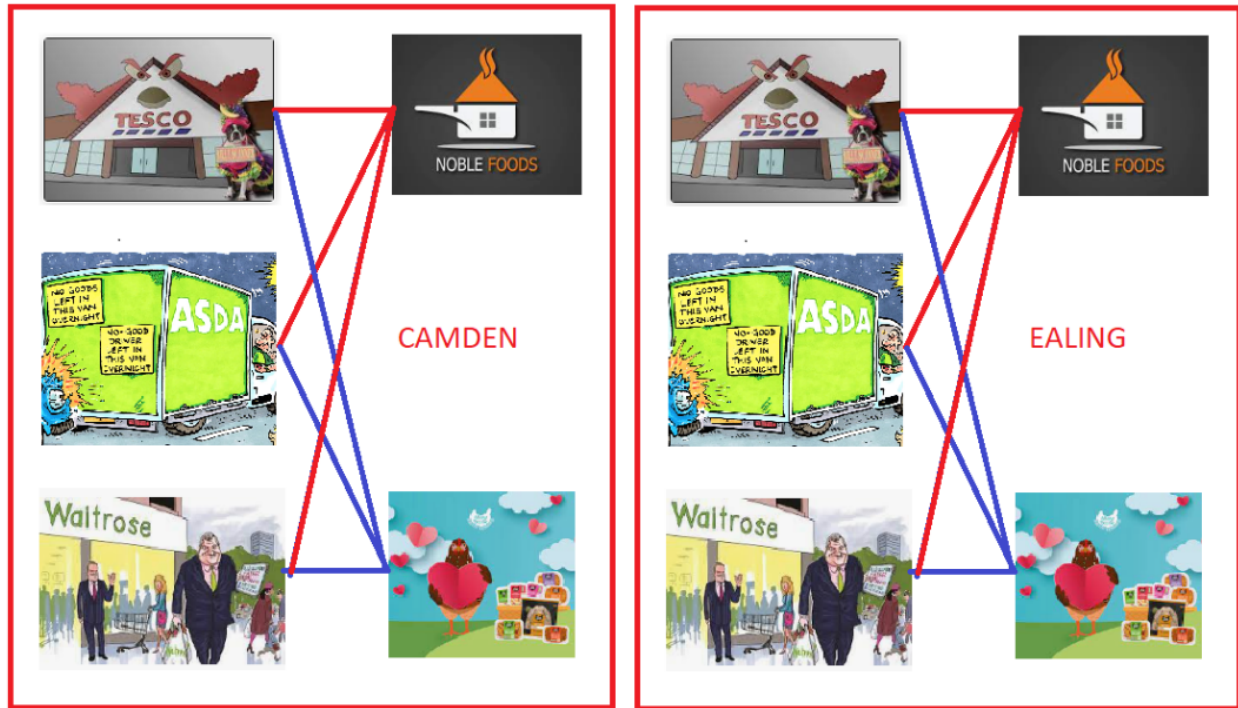


# Resource Allocation based on DHondt Method and BigQuery

## Problem statement:

We have three supermarket brands (for example, Lidl, Tesco, and Asda) we denote them Shop 1, Shop 2, and Shop 3. They have branches in Camden, Ealing, Greenwich, Hounslow, Richmond upon Thames, Hammersmith and Fulham, Kensington and Chelsea, and the City of Westminster. They use two suppliers that have branches in the same London Boroughs, we have a historical probability of items being in the given supplier branch of London Borough. We know how many items each supplier can deliver per day.

We are given a total number of items demanded by every supermarket brand and information about when (date) and where (London Borough) the given supermarket can accept part of this total demand but the exact value is not provided. The supplier can deliver items to supermarkets from the same Borough only. We have weights or a probability that the total supply for the given location is going to a particular supermarket. The task is to find the date, location, and number of items that should be delivered to all three supermarkets.



We are given Demand Weights that could be weights of the objective function that are used in linear programming:

**Table 1** Demand Weights defined by Optimization Objective in Linear Programming

| Demand Weight |        |        |
|---------------|--------|--------|
| Shop 1        | Shop 2 | Shop 3 |
| 0.2           | 0.3    | 0.5    |

The table below shows how many items are required by every supermarket in all considered locations during two days:

**Table 2** Total Number of Demanded Items per Time Interval (2 days in our case)

| Shop_Demand |        |        |
|-------------|--------|--------|
| Shop 1      | Shop 2 | Shop 3 |
| 150         | 500    | 300    |

Information about when (date) and where (London Borough) the given supermarket is available to accept part of the above total demand (see the table called Shop\_Demand above) but how much it will accept it depends on the supply in the given Borough and

Demand Weights.

If it is "+" (True) then the supermarket is available to accept the items on the particular date and London Borough (location) and it does not accept otherwise (when it is "-" or False:

**Table 3** Shop Demand Availability or Schedule when Shops update their Stocks

| N  | Date       | London Borough         | Shop Demand Availability |        |        |
|----|------------|------------------------|--------------------------|--------|--------|
|    |            |                        | Shop 1                   | Shop 2 | Shop 3 |
| 1  | 11/06/2022 | Camden                 | -                        | -      | -      |
| 2  | 11/06/2022 | Ealing                 | -                        | -      | +      |
| 3  | 11/06/2022 | Greenwich              | -                        | +      | -      |
| 4  | 11/06/2022 | Hounslow               | -                        | +      | +      |
| 5  | 11/06/2022 | Richmond upon Thames   | +                        | -      | -      |
| 6  | 11/06/2022 | Hammersmith and Fulham | +                        | -      | +      |
| 7  | 11/06/2022 | Kensington and Chelsea | +                        | +      | -      |
| 8  | 11/06/2022 | City of Westminster    | +                        | +      | +      |
| 9  | 12/06/2022 | Camden                 | -                        | -      | -      |
| 10 | 12/06/2022 | Ealing                 | -                        | -      | +      |
| 11 | 12/06/2022 | Greenwich              | -                        | +      | -      |
| 12 | 12/06/2022 | Hounslow               | -                        | +      | +      |
| 13 | 12/06/2022 | Richmond upon Thames   | +                        | -      | -      |
| 14 | 12/06/2022 | Hammersmith and Fulham | +                        | -      | +      |
| 15 | 12/06/2022 | Kensington and Chelsea | +                        | +      | -      |
| 16 | 12/06/2022 | City of Westminster    | +                        | +      | +      |
| 17 | Total      | -                      | 150                      | 500    | 300    |

The information about Supply includes the probability of supply over different London Borough (location) and the daily total amount of the supplied items (see Table below). The probability could be different for the different suppliers but in our example, it is the same for simplicity of presentation:

**Table 4** Supply Items Availability

| N  | Date       | London Borough         | Supply      |             |             |             |
|----|------------|------------------------|-------------|-------------|-------------|-------------|
|    |            |                        | Supplier 1  |             | Supplier 2  |             |
|    |            |                        | Probability | Daily Total | Probability | Daily Total |
| 1  | 11/06/2022 | Camden                 | 0.118       | 255         | 0.118       | 255         |
| 2  | 11/06/2022 | Ealing                 | 0.157       |             | 0.157       |             |
| 3  | 11/06/2022 | Greenwich              | 0.118       |             | 0.118       |             |
| 4  | 11/06/2022 | Hounslow               | 0.220       |             | 0.220       |             |
| 5  | 11/06/2022 | Richmond upon Thames   | 0.078       |             | 0.078       |             |
| 6  | 11/06/2022 | Hammersmith and Fulham | 0.192       |             | 0.192       |             |
| 7  | 11/06/2022 | Kensington and Chelsea | 0.039       |             | 0.039       |             |
| 8  | 11/06/2022 | City of Westminster    | 0.078       |             | 0.078       |             |
| 9  | 12/06/2022 | Camden                 | 0.118       | 510         | 0.118       | 255         |
| 10 | 12/06/2022 | Ealing                 | 0.157       |             | 0.157       |             |
| 11 | 12/06/2022 | Greenwich              | 0.118       |             | 0.118       |             |
| 12 | 12/06/2022 | Hounslow               | 0.220       |             | 0.220       |             |
| 13 | 12/06/2022 | Richmond upon Thames   | 0.078       |             | 0.078       |             |
| 14 | 12/06/2022 | Hammersmith and Fulham | 0.192       |             | 0.192       |             |
| 15 | 12/06/2022 | Kensington and Chelsea | 0.039       |             | 0.039       |             |
| 16 | 12/06/2022 | City of Westminster    | 0.078       |             | 0.078       |             |
| 17 | Total      |                        | 2           | 765         | 2           | 510         |

The algorithm consists of 3 major steps:

**STEP 1.** Computation of the number of supplied items per day, Borough, and supplier given the probability of supply over different Boroughs and the total number of supplied items per day and supplier. In the simplest case, we just multiply the probability of items distributed to a given Borough by the total number of supplied items per day, and supplier. But sometimes we get no integer numbers after this multiplication that is why we apply DHondt method instead. For example, given date 11/06/2022 and supplier 1 (see Table 4) we have the total amount of items available equal to 255 and the following vector of probabilities: `[0.118, 0.157, 0.118, 0.220, 0.078, 0.192, 0.039, 0.078]` over London Boroughs. This information is required by DHondt method to find the number of items that can be supplied on 11/06/2022 by Supplier 1 to each London Borough. Therefore, for every combination of date and supply we need to run DHondt method or 4 times in our case (see Quantity column in Table 5).

