Customer Analytics at flipkart.com

Case Summary

- Flipkart.com was an early entrant in the nascent Indian e-commerce market and quickly established itself as the leading company in this space.

- Valued over 15.2B as of 2015.

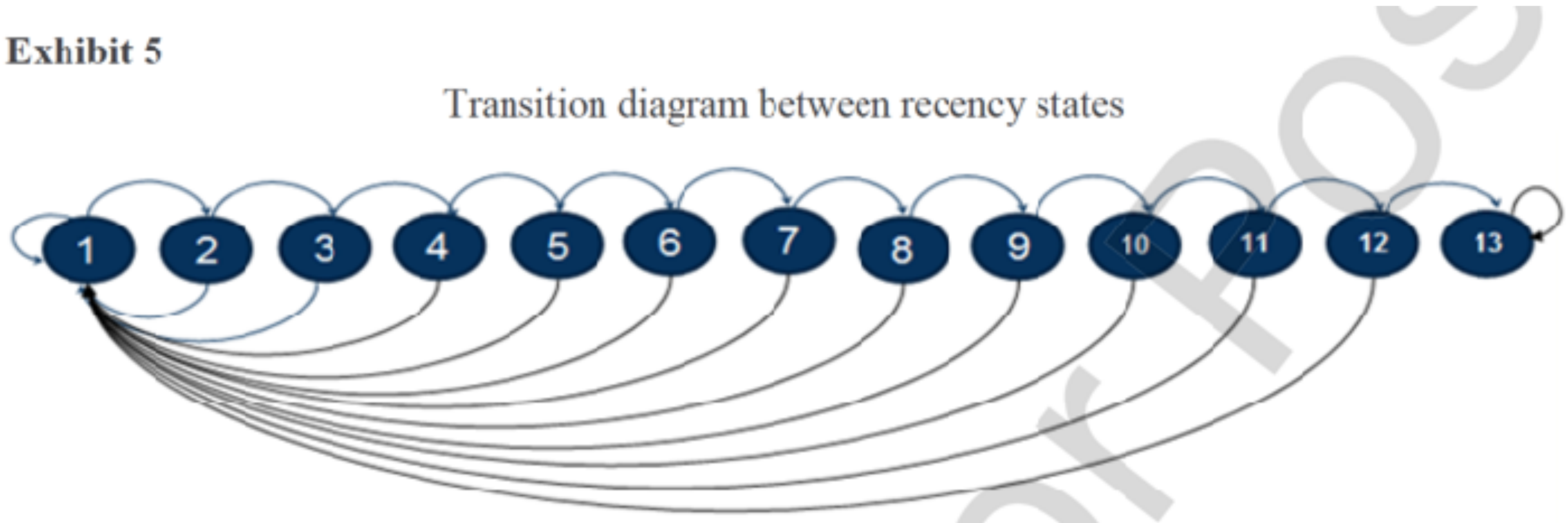
- It sells from >50,000 sellers in 70+ categories and has 30 exclusive brand associations.

- Customer churn is a major concern since it has direct impact on Customer Lifetime Value (CLV). CLV is an important measure to differentiate customers, which can further help the organization to manage them effectively.

- Main challenge: the exact life of the customer is unknown owing to data truncation (i.e, the actual point in time of customer churn).

Quick Review: Markov Chains

Exhibit 5



The probability of transitioning from state *i* to state *j* in 1 period is the *(i,j)th* entry of P

Exhibit 7

One-step transition probability matrix (recency states)

States	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.511	0.489	0	0	0	0	0	0	0	0	0	0	0
2	0.365	0	0.635	0	0	0	0	0	0	0	0	0	0
3	0.300	0	0	0.700	0	0	0	0	0	0	0	0	0
4	0.244	0	0	0	0.756	0	0	0	0	0	0	0	0
5	0.205	0	0	0	0	0.795	0	0	0	0	0	0	0
6	0.180	0	0	0	0	0	0.820	0	0	0	0	0	0
7	0.153	0	0	0	0	0	0	0.847	0	0	0	0	0
8	0.137	0	0	0	0	0	0	0	0.863	0	0	0	0
9	0.105	0	0	0	0	0	0	0	0	0.895	0	0	0
10	0.103	0	0	0	0	0	0	0	0	0	0.897	0	0
11	0.091	0	0	0	0	0	0	0	0	0	0	0.909	0
12	0.079	0	0	0	0	0	0	0	0	0	0	0	0.921
13	0	0	0	0	0	0	0	0	0	0	0	0	1

