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Agenda

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1. Business challenges
2. Markov Model Description
3. Customer Segmentation
4. Customer Lifetime Value (CLV)
5. Broadview Reward Vector
6. Broadview Revenue: With Policy & No Policy

Business Challenges

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- Leader in space, but spending aggressively and ultimately not profitable
- Facing increasing competition due to developing economy
- Want to spend money smarter based on customer study

Acquistion vs. Retention

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- Retaining: Understanding good vs. bad customers
- Customer churn analysis
- Cannot be defined using supervised learning

Model Description- RFM model

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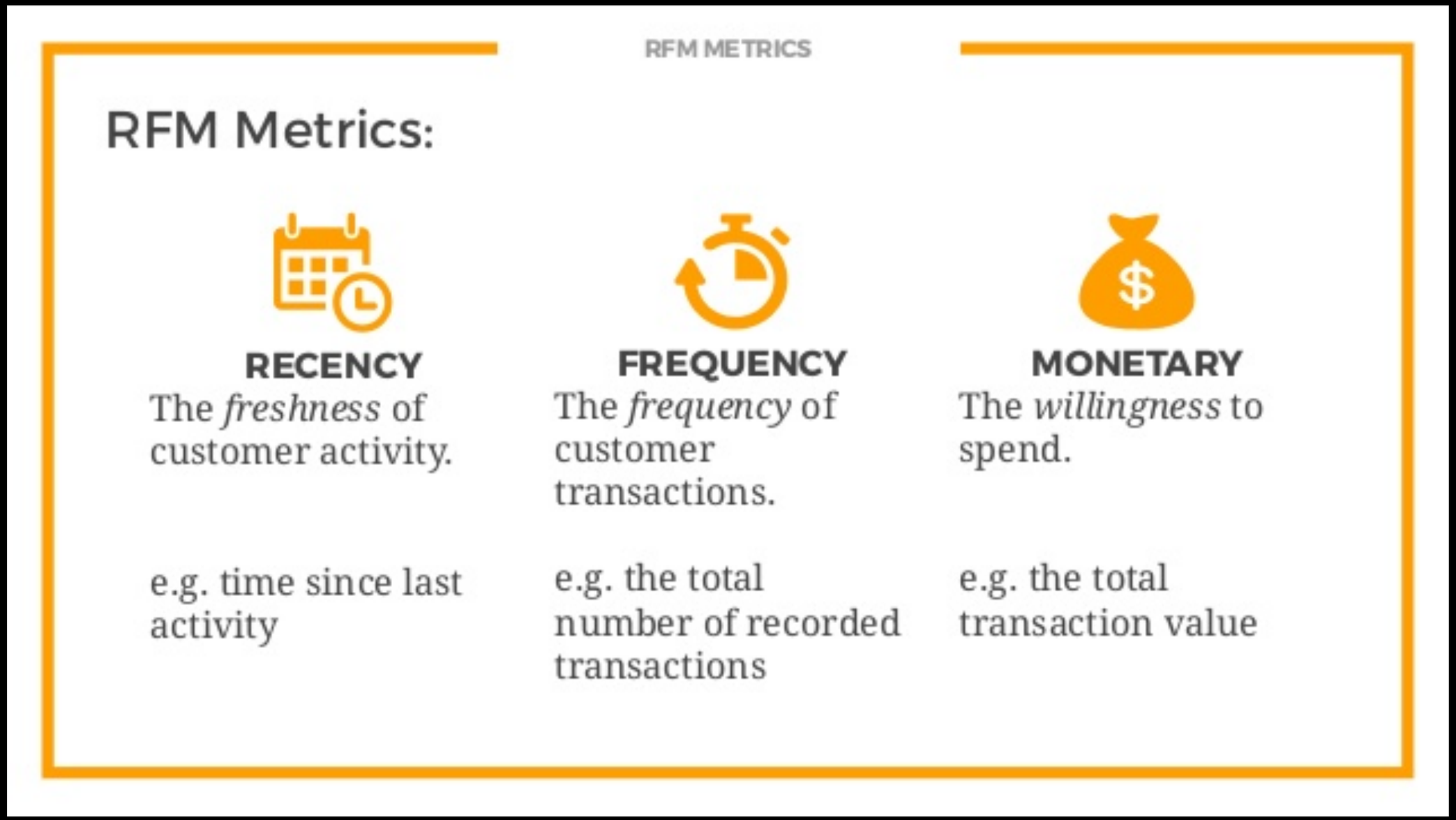

