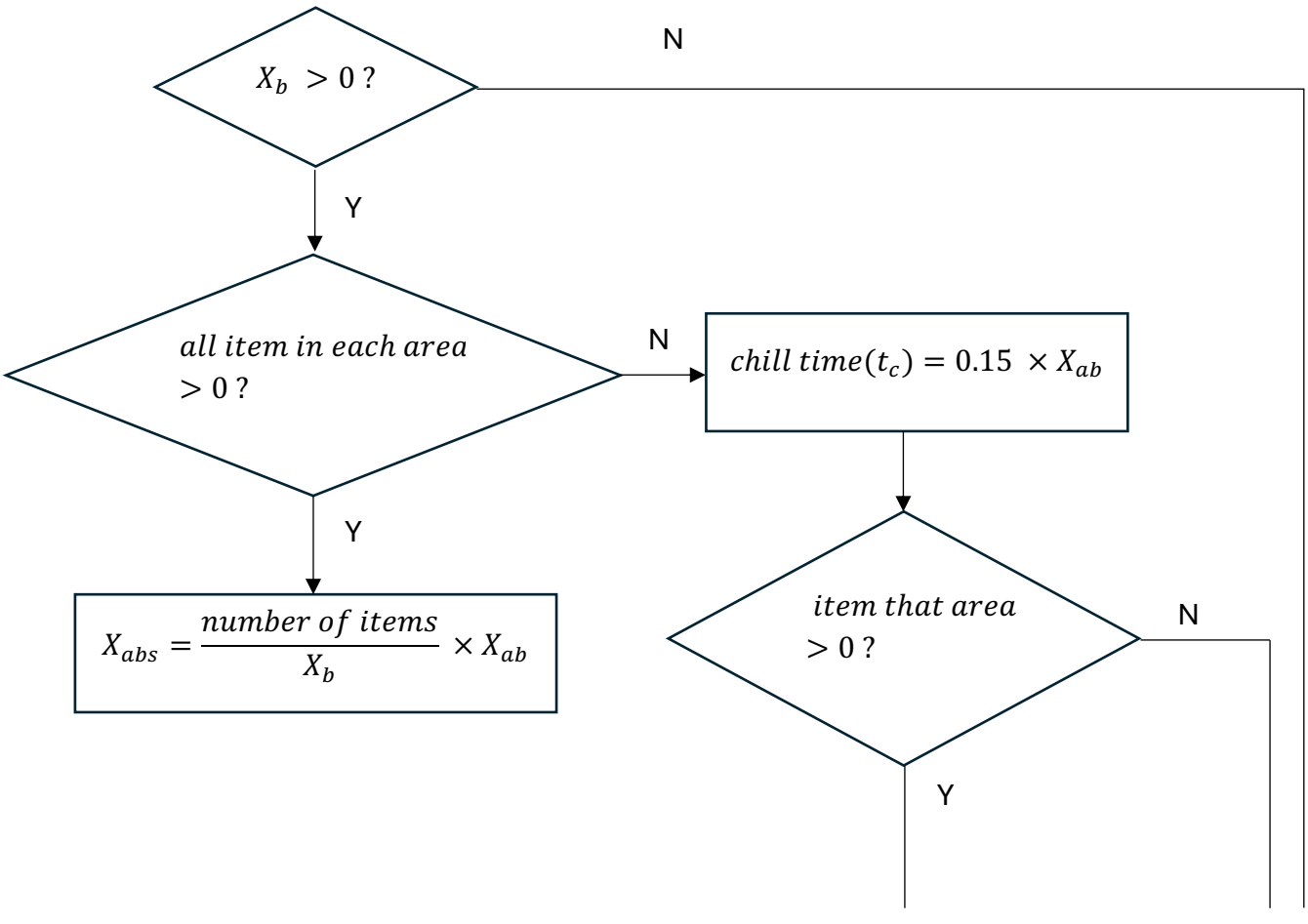
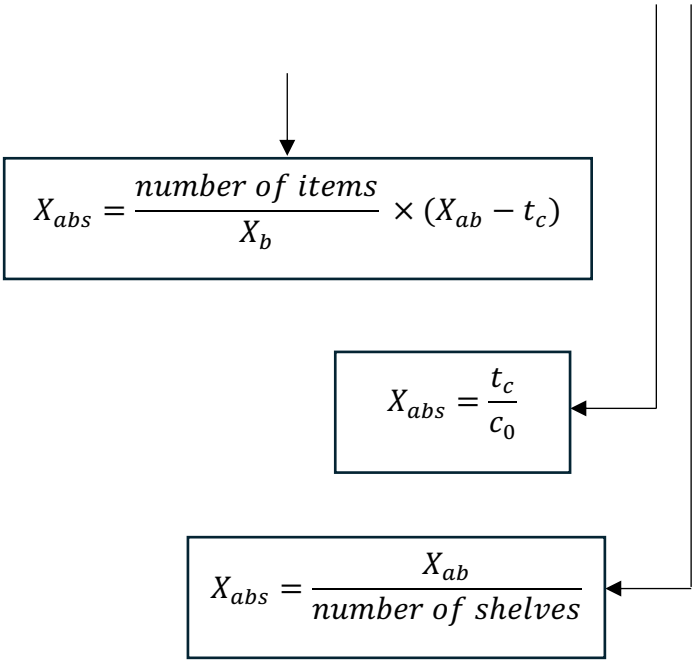
ShopperSim Logic

