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Determinant Dimensions
The Petrol Price Case Study

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1. Snapshot of an operational database

The following is a sample operational database that keeps the petrol prices (of different kind of petrol) of petrol stations within a period of time

Petrol station	Company	Address	Fuel Type	Price	Date	Day of Week	Suburb
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	Unleaded	120.9	1/08/16	Monday	Box Hill
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	Diesel	118.9	1/08/16	Monday	Box Hill
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	LPG	58.9	1/08/16	Monday	Box Hill
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	U95	132.9	1/08/16	Monday	Box Hill
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	Premium Unl	139.9	1/08/16	Monday	Box Hill
7-Eleven Clayton	7-Eleven	187-191 Clayton Road, Clayton	unleaded	122.7	1/08/16	Monday	Clayton
7-Eleven Clayton	7-Eleven	187-191 Clayton Road, Clayton	LTG	56.7	1/08/16	Monday	Clayton
7-Eleven Clayton	7-Eleven	187-191 Clayton Road, Clayton	diesel	115.9	1/08/16	Monday	Clayton
United Fitzroy	United	390 Nicholson Street, Fitzroy	Unleaded	119.9	1/08/16	Monday	Fitzroy
United Fitzroy	United	390 Nicholson Street, Fitzroy	Diesel	109.9	1/08/16	Monday	Fitzroy
United Fitzroy	United	390 Nicholson Street, Fitzroy	LPG	59.7	1/08/16	Monday	Fitzroy
7-Eleven Hawthorn	7-Eleven	747-755 Toorak Road, Hawthorn East	Unleaded	121.9	1/08/16	Monday	Hawthorn East
7-Eleven Hawthorn	7-Eleven	747-755 Toorak Road, Hawthorn East	Diesel	115.9	1/08/16	Monday	Hawthorn East
7-Eleven Hawthorn	7-Eleven	747-755 Toorak Road, Hawthorn East	LPG	57.9	1/08/16	Monday	Hawthorn East
7-Eleven Hawthorn	7-Eleven	747-755 Toorak Road, Hawthorn East	U95	132.9	1/08/16	Monday	Hawthorn East
7-Eleven Hawthorn	7-Eleven	747-755 Toorak Road, Hawthorn East	Premium Unl	137.9	1/08/16	Monday	Hawthorn East
United Point Cook	United	1 Wallace Avenue, Point Cook	Unleaded	123.7	1/08/16	Monday	Point Cook
United Point Cook	United	1 Wallace Avenue, Point Cook	Diesel	118.9	1/08/16	Monday	Point Cook
United Point Cook	United	1 Wallace Avenue, Point Cook	LPG	55.7	1/08/16	Monday	Point Cook
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	E10	114.9	1/08/16	Monday	Carnegie
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	Unleaded	119.9	1/08/16	Monday	Carnegie
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	Diesel	118.7	2/08/16	Monday	Carnegie
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	LPG	58.9	2/08/16	Monday	Carnegie
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	Premium Unl	124.9	2/08/16	Monday	Carnegie
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	unleaded	120.9	2/08/16	Tuesday	Box Hill
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	Diesel	118.9	2/08/16	Tuesday	Box Hill
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	LPG	58.9	2/08/16	Tuesday	Box Hill
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	U95	132.9	2/08/16	Tuesday	Box Hill
Caltex Star Mart Box Hill	Caltex	793-797 Whitehorse Road, Box Hill	Premium Unl	139.9	2/08/16	Tuesday	Box Hill
7-Eleven Box Hill	7-Eleven	786 Whitehorse Road& Elgar Road, Box Hill	unleaded	120.9	2/08/16	Tuesday	Box Hill
7-Eleven Box Hill	7-Eleven	786 Whitehorse Road& Elgar Road, Box Hill	Diesel	115.9	2/08/16	Tuesday	Box Hill
7-Eleven Box Hill	7-Eleven	786 Whitehorse Road& Elgar Road, Box Hill	LPG	58.9	2/08/16	Tuesday	Box Hill
7-Eleven Box Hill	7-Eleven	786 Whitehorse Road& Elgar Road, Box Hill	U95	131.9	2/08/16	Tuesday	Box Hill
7-Eleven Box Hill	7-Eleven	786 Whitehorse Road& Elgar Road, Box Hill	Premium Unl	136.9	2/08/16	Tuesday	Box Hill
