Insights from Decades of Earthquake Data: SQL Analysis of Events from 1965 to 2016

DR. BANUVATHY RAJAKUMAR

Data discovery

```
SELECT
    *
FROM
    eqdatabase;
```

Result Grid | Filter Rows: | Export: | Wrap Cell Content: | Fetch rows:

Date	Time	Year	Month	Week	Day name	Latitude	Longitude	Type	Depth	Depth error	Depth Seismic Stations	Magnitude	Magnitude Type	Magnitude Error
1965-01-02	13:44:18	1965	1	0	Saturday	19.246	145.616	Earthquake	131.6	0	0	6	MW	0
1965-01-04	11:29:49	1965	1	1	Monday	1.863	127.352	Earthquake	80	0	0	5.8	MW	0
1965-01-05	18:05:58	1965	1	1	Tuesday	-20.579	-173.972	Earthquake	20	0	0	6.2	MW	0
1965-01-08	18:49:43	1965	1	1	Friday	-59.076	-23.557	Earthquake	15	0	0	5.8	MW	0
1965-01-09	13:32:50	1965	1	1	Saturday	11.938	126.427	Earthquake	15	0	0	5.8	MW	0
1965-01-10	13:36:32	1965	1	2	Sunday	-13.405	166.629	Earthquake	35	0	0	6.7	MW	0
1965-01-12	13:32:25	1965	1	2	Tuesday	27.357	87.867	Earthquake	20	0	0	5.9	MW	0
1965-01-15	23:17:42	1965	1	2	Friday	-13.309	166.212	Earthquake	35	0	0	6	MW	0
1965-01-16	11:32:37	1965	1	2	Saturday	-56.452	-27.043	Earthquake	95	0	0	6	MW	0
1965-01-17	10:43:17	1965	1	3	Sunday	-24.563	178.487	Earthquake	565	0	0	5.8	MW	0

Result Grid | Filter Rows: | Export: | Wrap Cell Content: | Fetch rows:

ude	Magnitude Seismic Stations	Azimuthal Gap	Horizontal Distance	Horizontal Error	Root Mean Square	ID	Source	Location Source	Magnitude Source	Status
	0	0	0	0	0	ISCGEM860706	ISCGEM	ISCGEM	ISCGEM	Automatic
	0	0	0	0	0	ISCGEM860737	ISCGEM	ISCGEM	ISCGEM	Automatic
	0	0	0	0	0	ISCGEM860762	ISCGEM	ISCGEM	ISCGEM	Automatic
	0	0	0	0	0	ISCGEM860856	ISCGEM	ISCGEM	ISCGEM	Automatic
	0	0	0	0	0	ISCGEM860890	ISCGEM	ISCGEM	ISCGEM	Automatic
	0	0	0	0	0	ISCGEM860922	ISCGEM	ISCGEM	ISCGEM	Automatic
	0	0	0	0	0	ISCGEM861007	ISCGEM	ISCGEM	ISCGEM	Automatic
	0	0	0	0	0	ISCGEM861111	ISCGEM	ISCGEM	ISCGEM	Automatic
	0	0	0	0	0	ISCGEMSUP861125	ISCGEMSUP	ISCGEM	ISCGEM	Automatic
	0	0	0	0	0	ISCGEM861148	ISCGEM	ISCGEM	ISCGEM	Automatic

1) What is the distribution of earthquakes over different years and months?

```
SELECT
    YEAR, COUNT(*) AS No_of_EQS
FROM
    eqdatabase
GROUP BY
    Year
ORDER BY
    No_of_EQS DESC;
```

YEAR	No_of_EQS
2011	713
2007	608
1995	591
2004	571
2010	560
2000	553
1996	541
2005	533
1992	533
1990	528
2009	517
2008	508
2006	508
1994	508
1987	505
1988	489
2003	485
1986	485
1984	482
2014	480
1989	480
1985	476

YEAR	No_of_EQS
2002	444
2001	443
1991	429
1977	425
1975	412
1978	410
1973	401
1998	388
1972	388
1971	386
1974	361
1979	356
1980	348
1982	346
1970	345
1965	339
1969	323
1981	321
1968	305
1967	255
1966	234

Observation: Maximum number of Earthquakes (713) occurred in the year 2011 and Minimum number of earthquakes happened in the year 1966 between the interval 1965 and 2011.