Broadview's RFM model

- All customers assigned a "tuple" score
- Recency – Time since last activity
- Frequency- Total no. of recorded transactions
- Monetary value: Total transaction value each year/month

Customer Segmentation

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- RFM tuple infinite to finite state space
- Segmentation – Executive, Business, Personalized
- Define cut-off pt. for Churn – Probability of customer return is low

Broadview's Markov Model

- Purchase behavior -> Customer transtion to diff states

- Historical data -> Probability of state transition, (i,j)

P(i, j) = probability of transitioning from state i to state j over some time period

Broadview's Markov Model

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- Build matrix P of transition probabilities
- Size of matrix P = n x n, n=no. of states
- Assumption: Customer churn is permanent
- Absorbing state: Transition back to current stat

Sample Markov Model

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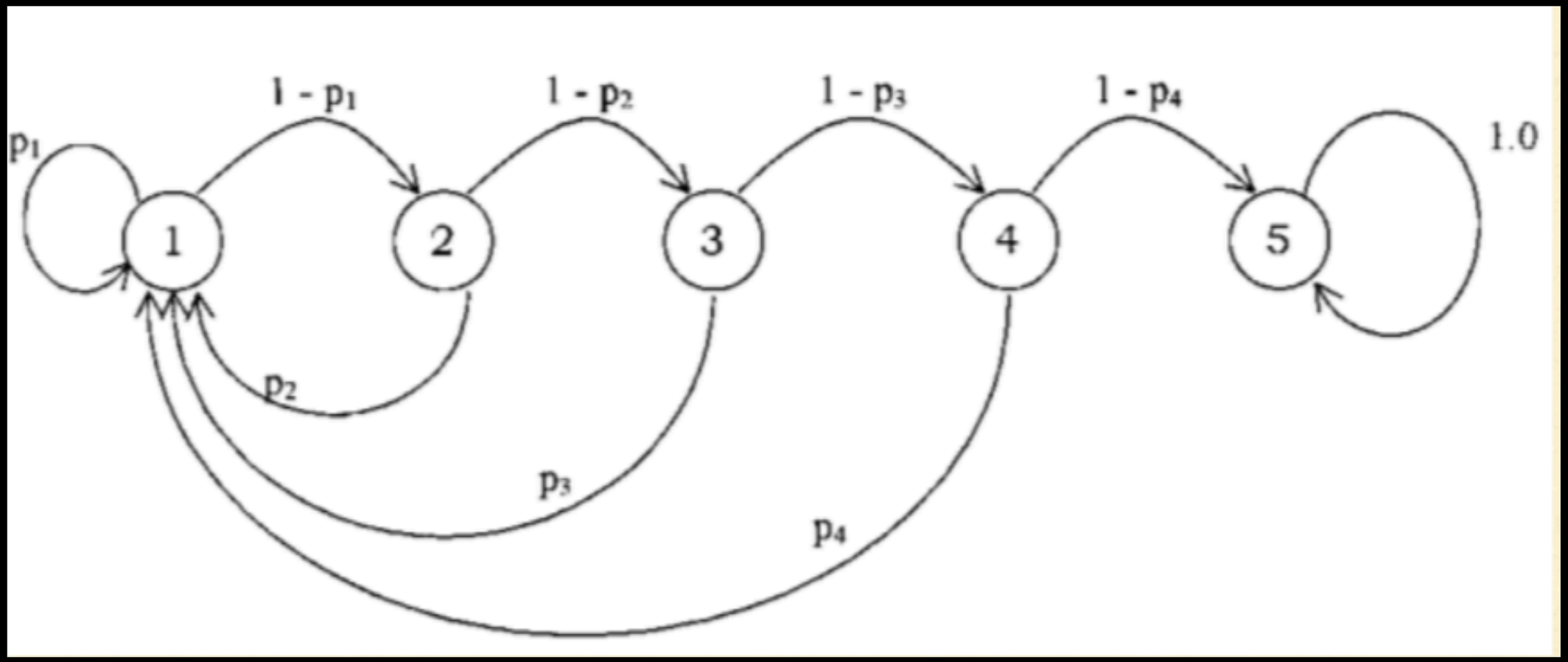

Markov Model- Predictions

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- State vector - “V_p(t)” at time-step t

- V_p is of size n; n is number of states

- V_p[i] = proportion of customers in state i

- V_p(t+i) = V_p(t)P

Customer Lifetime Value (CLV)

- Customer Value over infinite time frame

- CLV = -ve -→ Customer may churn

- Marketing budget decisions

CLV Calculation
Step 1: Reward Vector

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$$\mathbf{R} = \begin{bmatrix} NC - M \\ -M \\ -M \\ -M \\ 0 \end{bmatrix}$$