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	E10	114.9	2/08/16	Tuesday	Carnegie
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	Unleaded	118.9	2/08/16	Tuesday	Carnegie
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	Diesel	118.7	2/08/16	Tuesday	Carnegie
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	LPG	58.9	2/08/16	Tuesday	Carnegie
United Murrumbeena	United	90-92a Kangaroo Road, Carnegie	Premium Unl	124.9	2/08/16	Tuesday	Carnegie
BP AA Richmond - Church Street	BP	581 Church Street, Richmond	unleaded	121.9	2/08/16	Tuesday	Richmond
BP AA Richmond - Church Street	BP	581 Church Street, Richmond	LPG	58.9	2/08/16	Tuesday	Richmond
BP AA Richmond - Church Street	BP	581 Church Street, Richmond	Diesel	115.9	2/08/16	Tuesday	Richmond
Coles Oakleigh	Coles	1388 Dandenong Road, Oakleigh	Unleaded	122.9	2/08/16	Tuesday	Oakleigh
Coles Oakleigh	Coles	1388 Dandenong Road, Oakleigh	Diesel	115.9	2/08/16	Tuesday	Oakleigh
Coles Oakleigh	Coles	1388 Dandenong Road, Oakleigh	LPG	56.9	2/08/16	Tuesday	Oakleigh
Coles Oakleigh	Coles	1388 Dandenong Road, Oakleigh	U95	136.9	3/08/16	Tuesday	Oakleigh
Coles Oakleigh	Coles	1388 Dandenong Road, Oakleigh	Premium Unl	142.9	3/08/16	Tuesday	Oakleigh
7-Eleven Point Cook	7-Eleven	Cnr. Boardwalk Blvd. & Tom Roberts Parade, Po	Unleaded	119.7	3/08/16	Wednesday	Point Cook
7-Eleven Point Cook	7-Eleven	Cnr. Boardwalk Blvd. & Tom Roberts Parade, Po	Diesel	115.9	3/08/16	Wednesday	Point Cook
7-Eleven Point Cook	7-Eleven	Cnr. Boardwalk Blvd. & Tom Roberts Parade, Po	LPG	55.7	3/08/16	Wednesday	Point Cook
7-Eleven Point Cook	7-Eleven	Cnr. Boardwalk Blvd. & Tom Roberts Parade, Po	Premium Unl	135.7	3/08/16	Wednesday	Point Cook
7-Eleven Point Cook	7-Eleven	Cnr. Boardwalk Blvd. & Tom Roberts Parade, Po	U95	130.7	3/08/16	Wednesday	Point Cook
7-Eleven Point Cook	7-Eleven	Cnr. Boardwalk Blvd. & Tom Roberts Parade, Po	E10	117.7	3/08/16	Wednesday	Point Cook
Coles Express Ashburton	Coles	High & Johnston Streets, Ashburton	Unleaded	117.9	3/08/16	Wednesday	Ashburton
Coles Express Ashburton	Coles	High & Johnston Streets, Ashburton	Diesel	115.9	3/08/16	Wednesday	Ashburton
Coles Express Ashburton	Coles	High & Johnston Streets, Ashburton	Premium Unl	138.9	3/08/16	Wednesday	Ashburton
AA Glen Iris	AA	44-56 High street, Glen Iris	Unleaded	117.9	3/08/16	Wednesday	Glen Iris
AA Glen Iris	AA	44-56 High street, Glen Iris	Diesel	115.9	3/08/16	Wednesday	Glen Iris
AA Glen Iris	AA	44-56 High street, Glen Iris	LPG	58.9	3/08/16	Wednesday	Glen Iris
AA Glen Iris	AA	44-56 High street, Glen Iris	U95	125.9	3/08/16	Wednesday	Glen Iris
AA Glen Iris	AA	44-56 High street, Glen Iris	Premium Unl	133.9	3/08/16	Wednesday	Glen Iris
7-Eleven Black Rock	7-Eleven	583-589 Balcombe Road, Black Rock	Unleaded	117.9	3/08/16	Wednesday	Black Rock
7-Eleven Black Rock	7-Eleven	583-589 Balcombe Road, Black Rock	Diesel	116.9	3/08/16	Wednesday	Black Rock
7-Eleven Black Rock	7-Eleven	583-589 Balcombe Road, Black Rock	LPG	56.9	3/08/16	Wednesday	Black Rock
7-Eleven Black Rock	7-Eleven	583-589 Balcombe Road, Black Rock	Premium Unl	133.9	3/08/16	Wednesday	Black Rock
7-Eleven Black Rock	7-Eleven	583-589 Balcombe Road, Black Rock	U95	128.9	3/08/16	Wednesday	Black Rock
7-Eleven Black Rock	7-Eleven	583-589 Balcombe Road, Black Rock	E10	115.9	3/08/16	Wednesday	Black Rock
Coles Express Essendon North	Coles	249 Keilor Road, Essendon North	Unleaded	118.7	3/08/16	Wednesday	Essendon North
Coles Express Essendon North	Coles	249 Keilor Road, Essendon North	Diesel	116.9	4/08/16	Wednesday	Essendon North
Coles Express Essendon North	Coles	249 Keilor Road, Essendon North	Premium Unl	138.7	4/08/16	Wednesday	Essendon North
Coles Express Essendon North	Coles	249 Keilor Road, Essendon North	LPG	59.9	4/08/16	Wednesday	Essendon North

