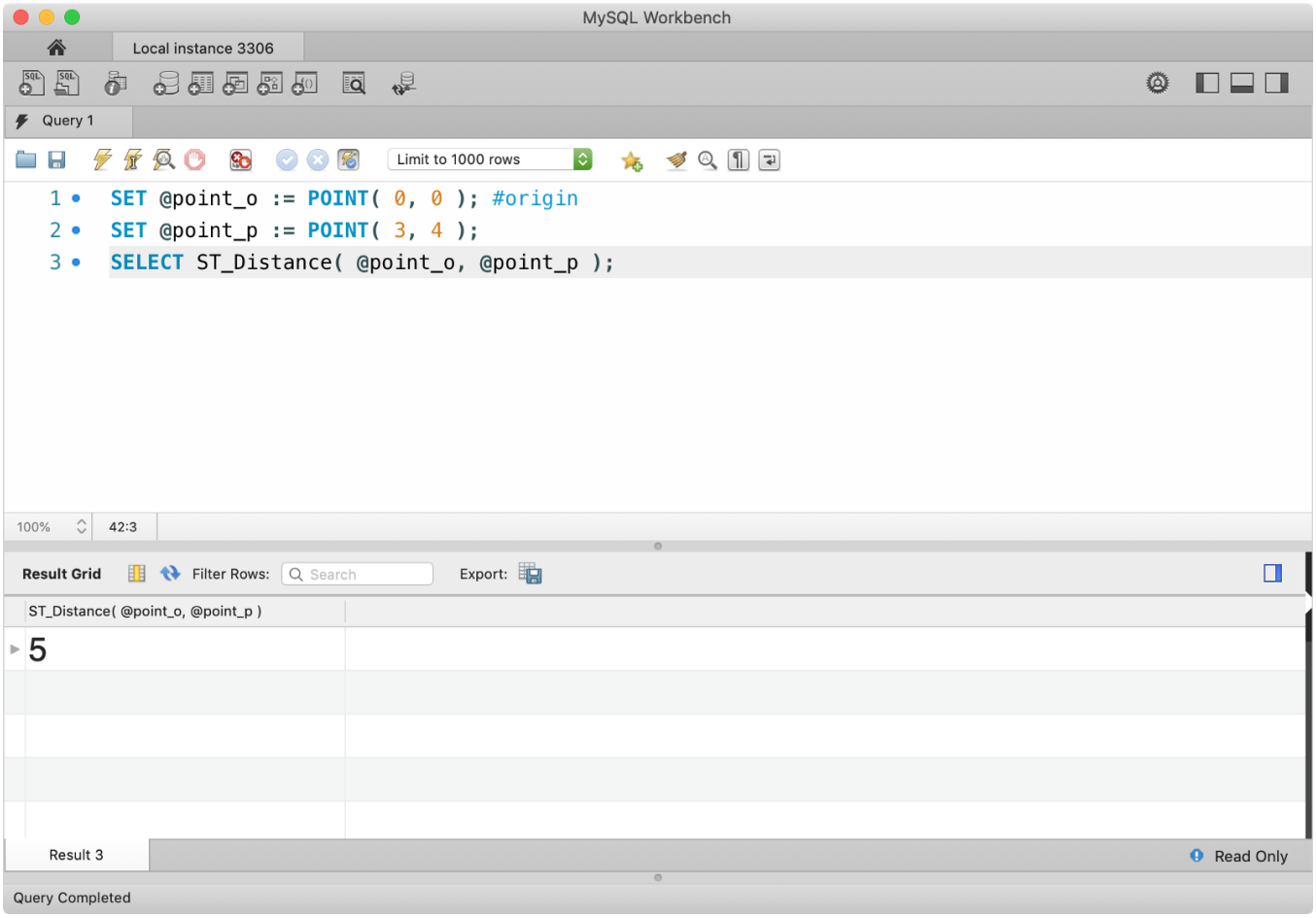
> *MySQL provides many built-in functions like POINT, LINESTRING, POLYGON etc. They are documented **here**. Since, we are going to talk about POINT only, I though I should mention this.*

Let's create a point with $x = 3$ and $y = 4$ on a coordinate system with **SRID 0** (*flat 2D cartesian coordinate system*). We will use `POINT` constructor function since its default **SRID** is **0**.



In the above query, we created a local variable `point_p` which is set to point `(3,4)` on the 2D coordinate plane (*SRID 0*). As we can see from the result, MySQL successfully created the point and saved in `BLOB` format. `BLOB` is the default storage format of MySQL for all the geometries (*do not get confused with WKB format, that is different, as we will see*).

Let's calculate the distance between the origin (*point 0,0*) and above point.



In the above query, we created another point `point_o` which is set to the origin point (0,0). Then we used MySQL's built-in function `ST_Distance` to calculate the distance between two points. As expected, we got result **5**. Hence, our theory is working just fine until now.

> *MySQL provides many built-in functions to test the relationship between two geometries (above, points). They are documented **here**, but we will cover most of them in this tutorial. `ST_` prefix in these functions stands for **Spatial Type**. You can find list of all **Spatial Type** functions from **here**.*

> ⚠️ *In newer version of MySQL (8.0+), old spatial functions like*

> *`GeomFromText`, `AsText` has been deprecated and not longer works. Make sure to follow **this list** from here onwords if you are facing issues with undefined function names.*

In this tutorial, we are not going to use MySQL's built-in constructor functions to create geometries (like points) **as it is non-standard and restrict to SRID 0**, but instead, we will be using MySQL's built-in functions to create geometries from **WKT** specification, they are documented **here**.

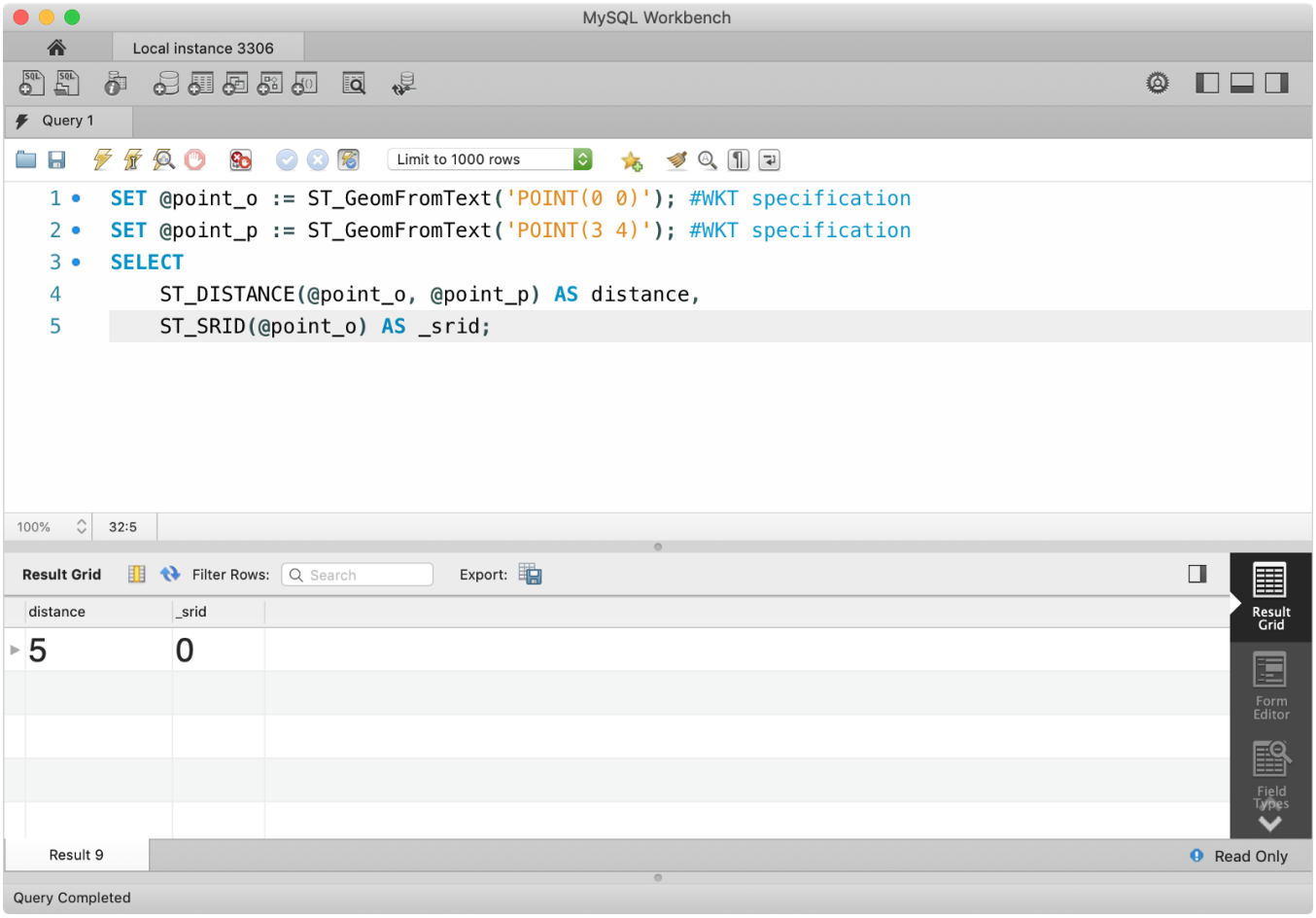
`ST_GeomFromText` is a built-in function to create a geometry in given SRID from WKT specification. `ST_PointFromText` can also be used to specifically state that we are creating `POINT` geometry but it's just an alias.

The syntax of `ST_GeomFromText` is as below

```
ST_GeomFromText(geom_wkt, [srid], [options])
```

`geom_wkt` is **WKT** representation of a geometry, `srid` is optional and defaults to 0 while `options` (*comma separated **key=value**)* argument is also optional.