- R[i] = Customer value at state I
- R = NC – M
- NC = Net Contribution = Money spent that year
- M = Marketing Cost

CLV Calculation
Step 1: Reward Vector

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$$\mathbf{R} = \begin{bmatrix} NC - M \\ -M \\ -M \\ -M \\ 0 \end{bmatrix}$$

- Customer with recency 0 = Non-Zero NC
- Unchurned Customers recency >=1
- = -ve Reward

- Churned Customers = 0 Marketing Cost
- = 0 Reward

CLV Calculation

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Step 2: Value Vector over time T

$$\mathbf{V}^T = \sum_{t=0}^{T} [(1 + d)^{-1}\mathbf{P}]^t\mathbf{R}$$

CLV Calculation

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Step 3: Extending timeframe to Infinity

$$\mathbf{V} \equiv \lim_{T \to \infty} \mathbf{V}^T$$

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

CLV Calculation

Step 4: Policy Adjustment

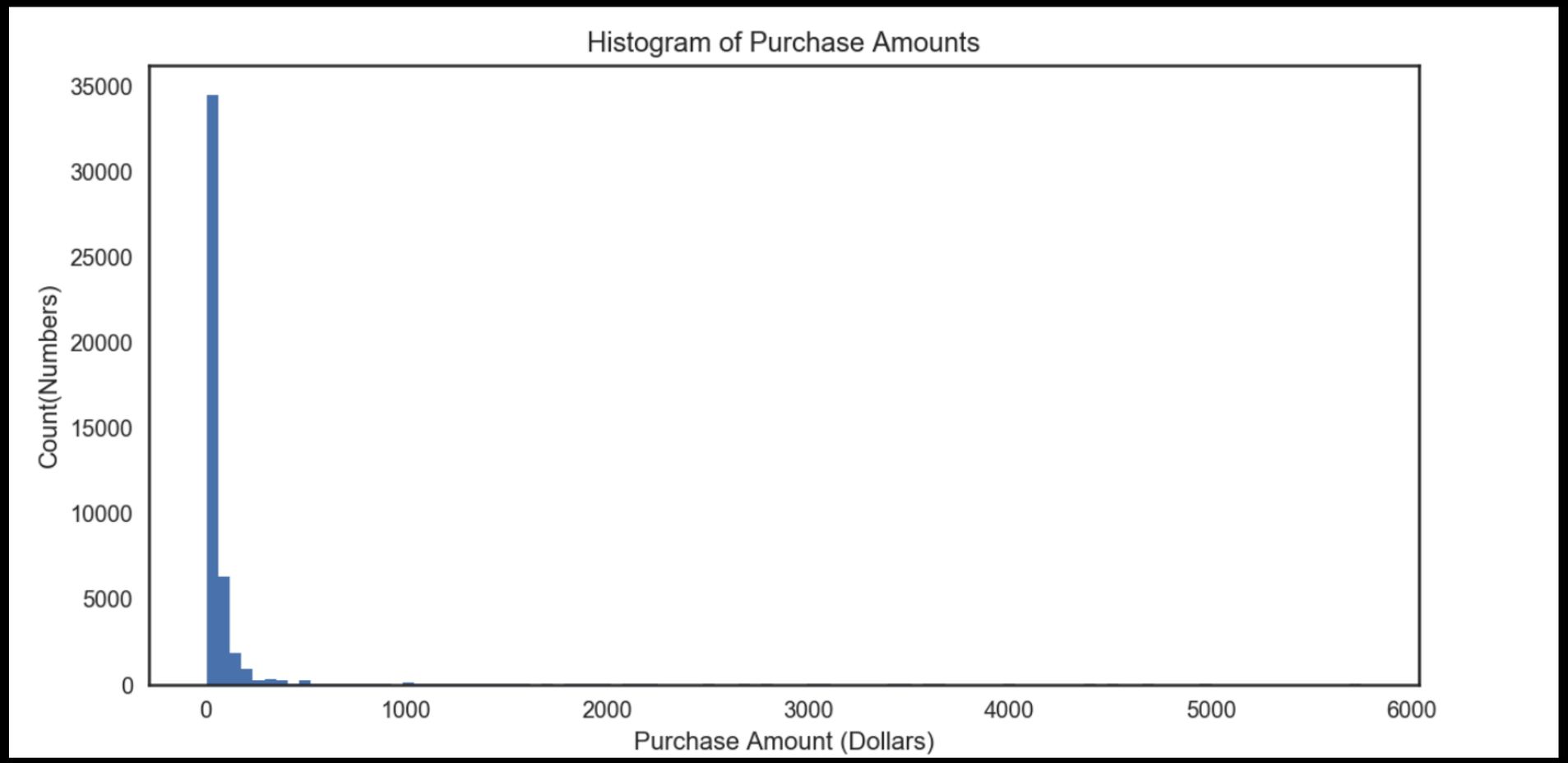
- Churned Customer = Stop marketing costs
- Customers with –ve CLV = Net loss to Broadview
- =Adjust policy to stop marketing costs