Source: Based on the data provided by Flipkart

The probability of transitioning from state *i* to state *j* in N periods is the *(i,j)th* entry of P^N

P^4=

TPM	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.388	0.2	0.137	0.111	0.164	0	0	0	0	0	0	0	0
2	0.357	0.179	0.117	0.079	0	0.267	0	0	0	0	0	0	0
3	0.329	0.16	0.101	0.065	0	0	0.345	0	0	0	0	0	0
4	0.299	0.144	0.087	0.053	0	0	0	0.417	0	0	0	0	0
5	0.273	0.129	0.077	0.045	0	0	0	0	0.476	0	0	0	0
6	0.24	0.117	0.068	0.039	0	0	0	0	0	0.537	0	0	0
7	0.22	0.099	0.06	0.033	0	0	0	0	0	0	0.587	0	0
8	0.199	0.091	0.05	0.03	0	0	0	0	0	0	0	0.6306	0
9	0.178	0.081	0.045	0.023	0	0	0	0	0	0	0	0	0.67287
10	0.111	0.074	0.042	0.022	0	0	0	0	0	0	0	0	0.75146
11	0.069	0.037	0.037	0.02	0	0	0	0	0	0	0	0	0.83772
12	0.032	0.017	0.013	0.017	0	0	0	0	0	0	0	0	0.92112
13	0	0	0	0	0	0	0	0	0	0	0	0	1

- Imagine you have a vector that indicates your initial state

$$\mathbf{S_0}=[s_{1,}\ s_{2,}\ s_{3,\ldots,}s_N]$$

If you want to know with what probability you'll end up in any of the N states after *one* period, it will be given by the product of the vector $\mathbf{S_0}$ by $\mathbf{P}$ (one-step transition matrix)

$$\mathbf{S_1= S_0P}$$

If you want to know the same thing after two periods, it is given by

$$\mathbf{S_2= S_1P} = \mathbf{S_0PP= S_2= S_1P} = \mathbf{S_0P^2}$$

Question 1

- Discuss whether the churn problem can be modeled as a Markov chain?

- What are the assumptions made while modeling customer churn as a Markov chain?

Answer

- When churned is not observed we can't use the usual tools
    - We don't have training data with observed churned customers
- Before using Markov Chain, we have to check
    - whether the transitions follow Markov chain using **Anderson-Goodman test**
    - whether the transitions are **stationary** using likelihood ratio tests (tests are discussed in detail in Styan G P&Smith H (1964))
    - We may fix a specific state as a churn state (there may be a small probability that a customer from this state may come back in the future and make a purchase)

Question 2

- How can churn be defined for e-commerce companies such as Flipkart?
- In Exhibit 6, the recency state 13 is identified as the churn rate. Comment on the use of state 13 as churn state.

Answer

- By definition, if a customer churns, then they will not have any further relationship with the firm. This can’t be satisfied in the instance of e-commerce companies.

- We have to **identify a state from which the probability of transaction with the company is highly unlikely.**

Question 3

- Using **Exhibit 7** (Markov chain with recency states), Ravi and his team wanted to find out on average how many months customers in each non-absorbing state (states 1 to 12) take to reach the churn state (state 13).

Answer

The one-step transition probability matrix is:

Exhibit 7

One-step transition probability matrix (recency states)

States	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.511	0.489	0	0	0	0	0	0	0	0	0	0	0
2	0.365	0	0.635	0	0	0	0	0	0	0	0	0	0
3	0.300	0	0	0.700	0	0	0	0	0	0	0	0	0
4	0.244	0	0	0	0.756	0	0	0	0	0	0	0	0
5	0.205	0	0	0	0	0.795	0	0	0	0	0	0	0
6	0.180	0	0	0	0	0	0.820	0	0	0	0	0	0
7	0.153	0	0	0	0	0	0	0.847	0	0	0	0	0
8	0.137	0	0	0	0	0	0	0	0.863	0	0	0	0
9	0.105	0	0	0	0	0	0	0	0	0.895	0	0	0
10	0.103	0	0	0	0	0	0	0	0	0	0.897	0	0
11	0.091	0	0	0	0	0	0	0	0	0	0	0.909	0
12	0.079	0	0	0	0	0	0	0	0	0	0	0	0.921
13	0	0	0	0	0	0	0	0	0	0	0	0	1