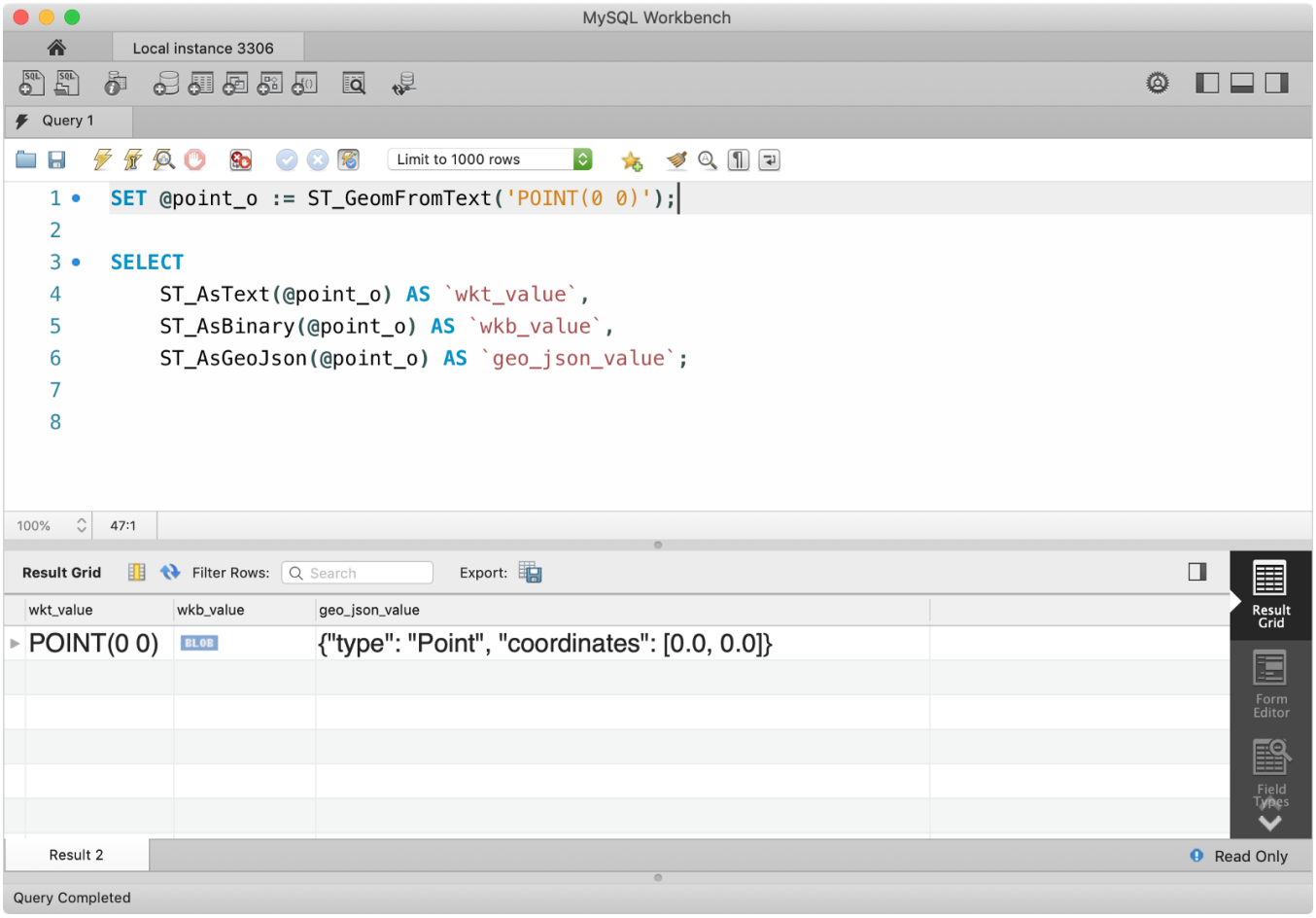
> *`options` is additional information provided to `ST_GeomFromText` function. As of now, it supports only `axis-order` key with the value being either `long-lat`, `lat-long` or `srid-defined`(default). This will come up later when SRID will be different than 0.*



In the above query, we simply replaced the generation of `POINT` geometries from using MySQL's constructor function to creating geometries from WKT specifications. We can also verify that default SRID of `ST_GeomFromText` function is **0** using `ST_SRID` built-in function which expects a geometry and returns SRID associated with that geometry.

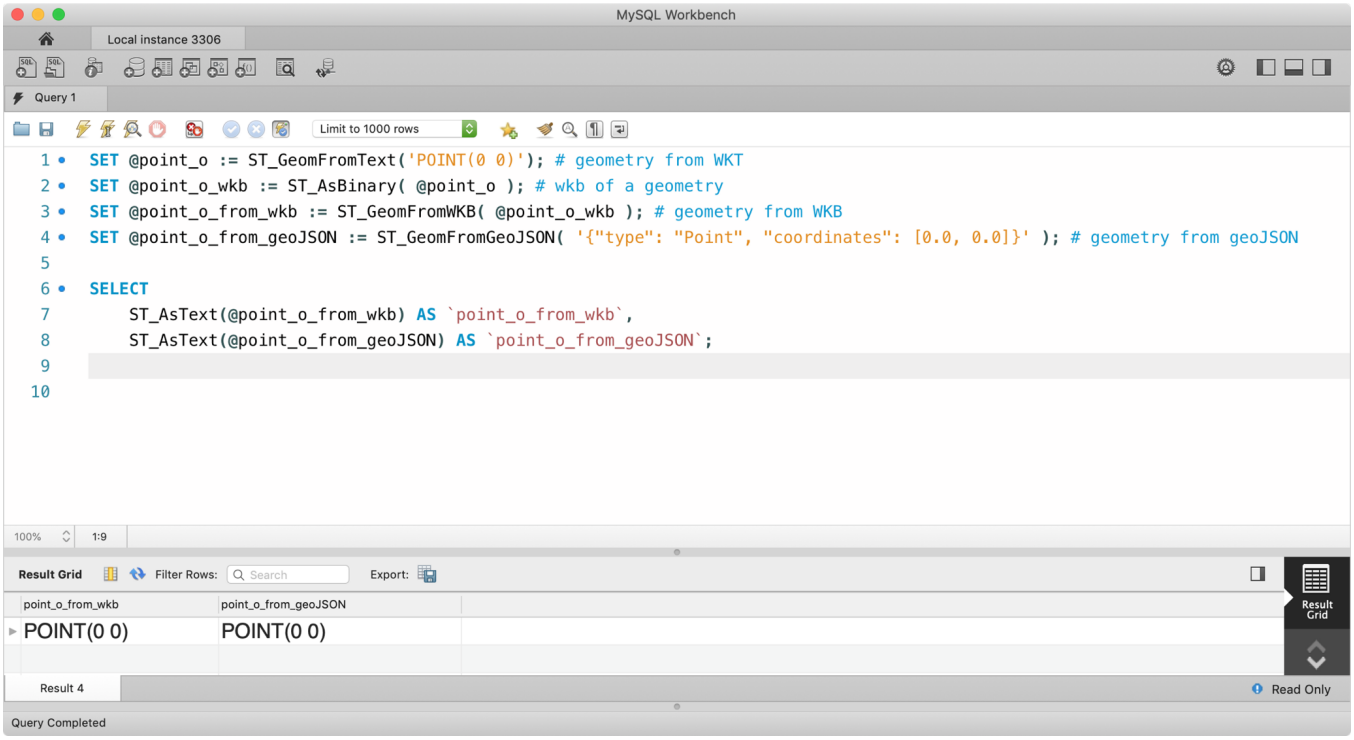
As we know, MySQL stores a geometry data type in `BLOB` format, but how can we make sure that the given point is correct if we can't read it. This can be solved using MySQL's built-in conversion functions, they are documented **here**. Using these functions, we can convert geometries into WKT, WKB and JSON formats (*and vice-versa*).

`ST_AsText(g, [options])` function expects a geometry and optional `options` argument which is used to set axis-order (as described in `ST_GeomFromText`) and returns `WKT` format of a geometry. `ST_AsBinary` expects the same arguments as `ST_AsText` and returns `WKB` format of a geometry. `ST_AsGeoJson(g)` expects a geometry and returns coordinates in JSON.

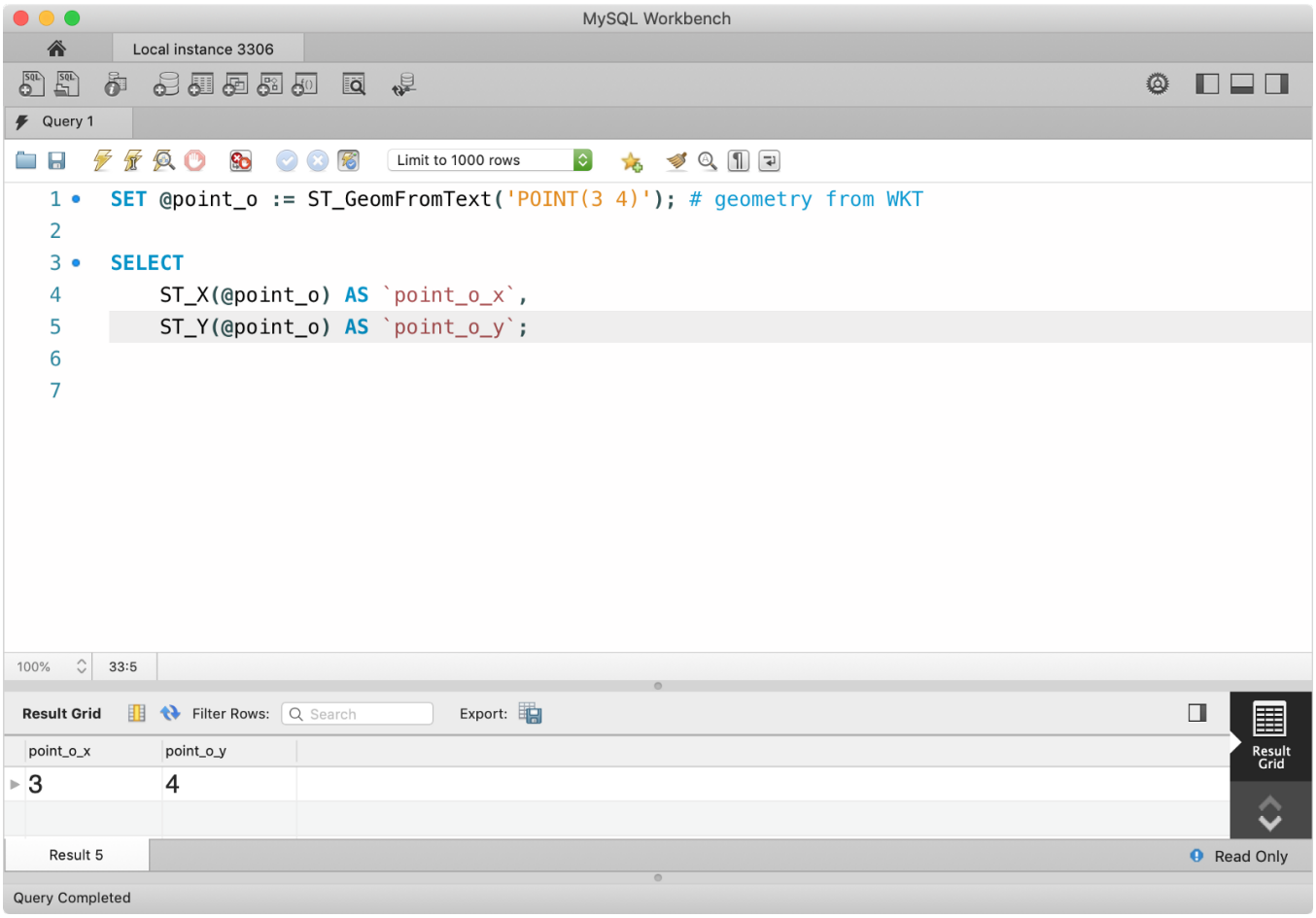


In the above example, we have converted a geometric shape of the type `POINT` into readable `WKT` value, binary `WKB` value and `JSON` format.

If you have a **GeoJSON** of a geometry, you can convert it back a geometry object using `ST_GeomFromGeoJSON(geo_json_string)` built-in function. You can also create geometry from WKB using `ST_GeomFromWKB` / `ST_PointFromWKB` function. Arguments for `ST_GeomFromWKB` is the same as `ST_GeomFromText` except geometry must be in **WKB** format.