**Table 5** Supply Information with estimated “Quantity” and “ALL” Columns

| N  | Date       | London Borough         | Supply      |          |       |             |          |     |       |
|----|------------|------------------------|-------------|----------|-------|-------------|----------|-----|-------|
|    |            |                        | Supplier 1  |          |       | Supplier 2  |          | ALL |       |
|    |            |                        | Probability | Quantity | Total | Probability | Quantity |     | Total |
| 1  | 11/06/2022 | Camden                 | 0.118       | 30       | 255   | 0.118       | 30       | 255 | 60    |
| 2  | 11/06/2022 | Ealing                 | 0.157       | 40       |       | 0.157       | 40       |     | 80    |
| 3  | 11/06/2022 | Greenwich              | 0.118       | 30       |       | 0.118       | 30       |     | 60    |
| 4  | 11/06/2022 | Hounslow               | 0.220       | 56       |       | 0.220       | 56       |     | 112   |
| 5  | 11/06/2022 | Richmond upon Thames   | 0.078       | 20       |       | 0.078       | 20       |     | 40    |
| 6  | 11/06/2022 | Hammersmith and Fulham | 0.192       | 49       |       | 0.192       | 49       |     | 98    |
| 7  | 11/06/2022 | Kensington and Chelsea | 0.039       | 10       |       | 0.039       | 10       |     | 20    |
| 8  | 11/06/2022 | City of Westminster    | 0.078       | 20       |       | 0.078       | 20       |     | 40    |
| 9  | 12/06/2022 | Camden                 | 0.118       | 60       | 510   | 0.118       | 30       | 255 | 90    |
| 10 | 12/06/2022 | Ealing                 | 0.157       | 80       |       | 0.157       | 40       |     | 120   |
| 11 | 12/06/2022 | Greenwich              | 0.118       | 60       |       | 0.118       | 30       |     | 90    |
| 12 | 12/06/2022 | Hounslow               | 0.220       | 112      |       | 0.220       | 56       |     | 168   |
| 13 | 12/06/2022 | Richmond upon Thames   | 0.078       | 40       |       | 0.078       | 20       |     | 60    |
| 14 | 12/06/2022 | Hammersmith and Fulham | 0.192       | 98       |       | 0.192       | 49       |     | 147   |
| 15 | 12/06/2022 | Kensington and Chelsea | 0.039       | 20       |       | 0.039       | 10       |     | 30    |
| 16 | 12/06/2022 | City of Westminster    | 0.078       | 40       |       | 0.078       | 20       |     | 60    |
| 17 | Total      |                        |             | 765      | 765   |             | 510      | 510 | 1275  |

**STEP 2.** Calculation of the maximum demand that can be satisfied or supplied. Using demand weights, demand availability, and the total possible number of supplied items per day and Borough (see 1) ) we compute how many items can be supplied given day, Borough, and shop. Therefore, we find the maximum number of items that the shop located in the corresponding London Borough can get on the given date. In order to find it we first multiply every row of Shop Demand Availability (see Table 3, where “+” can be interpreted as 1 and “-” as 0) by Demand Weights and normalise every row of the result in such a way that weights in the row sum to 1. Then using this row normalised weights and the total possible supplied in the given London Borough and date we calculate the number of the items that can be delivered to the corresponding shop on the given date and London Borough. We can apply DHondt method again - we need to run it 16 times for every combination of date and London Borough, the output of the DHondt in this case is the number of items (in our case, the output is a vector of three values - one value per shop) for the corresponding shop given date and London Borough (see Table 6). Then we aggregate the number of items over all dates and London Borough for every shop. Therefore, we get the number of items that suppliers can provide to the corresponding entire supermarket network for all location and dates. then we compare these numbers with Shop Demand (see Table 2) and for every shop choose the smallest number (see Table 7). Therefore, we find the number of items that are required by the shops and can be delivered by suppliers subject to constrain (see Table 1-4) over all days (in our case two days) and London Borough (we selected eight London Boroughs).

**Table 6 Distribution of Number of Available for Supply Items over Shops given Date and London Borough (see Supply AS Demand in red colour)**

| N  | Date       | London Borough         | Shop Demand Availability |        |        | Demand Weight |        |        | Row Normalised Weight |        |          | Supply AS Demand |        |        |
|----|------------|------------------------|--------------------------|--------|--------|---------------|--------|--------|-----------------------|--------|----------|------------------|--------|--------|
|    |            |                        | Shop 1                   | Shop 2 | Shop 3 | Shop 1        | Shop 2 | Shop 3 | Shop 1                | Shop 2 | Shop 3   | Shop 1           | Shop 2 | Shop 3 |
| 1  | 11/06/2022 | Camden                 | -                        | -      | -      | 0             | 0      | 0      | 0                     | 0      | 0        | 0                | 0      | 0      |
| 2  | 11/06/2022 | Ealing                 | -                        | -      | +      | 0             | 0      | 0.5    | 0                     | 0      | 1        | 0                | 0      | 80     |
| 3  | 11/06/2022 | Greenwich              | -                        | +      | -      | 0             | 0.3    | 0      | 0                     | 1      | 0        | 0                | 60     | 0      |
| 4  | 11/06/2022 | Hounslow               | -                        | +      | +      | 0             | 0.3    | 0.5    | 0                     | 0.375  | 0.625    | 0                | 42     | 70     |
| 5  | 11/06/2022 | Richmond upon Thames   | +                        | -      | -      | 0.2           | 0      | 0      | 1                     | 0      | 0        | 40               | 0      | 0      |
| 6  | 11/06/2022 | Hammersmith and Fulham | +                        | -      | +      | 0.2           | 0      | 0.5    | 0.285714              | 0      | 0.714286 | 28               | 0      | 70     |
| 7  | 11/06/2022 | Kensington and Chelsea | +                        | +      | -      | 0.2           | 0.3    | 0      | 0.4                   | 0.6    | 0        | 8                | 12     | 0      |
| 8  | 11/06/2022 | City of Westminster    | +                        | +      | +      | 0.2           | 0.3    | 0.5    | 0.2                   | 0.3    | 0.5      | 8                | 12     | 20     |
| 9  | 12/06/2022 | Camden                 | -                        | -      | -      | 0             | 0      | 0      | 0                     | 0      | 0        | 0                | 0      | 0      |
| 10 | 12/06/2022 | Ealing                 | -                        | -      | +      | 0             | 0      | 0.5    | 0                     | 0      | 1        | 0                | 0      | 120    |
| 11 | 12/06/2022 | Greenwich              | -                        | +      | -      | 0             | 0.3    | 0      | 0                     | 1      | 0        | 0                | 90     | 0      |
| 12 | 12/06/2022 | Hounslow               | -                        | +      | +      | 0             | 0.3    | 0.5    | 0                     | 0.375  | 0.625    | 0                | 63     | 105    |
| 13 | 12/06/2022 | Richmond upon Thames   | +                        | -      | -      | 0.2           | 0      | 0      | 1                     | 0      | 0        | 60               | 0      | 0      |
| 14 | 12/06/2022 | Hammersmith and Fulham | +                        | -      | +      | 0.2           | 0      | 0.5    | 0.285714              | 0      | 0.714286 | 42               | 0      | 105    |
| 15 | 12/06/2022 | Kensington and Chelsea | +                        | +      | -      | 0.2           | 0.3    | 0      | 0.4                   | 0.6    | 0        | 12               | 18     | 0      |
| 16 | 12/06/2022 | City of Westminster    | +                        | +      | +      | 0.2           | 0.3    | 0.5    | 0.2                   | 0.3    | 0.5      | 12               | 18     | 30     |
| 17 | Total      | -                      | 150                      | 500    | 300    | -             | -      | -      | -                     | -      | -        | 210              | 315    | 600    |

**Table 7 Available Demand Calculation**

| Super Market | Demand | Supply | Available Demand |
|--------------|--------|--------|------------------|
| Shop 1       | 150    | 210    | 150              |
| Shop 2       | 500    | 315    | 315              |
| Shop 3       | 300    | 600    | 300              |

**STEP 3.** Find weights for each shop using the corresponding column of Supply AS Demand (see Table 6) that is divided the corresponding total (for example, the total equal to 210, 315 and 600 for shop 1, 2 and 3, respectively, see Table 6). As a result we get “Column Normalise Weight” (see Table 8). After this we can multiply every column of “Column Normalised Weight” (see Table 8) that corresponds to the given shop by the corresponding value of “Available Demand” (see Table 7) to get the final allocation. As we mentioned before this approach give some float numbers therefore instead we apply DHondt method to every column of “Column Normalised Weight” (see Table 8) using the corresponding value of Available Demand (see Table 7). In our case we have three shops therefore we apply DHondt method three times and we get “Final Allocation” (see Table 8). Please note that, the following implementation in BigQuery gives slightly different numbers than what we get in Table 8 but it can be explained by difference in Python and BigQuery DHondt method implementations.

**Table 8**

| N  | Date       | London Borough         | Supply AS Demand |        |        | Column Normalised Weight |          |          | Final Allocation |        |        |
|----|------------|------------------------|------------------|--------|--------|--------------------------|----------|----------|------------------|--------|--------|
|    |            |                        | Shop 1           | Shop 2 | Shop 3 | Shop 1                   | Shop 2   | Shop 3   | Shop 1           | Shop 2 | Shop 3 |
| 1  | 11/06/2022 | Camden                 | 0                | 0      | 0      | 0                        | 0        | 0        | 0                | 0      | 0      |
| 2  | 11/06/2022 | Ealing                 | 0                | 0      | 80     | 0                        | 0        | 0.133333 | 0                | 0      | 40     |
| 3  | 11/06/2022 | Greenwich              | 0                | 60     | 0      | 0                        | 0.190476 | 0        | 0                | 60     | 0      |
| 4  | 11/06/2022 | Hounslow               | 0                | 42     | 70     | 0                        | 0.133333 | 0.116667 | 0                | 42     | 35     |
| 5  | 11/06/2022 | Richmond upon Thames   | 40               | 0      | 0      | 0.190476                 | 0        | 0        | 29               | 0      | 0      |
| 6  | 11/06/2022 | Hammersmith and Fulham | 28               | 0      | 70     | 0.133333                 | 0        | 0.116667 | 20               | 0      | 35     |
| 7  | 11/06/2022 | Kensington and Chelsea | 8                | 12     | 0      | 0.038095                 | 0.038095 | 0        | 5                | 12     | 0      |
| 8  | 11/06/2022 | City of Westminster    | 8                | 12     | 20     | 0.038095                 | 0.038095 | 0.033333 | 5                | 12     | 10     |
| 9  | 11/06/2022 | Camden                 | 0                | 0      | 0      | 0                        | 0        | 0        | 0                | 0      | 0      |
| 10 | 12/06/2022 | Ealing                 | 0                | 0      | 120    | 0                        | 0        | 0.2      | 0                | 0      | 60     |
| 11 | 12/06/2022 | Greenwich              | 0                | 90     | 0      | 0                        | 0.285714 | 0        | 0                | 90     | 0      |
| 12 | 12/06/2022 | Hounslow               | 0                | 63     | 105    | 0                        | 0.2      | 0.175    | 0                | 63     | 53     |
| 13 | 12/06/2022 | Richmond upon Thames   | 60               | 0      | 0      | 0.285714                 | 0        | 0        | 44               | 0      | 0      |
| 14 | 12/06/2022 | Hammersmith and Fulham | 42               | 0      | 105    | 0.2                      | 0        | 0.175    | 31               | 0      | 52     |
| 15 | 12/06/2022 | Kensington and Chelsea | 12               | 18     | 0      | 0.057143                 | 0.057143 | 0        | 8                | 18     | 0      |
| 15 | 12/06/2022 | City of Westminster    | 12               | 18     | 30     | 0.057143                 | 0.057143 | 0.05     | 8                | 18     | 15     |
| 17 | Total      | -                      | 210              | 315    | 600    | 1                        | 1        | 1        | 150              | 315    | 300    |

