1. a. Considering the three base cells $(a_1, a_2, a_3, c_4, \cdots, c_9, c_{10}), (b_1, b_2, b_3, c_4, \cdots, c_9, c_{10})$ and $(c_1, c_2, c_3, c_4, ..., c_9, c_{10})$, which implies that the dimension of cube is 10. And since their is only 1 level, so the number of cuboids is

$$\#\text{cuboid} = 2^{10} = 1024$$

b. For each base cell, we have corresponding number aggregate cells

$$\#\text{aggregate}_i = \sum_{j=2}^{10} \binom{10}{j} = 2^{10} - 1 = 1023$$

and considering the duplicated aggregated cells

$$\#\text{duplicated aggregate} = (3-1)\sum_{j=0}^{7} \binom{7}{j} = 256$$

As a result, we conclude that the total number of distinct aggregate cells is

$$\#\text{distinct aggregate} = 3 \cdot 1023 - 256 = 2813$$

c.

$$\#\text{count} > 2 = \sum_{j=0}^{7} \binom{7}{j} = 128$$

d. By definition of close cube, we have the following close cubes $(a_1, a_2, a_3, c_4, \cdots, c_9, c_{10})$, $(b_1, b_2, b_3, c_4, \cdots, c_9, c_{10})$, $(c_1, c_2, c_3, c_4, ..., c_9, c_{10})$ and $(*, *, *, c_4, ..., c_9, c_{10})$, in which the only one with count = 3 is $(*, *, *, c_4, ..., c_9, c_{10})$, and the non-star dimension is 7.

2. a. Since the dimension of data cube is 4, the number of cuboids is

$$\#\text{cuboid} = \prod_{i=0}^{4} L_i = 3 \cdot 2 \cdot 2 \cdot 2 = 24$$

b. By running code in *Question2.lbai5.py* to drop duplicated cells, we get that the number of cells in cuboid (Location(City), Category, Price, Rating) is 48.

c. Similarly, we get that the number of cells in cuboid (Location(State), Category, Price, Rating) is 34.

d. Similarly, we get that the number of cells in cuboid (*, Category, Price, Rating) is 23.

e. Similarly, we get that the number of cells in cuboid (Location(State) = Illinois, *, Price = mod is 2.

f. Similarly, we get that the number of cells in cuboid (Location(City) = food, Category = food, * is 2.

3. a. By running code in *Question3.lbai5.py* to drop duplicated cells, we get that

   1. The number of frequent patterns is 30.
   2. The number of frequent patterns with length 3 is 8.
   3. The number of max patterns is 7.

   b. Similarly, we have

   1. The number of frequent patterns is 55.
   2. The number of frequent patterns with length 3 is 20.
   3. The number of max patterns is 6.
   4. The confidence of rule (C, E) $\rightarrow$ A is 67.857%
   5. The confidence of rule (A, B, C) $\rightarrow$ E is 74.194%