2. Star Schema

The requirements for the data warehouse are to answer questions related to (a) average petrol price, (b) min petrol price, and (c) max petrol prices.

From the sample data above, we choose the following three angles to view the fact measures: (*i*) day of week, (*ii*) suburb, and (*iii*) petrol company.

From the **Day of Week** point of view, it is sensible to answer the question something like which day is has the lowest petrol price. We use a two-column table methodology to visualize a conceptual model of the star schema. Hence, the two-column table for the day of week is as follows:

Day of week	Total Petrol Price	Num of Petrol Station	Min Petrol Price	Max Petrol Price
Monday				
Tuesday				
…				

Notes:
1. In the above 2-column table, the first column (say column *A*, which is Day of Week) is a category. The second columns (say, columns *B*1, *B*2, *B*3, and *B*4) are the fact measures.
2. One of the requirements for the fact measure is average petrol price. Since, the fact table should not include an average as a fact measure, we include two attributes: total petrol price, and number of petrol stations, instead.

The visualization of the above two-column table for Day of Week is rather incomplete, because there is no data in the fact measure columns. Take a look at the Min Petrol Price column in the above table. What kind of value should be in that column? Supposed Monday has a value in the Min Petrol Price column, what does that value min? It does not specify which petrol type, whether it is Unleaded 91, or Premium 95, or Premium 98, for example. Therefore, the Min Petrol Price column, although seems right, does not make sense at all. How can this problem be solved?

One solution is to have one Min Petrol Price for each petrol type (e.g. Unleaded 91, Premium 95, Premium 98, E10, Diesel, and LPG). Therefore, we have 6 attributes to represent Min Petrol Prices, namely: Min Unleaded 91 Price, Min Premium 95 Price, Min Premium 98 Price, Min E10 Price, Min Diesel Price, and Min LPG Price.