Our BigQuery implementation of DHondt algorithm was inspired by the following Python implementation:

```
def DHondt_AD_v2(nSeats: int, weights: np.ndarray) -> np.ndarray:
    #
    if nSeats == 0:
        seats = np.zeros([0] * len(weights))
    else:
        quota = sum(weights) / (1 + nSeats)
        frac = [weight / quota for weight in weights]
        seats = np.floor(frac).astype(int)
        #
        n = nSeats - sum(seats) # number of seats remaining to allocate
        #
        if n < 0: # we over allocate by 1 seat
            # I modified over allocation case - it could over allocate only by 1 seat
            min_weights = np.min(weights[np.nonzero(seats)])
            # find smallest weight where seats is non zero
            index = np.argmax(weights == min_weights)
            # find smallest index for min_weights
            seats[index] -= 1
        elif n > 0: # We under allocate by n seats after initial allocation
            #
            # distribute the remaining number of seats to the elements of seats array
            # with the largest remainder
            remainders = frac - seats
            #
            n = int(n)
            # Find position of the first n largest reminders
            # in order to increase the number of seats
            index = np.argsort(remainders)[::-1][:n]
            #
            for i in index:
```

```

        seats[i] += 1
    #
    return seats
#
print("OK")

```

## 1. Inputs Definition

In this section we define inputs that illustrate our implementation of resource allocation algorithm (see Table 1-4 above).

```

demand_weight AS (
    SELECT 'shop_1' AS shop, 0.2 AS demand_weight UNION ALL
    SELECT 'shop_2',      0.3                        UNION ALL
    SELECT 'shop_3',      0.5
)

```

| Row | shop   | demand_weight |
|-----|--------|---------------|
| 1   | shop_1 | 0.2           |
| 2   | shop_2 | 0.3           |
| 3   | shop_3 | 0.5           |

```

shop_demand AS(
    SELECT 'shop_1' AS shop, 150 AS demand_quantity UNION ALL
    SELECT 'shop_2',      500                        UNION ALL
    SELECT 'shop_3',      300
)

```



| Row | shop   | demand_quantity |
|-----|--------|-----------------|
| 1   | shop_1 | 150             |
| 2   | shop_2 | 500             |
| 3   | shop_3 | 300             |

```

demand AS (
  SELECT '11/06/2022' AS day, 'Camden' AS London_Borough,
    False AS Shop_1, False AS Shop_2, False AS Shop_3 UNION ALL
  SELECT '11/06/2022' AS day, 'Ealing' AS London_Borough,
    False AS Shop_1, False AS Shop_2, True AS Shop_3 UNION ALL
  SELECT '11/06/2022' AS day, 'Greenwich' AS London_Borough,
    False AS Shop_1, True AS Shop_2, False AS Shop_3 UNION ALL
  SELECT '11/06/2022' AS day, 'Hounslow' AS London_Borough,
    False AS Shop_1, True AS Shop_2, True AS Shop_3 UNION ALL
  SELECT '11/06/2022' AS day, 'Richmond upon Thames' AS London_Borough,
    True AS Shop_1, False AS Shop_2, False AS Shop_3 UNION ALL
  SELECT '11/06/2022' AS day, 'Hammersmith and Fulham' AS London_Borough,
    True AS Shop_1, False AS Shop_2, True AS Shop_3 UNION ALL
  SELECT '11/06/2022' AS day, 'Kensington and Chelsea' AS London_Borough,
    True AS Shop_1, True AS Shop_2, False AS Shop_3 UNION ALL
  SELECT '11/06/2022' AS day, 'City of Westminster' AS London_Borough,
    True AS Shop_1, True AS Shop_2, True AS Shop_3 UNION ALL
  SELECT '12/06/2022' AS day, 'Camden' AS London_Borough,
    False AS Shop_1, False AS Shop_2, False AS Shop_3 UNION ALL
  SELECT '12/06/2022' AS day, 'Ealing' AS London_Borough,
    False AS Shop_1, False AS Shop_2, True AS Shop_3 UNION ALL
  SELECT '12/06/2022' AS day, 'Greenwich' AS London_Borough,
    False AS Shop_1, True AS Shop_2, False AS Shop_3 UNION ALL
  SELECT '12/06/2022' AS day, 'Hounslow' AS London_Borough,
    False AS Shop_1, True AS Shop_2, True AS Shop_3 UNION ALL
  SELECT '12/06/2022' AS day, 'Richmond upon Thames' AS London_Borough,
    True AS Shop_1, False AS Shop_2, False AS Shop_3 UNION ALL
  SELECT '12/06/2022' AS day, 'Hammersmith and Fulham' AS London_Borough,
    True AS Shop_1, False AS Shop_2, True AS Shop_3 UNION ALL
  SELECT '12/06/2022' AS day, 'Kensington and Chelsea' AS London_Borough,
    True AS Shop_1, True AS Shop_2, False AS Shop_3 UNION ALL
  SELECT '12/06/2022' AS day, 'City of Westminster' AS London_Borough,
    True AS Shop_1, True AS Shop_2, True AS Shop_3
)

```

| Row | day        | London_Borough         | Shop_1 | Shop_2 | Shop_3 |
|-----|------------|------------------------|--------|--------|--------|
| 1   | 11/06/2022 | Camden                 | false  | false  | false  |
| 2   | 11/06/2022 | Ealing                 | false  | false  | true   |
| 3   | 11/06/2022 | Greenwich              | false  | true   | false  |
| 4   | 11/06/2022 | Hounslow               | false  | true   | true   |
| 5   | 11/06/2022 | Richmond upon Thames   | true   | false  | false  |
| 6   | 11/06/2022 | Hammersmith and Fulham | true   | false  | true   |
| 7   | 11/06/2022 | Kensington and Chelsea | true   | true   | false  |
| 8   | 11/06/2022 | City of Westminster    | true   | true   | true   |
| 9   | 12/06/2022 | Camden                 | false  | false  | false  |
| 10  | 12/06/2022 | Ealing                 | false  | false  | true   |
| 11  | 12/06/2022 | Greenwich              | false  | true   | false  |
| 12  | 12/06/2022 | Hounslow               | false  | true   | true   |
| 13  | 12/06/2022 | Richmond upon Thames   | true   | false  | false  |
| 14  | 12/06/2022 | Hammersmith and Fulham | true   | false  | true   |
| 15  | 12/06/2022 | Kensington and Chelsea | true   | true   | false  |
| 16  | 12/06/2022 | City of Westminster    | true   | true   | true   |

```
-- SUPPLY
prob_of_supply_per_borough AS (
SELECT 'Camden' AS London_Borough, 0.118 AS supplier_1,
0.118 AS supplier_2 UNION ALL
SELECT 'Ealing' AS London_Borough, 0.157 AS supplier_1,
0.157 AS supplier_2 UNION ALL
SELECT 'Greenwich' AS London_Borough, 0.118 AS supplier_1,
0.118 AS supplier_2 UNION ALL
SELECT 'Hounslow' AS London_Borough, 0.220 AS supplier_1,
0.220 AS supplier_2 UNION ALL
SELECT 'Richmond upon Thames' AS London_Borough, 0.078 AS supplier_1,
0.078 AS supplier_2 UNION ALL
SELECT 'Hammersmith and Fulham' AS London_Borough, 0.192 AS supplier_1,
0.192 AS supplier_2 UNION ALL
SELECT 'Kensington and Chelsea' AS London_Borough, 0.039 AS supplier_1,
0.039 AS supplier_2 UNION ALL
SELECT 'City of Westminster' AS London_Borough, 0.078 AS supplier_1,
0.078 AS supplier_2
)
```

| Row | London_Borough         | supplier_1 | supplier_2 |
|-----|------------------------|------------|------------|
| 1   | Camden                 | 0.118      | 0.118      |
| 2   | Ealing                 | 0.157      | 0.157      |
| 3   | Greenwich              | 0.118      | 0.118      |
| 4   | Hounslow               | 0.22       | 0.22       |
| 5   | Richmond upon Thames   | 0.078      | 0.078      |
| 6   | Hammersmith and Fulham | 0.192      | 0.192      |
| 7   | Kensington and Chelsea | 0.039      | 0.039      |
| 8   | City of Westminster    | 0.078      | 0.078      |

```
daily_total_supplied_quantity AS(
SELECT '11/06/2022' AS day, 255 AS supplier_1, 255 AS supplier_2 UNION ALL
SELECT '12/06/2022' AS day, 510 AS supplier_1, 255 AS supplier_2
)
```

| Row | day        | supplier_1 | supplier_2 |
|-----|------------|------------|------------|
| 1   | 11/06/2022 | 255        | 255        |
| 2   | 12/06/2022 | 510        | 255        |

## 2. Daily Supplier Quantity per Day, Borough, and Supplier by DHondt

The output of this section is the column “daily\_supplier\_allocation” in the table called final\_step\_of\_DHondt\_daily\_supplier (see column called **Quantity** in Table 5 above).

```
un_pivot_prob_of_supply_per_borough AS (
SELECT London_Borough, supplier, probability FROM prob_of_supply_per_borough
UNPIVOT(probability FOR supplier IN (supplier_1, supplier_2))
)
```

| Row | London_Borough         | supplier   | probability |
|-----|------------------------|------------|-------------|
| 1   | Camden                 | supplier_1 | 0.118       |
| 2   | Camden                 | supplier_2 | 0.118       |
| 3   | Ealing                 | supplier_1 | 0.157       |
| 4   | Ealing                 | supplier_2 | 0.157       |
| 5   | Greenwich              | supplier_1 | 0.118       |
| 6   | Greenwich              | supplier_2 | 0.118       |
| 7   | Hounslow               | supplier_1 | 0.22        |
| 8   | Hounslow               | supplier_2 | 0.22        |
| 9   | Richmond upon Thames   | supplier_1 | 0.078       |
| 10  | Richmond upon Thames   | supplier_2 | 0.078       |
| 11  | Hammersmith and Fulham | supplier_1 | 0.192       |
| 12  | Hammersmith and Fulham | supplier_2 | 0.192       |
| 13  | Kensington and Chelsea | supplier_1 | 0.039       |
| 14  | Kensington and Chelsea | supplier_2 | 0.039       |
| 15  | City of Westminster    | supplier_1 | 0.078       |
| 16  | City of Westminster    | supplier_2 | 0.078       |

```

un_pivot_daily_total_supplied_quantity AS (
SELECT day, supplier, quantity FROM daily_total_supplied_quantity
UNPIVOT(quantity FOR supplier IN (supplier_1, supplier_2))
)