Broadview Case Specifics

Broadview Transaction Data

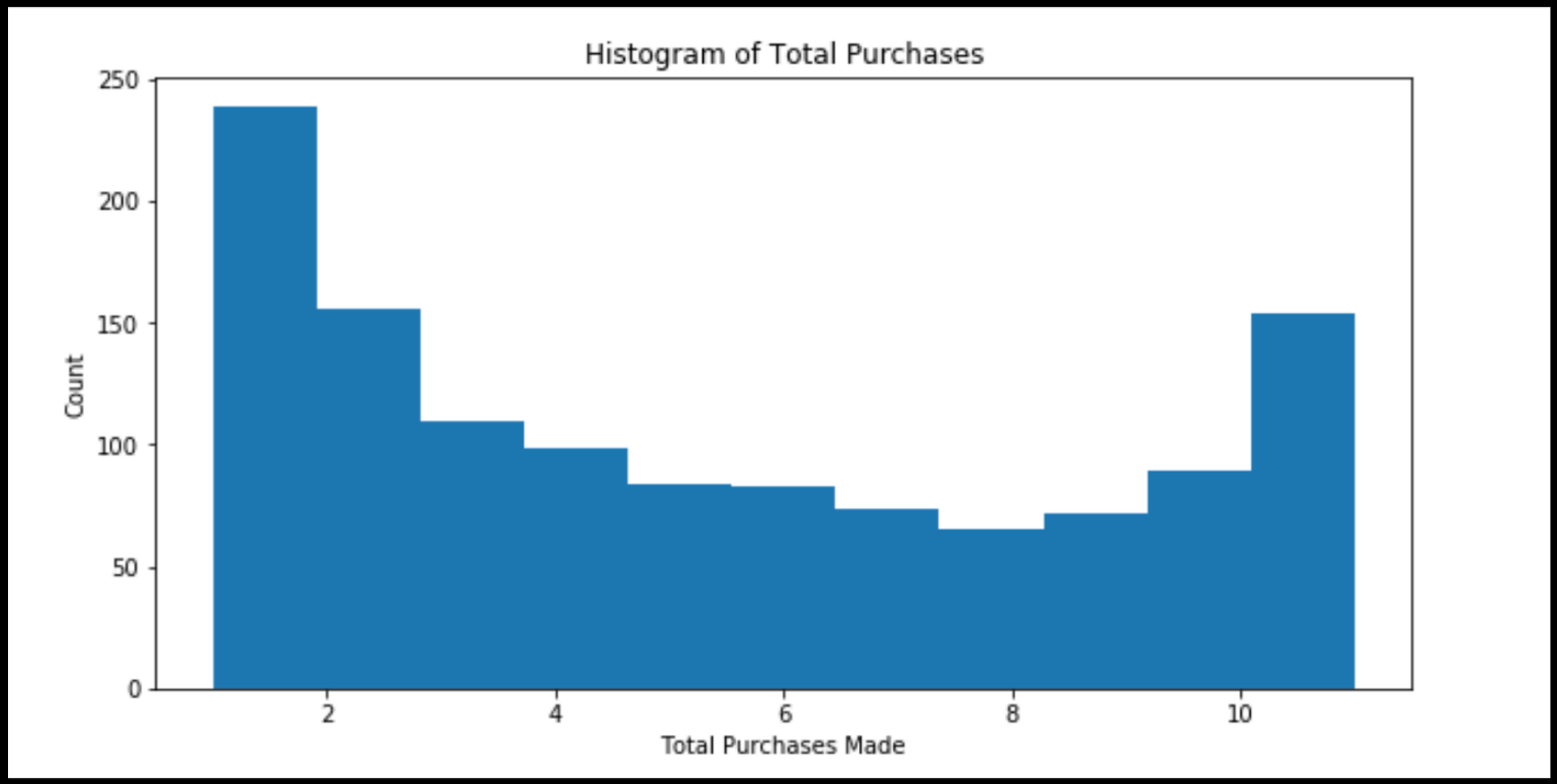
- No. of records = 44966
- Column Format = cust_id, purchase_amt, date_purchase
- Data range = 2005 to 2015