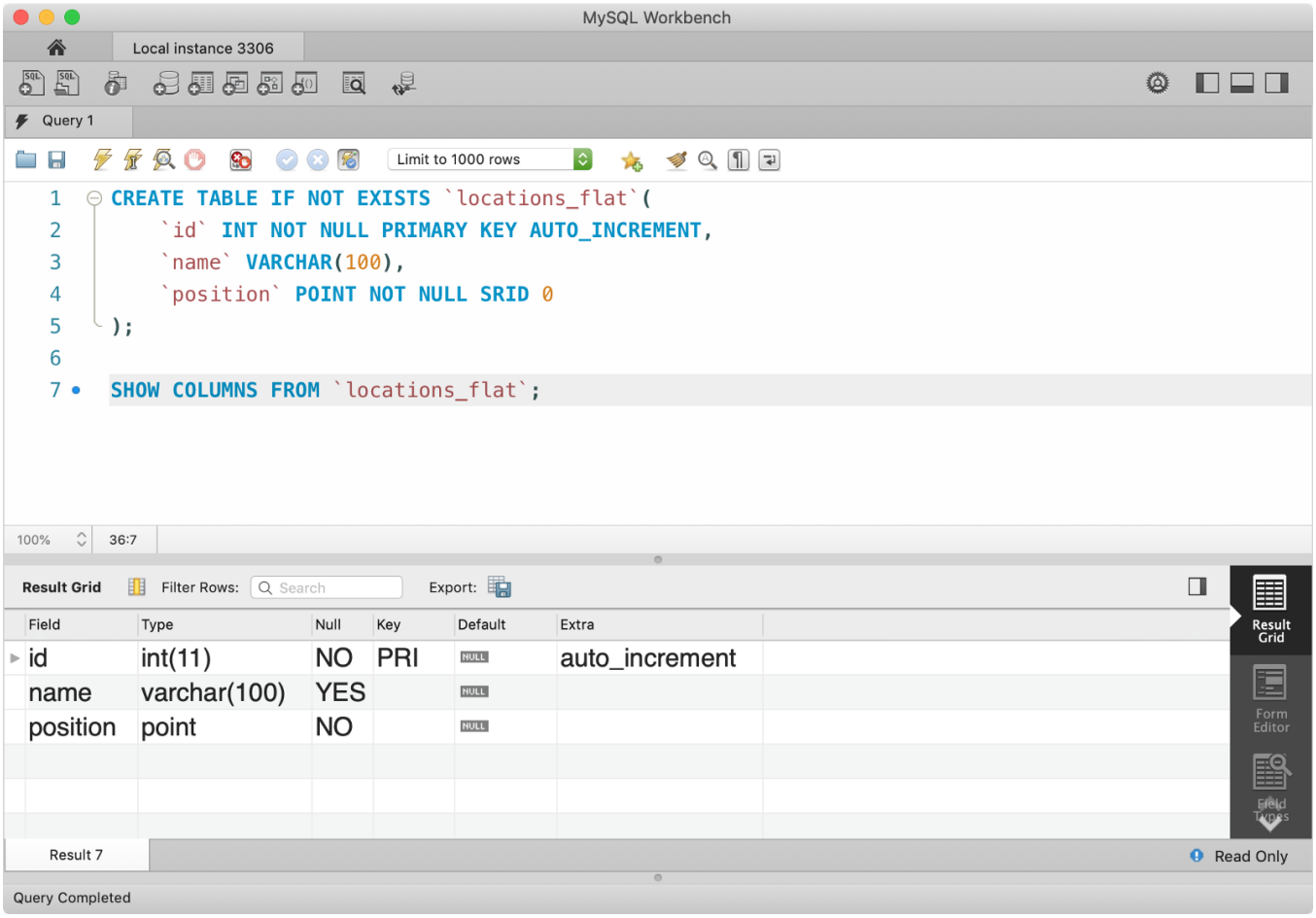
If you want to get X and Y coordinates of a `POINT` geometry, you can use `ST_X(g)` and `ST_Y(g)` built-in functions.



Let's create a `locations_flat` database table and populate it with some sample geometry `POINT` values.

```
CREATE TABLE IF NOT EXISTS `locations_flat`(
    `id` INT NOT NULL PRIMARY KEY AUTO_INCREMENT,
    `name` VARCHAR(100),
    `position` POINT NOT NULL SRID 0
);
```

```
SHOW COLUMNS FROM `locations_flat`;
```



You can use `POINT`, `POLYGON`, `LINESTRING` and other geometrical types (*mentioned **here***) to explicitly state the data type. MySQL also provides `GEOMETRY` data type if your column contains variable geometry types. `SRID` is optional, if omitted, the column can contain geometries of multiple SRIDs. But this is not recommended as this will not utilize the INDEX and query performance on large data set will be slower, as we will see later.

To insert some sample data, use below query

```
INSERT INTO `locations_flat`(`name`, `position`)
VALUES
 ( 'point_1', ST_GeomFromText( 'POINT( 1 1 )', 0 ) ),
```

```
 ( 'point_2', ST_GeomFromText( 'POINT( 2 2 )', 0 ) ),
 ( 'point_3', ST_GeomFromText( 'POINT( 3 3 )', 0 ) );
```

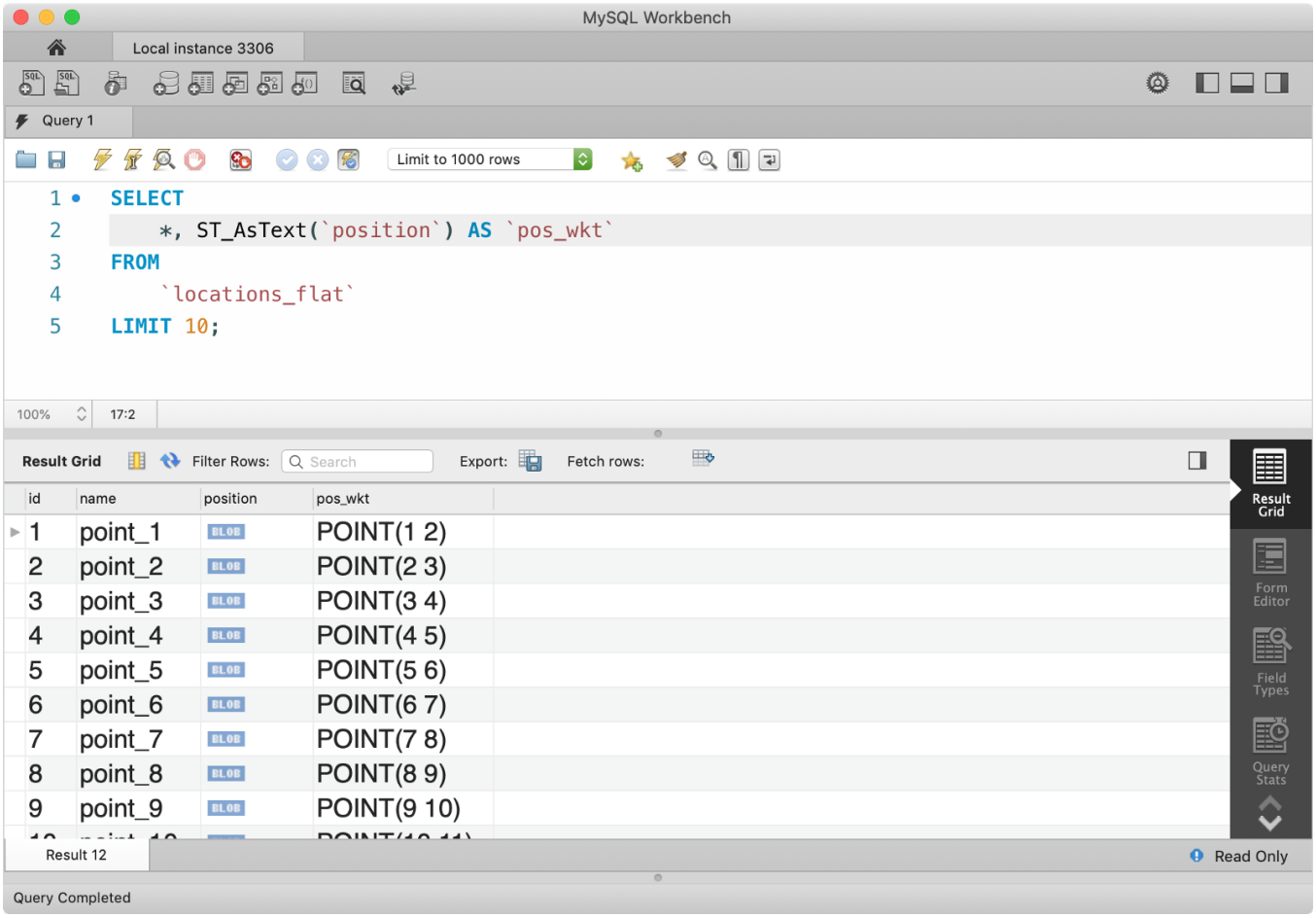
But since we need a large data set, set take help of JavaScript. Inside your JavaScript console, execute below code which will print above insert statement but with 1000 entry points.

```
var fn = `ST_GeomFromText`;
var values = new Array( 1000 ).fill(null).map( ( val, index ) => {
   var id = index + 1;
   return `('point_${ id }', ${fn}('POINT(${ id } ${ id + 1 })'))`;
} ).join(',\n\t');
```

```
console.log(`
  INSERT INTO \`locations_flat\`(\`name\`, \`position\`)
  VALUES
  ${ values };
`);
```

Let’s see a few data points in our table with a quick SELECT query.

```
SELECT
    *, ST_ASTEXT(`position`) AS `pos_wkt`
FROM
    `locations_flat`
LIMIT 10;
```