```

| Row | day        | supplier   | quantity |
|-----|------------|------------|----------|
| 1   | 11/06/2022 | supplier_1 | 255      |
| 2   | 11/06/2022 | supplier_2 | 255      |
| 3   | 12/06/2022 | supplier_1 | 510      |
| 4   | 12/06/2022 | supplier_2 | 255      |

```

-- START DHondt_daily_supplier
initial_step_of_DHondt_daily_supplier AS
(
SELECT day,
       London_Borough,
       d.supplier,
       probability,
       quantity,
       probability * (quantity + 1) AS fraction,
       FLOOR(probability * (quantity + 1)) AS res,

       SUM( FLOOR(probability * (quantity + 1)) ) OVER (PARTITION BY day, d.supplier)
       AS total_res,
       quantity -
       SUM( FLOOR(probability * (quantity + 1)) )
       OVER (PARTITION BY day, d.supplier) AS n,
       ROW_NUMBER() OVER (
           PARTITION BY day, d.supplier
           ORDER BY ( probability * (quantity + 1) -
                       FLOOR(probability * (quantity + 1)) ) DESC)
       AS th_largest_reminder,
       ROW_NUMBER() OVER (
           PARTITION BY day,
           d.supplier ORDER BY probability)

```

```

        AS smallest_weight
FROM un_pivot_daily_total_supplied_quantity AS d
INNER JOIN un_pivot_prob_of_supply_per_borough AS p ON d.supplier = p.supplier
),
final_step_of_DHondt_daily_supplier as (
SELECT *,
        CAST(CASE WHEN (n = -1) AND (smallest_weight = 1) THEN res - 1
                WHEN (n > 0) AND (th_largest_reminder <= n) THEN res + 1
                ELSE res
        END AS INT64) AS daily_supplier_allocation
FROM initial_step_of_DHondt_daily_supplier
),
-- END    DHondt_daily_supplier

```

| Row | day        | London_Borough         | supplier   | probability | quantity | fraction | res  | total_res | n   | th_largest_reminder | smallest_weight | daily_supplier_allocation |
|-----|------------|------------------------|------------|-------------|----------|----------|------|-----------|-----|---------------------|-----------------|---------------------------|
| 1   | 11/06/2022 | Kensington and Chelsea | supplier_1 | 0.039       | 255      | 9.984    | 9.0  | 252.0     | 3.0 | 1                   | 1               | 10                        |
| 2   | 11/06/2022 | Richmond upon Thames   | supplier_1 | 0.078       | 255      | 19.968   | 19.0 | 252.0     | 3.0 | 2                   | 2               | 20                        |
| 3   | 11/06/2022 | City of Westminster    | supplier_1 | 0.078       | 255      | 19.968   | 19.0 | 252.0     | 3.0 | 3                   | 3               | 20                        |
| 4   | 11/06/2022 | Camden                 | supplier_1 | 0.118       | 255      | 30.208   | 30.0 | 252.0     | 3.0 | 5                   | 4               | 30                        |
| 5   | 11/06/2022 | Greenwich              | supplier_1 | 0.118       | 255      | 30.208   | 30.0 | 252.0     | 3.0 | 6                   | 5               | 30                        |
| 6   | 11/06/2022 | Ealing                 | supplier_1 | 0.157       | 255      | 40.192   | 40.0 | 252.0     | 3.0 | 7                   | 6               | 40                        |
| 7   | 11/06/2022 | Hammersmith and Fulham | supplier_1 | 0.192       | 255      | 49.152   | 49.0 | 252.0     | 3.0 | 8                   | 7               | 49                        |
| 8   | 11/06/2022 | Hounslow               | supplier_1 | 0.22        | 255      | 56.32    | 56.0 | 252.0     | 3.0 | 4                   | 8               | 56                        |
| 9   | 11/06/2022 | Kensington and Chelsea | supplier_2 | 0.039       | 255      | 9.984    | 9.0  | 252.0     | 3.0 | 1                   | 1               | 10                        |
| 10  | 11/06/2022 | Richmond upon Thames   | supplier_2 | 0.078       | 255      | 19.968   | 19.0 | 252.0     | 3.0 | 2                   | 2               | 20                        |
| 11  | 11/06/2022 | City of Westminster    | supplier_2 | 0.078       | 255      | 19.968   | 19.0 | 252.0     | 3.0 | 3                   | 3               | 20                        |
| 12  | 11/06/2022 | Camden                 | supplier_2 | 0.118       | 255      | 30.208   | 30.0 | 252.0     | 3.0 | 5                   | 4               | 30                        |
| 13  | 11/06/2022 | Greenwich              | supplier_2 | 0.118       | 255      | 30.208   | 30.0 | 252.0     | 3.0 | 6                   | 5               | 30                        |
| 14  | 11/06/2022 | Ealing                 | supplier_2 | 0.157       | 255      | 40.192   | 40.0 | 252.0     | 3.0 | 7                   | 6               | 40                        |
| 15  | 11/06/2022 | Hammersmith and Fulham | supplier_2 | 0.192       | 255      | 49.152   | 49.0 | 252.0     | 3.0 | 8                   | 7               | 49                        |
| 16  | 11/06/2022 | Hounslow               | supplier_2 | 0.22        | 255      | 56.32    | 56.0 | 252.0     | 3.0 | 4                   | 8               | 56                        |

|    |            |                        |            |       |     |                    |       |       |     |   |   |     |
|----|------------|------------------------|------------|-------|-----|--------------------|-------|-------|-----|---|---|-----|
| 17 | 12/06/2022 | Kensington and Chelsea | supplier_1 | 0.039 | 510 | 19.929             | 19.0  | 507.0 | 3.0 | 1 | 1 | 20  |
| 18 | 12/06/2022 | Richmond upon Thames   | supplier_1 | 0.078 | 510 | 39.858             | 39.0  | 507.0 | 3.0 | 2 | 2 | 40  |
| 19 | 12/06/2022 | City of Westminster    | supplier_1 | 0.078 | 510 | 39.858             | 39.0  | 507.0 | 3.0 | 3 | 3 | 40  |
| 20 | 12/06/2022 | Camden                 | supplier_1 | 0.118 | 510 | 60.297999999999995 | 60.0  | 507.0 | 3.0 | 5 | 4 | 60  |
| 21 | 12/06/2022 | Greenwich              | supplier_1 | 0.118 | 510 | 60.297999999999995 | 60.0  | 507.0 | 3.0 | 6 | 5 | 60  |
| 22 | 12/06/2022 | Ealing                 | supplier_1 | 0.157 | 510 | 80.227             | 80.0  | 507.0 | 3.0 | 7 | 6 | 80  |
| 23 | 12/06/2022 | Hammersmith and Fulham | supplier_1 | 0.192 | 510 | 98.112000000000009 | 98.0  | 507.0 | 3.0 | 8 | 7 | 98  |
| 24 | 12/06/2022 | Hounslow               | supplier_1 | 0.22  | 510 | 112.42             | 112.0 | 507.0 | 3.0 | 4 | 8 | 112 |
| 25 | 12/06/2022 | Kensington and Chelsea | supplier_2 | 0.039 | 255 | 9.984              | 9.0   | 252.0 | 3.0 | 1 | 1 | 10  |
| 26 | 12/06/2022 | Richmond upon Thames   | supplier_2 | 0.078 | 255 | 19.968             | 19.0  | 252.0 | 3.0 | 2 | 2 | 20  |
| 27 | 12/06/2022 | City of Westminster    | supplier_2 | 0.078 | 255 | 19.968             | 19.0  | 252.0 | 3.0 | 3 | 3 | 20  |
| 28 | 12/06/2022 | Camden                 | supplier_2 | 0.118 | 255 | 30.208             | 30.0  | 252.0 | 3.0 | 5 | 4 | 30  |
| 29 | 12/06/2022 | Greenwich              | supplier_2 | 0.118 | 255 | 30.208             | 30.0  | 252.0 | 3.0 | 6 | 5 | 30  |
| 30 | 12/06/2022 | Ealing                 | supplier_2 | 0.157 | 255 | 40.192             | 40.0  | 252.0 | 3.0 | 7 | 6 | 40  |
| 31 | 12/06/2022 | Hammersmith and Fulham | supplier_2 | 0.192 | 255 | 49.152             | 49.0  | 252.0 | 3.0 | 8 | 7 | 49  |
| 32 | 12/06/2022 | Hounslow               | supplier_2 | 0.22  | 255 | 56.32              | 56.0  | 252.0 | 3.0 | 4 | 8 | 56  |

### 3. Row Normalised Shop Weights per Day, Borough, and Shop

In this section we compute **Row Normalised Weight** (see Table 6) that we need to compute the number of items supplier can provide to the given shop, date and London Borough.

```
un_pivot_demand AS (  
  SELECT day, London_Borough, shop, indicator FROM demand  
  UNPIVOT(indicator FOR shop IN (shop_1, shop_2, shop_3))  
)
```

| Row | day        | London_Borough         | shop   | indicator |
|-----|------------|------------------------|--------|-----------|
| 1   | 11/06/2022 | Camden                 | shop_1 | FALSE     |
| 2   | 11/06/2022 | Camden                 | shop_2 | FALSE     |
| 3   | 11/06/2022 | Camden                 | shop_3 | FALSE     |
| 4   | 11/06/2022 | Ealing                 | shop_1 | FALSE     |
| 5   | 11/06/2022 | Ealing                 | shop_2 | FALSE     |
| 6   | 11/06/2022 | Ealing                 | shop_3 | TRUE      |
| 7   | 11/06/2022 | Greenwich              | shop_1 | FALSE     |
| 8   | 11/06/2022 | Greenwich              | shop_2 | TRUE      |
| 9   | 11/06/2022 | Greenwich              | shop_3 | FALSE     |
| 10  | 11/06/2022 | Hounslow               | shop_1 | FALSE     |
| 11  | 11/06/2022 | Hounslow               | shop_2 | TRUE      |
| 12  | 11/06/2022 | Hounslow               | shop_3 | TRUE      |
| 13  | 11/06/2022 | Richmond upon Thames   | shop_1 | TRUE      |
| 14  | 11/06/2022 | Richmond upon Thames   | shop_2 | FALSE     |
| 15  | 11/06/2022 | Richmond upon Thames   | shop_3 | FALSE     |
| 16  | 11/06/2022 | Hammersmith and Fulham | shop_1 | TRUE      |
| 17  | 11/06/2022 | Hammersmith and Fulham | shop_2 | FALSE     |
| 18  | 11/06/2022 | Hammersmith and Fulham | shop_3 | TRUE      |
| 19  | 11/06/2022 | Kensington and Chelsea | shop_1 | TRUE      |
| 20  | 11/06/2022 | Kensington and Chelsea | shop_2 | TRUE      |
| 21  | 11/06/2022 | Kensington and Chelsea | shop_3 | FALSE     |
| 22  | 11/06/2022 | City of Westminster    | shop_1 | TRUE      |
| 23  | 11/06/2022 | City of Westminster    | shop_2 | TRUE      |
| 24  | 11/06/2022 | City of Westminster    | shop_3 | TRUE      |
| 25  | 12/06/2022 | Camden                 | shop_1 | FALSE     |
| 26  | 12/06/2022 | Camden                 | shop_2 | FALSE     |
| 27  | 12/06/2022 | Camden                 | shop_3 | FALSE     |
| 28  | 12/06/2022 | Ealing                 | shop_1 | FALSE     |
| 29  | 12/06/2022 | Ealing                 | shop_2 | FALSE     |
| 30  | 12/06/2022 | Ealing                 | shop_3 | TRUE      |
| 31  | 12/06/2022 | Greenwich              | shop_1 | FALSE     |
| 32  | 12/06/2022 | Greenwich              | shop_2 | TRUE      |
| 33  | 12/06/2022 | Greenwich              | shop_3 | FALSE     |
| 34  | 12/06/2022 | Hounslow               | shop_1 | FALSE     |
| 35  | 12/06/2022 | Hounslow               | shop_2 | TRUE      |
| 36  | 12/06/2022 | Hounslow               | shop_3 | TRUE      |
| 37  | 12/06/2022 | Richmond upon Thames   | shop_1 | TRUE      |
| 38  | 12/06/2022 | Richmond upon Thames   | shop_2 | FALSE     |
| 39  | 12/06/2022 | Richmond upon Thames   | shop_3 | FALSE     |
| 40  | 12/06/2022 | Hammersmith and Fulham | shop_1 | TRUE      |
| 41  | 12/06/2022 | Hammersmith and Fulham | shop_2 | FALSE     |
| 42  | 12/06/2022 | Hammersmith and Fulham | shop_3 | TRUE      |
| 43  | 12/06/2022 | Kensington and Chelsea | shop_1 | TRUE      |
| 44  | 12/06/2022 | Kensington and Chelsea | shop_2 | TRUE      |
| 45  | 12/06/2022 | Kensington and Chelsea | shop_3 | FALSE     |
| 46  | 12/06/2022 | City of Westminster    | shop_1 | TRUE      |
| 47  | 12/06/2022 | City of Westminster    | shop_2 | TRUE      |
| 48  | 12/06/2022 | City of Westminster    | shop_3 | TRUE      |

```

deman_weight_un_pivot_demand AS (
SELECT day,
        London_Borough,
        u.shop,
        indicator,