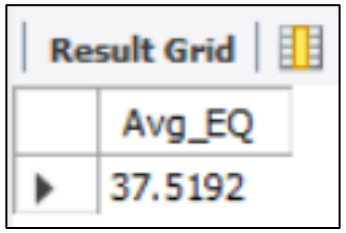
```
SELECT
    MONTH, COUNT(*) as No_of_EQS
FROM
    eqdatabase
GROUP BY
    Month
ORDER BY
    No_of_EQS desc;
```

MONTH	No_of_EQS
3	2114
8	2014
12	2001
11	1987
9	1985
4	1971
5	1964
10	1952
1	1891
7	1880
2	1829
6	1824

Observation: March and July had a maximum number of Earthquakes followed by December and November

2) What is the average number of earthquakes per month?

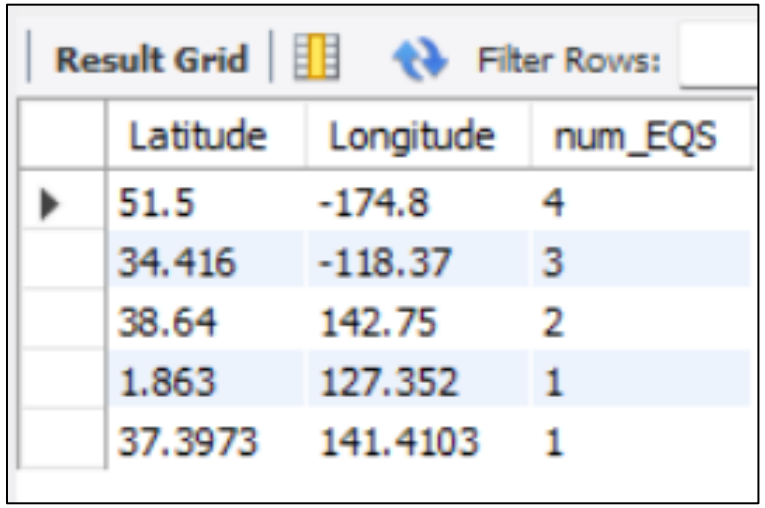
```
SELECT
    AVG(num_EQS) AS Avg_EQ
FROM
    (
    SELECT
        YEAR,
        MONTH,
        COUNT(*) AS num_EQS
    FROM
        eqdatabase
    GROUP BY
        YEAR,
        MONTH ) AS EQS;
```



Observation: On an average, 37 earthquakes occurred per month

3) What are the top 5 regions with the highest number of earthquakes?

```sql
SELECT
    Latitude,
    Longitude,
    COUNT(*) AS num_EQS
FROM
    eqdatabase
GROUP BY
    Latitude,
    Longitude
ORDER BY
    num_EQS DESC
LIMIT 5;
```



Latitude	Longitude	num_EQS
51.5	-174.8	4
34.416	-118.37	3
38.64	142.75	2
1.863	127.352	1
37.3973	141.4103	1

Observation: Latitude and longitude positions of first five areas with highest number of earthquakes are shown

4) What is the average magnitude of earthquakes for each type?

```
SELECT
    DISTINCT(Type),
    ROUND(AVG(Magnitude),2) as Avg_mag
FROM
    eqdatabase
GROUP BY
    Type;
```

Result Grid | Filter Rows:

Type	Avg_mag
Earthquake	5.88
Nuclear Explosion	5.85
Explosion	5.85
Rock Burst	6.2

Observation: Earthquakes due to Rock burst found to have a earthquake with average magnitude of 6.2

5) How many earthquakes are reported from each source?

```
SELECT
    Source, COUNT(*) as EQS_reported
FROM
    eqdatabase
GROUP BY
    Source
ORDER BY
    EQS_reported DESC;
```

Result Grid | Filter Rows:

Source	EQS_reported
US	20630
ISCGEM	2460
ISCGEMSUP	120
CI	61
GCMT	55
NC	51
AK	12
OFFICIAL	8
UW	6
NN	4
ATLAS	3
SE	1
PR	1

Observation: University of Washington (US) reported the maximum number of earthquakes. It was then followed by International Seismological Centre Global Earthquake Model .