1. Customer comes to store with 2 parameters: shopping time and basket size ($X_s \; and \; X_b$).
   e.g., customer 1 has shopping time = 20 min, basket size = 5
2. The areas that customer will visit will be decided by Markov chain following some specified transition matrix. As a result, each customer will have areas to visit.
   e.g., customer 1 will visit 6 areas: [(0,0), (5,2), (6,8), (1,1), (3,2), (0,4)]
3. Next, the algorithm will decide how many items that each customer should buy in each areas using multinomial random variable with equal probability.
   e.g., customer 1 will buy : [1 item at (0,0), 2 item at (5,2), 0 item at (6,8), 1 item at (1,1), 0 item at (3,2), 1 item at (0,4)]
4. Create guidance system to navigate customer to areas using heuristic method called "nearest neighborhood"
5. Find actual buying time at each area by:
   5.1 find total walking time
   5.2 find number of segments that buy 0 item (c_0). In this case, customer 1 has 2 segments. This is crucial to calculate and will be used later to find actual time spent
   5.3 $actual\ buying\ time(X_{ab}) \; = \; X_s - total\ walking\ time$
   5.4 create logic to find actual buying time in each segment (X_{abs}) in different cases as shown in flow chart:



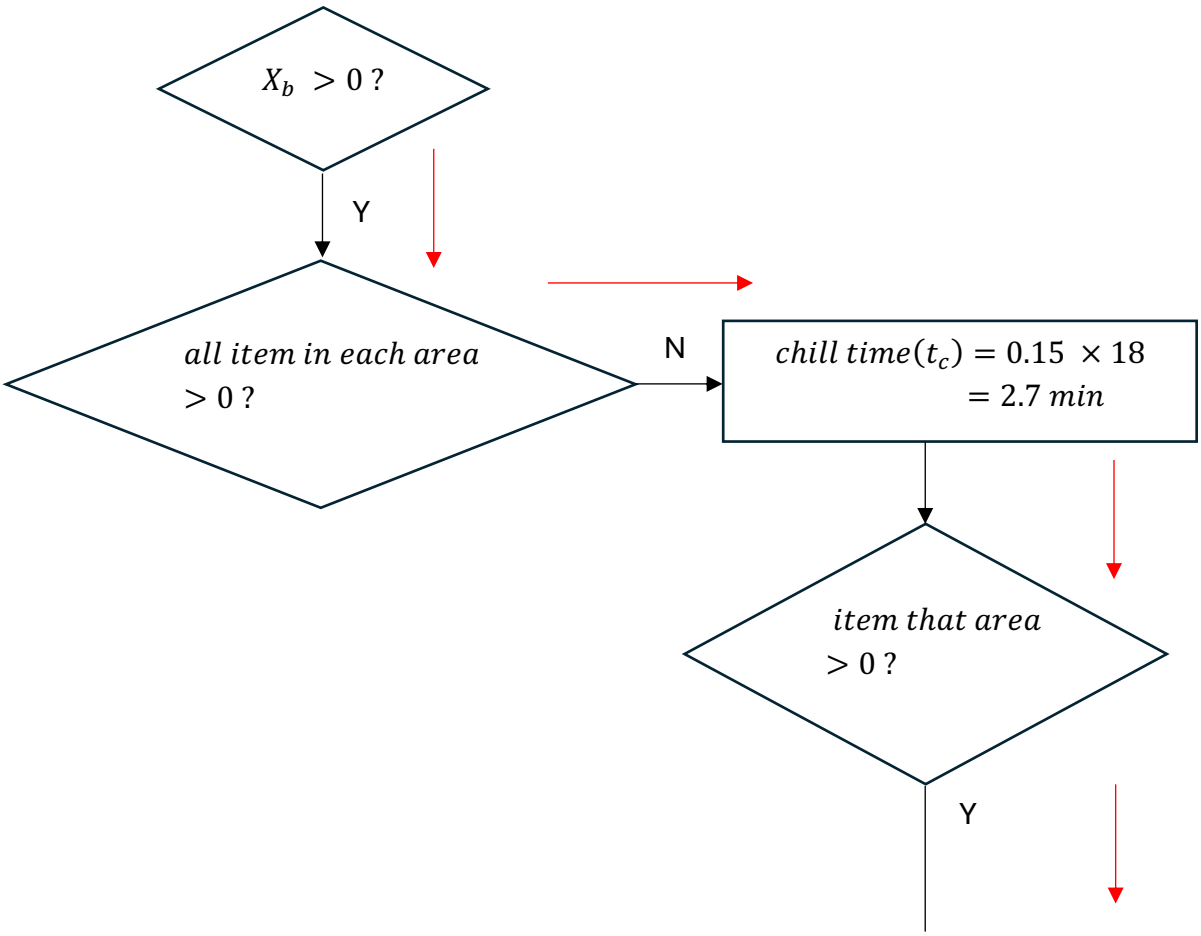


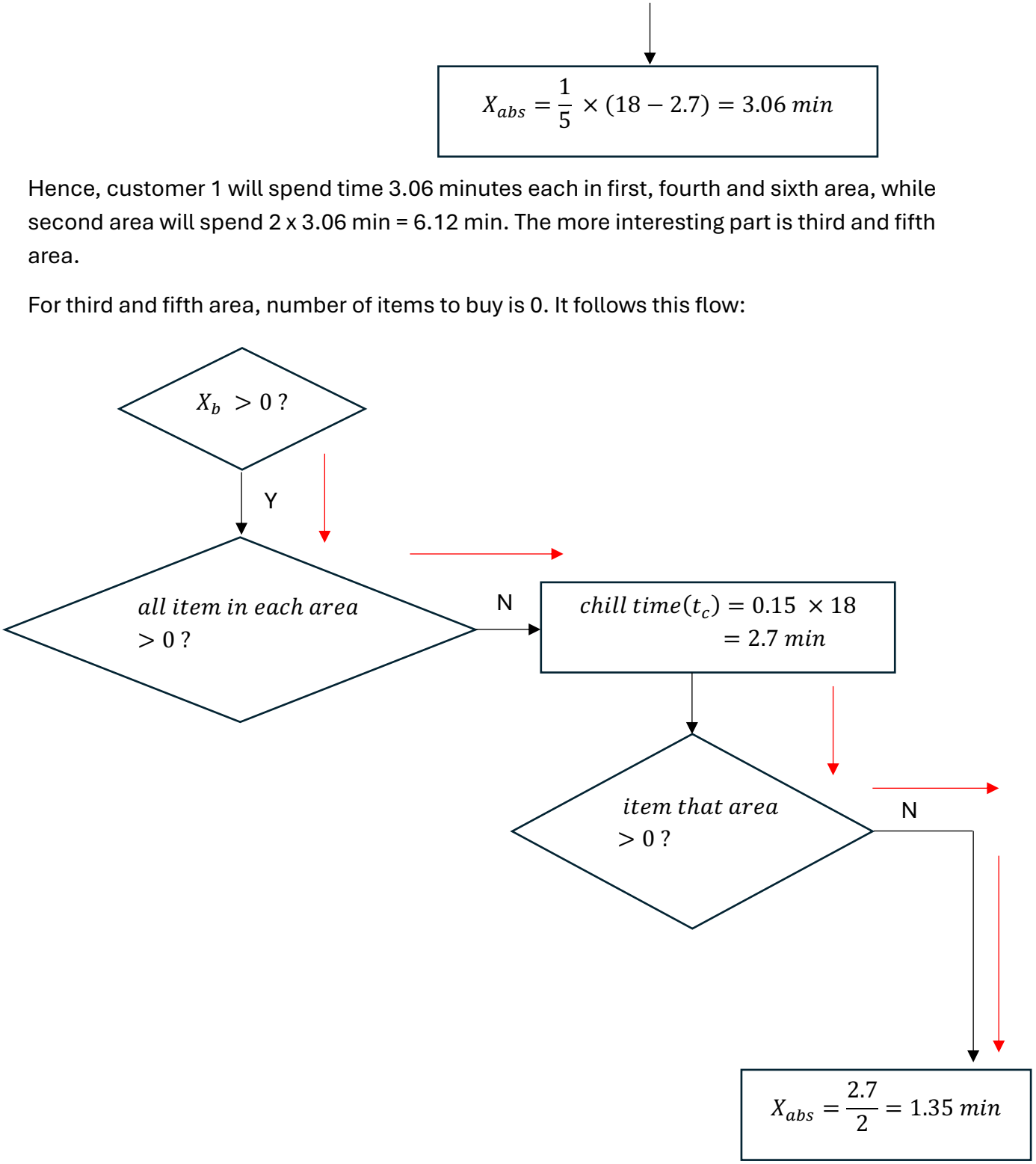
Example

Customer 1 has $X_s = 20,\ X_b = 5$, where number of items to buy profile = [1,2,0,1,0,1]

Assume total walking time is 2 mins. $X_{ab} = 20 - 2 = 18\ mins$, $c_0 = 2$

For first, fourth, and sixth area, number of item to buy is 1. It follows this flow:





Hence, customer 1 will spend time 3.06 minutes each in first, fourth and sixth area, while second area will spend 2 x 3.06 min = 6.12 min. The more interesting part is third and fifth area.

For third and fifth area, number of items to buy is 0. It follows this flow:

Hence, customer 1 will spend time 1.35 minutes each in third and fifth area

As a result, customer 1 will spend 3.06 min at first area

will spend 6.12 min at second area

will spend 1.35 min at third area

will spend 3.06 min at fourth area

will spend 1.35 min at fifth area

will spend 3.06 min at sixth area

In total, customer 1 will spend 3.06 + 6.12 + 1.35 + 3.06 + 1.35 + 3.06 = 18 mins, which is equal to X_{ab} at the beginning of the calculation.

6. Customer will keep buying items until they visit all area. Then, move to cashier
7. Cashier service time is assumed to be exponential distribution with rate depends on basket size
8. Customer leaves store