Source: Based on the data provided by Flipkart

If you consider only the periods that you were “alive” (non-absorbing states) you get the following matrix, **Q:**

State	1	2	3	4	5	6	7	8	9	10	11	12
1	0.511	0.489	0	0	0	0	0	0	0	0	0	0
2	0.365	0	0.635	0	0	0	0	0	0	0	0	0
3	0.3	0	0	0.7	0	0	0	0	0	0	0	0
4	0.244	0	0	0	0.756	0	0	0	0	0	0	0
5	0.205	0	0	0	0	0.795	0	0	0	0	0	0
6	0.18	0	0	0	0	0	0.82	0	0	0	0	0
7	0.153	0	0	0	0	0	0	0.847	0	0	0	0
8	0.137	0	0	0	0	0	0	0	0.863	0	0	0
9	0.105	0	0	0	0	0	0	0	0	0.895	0	0
10	0.103	0	0	0	0	0	0	0	0	0	0.897	0
11	0.091	0	0	0	0	0	0	0	0	0	0	0.909
12	0.079	0	0	0	0	0	0	0	0	0	0	0

The infinite sum of $\mathbf{Q^0+Q^1+Q^2+Q^3+}$… is equal to $\mathbf{(I-Q)^{-1}}$. Applying this formula, we get the matrix as given below

State	1	2	3	4	5	6	7	8	9	10	11	12
1	18.99	9.283	5.898	4.129	3.121	2.48	2.033	1.722	1.486	1.331	1.194	1.086
2	16.94	9.283	5.898	4.129	3.121	2.48	2.033	1.722	1.486	1.331	1.194	1.086
3	15.77	7.709	5.898	4.129	3.121	2.48	2.033	1.722	1.486	1.331	1.194	1.086
4	14.39	7.035	4.47	4.129	3.121	2.48	2.033	1.722	1.486	1.331	1.194	1.086
5	12.9	6.308	4.008	2.806	3.121	2.48	2.033	1.722	1.486	1.331	1.194	1.086
6	11.33	5.54	3.52	2.464	1.862	2.48	2.033	1.722	1.486	1.331	1.194	1.086
7	9.647	4.716	2.996	2.098	1.585	1.26	2.033	1.722	1.486	1.331	1.194	1.086
8	7.959	3.891	2.472	1.731	1.308	1.039	0.852	1.722	1.486	1.331	1.194	1.086
9	6.212	3.037	1.929	1.351	1.021	0.811	0.665	0.563	1.486	1.331	1.194	1.086
10	4.72	2.307	1.466	1.026	0.776	0.616	0.505	0.428	0.369	1.331	1.194	1.086
11	3.081	1.506	0.957	0.67	0.506	0.402	0.33	0.279	0.241	0.216	1.194	1.086
12	1.498	0.732	0.465	0.326	0.246	0.196	0.16	0.136	0.117	0.105	0.094	1.086

Time to churn for each of the non-absorbing states is

the sum of each row in the matrix.

Rounding to decimals, we obtain the following values for time to churn from each transient state:

Non-absorbing states	*Expected number of months to churn*
1	53
2	51
3	48
4	45
5	41
6	37
7	32
8	27
9	21
10	16
11	11
12	6

Question 4

- Given a hypothetical case of 1,000 customers being in State 1, what would be the distribution of these 1,000 customers over a period of 4 months?

Answer

Using the stationary TPM provided in Exhibit 7, we calculate the TPM after 4 months by multiplying the matrix 4 times,