Day of week	Total Petrol Price	Num of Petrol Station	Min Petrol Price						Max Petrol Price
			Unleaded	P95	P98	E10	Diesel	LPG	
Monday			119.9c	132.9c	139.9c	114.9c	115.9c	55.7c	
Tuesday			118.9c	131.9c	136.9c	114.9c	115.9c	56.9c	
…									

We need to do the same for the Total Price, and Max Petrol Price; each of which should be divided into 6 columns. The new two-column table for Day of Week is then shown as follows:

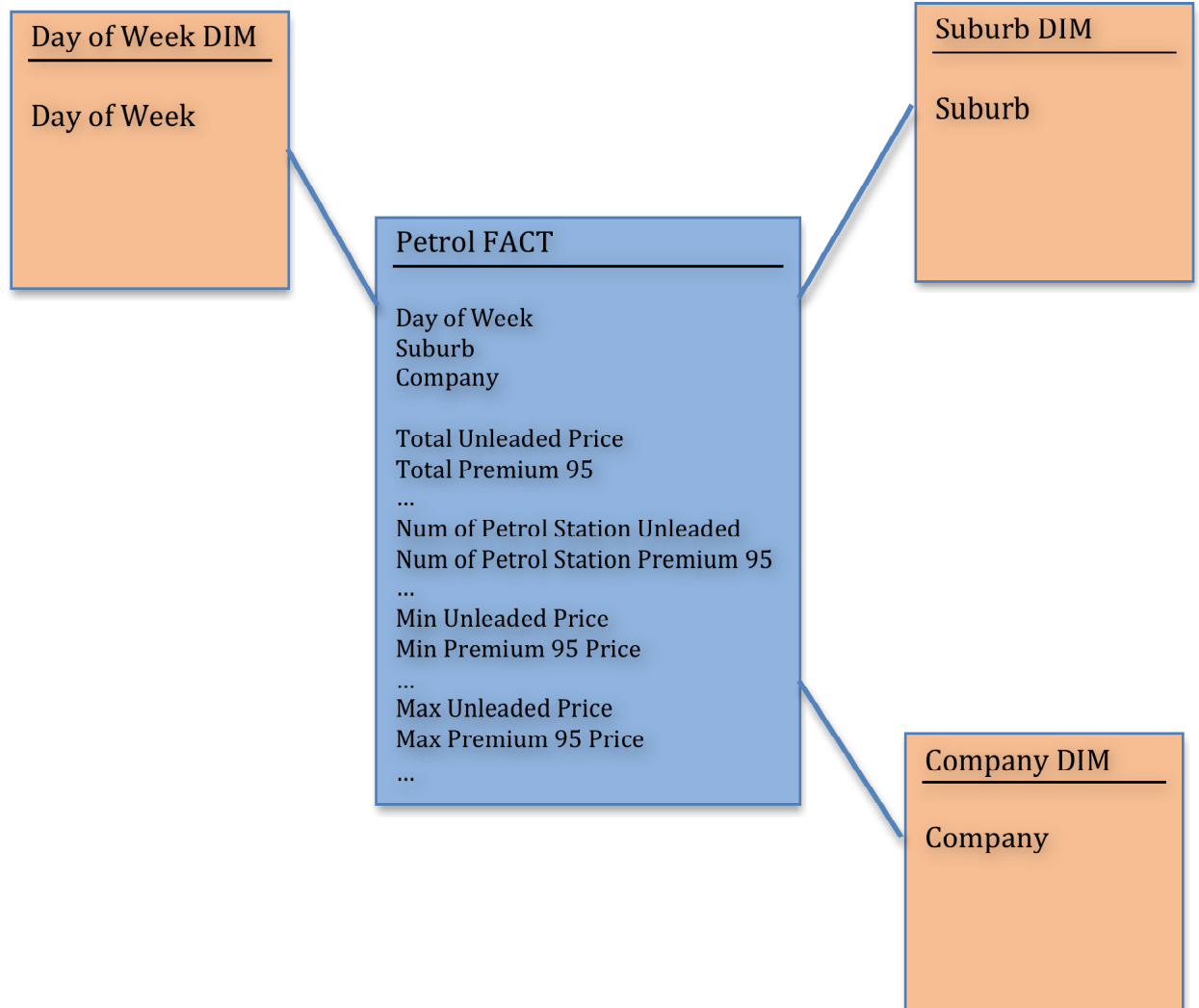| Day of Week	Total Petrol Price						Num of Petrol Station	Min Petrol Price						Max Petrol Price					
	U	95	98	E	D	LPG		U	95	98	E	D	LPG	U	95	98	E	D	LPG
Monday																			
Tuesday																			