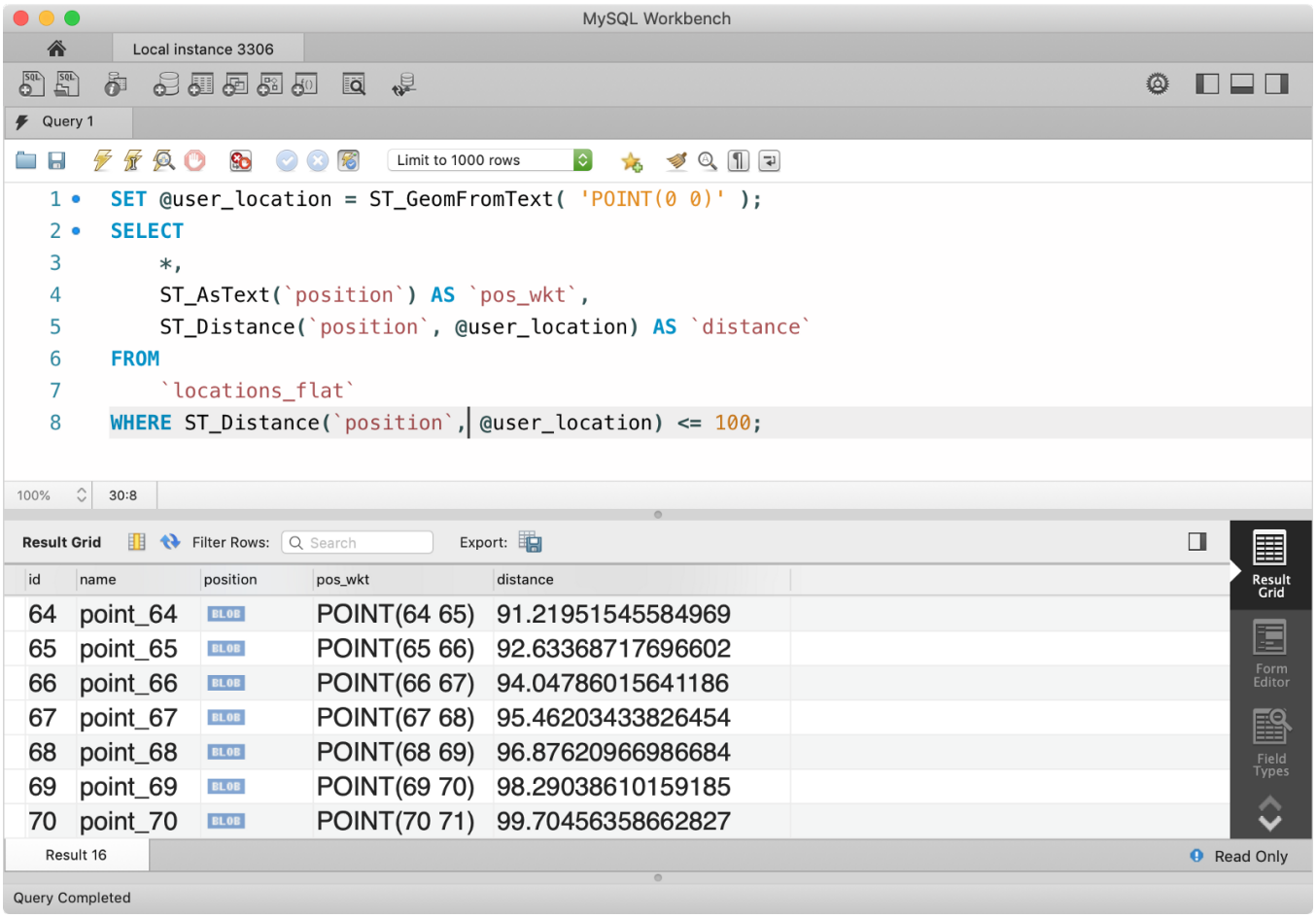
> *It is perfectly legal to pass a column name to `ST_` built-in function as long as its input parameters are legal. Also, all `ST_` function names are case-insensitive. Hence, you can also use `ST_AsText` as `ST_ASTEXT` or `st_asText`.*

Let's consider these points as places and our user is located at the ***origin(0,0)***. If we want to search for places which are within 100 unit distance from him (*let's say the user is male*), we need to calculate the distance of each place and compare if it is less than or equal to 100. We have used distance function before, which is `ST_Distance`. We are going to use this function in `WHERE` clause in our MySQL query.

```
SET @user_location = ST_GeomFromText( 'POINT(0 0)' );
```

```
SELECT
    *,
    ST_AsText(`position`) AS `pos_wkt`,
    ST_Distance(`position`, @user_location) AS `distance`
FROM
    `locations_flat`
WHERE ST_Distance(`position`, @user_location) <= 100;
```

From the above query, we created a sample origin geometry `POINT` at `(0,0)` and used a reference point to calculate the distance of each point. `WHERE` clause filtered the results based on distance and we got around 70 results.



But we can also achieve this using `ST_Buffer(g, d)` built-in function (*documented **here***) to create geometry (*as stated in the documentation*) that represents all points whose distance from the geometry value ***g*** is less than or equal to a distance of ***d***. In nutshell, it creates **a circular surface area**.

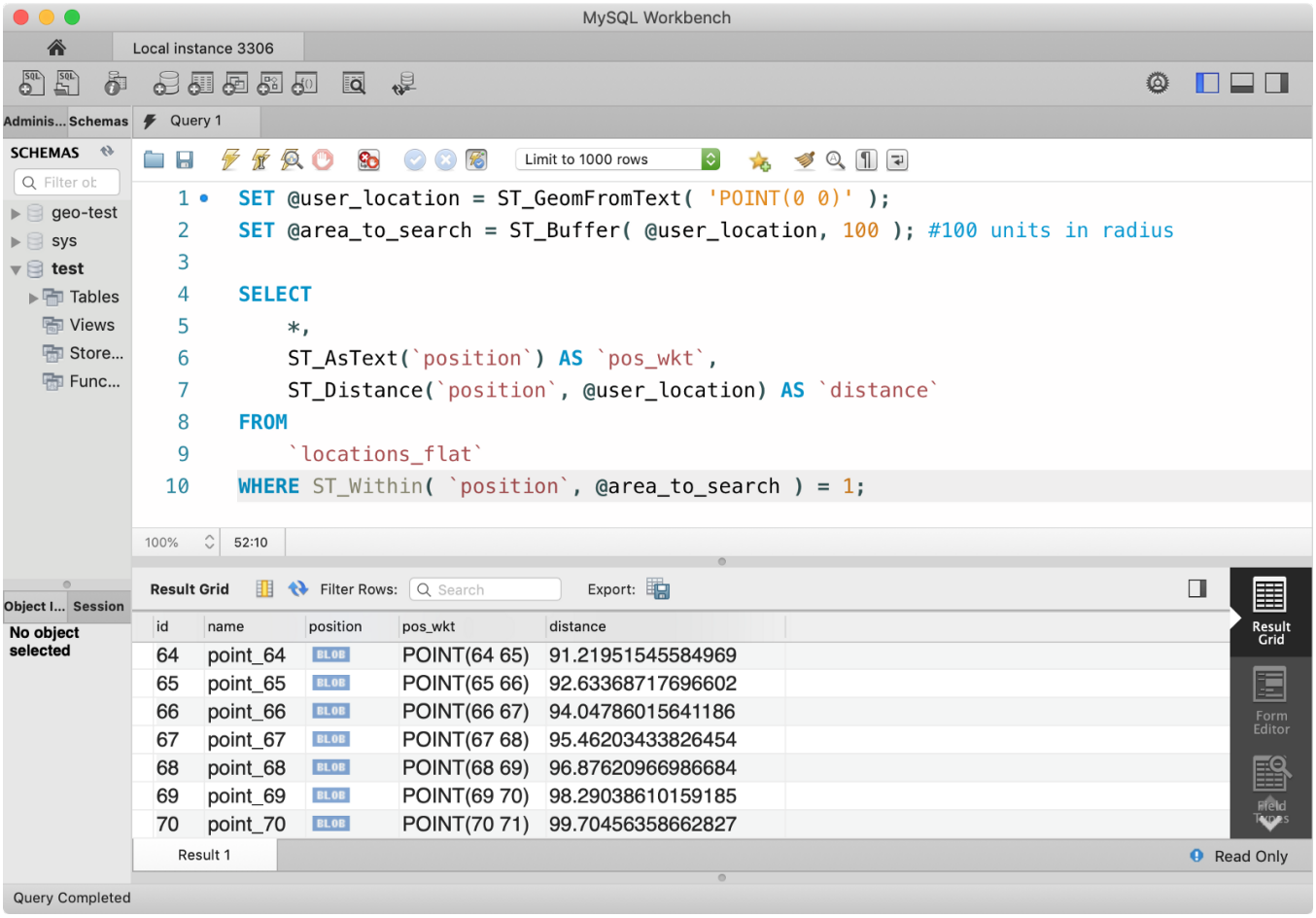
> ⚠️ *It should be noted that `ST_Buffer` can only create geometry for **SRID 0** (plane surface). Since, `g` in our case has SRID = 0, hence this works for us. But a circular area on a spherical surface is rather complex, MySQL just gives up there.*

Using this geometry, we can check whether a geometry (point) lies inside it or not. This can be done using `ST_Contains(g1, g2)` function which returns **1** if the geometry `g1` contains `g2`, else **0**. Otherwise, we can use `ST_Within(g1, g2)`

function which returns **1** if `g1` is within `g2`, which is quite opposite of `ST_Contains` function but works for us as well.

```
SET @user_location = ST_GeomFromText( 'POINT(0 0)' );
SET @area_to_search = ST_Buffer( @user_location, 100 );
```

```
SELECT
    *,
    ST_AsText(`position`) AS `pos_wkt`,
    ST_Distance(`position`, @user_location) AS `distance`
FROM
    `locations_flat`
WHERE ST_Within( `position`, @area_to_search ) = 1;
```



Let's talk about performance now. We all know about MySQL Indexes. If not then there is a lot of literature about it on the internet which you can read. Basically, MySQL maintains an index of a table with rows being ordered according to column values in the [B-Tree index]. Whenever we try to search something from the table, MySQL looks into the index and uses nodes created by **B-Tree** to shortened the search path. An index of a table won't be created unless we tell it (*in*

*some case, MySQL does that on its own, like **Primary Key**).*

In the case of Spatial Data, MySQL uses **SPATIAL INDEX** which is for complex multi-dimensional data values and it maintains this index in **R-Tree** tree structure. Understanding how it works is not very important at this moment.

Let's first add **SPATIAL INDEX** on the table `locations_flat`. You can do this in three ways. You can add index while creation of the table.

```
CREATE TABLE IF NOT EXISTS `locations_flat`(
    `id` INT NOT NULL PRIMARY KEY AUTO_INCREMENT,
    `name` VARCHAR(100),
    `position` POINT NOT NULL SRID 0,
    SPATIAL INDEX(`position`)
);
```

You can also alter the table and add **SPATIAL INDEX**.

