## Introduction to Uplift Modeling

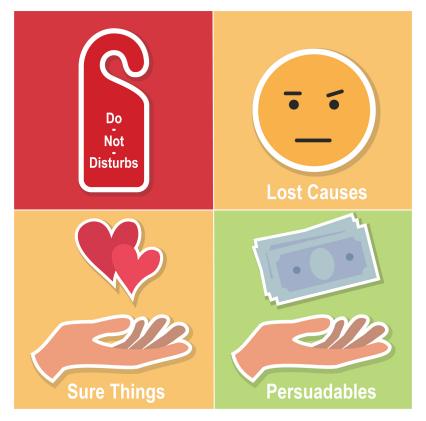
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## **Motivation**

How can we optimally select customers to be treated by marketing incentives?



# We can not send and not send incentives to the same customers at the same time



## What is Uplift Modeling?

From Gutierrez, P., & Gérardy, J. Y. (2017). "Causal Inference and Uplift Modelling: A Review of the Literature"

- Uplift modeling refers to the set of techniques used to model the incremental impact of an action or treatment on a customer outcome.
- Uplift modeling is therefore both a Causal Inference problem and a Machine Learning one.

## **Conditional Average Treatment Effect**

- Let  $Y_i^1$  denote person i's outcome when it receives the treatment and  $Y_i^0$  when it does not receive the treatment.
- We are interested in understanding the causal effect  $Y_i^1-Y_i^0$  and the conditional average treatment effect  $CATE=E[Y_i^1|X_i]-E[Y_i^0|X_i]$ , where  $X_i$  is a feature vector of the i-th person.
- However, we can not observe them!

## **Uplift**

Let  $W_i$  is a binary variable indicating whether person i received the treatment, so that

$$Y_{i}^{obs} = Y_{i}^{1}W_{i} + (1-W_{i})Y_{i}^{0}$$

### **Unconfoundedness Assumption**

If we **assume** that the treatment assignment  $W_i$  is independent of  $Y_i^1$  and  $Y_i^0$  conditional on  $X_i$ , then we can estimate the CATE from observational data by computing the empirical counterpart:

$$\mathbf{uplift} = \widehat{CATE} = E[Y_i|X_i, W_i = 1] - E[Y_i|X_i, W_i = 0]$$

## Solo Model

#### **Training**

$$\left(\begin{array}{cccc} x_{11} & \cdots & x_{1k} & w_1 \\ \vdots & \ddots & \vdots & \vdots \\ x_{11} & \cdots & x_{nk} & w_n \end{array}\right) \xrightarrow{f} \left(\begin{array}{c} y_1 \\ \vdots \\ y_n \end{array}\right)$$

$$X \bigoplus W$$

#### **Uplift Prediction**

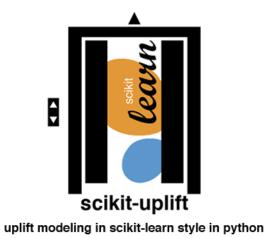
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ight)$$

# Some python implementations

causalml



• scikit-uplift



#### References:

- Gutierrez, P., & Gérardy, J. Y. (2017). "Causal Inference and Uplift Modelling: A Review of the Literature"
- Karlsson, H. (2019) "Uplift Modeling: Identifying Optimal Treatment Group Allocation and Whom to Contact to Maximize Return on Investment"

# Thank you!

More Info: juanitorduz.github.io/