```



```
        demand_weight,  
        CASE WHEN indicator THEN demand_weight ELSE 0 END AS indicator_weight,  
  
FROM un_pivot_demand AS u  
INNER JOIN demand_weight AS d ON d.shop=u.shop  
)
```

| Row | day        | London_Borough         | shop   | indicator | demand_weight | indicator_weight |
|-----|------------|------------------------|--------|-----------|---------------|------------------|
| 1   | 11/06/2022 | Camden                 | shop_1 | FALSE     | 0.2           | 0                |
| 2   | 11/06/2022 | Camden                 | shop_2 | FALSE     | 0.3           | 0                |
| 3   | 11/06/2022 | Camden                 | shop_3 | FALSE     | 0.5           | 0                |
| 4   | 11/06/2022 | Ealing                 | shop_1 | FALSE     | 0.2           | 0                |
| 5   | 11/06/2022 | Ealing                 | shop_2 | FALSE     | 0.3           | 0                |
| 6   | 11/06/2022 | Ealing                 | shop_3 | TRUE      | 0.5           | 0.5              |
| 7   | 11/06/2022 | Greenwich              | shop_1 | FALSE     | 0.2           | 0                |
| 8   | 11/06/2022 | Greenwich              | shop_2 | TRUE      | 0.3           | 0.3              |
| 9   | 11/06/2022 | Greenwich              | shop_3 | FALSE     | 0.5           | 0                |
| 10  | 11/06/2022 | Hounslow               | shop_1 | FALSE     | 0.2           | 0                |
| 11  | 11/06/2022 | Hounslow               | shop_2 | TRUE      | 0.3           | 0.3              |
| 12  | 11/06/2022 | Hounslow               | shop_3 | TRUE      | 0.5           | 0.5              |
| 13  | 11/06/2022 | Richmond upon Thames   | shop_1 | TRUE      | 0.2           | 0.2              |
| 14  | 11/06/2022 | Richmond upon Thames   | shop_2 | FALSE     | 0.3           | 0                |
| 15  | 11/06/2022 | Richmond upon Thames   | shop_3 | FALSE     | 0.5           | 0                |
| 16  | 11/06/2022 | Hammersmith and Fulham | shop_1 | TRUE      | 0.2           | 0.2              |
| 17  | 11/06/2022 | Hammersmith and Fulham | shop_2 | FALSE     | 0.3           | 0                |
| 18  | 11/06/2022 | Hammersmith and Fulham | shop_3 | TRUE      | 0.5           | 0.5              |
| 19  | 11/06/2022 | Kensington and Chelsea | shop_1 | TRUE      | 0.2           | 0.2              |
| 20  | 11/06/2022 | Kensington and Chelsea | shop_2 | TRUE      | 0.3           | 0.3              |
| 21  | 11/06/2022 | Kensington and Chelsea | shop_3 | FALSE     | 0.5           | 0                |
| 22  | 11/06/2022 | City of Westminster    | shop_1 | TRUE      | 0.2           | 0.2              |
| 23  | 11/06/2022 | City of Westminster    | shop_2 | TRUE      | 0.3           | 0.3              |
| 24  | 11/06/2022 | City of Westminster    | shop_3 | TRUE      | 0.5           | 0.5              |
| 25  | 12/06/2022 | Camden                 | shop_1 | FALSE     | 0.2           | 0                |
| 26  | 12/06/2022 | Camden                 | shop_2 | FALSE     | 0.3           | 0                |
| 27  | 12/06/2022 | Camden                 | shop_3 | FALSE     | 0.5           | 0                |
| 28  | 12/06/2022 | Ealing                 | shop_1 | FALSE     | 0.2           | 0                |
| 29  | 12/06/2022 | Ealing                 | shop_2 | FALSE     | 0.3           | 0                |
| 30  | 12/06/2022 | Ealing                 | shop_3 | TRUE      | 0.5           | 0.5              |
| 31  | 12/06/2022 | Greenwich              | shop_1 | FALSE     | 0.2           | 0                |
| 32  | 12/06/2022 | Greenwich              | shop_2 | TRUE      | 0.3           | 0.3              |
| 33  | 12/06/2022 | Greenwich              | shop_3 | FALSE     | 0.5           | 0                |
| 34  | 12/06/2022 | Hounslow               | shop_1 | FALSE     | 0.2           | 0                |
| 35  | 12/06/2022 | Hounslow               | shop_2 | TRUE      | 0.3           | 0.3              |
| 36  | 12/06/2022 | Hounslow               | shop_3 | TRUE      | 0.5           | 0.5              |
| 37  | 12/06/2022 | Richmond upon Thames   | shop_1 | TRUE      | 0.2           | 0.2              |
| 38  | 12/06/2022 | Richmond upon Thames   | shop_2 | FALSE     | 0.3           | 0                |
| 39  | 12/06/2022 | Richmond upon Thames   | shop_3 | FALSE     | 0.5           | 0                |
| 40  | 12/06/2022 | Hammersmith and Fulham | shop_1 | TRUE      | 0.2           | 0.2              |
| 41  | 12/06/2022 | Hammersmith and Fulham | shop_2 | FALSE     | 0.3           | 0                |
| 42  | 12/06/2022 | Hammersmith and Fulham | shop_3 | TRUE      | 0.5           | 0.5              |
| 43  | 12/06/2022 | Kensington and Chelsea | shop_1 | TRUE      | 0.2           | 0.2              |
| 44  | 12/06/2022 | Kensington and Chelsea | shop_2 | TRUE      | 0.3           | 0.3              |
| 45  | 12/06/2022 | Kensington and Chelsea | shop_3 | FALSE     | 0.5           | 0                |
| 46  | 12/06/2022 | City of Westminster    | shop_1 | TRUE      | 0.2           | 0.2              |
| 47  | 12/06/2022 | City of Westminster    | shop_2 | TRUE      | 0.3           | 0.3              |
| 48  | 12/06/2022 | City of Westminster    | shop_3 | TRUE      | 0.5           | 0.5              |

```

row_normalised_deman_weight_un_pivot_demand AS (
  SELECT
    day,
    London_Borough,
    shop,

```

```

        indicator,
        demand_weight,
        indicator_weight,
        CASE WHEN SUM(indicator_weight) OVER(PARTITION BY day, London_Borough) > 0
              THEN indicator_weight / SUM(indicator_weight)
              OVER(PARTITION BY day, London_Borough)
              ELSE 0
        END AS row_normalise_weight
FROM deman_weight_un_pivot_demand
WHERE indicator_weight > 0
)

```

| Row | day        | London_Borough         | shop   | indicator | demand_weight | indicator_weight | row_normalise_weight |
|-----|------------|------------------------|--------|-----------|---------------|------------------|----------------------|
| 1   | 11/06/2022 | City of Westminster    | shop_1 | TRUE      | 0.2           | 0.2              | 0.2                  |
| 2   | 11/06/2022 | City of Westminster    | shop_2 | TRUE      | 0.3           | 0.3              | 0.3                  |
| 3   | 11/06/2022 | City of Westminster    | shop_3 | TRUE      | 0.5           | 0.5              | 0.5                  |
| 4   | 11/06/2022 | Ealing                 | shop_3 | TRUE      | 0.5           | 0.5              | 1                    |
| 5   | 11/06/2022 | Greenwich              | shop_2 | TRUE      | 0.3           | 0.3              | 1                    |
| 6   | 11/06/2022 | Hammersmith and Fulham | shop_1 | TRUE      | 0.2           | 0.2              | 0.285714286          |
| 7   | 11/06/2022 | Hammersmith and Fulham | shop_3 | TRUE      | 0.5           | 0.5              | 0.714285714          |
| 8   | 11/06/2022 | Hounslow               | shop_2 | TRUE      | 0.3           | 0.3              | 0.375                |
| 9   | 11/06/2022 | Hounslow               | shop_3 | TRUE      | 0.5           | 0.5              | 0.625                |
| 10  | 11/06/2022 | Kensington and Chelsea | shop_1 | TRUE      | 0.2           | 0.2              | 0.4                  |
| 11  | 11/06/2022 | Kensington and Chelsea | shop_2 | TRUE      | 0.3           | 0.3              | 0.6                  |
| 12  | 11/06/2022 | Richmond upon Thames   | shop_1 | TRUE      | 0.2           | 0.2              | 1                    |
| 13  | 12/06/2022 | City of Westminster    | shop_1 | TRUE      | 0.2           | 0.2              | 0.2                  |
| 14  | 12/06/2022 | City of Westminster    | shop_2 | TRUE      | 0.3           | 0.3              | 0.3                  |
| 15  | 12/06/2022 | City of Westminster    | shop_3 | TRUE      | 0.5           | 0.5              | 0.5                  |
| 16  | 12/06/2022 | Ealing                 | shop_3 | TRUE      | 0.5           | 0.5              | 1                    |
| 17  | 12/06/2022 | Greenwich              | shop_2 | TRUE      | 0.3           | 0.3              | 1                    |
| 18  | 12/06/2022 | Hammersmith and Fulham | shop_1 | TRUE      | 0.2           | 0.2              | 0.285714286          |
| 19  | 12/06/2022 | Hammersmith and Fulham | shop_3 | TRUE      | 0.5           | 0.5              | 0.714285714          |
| 20  | 12/06/2022 | Hounslow               | shop_2 | TRUE      | 0.3           | 0.3              | 0.375                |
| 21  | 12/06/2022 | Hounslow               | shop_3 | TRUE      | 0.5           | 0.5              | 0.625                |
| 22  | 12/06/2022 | Kensington and Chelsea | shop_1 | TRUE      | 0.2           | 0.2              | 0.4                  |
| 23  | 12/06/2022 | Kensington and Chelsea | shop_2 | TRUE      | 0.3           | 0.3              | 0.6                  |
| 24  | 12/06/2022 | Richmond upon Thames   | shop_1 | TRUE      | 0.2           | 0.2              | 1                    |