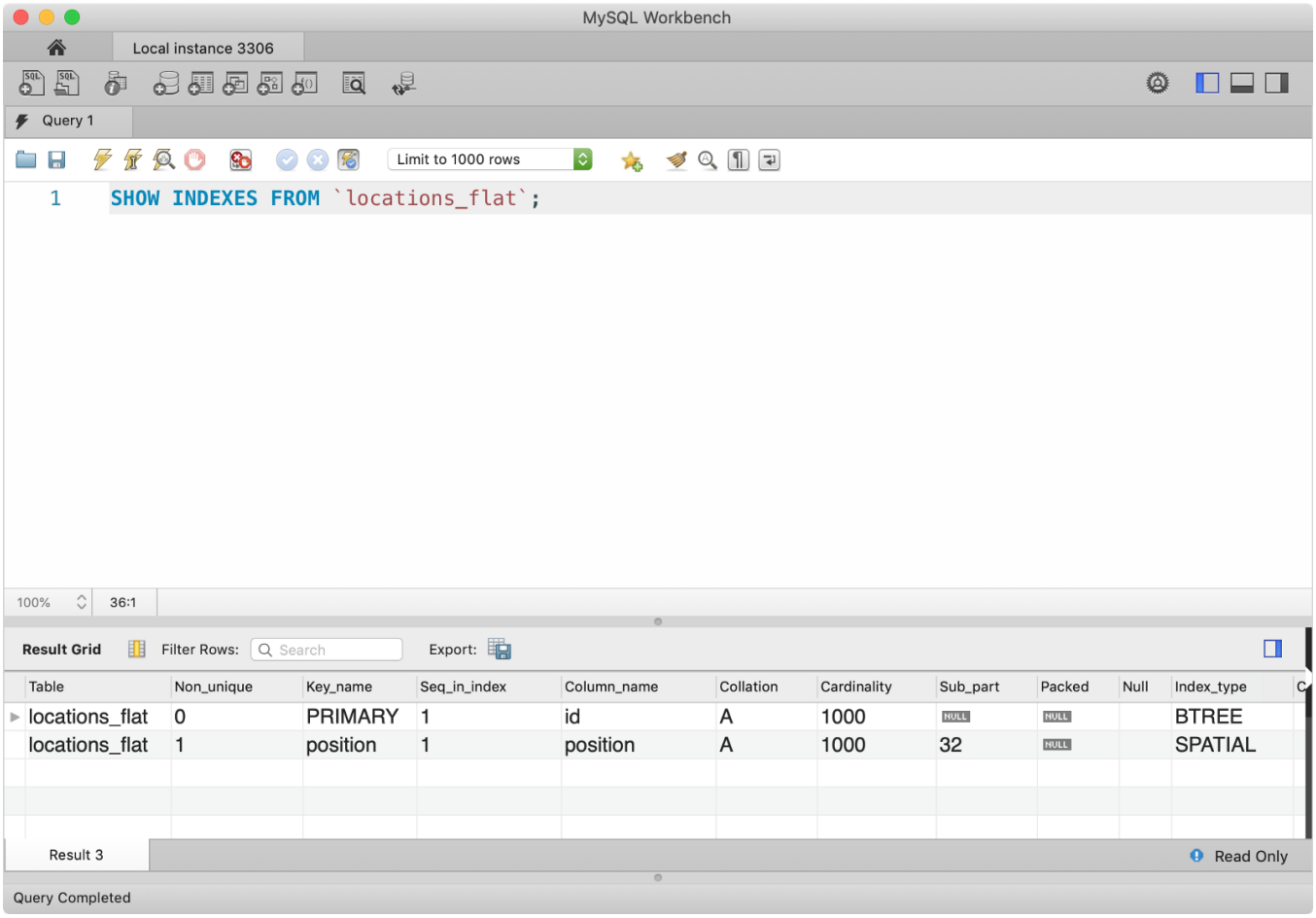
```
ALTER TABLE `locations_flat` ADD SPATIAL INDEX(`position`);
```

Or you can add index manually using `CREATE SPATIAL INDEX` statement.

```
CREATE SPATIAL INDEX position_index ON locations_flat(`position`);
```

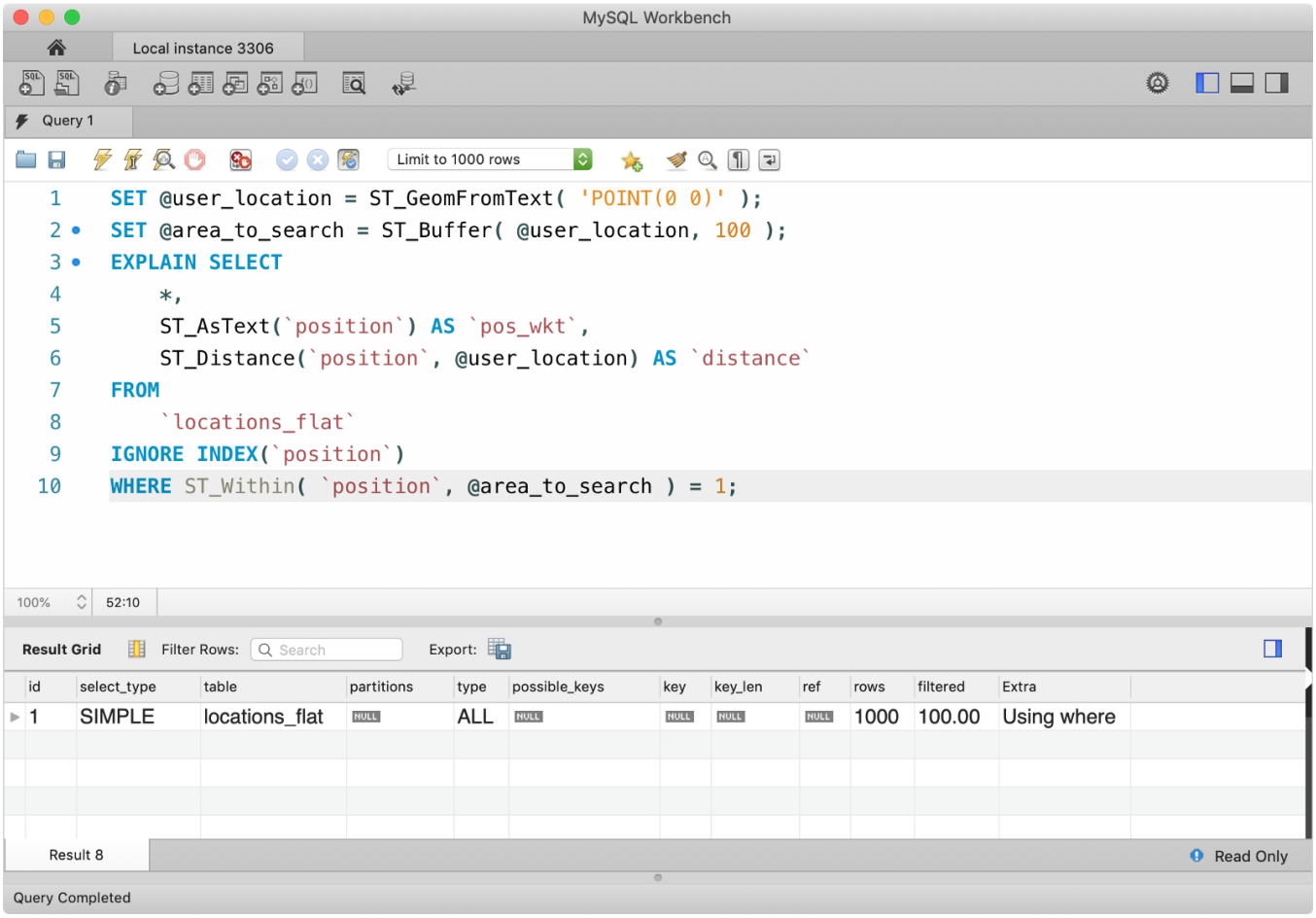
> ⚠️ *A spatial index can only be created on a column with geometry type. It must be a NOT NULL column and should contain data of only one SRID.*

Once, **SPATIAL INDEX** is created, you can verify indexes on the table using query `SHOW INDEXES FROM `locations_flat`;`



Let's see how our earlier location search example is doing without using SPATIAL INDEX (ignore index).

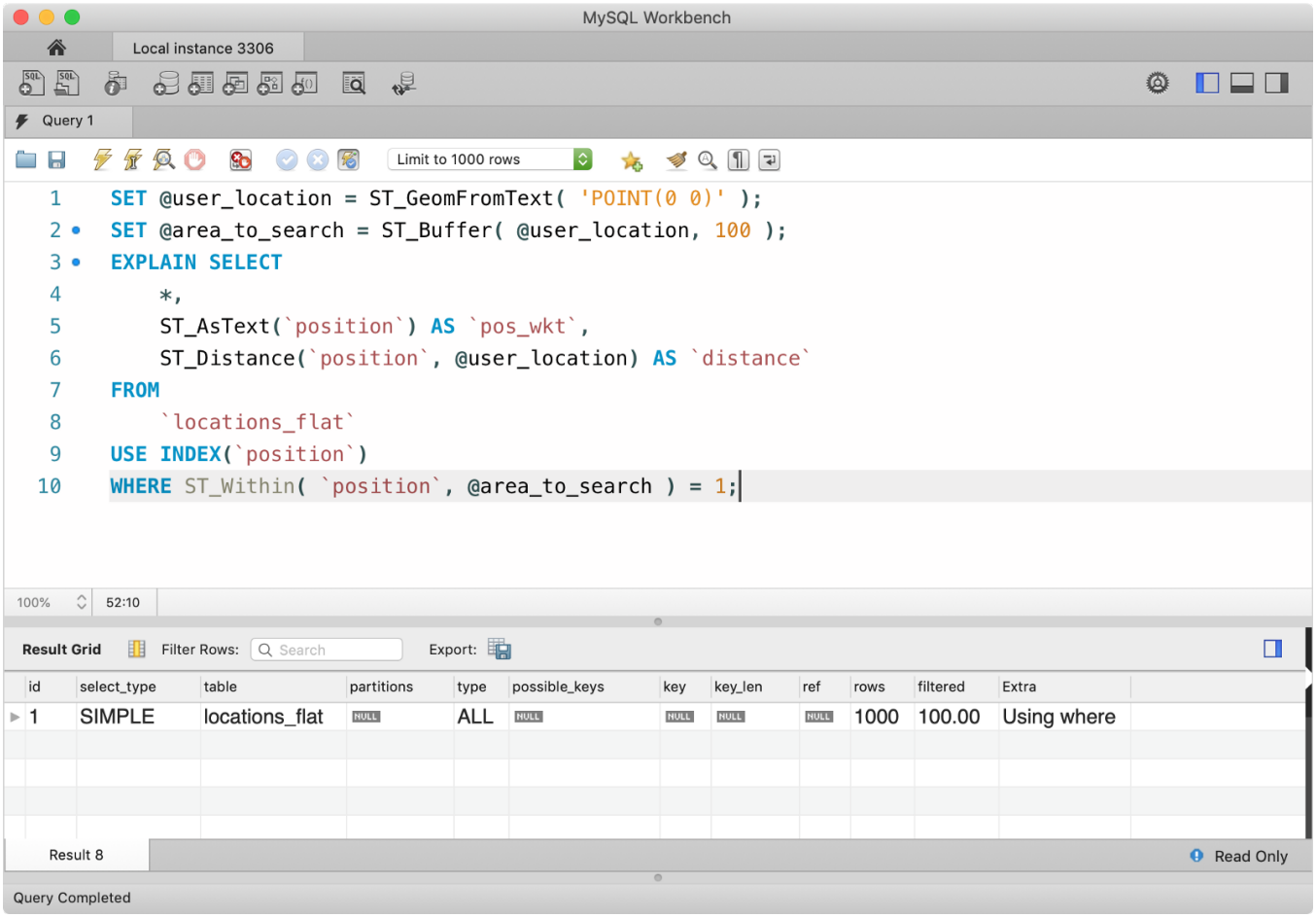
```
SET @user_location = ST_GeomFromText( 'POINT(0 0)' );
SET @area_to_search = ST_Buffer( @user_location, 100 );
EXPLAIN SELECT
    *,
    ST_AsText(`position`) AS `pos_wkt`,
    ST_Distance(`position`, @user_location) AS `distance`
FROM
    `locations_flat`
IGNORE INDEX(`position`)
WHERE ST_Within( `position`, @area_to_search ) = 1;
```