The matter will become more complicated if number of petrol stations that has Unleaded 91 is different from that of Premium 98, for example. Then to calculate an average of Unleaded 91 on Monday, and an average of Premium 98 on Monday cannot be simply a division between Tot91 and Num of Petrol Stations, and between Tot98 and Num of Petrol Stations, because the based line, which is Num of Petrol Stations for different fuel type is different. Therefore, we need to divide the Num of Petrol Stations column into 6 columns – one for each petrol type. As a result, we will end up with 24 columns to store the fact measures, instead of just 4 columns, as initially thought.

Using the same principle, we can have a two-column table for **Suburb**, and another one for **Company**.

Suburb	Total Petrol Price						Num of Petrol Station						Min Petrol Price						Max Petrol Price					
	U	95	98	E10	D	L	U	95	98	E10	D	L	U	95	98	E10	D	L	U	95	98	E10	D	L
Box Hill																								
Clayton																								

Company	Total Petrol Price						Num of Petrol Station						Min Petrol Price						Max Petrol Price					
	U	95	98	E	D	L	U	95	98	E	D	L	U	95	98	E	D	L	U	95	98	E	D	L
Caltex																								
7-Eleven																								

Based on the above three two-column tables, we are now confident to have the following star schema:

Day of Week DIM

Day of Week

Suburb DIM

Suburb

Petrol FACT

Day of Week
Suburb
Company

Total Unleaded Price
Total Premium 95
...
Num of Petrol Station Unleaded
Num of Petrol Station Premium 95
...
Min Unleaded Price
Min Premium 95 Price
...
Max Unleaded Price
Max Premium 95 Price
...

Company DIM

Company

3. Star Schema version-2

Is there another way to reduce the number of fact measures? The above star schema has 24 fact measures, because there are 6 different kinds of petrol. The answer is yes!!!