6) What are the different earthquake statuses and their frequencies?

```sql
WITH CTE AS (
    SELECT
        STATUS,
        COUNT(*) AS Count_of_status
    FROM
        eqdatabase
    GROUP BY
        STATUS
)
SELECT
    STATUS,
    Count_of_status,
    (Count_of_status/ (SELECT SUM(Count_of_status) FROM CTE))*100 AS pct
FROM
    CTE
ORDER BY pct desc;
```

Result Grid | Filter Rows:

STATUS	Count_of_status	pct
Reviewed	20773	88.7280
Automatic	2639	11.2720

Observation: Almost 88% of the earthquakes were reviewed while remaining 11% were in the form of Automatic or Preliminary reports.

7) How does the frequency of earthquakes vary over time, considering rolling averages or moving averages?

```
WITH T2 AS
(SELECT
    Year,
    Month,
    Count(*) AS No_of_EQS
FROM
    eqdatabase
GROUP BY
    Year,
    Month)
SELECT
    Year,
    Month,
    AVG(No_of_EQS) OVER(ORDER BY Year, Month ROWS BETWEEN 3 PRECEDING AND 3 FOLLOWING) AS moving_avgs
FROM T2;
```

Result Grid | Filter Rows:

Year	Month	moving_avgs
1965	1	34.5000
1965	2	32.0000
1965	3	32.0000
1965	4	30.4286
1965	5	33.4286
1965	6	29.7143
1965	7	26.7143
1965	8	25.8571
1965	9	25.5714
1965	10	22.7143
1965	11	23.5714
1965	12	22.0000
1966	1	21.0000
1966	2	21.7143
1966	3	21.7143
1966	4	20.5714
1966	5	23.8571
1966	6	21.7143
1966	7	20.2857
1966	8	19.1429
1966	9	18.4286
1966	10	19.7143

Result Grid | Filter Rows:

Year	Month	moving_avgs
2010	6	43.7143
2010	7	40.4286
2010	8	39.8571
2010	9	41.7143
2010	10	42.4286
2010	11	41.4286
2010	12	67.8571
2011	1	69.1429
2011	2	70.5714
2011	3	71.8571
2011	4	73.8571
2011	5	75.1429
2011	6	75.0000
2011	7	47.7143
2011	8	46.0000
2011	9	43.1429
2011	10	41.4286
2011	11	37.8571
2011	12	35.2857
2012	1	37.8571
2012	2	37.2857
2012	3	36.8571
2012	4	37.7143

Observation: Moving averages of number of earthquakes were found to be high for the first 6 months of the 2011

8) Can we rank earthquakes based on their magnitudes within each year?

```sql
WITH Mag AS
(
SELECT
    Year,
    Latitude,
    Longitude,
    Magnitude,
    RANK() OVER(PARTITION BY Year ORDER BY Magnitude DESC) AS Mag_rank
FROM
    eqdatabase
    )
SELECT
    Year,
    Latitude,
    Longitude,
    Magnitude,
    Mag_rank
FROM Mag;
```

Result Grid | Filter Rows: | Export:

Year	Latitude	Longitude	Magnitude	Mag_rank
1965	51.251	178.715	8.7	1
1965	-2.608	125.952	8.2	2
1965	52.99	-167.739	7.8	3
1965	-14.921	167.34	7.7	4
1965	50.282	177.959	7.6	5
1965	-15.861	167.092	7.6	5
1965	36.405	70.724	7.4	7
1965	-32.522	-71.233	7.4	7
1965	-15.871	166.96	7.4	7
1965	16.081	-95.867	7.4	7
1965	51.443	179.605	7.3	11
1965	-56.046	157.922	7.3	11
1965	44.578	148.699	7.2	13
1965	-15.449	166.98	7.2	13
1965	-16.198	167.607	7.2	13
1965	-25.633	-70.679	7	16
1965	44.608	149.022	7	16
1965	58.09	-152.525	7	16

Result Grid | Filter Rows: | Export:

Year	Latitude	Longitude	Magnitude	Mag_rank
2011	38.297	142.373	9.1	1
2011	36.281	141.111	7.9	2
2011	38.058	144.59	7.7	3
2011	-29.539	-176.34	7.6	4
2011	-28.993	-176.238	7.4	5
2011	38.435	142.842	7.3	6
2011	52.05	-171.836	7.3	6
2011	-21.611	-179.528	7.3	6
2011	-38.355	-73.326	7.2	9
2011	28.777	63.951	7.2	9
2011	-18.365	168.143	7.2	9
2011	38.276	141.588	7.1	12
2011	-18.311	168.218	7.1	12
2011	38.721	43.508	7.1	12
2011	-7.551	146.809	7.1	12
2011	-26.803	-63.136	7	16
2011	-20.628	168.471	7	16
2011	38.034	143.264	7	16

Observation: By using Rank window function, tied rows will continue to have same rank while the consecutive ranks would be skipped for the following rows.