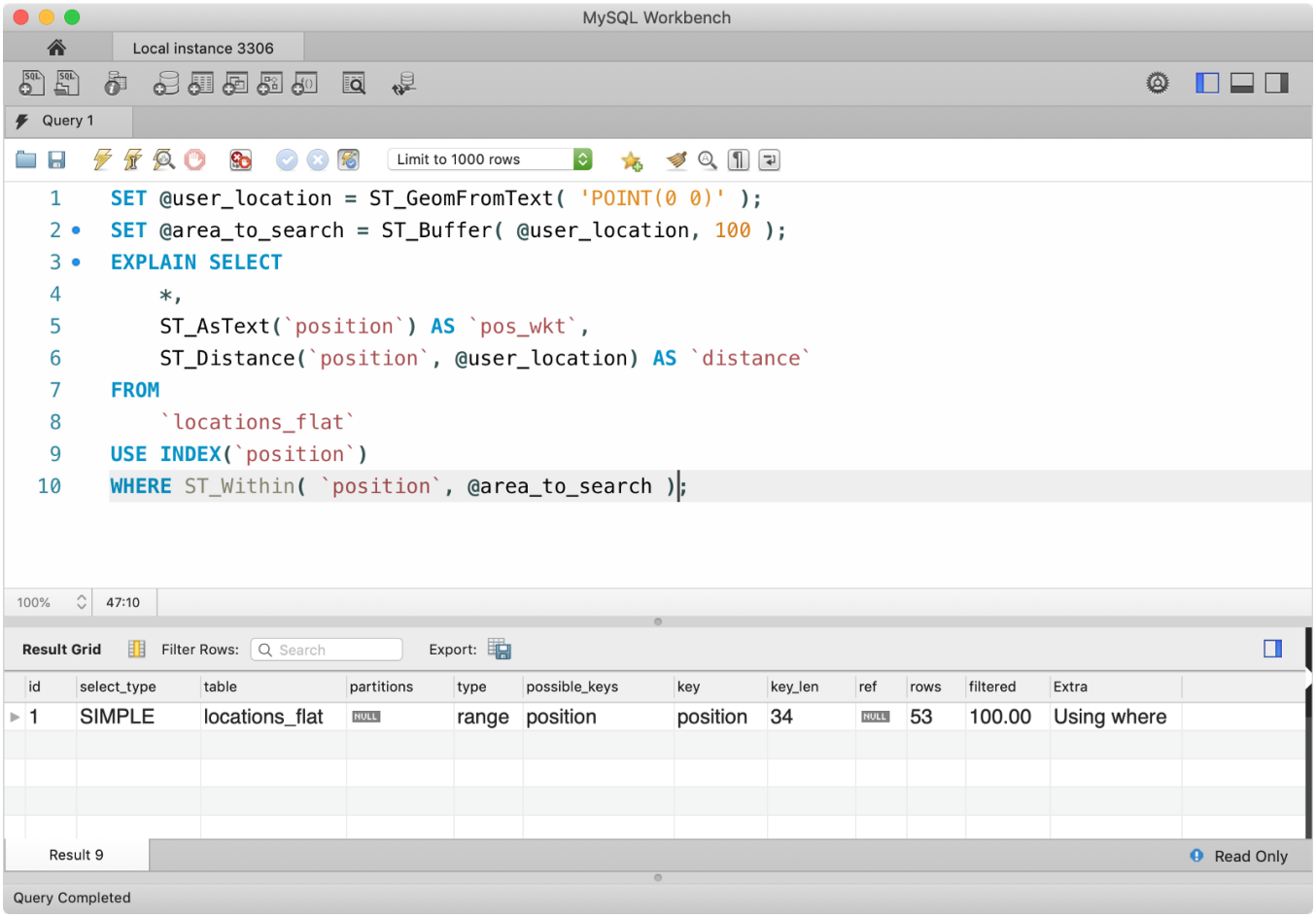
Seems like MySQL is using **full-table scan** and results show that 1000 rows are being searched for the match. Also, `possible_keys` are empty which shows that no index was used to perform the search.

Let's now use the index to find locations, we are going to use statement `USE INDEX` but that is optional as `position` column by-default uses the index.

```
SET @user_location = ST_GeomFromText( 'POINT(0 0)' );
SET @area_to_search = ST_Buffer( @user_location, 100 );
EXPLAIN SELECT
    *,
    ST_AsText(`position`) AS `pos_wkt`,
    ST_Distance(`position`, @user_location) AS `distance`
FROM
    `locations_flat`
USE INDEX(`position`)
WHERE ST_Within( `position`, @area_to_search ) = 1;
```



Aha! We see no difference. Don't worry, this is a ⚠️ **documented MySQL bug**. When we compare the return value of a spatial function in `WHERE` clause (*like we did with* `ST_Within( `position`, @area_to_search ) = 1;`, MySQL ignores the index. Since `ST_Within` returns **1** or **0**, it's perfectly safe to ignore `=1` in the statement and `WHERE` clause will only select value which returns **1**.



Yess! Now we can see that only 53 rows were scanned to return the result and `possible_keys` column shows that `position` index was used for the search.

> ⚠️ *In my experience, I found that in case of a search on small data set, MySQL ignores the index. So, don't worry if your `EXPLAIN` statement doesn't seem ok.*

Geographic Coordinate System

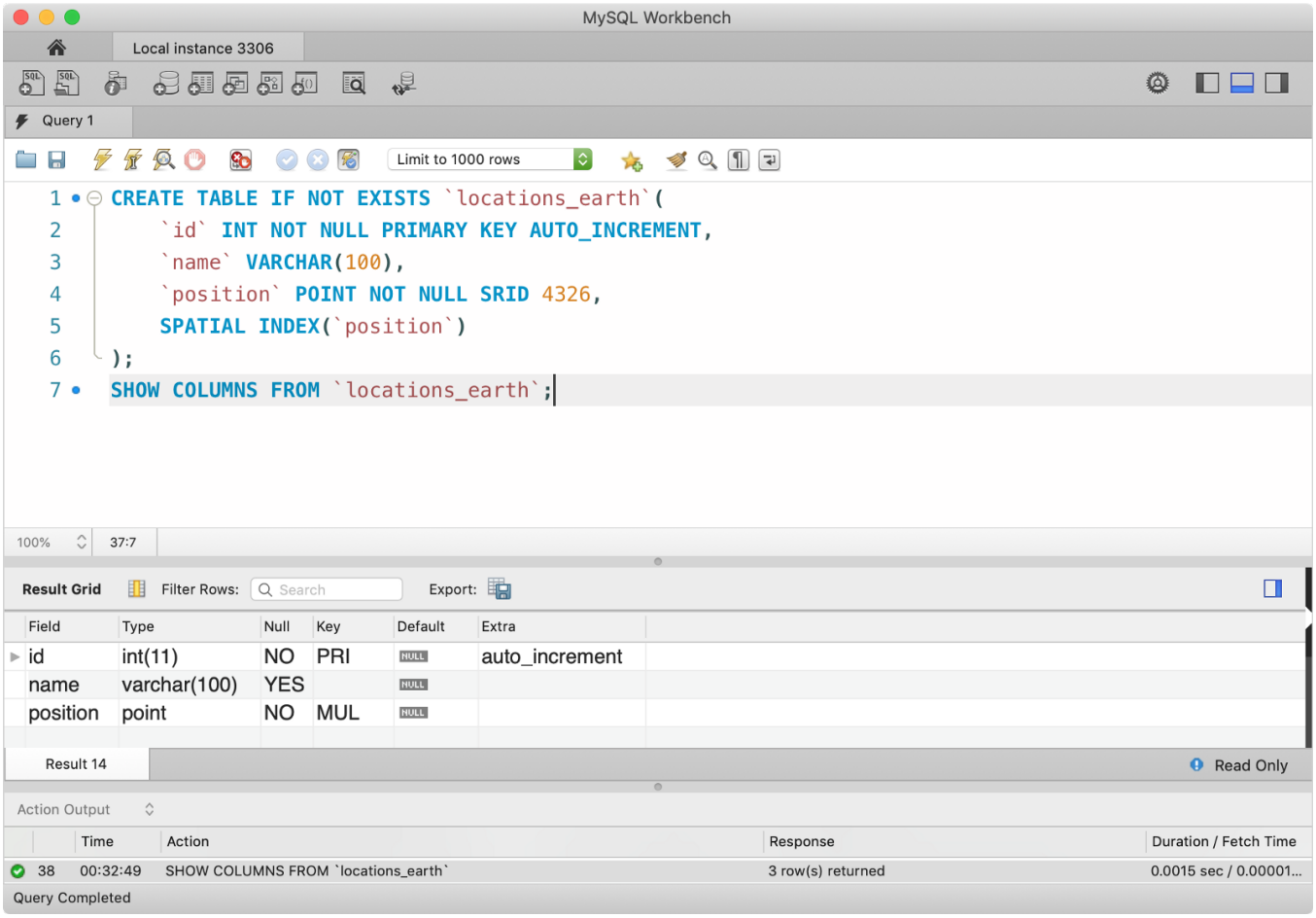
We talked a lot about 2D Cartesian Coordinate System, but I know, you must be thinking what's the use of that. Basically, it helped us understand how we can use MySQL's powerful spatial features and use spatial indexes to improve our query performance.

Now, it's time to come back to Earth and focus on Geographic data points. Before we begin, let me tell you a bitter truth. In MySQL, Earth has been approximated as a sphere with a mean radius equal to **6,370,986** meters. This may create some errors while calculating distances but works in the approximated world. Also, SRID for the geographic coordinate system is **4326**, hence any `POINT` we are

going to create must use 4326 SRID.

Let's create a table `locations_sphere` with **SPATIAL INDEX** and populate it with some sample data points.

```
CREATE TABLE IF NOT EXISTS `locations_earth`(
    `id` INT NOT NULL PRIMARY KEY AUTO_INCREMENT,
    `name` VARCHAR(100),
    `position` POINT NOT NULL SRID 4326,
    SPATIAL INDEX(`position`)
);
SHOW COLUMNS FROM `locations_earth`;
```



Let's populate the `locations_earth` table with sample geometry points with SRID 4326. We are going to take help of JavaScript here.

```
var fn = `ST_GeomFromText`;
var values = new Array( 1000 ).fill(null).map( ( val, index ) => {
   var id = index + 1;
   var lat = (90/1000) * id; // 0-90 deg latitude
   var long = (180/1000) * id; // 0-180 deg longitude
```

```
   return `('point_${ id }', ${fn}('POINT(${ lat.toFixed(5) } ${
long.toFixed(5) })', 4326))`;
} ).join(',\n\t');
console.log(`
  INSERT INTO \`locations_earth\`(\`name\`, \`position\`)
  VALUES
  ${ values };
`);
```

In the above query generator, we made sure that each geometry point on the sphere should not exceed 90 degree latitude and 180 degrees longitude, though all our points are in the northern-eastern hemisphere. Above code will produce a query like below.

```
INSERT INTO `locations_earth`(`name`, `position`) VALUES
 ('point_1', ST_GeomFromText('POINT(0.09000 0.18000)', 4326)),
 ('point_2', ST_GeomFromText('POINT(0.18000 0.36000)', 4326)),
 ('point_3', ST_GeomFromText('POINT(0.27000 0.54000)', 4326));
```

As per the OpenGIS specification by OGC, WKT for `POINT` geometry is `POINT(lat, long)`. In our case, `ST_GeomFromText` function returns a geometry `POINT` with SRID 4326, hence our data points truly belong to spherical coordinates or geographic coordinate system.