## 4. Available Demand

In this section we compute **Supply AS Demand** (see Table 6) and **Available Demand** (see Table 7).

```

-- START DHondt_supply_AS_demand
initial_step_of_DHondt_supply_AS_demand AS (
SELECT
    r.day,
    r.London_Borough,

```

```

shop,
row_normalise_weight,
daily_supplier_allocation,

row_normalise_weight * (daily_supplier_allocation + 1)      AS fraction,
FLOOR(row_normalise_weight * (daily_supplier_allocation + 1)) AS res,

SUM( FLOOR(row_normalise_weight * (daily_supplier_allocation + 1)) )
  OVER (PARTITION BY r.day, r.London_Borough) AS total_res,
daily_supplier_allocation -
  SUM( FLOOR(row_normalise_weight * (daily_supplier_allocation + 1)) )
  OVER (PARTITION BY r.day, r.London_Borough) AS n,
ROW_NUMBER() OVER (
  PARTITION BY r.day, r.London_Borough
  ORDER BY ( row_normalise_weight * (daily_supplier_allocation + 1) -
    FLOOR(row_normalise_weight * (daily_supplier_allocation + 1)) ) DESC)
  AS th_largest_reminder,
ROW_NUMBER() OVER (PARTITION BY r.day, r.London_Borough
  ORDER BY row_normalise_weight) AS smallest_weight
FROM row_normalised_deman_weight_un_pivot_demand AS r
INNER JOIN (
  SELECT  day,
          London_Borough,
          SUM(daily_supplier_allocation) AS daily_supplier_allocation
  FROM final_step_of_DHondt_daily_supplier
  GROUP BY day, London_Borough
  ) as s ON r.day = s.day AND r.London_Borough = s.London_Borough
WHERE row_normalise_weight > 0
),
final_step_of_DHondt_supply_AS_demand as (
SELECT *,
  CAST(CASE WHEN (n = -1) AND (smallest_weight = 1) THEN res - 1
    WHEN (n > 0) AND (th_largest_reminder <= n) THEN res + 1
    ELSE res
  END AS INT64) AS allocation
FROM initial_step_of_DHondt_supply_AS_demand
ORDER BY day, London_Borough, shop
),
-- END DHondt_supply_AS_demand

```

| Row | day        | London_Borough         | shop   | row_normalise_weight | daily_supplier_allocation | fraction | res | total_res | n  | th_largest_reminder | smallest_weight | allocation |
|-----|------------|------------------------|--------|----------------------|---------------------------|----------|-----|-----------|----|---------------------|-----------------|------------|
| 1   | 11/06/2022 | City of Westminster    | shop_1 | 0.2                  | 40                        | 8.2      | 8   | 40        | 0  | 3                   | 1               | 8          |
| 2   | 11/06/2022 | City of Westminster    | shop_2 | 0.3                  | 40                        | 12.3     | 12  | 40        | 0  | 2                   | 2               | 12         |
| 3   | 11/06/2022 | City of Westminster    | shop_3 | 0.5                  | 40                        | 20.5     | 20  | 40        | 0  | 1                   | 3               | 20         |
| 4   | 11/06/2022 | Ealing                 | shop_3 | 1                    | 80                        | 81       | 81  | 81        | -1 | 1                   | 1               | 80         |
| 5   | 11/06/2022 | Greenwich              | shop_2 | 1                    | 60                        | 61       | 61  | 61        | -1 | 1                   | 1               | 60         |
| 6   | 11/06/2022 | Hammersmith and Fulham | shop_1 | 0.285714286          | 98                        | 28.28571 | 28  | 98        | 0  | 2                   | 1               | 28         |
| 7   | 11/06/2022 | Hammersmith and Fulham | shop_3 | 0.714285714          | 98                        | 70.71429 | 70  | 98        | 0  | 1                   | 2               | 70         |
| 8   | 11/06/2022 | Hounslow               | shop_2 | 0.375                | 112                       | 42.375   | 42  | 112       | 0  | 2                   | 1               | 42         |
| 9   | 11/06/2022 | Hounslow               | shop_3 | 0.625                | 112                       | 70.625   | 70  | 112       | 0  | 1                   | 2               | 70         |
| 10  | 11/06/2022 | Kensington and Chelsea | shop_1 | 0.4                  | 20                        | 8.4      | 8   | 20        | 0  | 2                   | 1               | 8          |
| 11  | 11/06/2022 | Kensington and Chelsea | shop_2 | 0.6                  | 20                        | 12.6     | 12  | 20        | 0  | 1                   | 2               | 12         |
| 12  | 11/06/2022 | Richmond upon Thames   | shop_1 | 1                    | 40                        | 41       | 41  | 41        | -1 | 1                   | 1               | 40         |
| 13  | 12/06/2022 | City of Westminster    | shop_1 | 0.2                  | 60                        | 12.2     | 12  | 60        | 0  | 3                   | 1               | 12         |
| 14  | 12/06/2022 | City of Westminster    | shop_2 | 0.3                  | 60                        | 18.3     | 18  | 60        | 0  | 2                   | 2               | 18         |
| 15  | 12/06/2022 | City of Westminster    | shop_3 | 0.5                  | 60                        | 30.5     | 30  | 60        | 0  | 1                   | 3               | 30         |
| 16  | 12/06/2022 | Ealing                 | shop_3 | 1                    | 120                       | 121      | 121 | 121       | -1 | 1                   | 1               | 120        |
| 17  | 12/06/2022 | Greenwich              | shop_2 | 1                    | 90                        | 91       | 91  | 91        | -1 | 1                   | 1               | 90         |
| 18  | 12/06/2022 | Hammersmith and Fulham | shop_1 | 0.285714286          | 147                       | 42.28571 | 42  | 147       | 0  | 2                   | 1               | 42         |
| 19  | 12/06/2022 | Hammersmith and Fulham | shop_3 | 0.714285714          | 147                       | 105.7143 | 105 | 147       | 0  | 1                   | 2               | 105        |
| 20  | 12/06/2022 | Hounslow               | shop_2 | 0.375                | 168                       | 63.375   | 63  | 168       | 0  | 2                   | 1               | 63         |
| 21  | 12/06/2022 | Hounslow               | shop_3 | 0.625                | 168                       | 105.625  | 105 | 168       | 0  | 1                   | 2               | 105        |
| 22  | 12/06/2022 | Kensington and Chelsea | shop_1 | 0.4                  | 30                        | 12.4     | 12  | 30        | 0  | 2                   | 1               | 12         |
| 23  | 12/06/2022 | Kensington and Chelsea | shop_2 | 0.6                  | 30                        | 18.6     | 18  | 30        | 0  | 1                   | 2               | 18         |
| 24  | 12/06/2022 | Richmond upon Thames   | shop_1 | 1                    | 60                        | 61       | 61  | 61        | -1 | 1                   | 1               | 60         |

```

available_demand AS (
SELECT
    s.shop,
    demand_quantity,
    supply_quantity,
    CASE WHEN demand_quantity < supply_quantity
        THEN demand_quantity
        ELSE supply_quantity
    END AS available_demand
FROM shop_demand as s
INNER JOIN (
    SELECT
        shop,
        SUM(allocation) AS supply_quantity
    FROM final_step_of_DHondt_supply_AS_demand
    GROUP BY shop
) AS f ON s.shop = f.shop
)

```

| Row | shop   | demand_quantity | supply_quantity | available_demand |
|-----|--------|-----------------|-----------------|------------------|
| 1   | shop_1 | 150             | 210             | 150              |
| 2   | shop_2 | 500             | 315             | 315              |
| 3   | shop_3 | 300             | 600             | 300              |

## 5. Final Allocation by DHondt

It is the final section where compute the output similar to “**Final Allocation**” (see Table 8).

```
pre_final AS
(
    SELECT
        day,
        London_Borough,
        f.shop,
        allocation * 1.0 / SUM(allocation)
            OVER(PARTITION BY f.shop) AS column_normalised_weight,
        available_demand
    FROM final_step_of_DHondt_supply_AS_demand AS f
    INNER JOIN available_demand AS a on f.shop = a.shop
)
```

