Agenda

1. Customer Lifetime Value
2. Insurance Context & Problem Statement
3. Contacts
4. Appendix (Experiment Details, Example & References)

Customer Lifetime Value

What is Customer Lifetime Value?

- Customer lifetime value (CLV or LTV) represents the **total expected profit** a company expects from a client throughout their entire relationship

- Used in multiple industries in order to evaluate the **financial value of a customer** and better tailor the approach of the company towards customers (pricing, marketing, etc.)

- Customer lifetime value is separated in three core items:
  1. **Acquisition** of a new client
  2. **Retention** of an existing client/product
  3. **Expansion** of the products of the client (cross-selling)

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Show me the math!

- $\boldsymbol{S_t}$ is the state of a client at time t
  - S_t^P represents what **product** is bought by the client at time t
  - S_t^C is the **characteristics** of the client/products at time t
  - $S_t = \left(S_t^P, S_t^C\right)$

- $\boldsymbol{Cost(S_t)}$ is the cost at time t

- $\boldsymbol{Price(S_t)}$ is the price proposed at time t

- $\mathbb{P}(\boldsymbol{S_{t+1} = s' | S_t = s})$ is the transition probability of changing from state s to state s'

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Show me the math!

- $\boldsymbol{Profit(S_t)} = Price(S_t) - Cost(S_t)$

- $\boldsymbol{\gamma}$ is a discounting factor to account for time-value of money

- $\boldsymbol{CLV(S_0 = s)}$
  - $= \mathbb{E}\left(\sum_{t=1}^{\infty} \gamma^t \cdot \mathrm{Profit}(S_t) \mid S_0 = s\right)$
  - $= \sum_{\forall s' \in \mathbb{S}} \mathbb{P}(S_1 = s' | S_0 = s) \cdot \gamma^1 \cdot \left(\mathrm{Profit}(S_1 = s') + CLV(S_1 = s')\right)$

* It assumes that states and time are discrete. It excludes the current state profit but could be included.

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Insurance Context

& Problem Statements

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Insured State

- S_t^P : The state of an insured would represent **what insurance product the client has** and **which is insured with the company**

- S_t^C: The **insured and the product's characteristics** would also be represented in the state of the insured

- Note that the above definition defined the states for a **multi-product setting**

- However, if the focus is on the acquisition/retention problem alone, the state can be defined for a **single product**

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Insured Cost & Price

- The **cost** of insuring a product is the sum of the **claim losses** during a period and the **expenses** generated

- Claims losses:
  - **Stochastic** by nature
  - For the sake of this workshop, **expected claims losses** will be given

- Expenses:
  - Partially **stochastic and deterministic**
  - **Expected expenses** will be given as well
  - Expenses will be assumed to be a **percentage of the price**

- The **price** comes from a pricing algorithm set by the insurance company to consider **business objectives**

Insured State Transition

- The state transition probability can be simplified to:

$$\mathbb{P}(\boldsymbol{S}_{t+1} = \boldsymbol{s}' \,|\boldsymbol{S}_t = \boldsymbol{s}) \approx \mathbb{P}\left(\boldsymbol{S}_{t+1}^{P} = \boldsymbol{s}'^{P} | \boldsymbol{S}_t = \boldsymbol{s}\right) \cdot \mathbb{P}\left(\boldsymbol{S}_{t+1}^{C} = \boldsymbol{s}'^{C} | \boldsymbol{S}_t^{C} = \boldsymbol{s}^{C}\right)$$

- $\mathbb{P}\left(\boldsymbol{S}_{t+1}^{P} = \boldsymbol{s}'^{P} | \boldsymbol{S}_t = \boldsymbol{s}\right)$ is the probability of acquiring a product or keeping an existing product

- $\mathbb{P}\left(\boldsymbol{S}_{t+1}^{C} = \boldsymbol{s}'^{C} | \boldsymbol{S}_t^{C} = \boldsymbol{s}^{C}\right)$ is the characteristics transition probability

- A model that calculates $\mathbb{P}\left(\boldsymbol{S}_{t+1}^{P} = \boldsymbol{s}'^{P} | \boldsymbol{S}_t = \boldsymbol{s}\right)$ will be provided but **we need your help on how we can calculate** $\mathbb{P}\left(\boldsymbol{S}_{t+1}^{C} = \boldsymbol{s}'^{C} | \boldsymbol{S}_t^{C} = \boldsymbol{s}^{C}\right)$**!**

Problem #1

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Insured Customer Lifetime Value

- Assuming Problem #1 is solved, **how can we calculate efficiently the CLV (acquisition/retention) of a client?**
  - $CLV(S_0 = s) = \mathbb{E}(\sum_{t=1}^{\infty} \gamma^t \cdot \mathrm{Profit}(S_t) \mid S_0 = s)$
  - Should we use Monte-Carlo estimation, recursive approaches, etc.?