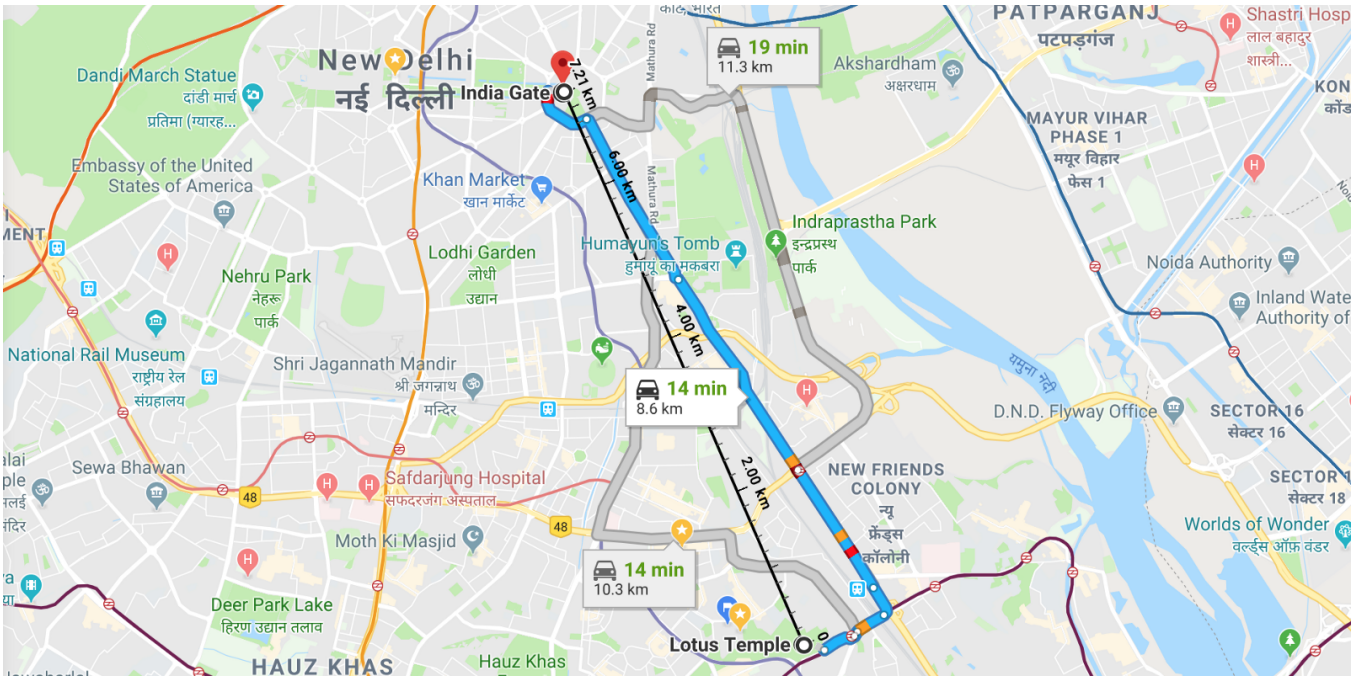
Let's calculate the distance between two points on the globe. As we seen in the case of the 2D surface, we used `ST_Distance` function to calculate the distance between two points. But in the case of a spherical coordinate system, we are going to use `ST_Distance_Sphere` function. The signature of `ST_Distance_Sphere` function is as below.

```
ST_Distance_Sphere(g1, g2 [, radius])
```

Here, `g1` and `g2` are geometries on the sphere, like `POINTs` in our case. `radius` argument is optional and defaults to the radius of the earth. This function returns the shortest distance on the sphere (earth) in meters.

For the test and accuracy test of this function, let's pick two random locations on the google map. Since I live in Delhi - India, I am going to pick **Lotus Temple** (*28.553298, 77.259221*) and **India Gate** (*28.612849, 77.229883*).

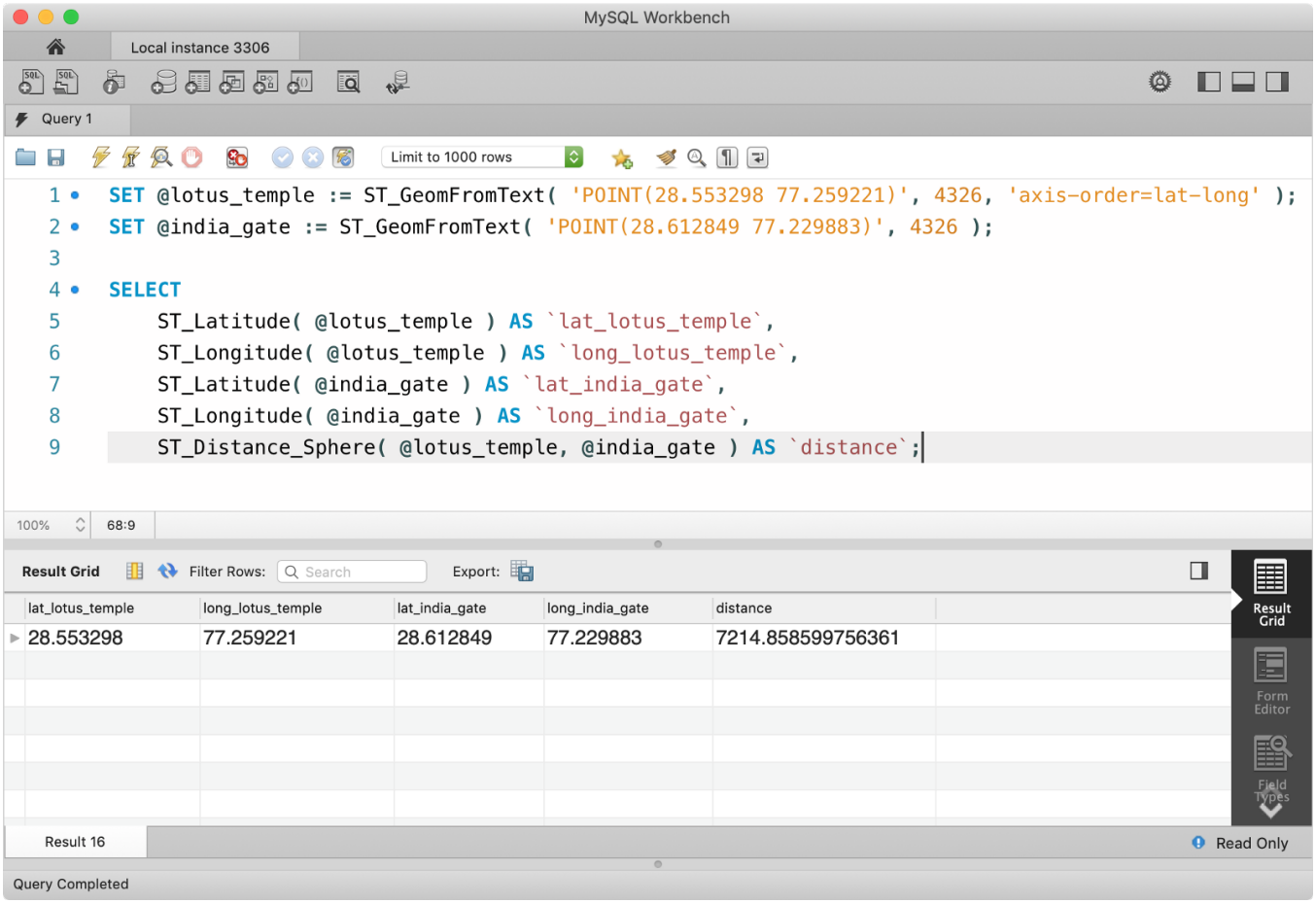
> *You can find (**latitude, longitude**) combination of a location on google map by right-clicking on a place and selecting **what's here**?*



The distance between these two places is 7.21km or 7210 meters.

```
SET @lotus_temple := ST_GeomFromText( 'POINT(28.553298 77.259221)', 4326,
'axis-order=lat-long' );
SET @india_gate := ST_GeomFromText( 'POINT(28.612849 77.229883)', 4326 );
```

```
SELECT
    ST_Latitude( @lotus_temple ) AS `lat_lotus_temple`,
    ST_Longitude( @lotus_temple ) AS `long_lotus_temple`,
    ST_Latitude( @india_gate ) AS `lat_india_gate`,
    ST_Longitude( @india_gate ) AS `long_india_gate`,
    ST_Distance_Sphere( @lotus_temple, @india_gate ) AS `distance`;
```



From the above result, we can see that Google and we are not that far off. Google measured distance **7210** meters while we measured it to be **7214** meters (*difference of 4 meters*). As we know, both of these values certainly can't be used in sensitive studies but it's pretty damn close.

As you can see in the above query, we have used `options` argument of `ST_GeomFromText` function to explicitly provide information about the axis order of `POINT` geometry in **WKT**. Also, we can use `ST_Latitude` and `ST_Longitude` to get **latitude** and **longitude** value geometry types of 4326 SRID.

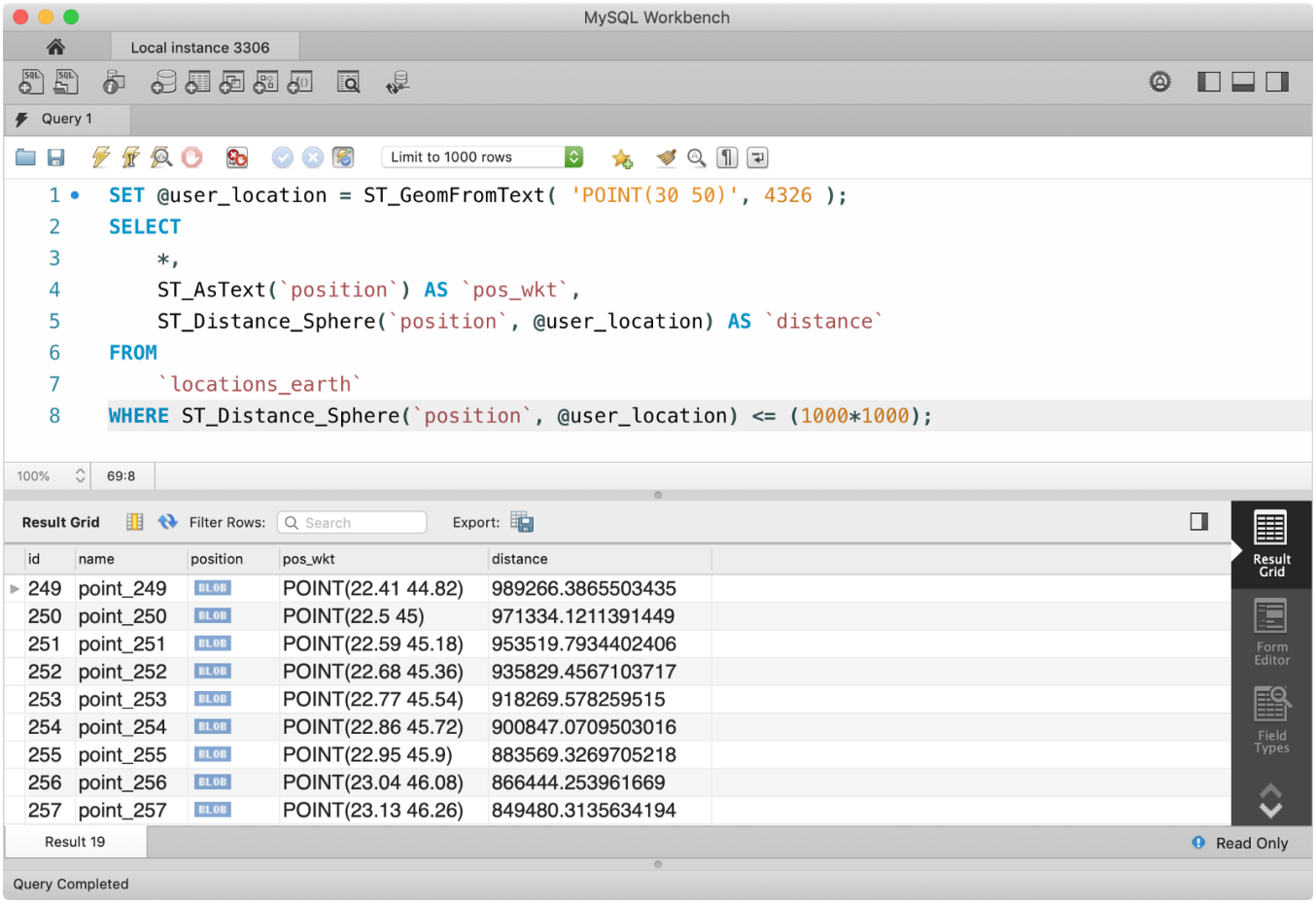
Now, let's focus on the application side. As in earlier examples of 2D flat surface, we calculated points inside a given radius using `ST_Buffer` circular area geometry. **But unfortunately, MySQL does not support creating circular area geometry in any other SRID besides 0**. Also, we can not transform any geometry from SRID 0 to other coordinate systems using the **`ST_Transform`** function. Seems like our luck is running out.