| Row | day        | London_Borough         | shop   | column_normalised_weight | available_demand |
|-----|------------|------------------------|--------|--------------------------|------------------|
| 1   | 11/06/2022 | City of Westminster    | shop_1 | 0.038095238              | 150              |
| 2   | 11/06/2022 | City of Westminster    | shop_2 | 0.038095238              | 315              |
| 3   | 11/06/2022 | City of Westminster    | shop_3 | 0.033333333              | 300              |
| 4   | 11/06/2022 | Ealing                 | shop_3 | 0.133333333              | 300              |
| 5   | 11/06/2022 | Greenwich              | shop_2 | 0.19047619               | 315              |
| 6   | 11/06/2022 | Hammersmith and Fulham | shop_1 | 0.133333333              | 150              |
| 7   | 11/06/2022 | Hammersmith and Fulham | shop_3 | 0.116666667              | 300              |
| 8   | 11/06/2022 | Hounslow               | shop_2 | 0.133333333              | 315              |
| 9   | 11/06/2022 | Hounslow               | shop_3 | 0.116666667              | 300              |
| 10  | 11/06/2022 | Kensington and Chelsea | shop_1 | 0.038095238              | 150              |
| 11  | 11/06/2022 | Kensington and Chelsea | shop_2 | 0.038095238              | 315              |
| 12  | 11/06/2022 | Richmond upon Thames   | shop_1 | 0.19047619               | 150              |
| 13  | 12/06/2022 | City of Westminster    | shop_1 | 0.057142857              | 150              |
| 14  | 12/06/2022 | City of Westminster    | shop_2 | 0.057142857              | 315              |
| 15  | 12/06/2022 | City of Westminster    | shop_3 | 0.05                     | 300              |
| 16  | 12/06/2022 | Ealing                 | shop_3 | 0.2                      | 300              |
| 17  | 12/06/2022 | Greenwich              | shop_2 | 0.285714286              | 315              |
| 18  | 12/06/2022 | Hammersmith and Fulham | shop_1 | 0.2                      | 150              |
| 19  | 12/06/2022 | Hammersmith and Fulham | shop_3 | 0.175                    | 300              |
| 20  | 12/06/2022 | Hounslow               | shop_2 | 0.2                      | 315              |
| 21  | 12/06/2022 | Hounslow               | shop_3 | 0.175                    | 300              |
| 22  | 12/06/2022 | Kensington and Chelsea | shop_1 | 0.057142857              | 150              |
| 23  | 12/06/2022 | Kensington and Chelsea | shop_2 | 0.057142857              | 315              |
| 24  | 12/06/2022 | Richmond upon Thames   | shop_1 | 0.285714286              | 150              |

```

-- START DHondt_final
initial_step_of_DHondt_final AS (
SELECT
    day,
    London_Borough,
    shop,
    column_normalised_weight,
    available_demand,

    column_normalised_weight * (available_demand + 1)          AS fraction,
    FLOOR( column_normalised_weight * (available_demand + 1) ) AS res,

    SUM( FLOOR( column_normalised_weight * (available_demand + 1)) )
      OVER (PARTITION BY shop) AS total_res,
    available_demand -
      SUM( FLOOR( column_normalised_weight * (available_demand + 1)) )
      OVER (PARTITION BY shop)   AS n,
    ROW_NUMBER() OVER (
        PARTITION BY shop
        ORDER BY ( column_normalised_weight * (available_demand + 1) -
            FLOOR( column_normalised_weight * (available_demand + 1) )) DESC)
        AS th_largest_reminder,
    ROW_NUMBER() OVER (
        PARTITION BY shop
        ORDER BY column_normalised_weight)
        AS smallest_weight
FROM pre_final
),
final_step_of_DHondt_final as (
SELECT *,
    CAST(CASE WHEN (n = -1) AND (smallest_weight = 1) THEN res - 1
        WHEN (n > 0) AND (th_largest_reminder <= n) THEN res + 1
        ELSE res
    END AS INT64) AS allocation
FROM initial_step_of_DHondt_final
),
-- END DHondt_final

```

| Row | day        | London_Borough    | shop   | column_normalised_weight | available_demand | fraction | res | total_res | n | th_largest_reminder | smallest_weight | allocation |
|-----|------------|-------------------|--------|--------------------------|------------------|----------|-----|-----------|---|---------------------|-----------------|------------|
| 1   | 11/06/2022 | nsington and Chel | shop_1 | 0.038095238              | 150              | 5.752381 | 5   | 147       | 3 | 2                   | 1               | 6          |
| 2   | 11/06/2022 | ity of Westminste | shop_1 | 0.038095238              | 150              | 5.752381 | 5   | 147       | 3 | 3                   | 2               | 6          |
| 3   | 12/06/2022 | ity of Westminste | shop_1 | 0.057142857              | 150              | 8.628571 | 8   | 147       | 3 | 4                   | 3               | 8          |
| 4   | 12/06/2022 | nsington and Chel | shop_1 | 0.057142857              | 150              | 8.628571 | 8   | 147       | 3 | 5                   | 4               | 8          |
| 5   | 11/06/2022 | mersmith and Ful  | shop_1 | 0.133333333              | 150              | 20.13333 | 20  | 147       | 3 | 8                   | 5               | 20         |
| 6   | 11/06/2022 | hmond upon Than   | shop_1 | 0.19047619               | 150              | 28.7619  | 28  | 147       | 3 | 1                   | 6               | 29         |
| 7   | 12/06/2022 | mersmith and Ful  | shop_1 | 0.2                      | 150              | 30.2     | 30  | 147       | 3 | 6                   | 7               | 30         |
| 8   | 12/06/2022 | hmond upon Than   | shop_1 | 0.285714286              | 150              | 43.14286 | 43  | 147       | 3 | 7                   | 8               | 43         |
| 9   | 11/06/2022 | nsington and Chel | shop_2 | 0.038095238              | 315              | 12.0381  | 12  | 315       | 0 | 7                   | 1               | 12         |
| 10  | 11/06/2022 | ity of Westminste | shop_2 | 0.038095238              | 315              | 12.0381  | 12  | 315       | 0 | 8                   | 2               | 12         |
| 11  | 12/06/2022 | ity of Westminste | shop_2 | 0.057142857              | 315              | 18.05714 | 18  | 315       | 0 | 5                   | 3               | 18         |
| 12  | 12/06/2022 | nsington and Chel | shop_2 | 0.057142857              | 315              | 18.05714 | 18  | 315       | 0 | 6                   | 4               | 18         |
| 13  | 11/06/2022 | Hounslow          | shop_2 | 0.133333333              | 315              | 42.13333 | 42  | 315       | 0 | 4                   | 5               | 42         |
| 14  | 11/06/2022 | Greenwich         | shop_2 | 0.19047619               | 315              | 60.19048 | 60  | 315       | 0 | 3                   | 6               | 60         |
| 15  | 12/06/2022 | Hounslow          | shop_2 | 0.2                      | 315              | 63.2     | 63  | 315       | 0 | 2                   | 7               | 63         |
| 16  | 12/06/2022 | Greenwich         | shop_2 | 0.285714286              | 315              | 90.28571 | 90  | 315       | 0 | 1                   | 8               | 90         |
| 17  | 11/06/2022 | ity of Westminste | shop_3 | 0.033333333              | 300              | 10.03333 | 10  | 299       | 1 | 8                   | 1               | 10         |
| 18  | 12/06/2022 | ity of Westminste | shop_3 | 0.05                     | 300              | 15.05    | 15  | 299       | 1 | 7                   | 2               | 15         |
| 19  | 11/06/2022 | mersmith and Ful  | shop_3 | 0.116666667              | 300              | 35.11667 | 35  | 299       | 1 | 5                   | 3               | 35         |
| 20  | 11/06/2022 | Hounslow          | shop_3 | 0.116666667              | 300              | 35.11667 | 35  | 299       | 1 | 6                   | 4               | 35         |
| 21  | 11/06/2022 | Ealing            | shop_3 | 0.133333333              | 300              | 40.13333 | 40  | 299       | 1 | 4                   | 5               | 40         |
| 22  | 12/06/2022 | mersmith and Ful  | shop_3 | 0.175                    | 300              | 52.675   | 52  | 299       | 1 | 1                   | 6               | 53         |
| 23  | 12/06/2022 | Hounslow          | shop_3 | 0.175                    | 300              | 52.675   | 52  | 299       | 1 | 2                   | 7               | 52         |
| 24  | 12/06/2022 | Ealing            | shop_3 | 0.2                      | 300              | 60.2     | 60  | 299       | 1 | 3                   | 8               | 60         |

```

pivot_final AS(
SELECT day,
       London_Borough,
       IFNULL(CAST(allocation_shop_1 AS INT64), 0) AS allocation_shop_1,
       IFNULL(CAST(allocation_shop_2 AS INT64), 0) AS allocation_shop_2,
       IFNULL(CAST(allocation_shop_3 AS INT64), 0) AS allocation_shop_3
FROM
(
  -- #1 from_item
  SELECT
    day,
    London_Borough,
    shop,
    CAST(allocation AS INT64) AS allocation
  FROM final_step_of_DHondt_final
)
PIVOT
(
  -- #2 aggregate
  AVG(allocation) AS allocation
  -- #3 pivot_column
  FOR shop in ('shop_1', 'shop_2', 'shop_3')
)
ORDER BY day, London_Borough
)

```



| Row | day        | London_Borough         | allocation_shop_1 | allocation_shop_2 | allocation_shop_3 |
|-----|------------|------------------------|-------------------|-------------------|-------------------|
| 1   | 11/06/2022 | City of Westminster    | 6                 | 12                | 10                |
| 2   | 11/06/2022 | Ealing                 | 0                 | 0                 | 40                |
| 3   | 11/06/2022 | Greenwich              | 0                 | 60                | 0                 |
| 4   | 11/06/2022 | Hammersmith and Fulham | 20                | 0                 | 35                |
| 5   | 11/06/2022 | Hounslow               | 0                 | 42                | 35                |
| 6   | 11/06/2022 | Kensington and Chelsea | 6                 | 12                | 0                 |
| 7   | 11/06/2022 | Richmond upon Thames   | 29                | 0                 | 0                 |
| 8   | 12/06/2022 | City of Westminster    | 8                 | 18                | 15                |
| 9   | 12/06/2022 | Ealing                 | 0                 | 0                 | 60                |
| 10  | 12/06/2022 | Greenwich              | 0                 | 90                | 0                 |
| 11  | 12/06/2022 | Hammersmith and Fulham | 30                | 0                 | 53                |
| 12  | 12/06/2022 | Hounslow               | 0                 | 63                | 52                |
| 13  | 12/06/2022 | Kensington and Chelsea | 8                 | 18                | 0                 |
| 14  | 12/06/2022 | Richmond upon Thames   | 43                | 0                 | 0                 |

```

WITH
demand_weight AS (
    SELECT 'shop_1' AS shop, 0.2 AS demand_weight UNION ALL
    SELECT 'shop_2',          0.3                      UNION ALL
    SELECT 'shop_3',          0.5
),
shop_demand AS(
    SELECT 'shop_1' AS shop, 150 AS demand_quantity UNION ALL
    SELECT 'shop_2',          500                      UNION ALL
    SELECT 'shop_3',          300
),
demand AS (
    SELECT '11/06/2022' AS day, 'Camden'                AS London_Borough,
           False AS Shop_1, False AS Shop_2, False AS Shop_3 UNION ALL
    SELECT '11/06/2022' AS day, 'Ealing'                 AS London_Borough,
           False AS Shop_1, False AS Shop_2, True AS Shop_3 UNION ALL
    SELECT '11/06/2022' AS day, 'Greenwich'              AS London_Borough,
           False AS Shop_1, True AS Shop_2, False AS Shop_3 UNION ALL
    SELECT '11/06/2022' AS day, 'Hounslow'               AS London_Borough,
           False AS Shop_1, True AS Shop_2, True AS Shop_3 UNION ALL
    SELECT '11/06/2022' AS day, 'Richmond upon Thames'  AS London_Borough,
           True AS Shop_1, False AS Shop_2, False AS Shop_3 UNION ALL
    SELECT '11/06/2022' AS day, 'Hammersmith and Fulham' AS London_Borough,
           True AS Shop_1, False AS Shop_2, True AS Shop_3 UNION ALL
    SELECT '11/06/2022' AS day, 'Kensington and Chelsea' AS London_Borough,
           True AS Shop_1, True AS Shop_2, False AS Shop_3 UNION ALL