Problem #2

- So far, the expansion (cross-selling) component was excluded from the CLV calculation, **how can we adapt the previous formulation to integrate the expansion value?**

Problem #3

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Contacts

Appendix

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Experiment Details – Problem #1

How can we calculate $\mathbb{P}(S_{t+1}^{C} = s'^{C} | S_{t}^{C} = s^{C})$***?***

- A single product is defined by the key of:
  - POLICY_NUMBER x VEHICLE_NUMBER

- A year is defined by:
  - INFORCE_YEAR

- The state characteristics is all the features listed in the dataframe (excluding POLICY_NUMBER, VEHICLE_NUMBER & INFORCE_YEAR)

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Experiment Details – Problem #2

How can we calculate efficiently the CLV** (acquisition/retention)**?

- A python script (models.py) defines the different profit calculation and the retention/acquisition probability

- You can create your own script starting from this to try to calculate CLV

- In model.py, an empty function called aging can be created to generate trajectories

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Experiment Details – Problem #3

How can we integrate the expansion value in CLV calculation?

- For this workshop, a new car within a policy would be considered an expansion
- The client in the dataset is defined by the POLICY_NUMBER
- The number of vehicles can be assess by looking at the evolution of VEHICLE_NUMBER for a single POLICY_NUMBER
  - Who will likely change car or get a new one?
  - What is the new car that is more likely to be generated?

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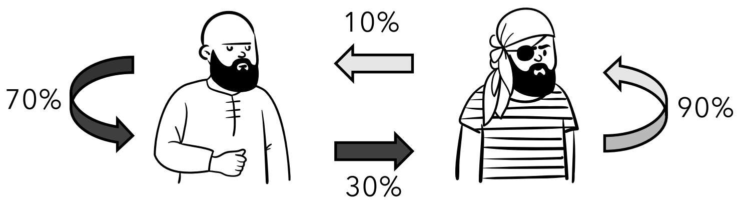
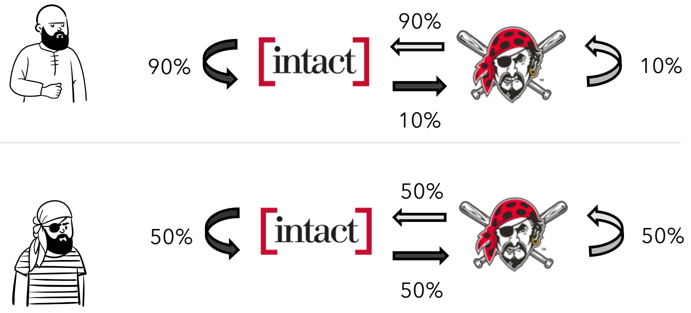
CLV Calculation – Example

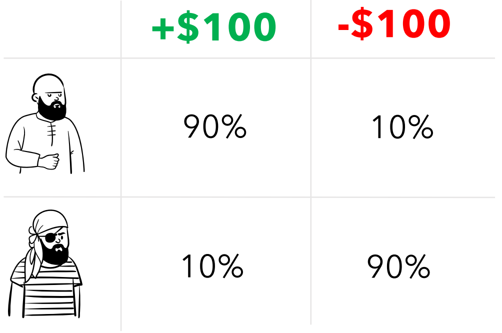
Characteristics Transition



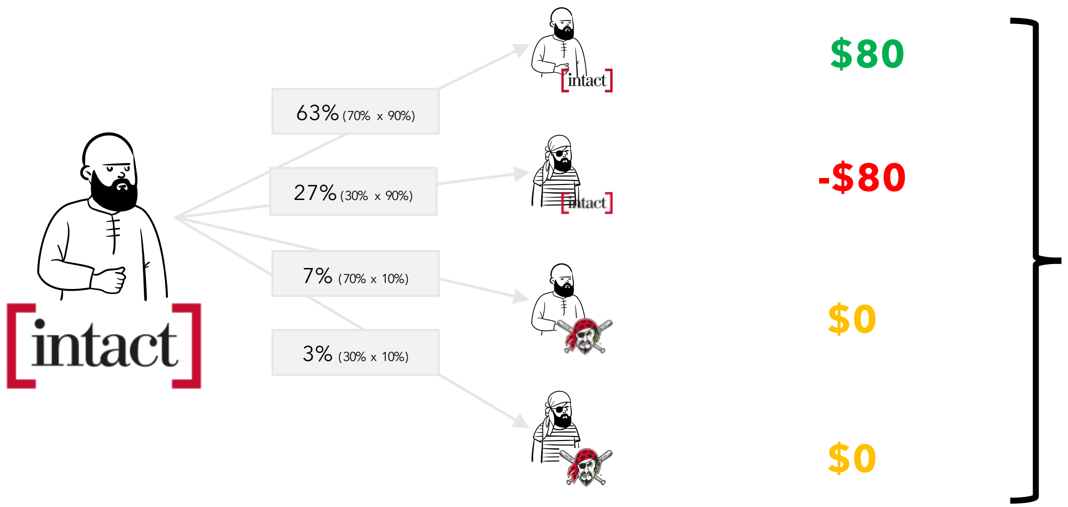
Binding Transition



Profit



State (t=0) | ***Transition Probability*** | ***State (t=1)*** | ***Expected Profit (t=1) given state (t=1)*** | ***Expected Profit (t=1) given state (t=0)***



= 63% x $80 + 27% x -$80
= $28.8

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References

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Thank you!