But we can use a simple but expensive approach to calculate distances of each point on the sphere from the reference point and check if they are within a given

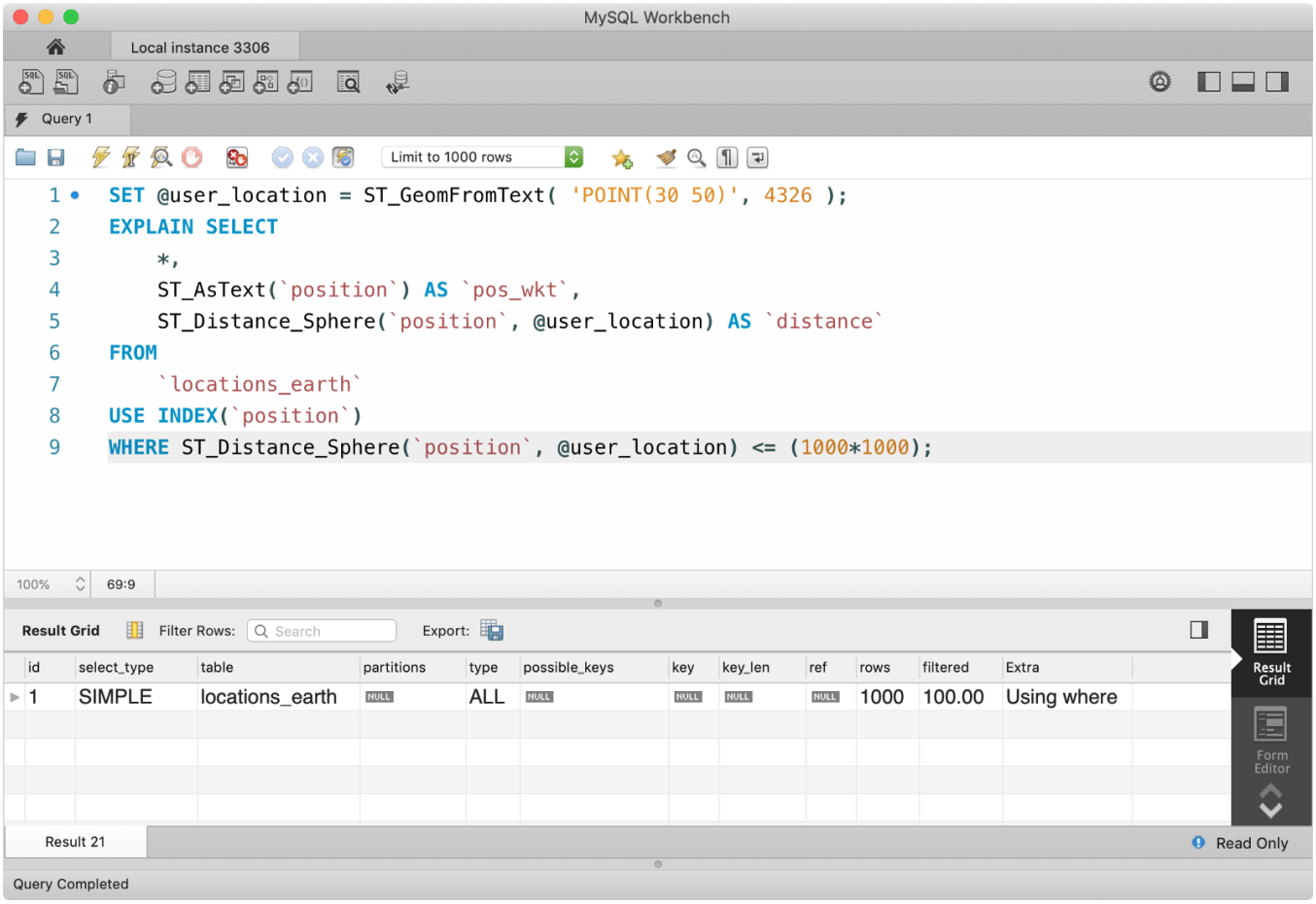
radius, like we did earlier.

Let's say that we are looking for places in 1000km (1000 * 1000m) radius from `location(30, 50)`. Here 30 is latitude and 50 is longitude. Using same old SQL query, we get below result.

```
SET @user_location = ST_GeomFromText( 'POINT(30 50)', 4326 );
SELECT
    *,
    ST_AsText(`position`) AS `pos_wkt`,
    ST_Distance_Sphere(`position`, @user_location) AS `distance`
FROM
    `locations_earth`
WHERE ST_Distance_Sphere(`position`, @user_location) <= (1000*1000);
```



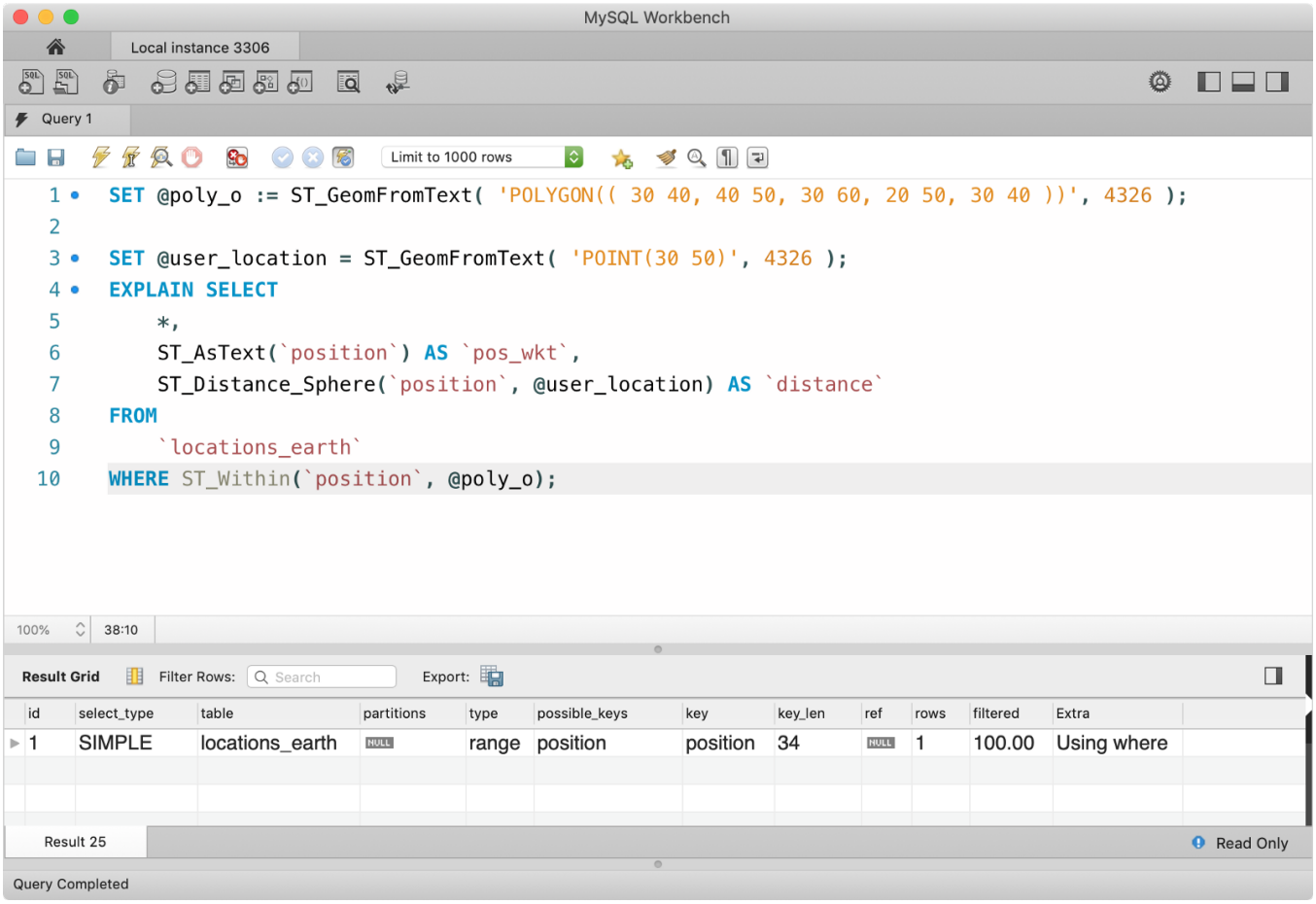
We have found around 87 results but let's see how our query is doing.



So even with the SPATIAL INDEX on, the query is performing the **full-table scan**. Since we are comparing value returned by `ST_Distance_Sphere` function inside the `WHERE` clause, MySQL is ignoring the index.

The only solution is to ignore comparison in `WHERE` clause but since we can not create a circular geometry in a spherical coordinate system, the closest thing we have is `POLYGON` geometry type. To approximate a circle but not wasting too much memory, we can safely use 6 sided polygon.

Let's see if this works by enclosing a 4 sided polygon around user location. I know this is very inaccurate, but it will prove that we can do it.



Hurray! So this works. So far I haven't found a formula that can take proximity radius from a point on the globe and draw a polygon with `n` sides. I guess this will be a TODO and as soon as I find some solution, I will make sure to update this tutorial. But if you have any suggestions or know any resource material on the internet, please drop a comment.

⚠️ By the way, **Postgres** database has far better support for spacial geographic data calculation using **PostGIS extension**. Just to mention one, unlike MySQL, PostGIS provides a built-in function `ST_DWithin` to check if two geometries are within the specified distance of one another, which can be used in `WHERE` clause and increase performance by utilizing the index.

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