We can have a new dimension called Petrol Type DIM, which stores the different kinds of petrol. With this new dimension, the fact measure is reduced to 4, which is the original fact measures we had in the beginning. Therefore, the new star schema becomes as follows:

```
Day of Week DIM                                        Suburb DIM

Day of Week                                            Suburb


                    Petrol FACT

                    Day of Week
                    Suburb
                    Company
                    Petrol Type

                    Total Petrol Price
                    Num of Petrol Station
                    Min Petrol Price
                    Max Petrol Price
                                                       Company DIM

Petrol Type DIM                                        Company

Petrol Type
```
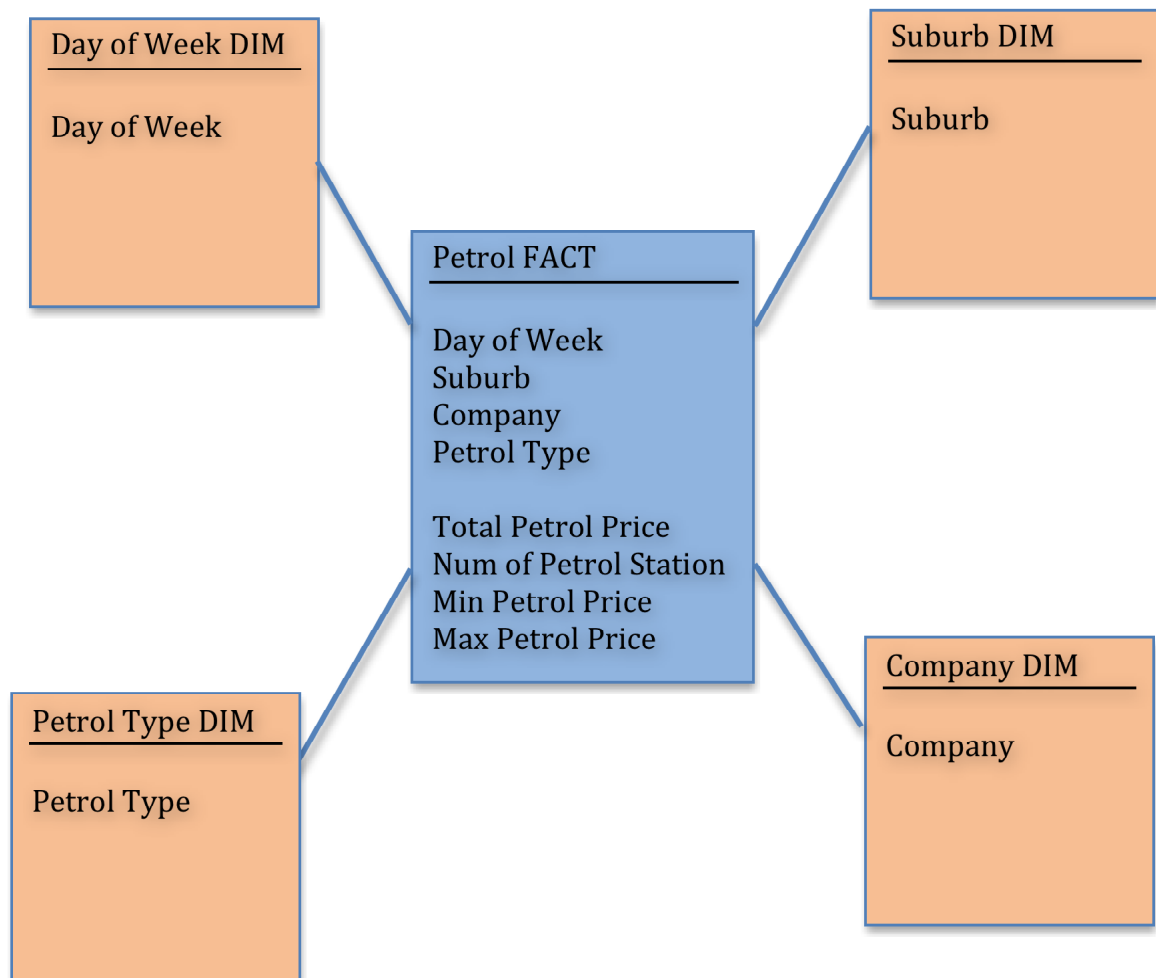
With this new star schema, as an example, we can retrieve data that shows the Min Petrol Price of Premium 98 on Monday. Or another example is to get the Average Petrol Price (which is Total Petrol Price/Num of Petrol Station) of Unleaded Petrol in 7-Eleven petrol station located at Clayton.

Note that when retrieving data from a data warehouse, there is no obligation that we must use all dimensions. In the Monday Premium 98 example, only two dimensions are used, which are Day of Week DIM, and Petrol Type DIM. And in the second example, only three dimensions are used: Petrol Type DIM, Company DIM, and Suburb DIM. So, to retrieve data from the data warehouse, we can use

as few as one dimension table; but we can also use all dimension tables. We are not restricted to which dimension we have to use.

However, this imposes a new problem. For example, the above star schema allows us to retrieve the Min Petrol Price of Monday, which uses only Day of Week DIM. This data retrieval does not make any sense; which petrol type are we referring to?

Based on this case study, it is clear that the Petrol Type DIM holds the key to any data retrieval. We must use the Petrol Type DIM in any retrieval, such as the Min Petrol Price of Premium 98 on Monday, or the Average Petrol Price of Unleaded in 7-Eleven petrol station located in Clayton suburb.

The Petrol Type DIM, in this example, is called a "**Determinant Dimension**" – a dimension which needs to be used in the data retrieval, because the fact measures are determined by this dimension. In order to differentiate between Determinant Dimension and all other dimensions, Determinant Dimension is denoted by a star. The fact measures are also denoted by a star. The new star schema with a Determinant Dimension is as follows:

Day of Week DIM
Day of Week

Suburb DIM
Suburb

Petrol FACT
Day of Week Suburb Company Petrol Type * Total Petrol Price * Num of Petrol Station * Min Petrol Price * Max Petrol Price

* Petrol Type DIM
Petrol Type

Company DIM
Company