```

```

SELECT '11/06/2022' AS day, 'City of Westminster' AS London_Borough,
      True AS Shop_1, True AS Shop_2, True AS Shop_3 UNION ALL
SELECT '12/06/2022' AS day, 'Camden' AS London_Borough,
      False AS Shop_1, False AS Shop_2, False AS Shop_3 UNION ALL
SELECT '12/06/2022' AS day, 'Ealing' AS London_Borough,
      False AS Shop_1, False AS Shop_2, True AS Shop_3 UNION ALL
SELECT '12/06/2022' AS day, 'Greenwich' AS London_Borough,
      False AS Shop_1, True AS Shop_2, False AS Shop_3 UNION ALL
SELECT '12/06/2022' AS day, 'Hounslow' AS London_Borough,
      False AS Shop_1, True AS Shop_2, True AS Shop_3 UNION ALL
SELECT '12/06/2022' AS day, 'Richmond upon Thames' AS London_Borough,
      True AS Shop_1, False AS Shop_2, False AS Shop_3 UNION ALL
SELECT '12/06/2022' AS day, 'Hammersmith and Fulham' AS London_Borough,
      True AS Shop_1, False AS Shop_2, True AS Shop_3 UNION ALL
SELECT '12/06/2022' AS day, 'Kensington and Chelsea' AS London_Borough,
      True AS Shop_1, True AS Shop_2, False AS Shop_3 UNION ALL
SELECT '12/06/2022' AS day, 'City of Westminster' AS London_Borough,
      True AS Shop_1, True AS Shop_2, True AS Shop_3
),

```

```

-- SUPPLY
prob_of_supply_per_borough AS (
SELECT 'Camden' AS London_Borough, 0.118 AS supplier_1,
      0.118 AS supplier_2 UNION ALL
SELECT 'Ealing' AS London_Borough, 0.157 AS supplier_1,
      0.157 AS supplier_2 UNION ALL
SELECT 'Greenwich' AS London_Borough, 0.118 AS supplier_1,
      0.118 AS supplier_2 UNION ALL
SELECT 'Hounslow' AS London_Borough, 0.220 AS supplier_1,
      0.220 AS supplier_2 UNION ALL
SELECT 'Richmond upon Thames' AS London_Borough, 0.078 AS supplier_1,
      0.078 AS supplier_2 UNION ALL
SELECT 'Hammersmith and Fulham' AS London_Borough, 0.192 AS supplier_1,
      0.192 AS supplier_2 UNION ALL
SELECT 'Kensington and Chelsea' AS London_Borough, 0.039 AS supplier_1,
      0.039 AS supplier_2 UNION ALL
SELECT 'City of Westminster' AS London_Borough, 0.078 AS supplier_1,
      0.078 AS supplier_2
),
daily_total_supplied_quantity AS(
SELECT '11/06/2022' AS day, 255 AS supplier_1, 255 AS supplier_2 UNION ALL
SELECT '12/06/2022' AS day, 510 AS supplier_1, 255 AS supplier_2
),
un_pivot_demand AS (
SELECT day, London_Borough, shop, indicator FROM demand
UNPIVOT(indicator FOR shop IN (shop_1, shop_2, shop_3))
),
deman_weight_un_pivot_demand AS (
SELECT day,
      London_Borough,

```

```

        u.shop,
        indicator,
        demand_weight,
        CASE WHEN indicator THEN demand_weight ELSE 0 END AS indicator_weight,

FROM un_pivot_demand AS u
INNER JOIN demand_weight AS d ON d.shop=u.shop
),
row_normalised_deman_weight_un_pivot_demand AS (
    SELECT
        day,
        London_Borough,
        shop,
        indicator,
        demand_weight,
        indicator_weight,
        CASE WHEN SUM(indicator_weight) OVER(PARTITION BY day, London_Borough) > 0
                THEN indicator_weight / SUM(indicator_weight)
                OVER(PARTITION BY day, London_Borough)
                ELSE 0
        END AS row_normalise_weight
FROM deman_weight_un_pivot_demand
WHERE indicator_weight > 0
),
un_pivot_prob_of_supply_per_borough AS (
    SELECT London_Borough, supplier, probability FROM prob_of_supply_per_borough
    UNPIVOT(probability FOR supplier IN (supplier_1, supplier_2))
),
un_pivot_daily_total_supplied_quantity AS (
    SELECT day, supplier, quantity FROM daily_total_supplied_quantity
    UNPIVOT(quantity FOR supplier IN (supplier_1, supplier_2))
),
-- START DHondt_daily_supplier
initial_step_of_DHondt_daily_supplier AS
(
    SELECT day,
        London_Borough,
        d.supplier,
        probability,
        quantity,
        probability * (quantity + 1) AS fraction,
        FLOOR(probability * (quantity + 1)) AS res,

        SUM( FLOOR(probability * (quantity + 1)) ) OVER (PARTITION BY day, d.supplier)
        AS total_res,
        quantity -
            SUM( FLOOR(probability * (quantity + 1)) )
            OVER (PARTITION BY day, d.supplier) AS n,
        ROW_NUMBER() OVER (
            PARTITION BY day, d.supplier
            ORDER BY ( probability * (quantity + 1) -
                FLOOR(probability * (quantity + 1)) ) DESC)
        AS th_largest_reminder,
        ROW_NUMBER() OVER (

```

```

PARTITION BY day,
d.supplier ORDER BY probability)
AS smallest_weight
FROM un_pivot_daily_total_supplied_quantity AS d
INNER JOIN un_pivot_prob_of_supply_per_borough AS p ON d.supplier = p.supplier
),
final_step_of_DHondt_daily_supplier as (
SELECT *,
CAST(CASE WHEN (n = -1) AND (smallest_weight = 1) THEN res - 1
WHEN (n > 0) AND (th_largest_reminder <= n) THEN res + 1
ELSE res
END AS INT64) AS daily_supplier_allocation
FROM initial_step_of_DHondt_daily_supplier
),
-- END DHondt_daily_supplier
-- START DHondt_supply_AS_demand
initial_step_of_DHondt_supply_AS_demand AS (
SELECT
r.day,
r.London_Borough,
shop,
row_normalise_weight,
daily_supplier_allocation,

row_normalise_weight * (daily_supplier_allocation + 1) AS fraction,
FLOOR(row_normalise_weight * (daily_supplier_allocation + 1)) AS res,

SUM( FLOOR(row_normalise_weight * (daily_supplier_allocation + 1)) )
OVER (PARTITION BY r.day, r.London_Borough) AS total_res,
daily_supplier_allocation -
SUM( FLOOR(row_normalise_weight * (daily_supplier_allocation + 1)) )
OVER (PARTITION BY r.day, r.London_Borough) AS n,
ROW_NUMBER() OVER (
PARTITION BY r.day, r.London_Borough
ORDER BY ( row_normalise_weight * (daily_supplier_allocation + 1) -
FLOOR(row_normalise_weight * (daily_supplier_allocation + 1)) ) DESC)
AS th_largest_reminder,
ROW_NUMBER() OVER (PARTITION BY r.day, r.London_Borough
ORDER BY row_normalise_weight) AS smallest_weight
FROM row_normalised_deman_weight_un_pivot_demand AS r
INNER JOIN (
SELECT day,
London_Borough,
SUM(daily_supplier_allocation) AS daily_supplier_allocation
FROM final_step_of_DHondt_daily_supplier
GROUP BY day, London_Borough
) as s ON r.day = s.day AND r.London_Borough = s.London_Borough
WHERE row_normalise_weight > 0
),
final_step_of_DHondt_supply_AS_demand as (
SELECT *,
CAST(CASE WHEN (n = -1) AND (smallest_weight = 1) THEN res - 1
WHEN (n > 0) AND (th_largest_reminder <= n) THEN res + 1

```

```

        ELSE res
    END AS INT64) AS allocation
FROM initial_step_of_DHondt_supply_AS_demand
ORDER BY day, London_Borough, shop
),
-- END DHondt_supply_AS_demand
available_demand AS (
SELECT
    s.shop,
    demand_quantity,
    supply_quantity,
    CASE WHEN demand_quantity < supply_quantity
        THEN demand_quantity
        ELSE supply_quantity
    END AS available_demand
FROM shop_demand as s
INNER JOIN (
    SELECT
        shop,
        SUM(allocation) AS supply_quantity
    FROM final_step_of_DHondt_supply_AS_demand
    GROUP BY shop

) AS f ON s.shop = f.shop
),
pre_final AS
(
    SELECT
        day,
        London_Borough,
        f.shop,
        allocation * 1.0 / SUM(allocation) OVER(PARTITION BY f.shop)
        AS column_normalised_weight,
        available_demand
    FROM final_step_of_DHondt_supply_AS_demand AS f
    INNER JOIN available_demand AS a on f.shop = a.shop
),
-- START DHondt_final
initial_step_of_DHondt_final AS (
SELECT
    day,
    London_Borough,
    shop,
    column_normalised_weight,
    available_demand,

    column_normalised_weight * (available_demand + 1) AS fraction,
    FLOOR( column_normalised_weight * (available_demand + 1) ) AS res,

    SUM( FLOOR( column_normalised_weight * (available_demand + 1)) )
    OVER (PARTITION BY shop) AS total_res,
    available_demand -
    SUM( FLOOR( column_normalised_weight * (available_demand + 1)) )
    OVER (PARTITION BY shop) AS n,

```

```

        ROW_NUMBER() OVER (
            PARTITION BY shop
            ORDER BY ( column_normalised_weight * (available_demand + 1) -
                FLOOR( column_normalised_weight * (available_demand + 1) )) DESC)
        AS th_largest_reminder,
        ROW_NUMBER() OVER (
            PARTITION BY shop
            ORDER BY column_normalised_weight)
        AS smallest_weight
FROM pre_final
),
final_step_of_DHondt_final as (
SELECT *,
        CAST(CASE WHEN (n = -1) AND (smallest_weight = 1) THEN res - 1
            WHEN (n > 0) AND (th_largest_reminder <= n) THEN res + 1
            ELSE res
        END AS INT64) AS allocation
FROM initial_step_of_DHondt_final
),
-- END DHondt_final
pivot_final AS(
SELECT day,
        London_Borough,
        IFNULL(CAST(allocation_shop_1 AS INT64), 0) AS allocation_shop_1,
        IFNULL(CAST(allocation_shop_2 AS INT64), 0) AS allocation_shop_2,
        IFNULL(CAST(allocation_shop_3 AS INT64), 0) AS allocation_shop_3
FROM
(
    -- #1 from_item
    SELECT
        day,
        London_Borough,
        shop,
        CAST(allocation AS INT64) AS allocation
    FROM final_step_of_DHondt_final
)
PIVOT
(
    -- #2 aggregate
    AVG(allocation) AS allocation
    -- #3 pivot_column
    FOR shop in ('shop_1', 'shop_2', 'shop_3')
)
ORDER BY day, London_Borough
)

select * from pivot_final

```