EDA – Purchase Amounts



Purchase data right skewed

EDA – Total Purchases



Median = 5

EDA – Boolean Matrix

year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
cust_id											
10	1	0	0	0	0	0	0	0	0	0	0
80	1	0	1	0	1	0	1	0	1	1	1
90	1	1	1	1	1	1	1	1	1	0	0
130	1	0	1	0	0	0	0	0	0	0	0
190	1	1	1	1	1	0	0	0	0	0	0

Customer purchses/yr = 1 = Markov transaction period

Recency Transition Matrix

	0	1	2	3	4	5	6	7	8	9	10
0	0.716090	0.28391	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1	0.329261	0.00000	0.670739	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.137864	0.00000	0.000000	0.862136	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
3	0.086849	0.00000	0.000000	0.000000	0.913151	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4	0.074963	0.00000	0.000000	0.000000	0.000000	0.925037	0.000000	0.000000	0.000000	0.000000	0.000000
5	0.035842	0.00000	0.000000	0.000000	0.000000	0.000000	0.964158	0.000000	0.000000	0.000000	0.000000
6	0.057732	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.942268	0.000000	0.000000	0.000000
7	0.041162	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.958838	0.000000	0.000000
8	0.009585	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.990415	0.000000
9	0.020492	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.979508
10	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

For R >=7, Churn State Probability is <5%

Customer Segmentation

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Recency: R =0 // <R<7 // R>=7

Frequency: R <=5 // F>5

Monetary: M <=30 // 30 < M<=50 // M>50

RFM States = 3*2*3 = 18

States with R >=7 = Absorbing States

State Matrix

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year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
cust_id											
10	6	12	12	12	12	12	18	18	18	18	18
80	5	11	4	10	4	10	4	10	4	1	1
90	4	4	4	4	4	1	1	1	1	7	7
130	5	11	4	10	10	10	10	10	16	16	16
190	5	4	6	4	4	10	10	10	10	10	16

Calculate RFM tuples from Boolean Matrix

Convert to State values using segments

RFM Transition Matrix

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year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
cust_id											
10	6	12	12	12	12	12	18	18	18	18	18
80	5	11	4	10	4	10	4	10	4	1	1
90	4	4	4	4	4	1	1	1	1	7	7
130	5	11	4	10	10	10	10	10	16	16	16
190	5	4	6	4	4	10	10	10	10	10	16

TOO LARGE to illustrate

Broadview Reward Vector

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```
[[ 46.03911622],
 [ 46.03911622],
 [ 46.03911622],
 [ 46.03911622],
 [ 46.03911622],
 [ 46.03911622],
 [-25.        ],
 [-25.        ],
 [-25.        ],
 [-25.        ],
 [-25.        ],
 [-25.        ],
 [  0.        ],
 [  0.        ],
 [  0.        ],
 [  0.        ],
 [  0.        ],
 [  0.        ],
 [  0.        ]]
```

Mean Purchase Amount, M = 71 (approx)

Marketing Cost/Year, M = $25

Broadview CLV

```
[ 164.97606887],
[ 163.53654628],
[ 132.88523581],
[ 141.27641545],
[ 133.1715939 ],
[  94.75529752],
[  13.41616067],
[  11.0259514 ],
[  -7.17343942],
[  -5.88976893],
[  -4.71694682],
[ -18.15269545],
[   0.        ],
[   0.        ],
[   0.        ],
[   0.        ],
[   0.        ],
[   0.        ]]
```

States 9 to 12= Unchurned but –ve CLV

Policy Conclusion = Stop Marketing Costs for them

Broadview Revenue: No Policy

2016	117192.674744
2017	213756.539922
2018	274843.715024
2019	292909.959191
2020	295450.852444
2021	292481.817299
2022	287665.24994
2023	282355.970819
2024	277062.491102
2025	271977.620176

Total Revenue = 2.7M (approx)

Broadview Revenue: With Policy

2016	242931.3269
2017	339495.192079
2018	387466.427388
2019	400117.133611
2020	399549.233561
2021	394034.374733
2022	386729.05203
2023	378889.023419
2024	371044.570756
2025	363435.328919

Total Revenue = 3.6M (approx)

Broadview Revenue Calculation

Use T = 10

Historical Data Observation= Avg. Customers/Yr = 2144

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Thank you!