P^4=

TPM	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.388	0.2	0.137	0.111	0.164	0	0	0	0	0	0	0	0
2	0.357	0.179	0.117	0.079	0	0.267	0	0	0	0	0	0	0
3	0.329	0.16	0.101	0.065	0	0	0.345	0	0	0	0	0	0
4	0.299	0.144	0.087	0.053	0	0	0	0.417	0	0	0	0	0
5	0.273	0.129	0.077	0.045	0	0	0	0	0.476	0	0	0	0
6	0.24	0.117	0.068	0.039	0	0	0	0	0	0.537	0	0	0
7	0.22	0.099	0.06	0.033	0	0	0	0	0	0	0.587	0	0
8	0.199	0.091	0.05	0.03	0	0	0	0	0	0	0	0.6306	0
9	0.178	0.081	0.045	0.023	0	0	0	0	0	0	0	0	0.67287
10	0.111	0.074	0.042	0.022	0	0	0	0	0	0	0	0	0.75146
11	0.069	0.037	0.037	0.02	0	0	0	0	0	0	0	0	0.83772
12	0.032	0.017	0.013	0.017	0	0	0	0	0	0	0	0	0.92112
13	0	0	0	0	0	0	0	0	0	0	0	0	1

We can calculate $P_0 \times \mathbf{P}^4$, where $\mathbf{P_0}$ is:

State	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of Customers	1000	0	0	0	0	0	0	0	0	0	0	0	0

Number of customers in different states after 4 periods is given by:

State	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of Customers	388	200	137	111	164	0	0	0	0	0	0	0	0

Question 5

- Given a hypothetical case of 1,000 customers in State 1, 1,000 customers in State 2, and 1,000 customers in State 3, predict the distribution of the customers after a period of 4 months from now. (Use Exhibit 7, recency state transition matrix)

Answer

In this case $\mathbf{P_0}$ is:

State	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of Customers	1000	1000	1000	0	0	0	0	0	0	0	0	0	0

$\boldsymbol{P_0 \times} \mathbf{P}^4$ is given by:

State	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of Customers	1075	539	354	256	164	267	345	0	0	0	0	0	0

Question 6

- Ravi wants to evaluate Flipkart's relationship with a customer by calculating the expected life time value (CLV) for infinite horizon. Assuming Flipkart is risk neutral and willing to make decisions based on expected net present value, calculate the CLV of a customer using Exhibit 7 and information given below:

- Discount rate d=0.2

- Reward Vector (R)=[1000 -200 -200 -200 ….0]

Answer

The Markov decision process provides the mechanism to calculate the expected life time value using the formula given below (refer to Heifer P E and Caraway R, 2000):

$$V = \{I - (1 + d)^{-1}\, P\}^{-1}\, R$$

where I is the identity matrix. Given P, we can calculate $[1\text{-}(1\text{+}d)^{-1}\text{*}P]^{-1}$

.960	1.206	0.638	0.373	0.235	0.155	0.106	0.075	0.054	0.040	0.030	0.023	0.105
1.717	1.699	0.900	0.525	0.331	0.219	0.150	0.106	0.076	0.057	0.042	0.032	0.148
1.543	0.629	1.333	0.778	0.490	0.324	0.222	0.156	0.112	0.084	0.063	0.048	0.219
1.377	0.561	0.297	1.173	0.739	0.489	0.334	0.236	0.170	0.127	0.095	0.072	0.330
1.230	0.501	0.265	0.155	1.097	0.727	0.496	0.350	0.252	0.188	0.141	0.107	0.491
1.092	0.445	0.236	0.137	0.087	1.057	0.722	0.510	0.367	0.274	0.205	0.155	0.714
0.948	0.386	0.204	0.119	0.075	0.050	1.034	0.730	0.525	0.392	0.293	0.222	1.022
0.808	0.329	0.174	0.102	0.064	0.042	0.029	1.020	0.734	0.548	0.409	0.310	1.429
0.654	0.267	0.141	0.082	0.052	0.034	0.023	0.017	1.012	0.755	0.564	0.428	1.970
0.531	0.216	0.115	0.067	0.042	0.028	0.019	0.013	0.010	1.007	0.753	0.571	2.628
0.371	0.151	0.080	0.047	0.029	0.019	0.013	0.009	0.007	0.005	1.004	0.761	3.504
0.195	0.079	0.042	0.024	0.015	0.010	0.007	0.005	0.004	0.003	0.002	1.001	4.612
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.000

And the value is obtained by multiplying the above results with reward vector (R):

1	2373.222
2	889.4956
3	695.5845
4	518.6123
5	374.001
6	253.5768
7	141.8907
8	55.49104
9	-20.7268
10	-36.9329
11	-54.2905
12	-43.9919
13	0

The above result indicates that at the current level of revenue and cost of promotion, it is not advisable to promote customers from states 9 onwards (since CLV is negative).