9) Using Dense_Rank?

```
WITH Mag AS
(
SELECT
    Year,
    Latitude,
    Longitude,
    Magnitude,
    DENSE_RANK() OVER(PARTITION BY Year ORDER BY Magnitude DESC) AS Mag_rank
FROM
    eqdatabase
    )
SELECT
    Year,
    Latitude,
    Longitude,
    Magnitude,
    Mag_rank
FROM Mag;
```

Result Grid | Filter Rows: | Export:

Year	Latitude	Longitude	Magnitude	Mag_rank
1965	51.251	178.715	8.7	1
1965	-2.608	125.952	8.2	2
1965	52.99	-167.739	7.8	3
1965	-14.921	167.34	7.7	4
1965	50.282	177.959	7.6	5
1965	-15.861	167.092	7.6	5
1965	36.405	70.724	7.4	6
1965	-32.522	-71.233	7.4	6
1965	-15.871	166.96	7.4	6
1965	16.081	-95.867	7.4	6
1965	51.443	179.605	7.3	7
1965	-56.046	157.922	7.3	7
1965	44.578	148.699	7.2	8
1965	-15.449	166.98	7.2	8
1965	-16.198	167.607	7.2	8
1965	-25.633	-70.679	7	9
1965	44.608	149.022	7	9
1965	58.09	-152.525	7	9

Observation: By using DENSE_RANK window function, tied rows will continue to have same rank while the consecutive ranks would not be skipped for the following rows.

10) What are the top regions with the highest number of earthquakes?

```sql
SELECT
    latitude, longitude, COUNT(*) as Number_of_EQS
FROM
    eqdatabase
GROUP BY
    latitude, longitude
ORDER BY
    Number_of_EQS desc;
```

Result Grid | Filter Rows:

latitude	longitude	Number_of_EQS
51.5	-174.8	4
34.416	-118.37	3
38.64	142.75	2
19.246	145.616	1
1.863	127.352	1
-20.579	-173.972	1
-59.076	-23.557	1
11.938	126.427	1
-13.405	166.629	1
27.357	87.867	1
-13.309	166.212	1
-56.452	-27.043	1

11) Average magnitude of earthquakes each year?

```
SELECT
    YEAR, COUNT(*) as Number_of_EQS, ROUND(AVG(Magnitude),2) as Avg_mag
FROM
    eqdatabase
GROUP BY
    Year
ORDER BY
    Avg_mag desc;
```

YEAR	Number_of_EQS	Avg_mag
1968	305	6.08
1966	234	6.04
1970	345	6.04
1965	339	6.01
1969	323	6.01
1967	255	6
1971	386	5.97
1972	388	5.94
2008	508	5.91
2015	446	5.91
2010	560	5.9
1995	591	5.9

Observation: Although the number of earthquakes were 305 in 1968 (nearly half the number of EQS happened in 2011) , average magnitude of Earthquake was high compared to the other years

12) Highest magnitude of earthquake?

```
SELECT
    *
FROM
    eqdatabase
WHERE
    Magnitude=(SELECT MAX(Magnitude) FROM eqdatabase);
```

Result Grid | Filter Rows: | Export: | Wrap Cell Content:

Date	Time	Year	Month	Week	Day name	Latitude	Longitude	Type	Depth	Depth error	Depth Seismic Stations	Magnitude	Magnitude Type	Magnitude Error	Magr Stati
2004-12-26	00:58:53	2004	12	52	Sunday	3.295	95.982	Earthquake	30	0	601	9.1	MW	0	0
2011-03-11	05:46:24	2011	3	10	Friday	38.297	142.373	Earthquake	29	0	541	9.1	MWW	0	0

Observation: Highest magnitude of earthquake (9.1) occurred in 2004 and 2011

Insights

1. Maximum earthquakes occurred in 2011, with March and July being the most active months.
2. University of Washington reported the highest number of earthquakes.
3. The majority of earthquakes were reviewed by experts, indicating a robust reporting and analysis system.
4. The analysis revealed fluctuations in earthquake frequency over time, with a peak in 2011.
5. The highest magnitude earthquakes were recorded in 2004 and 2011.