Data-Driven Demand Learning and Dynamic Pricing Strategies in Competitive Markets

Dynamic Pricing Challenge

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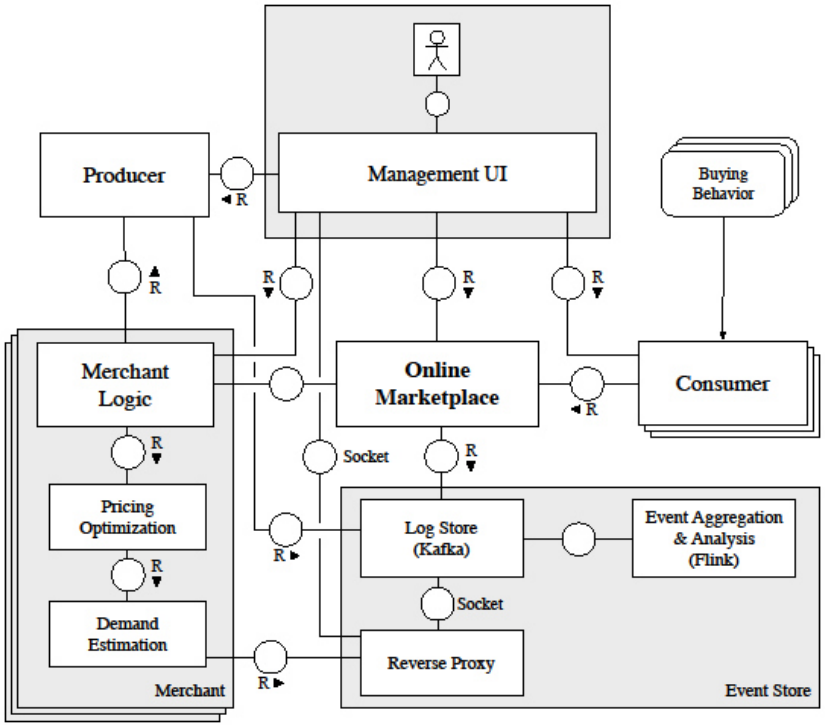
Outline

- Questions/Support: Demand Learning (Exercise II)
- Questions/Support: Price Wars Platform
- Dynamic Pricing Challenge
- Assigning Teams
- First Steps & Hints

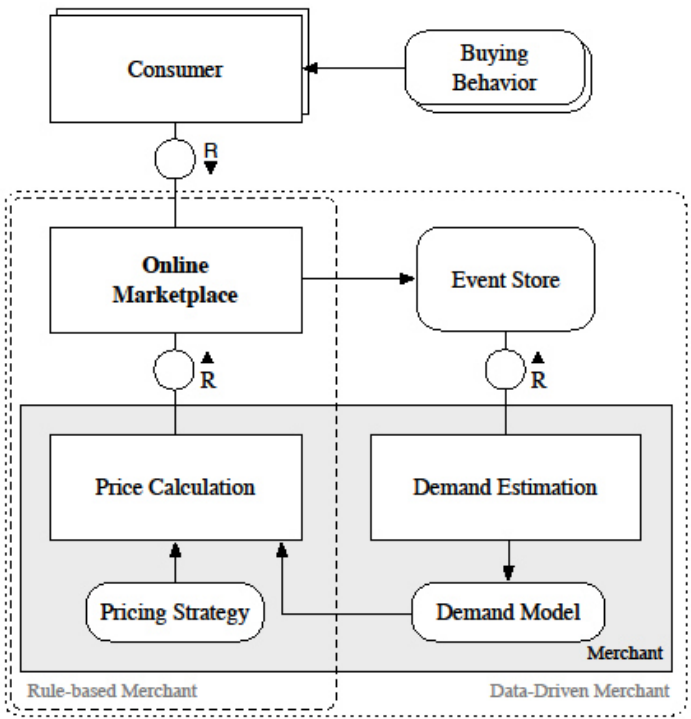
Goals for Today

- We want to play “dynamic pricing competition”
- How does our pricing simulation platform work?
- What will be expected from you?
- Would you like to work in Teams?
- What kind of scenarios/setups will be considered?

How does our pricing simulation platform work?



Pricing Strategies and Demand Learning



Outlook: Dynamic Pricing Challenges

- Setting: Duopoly + Oligopoly
- Features: Price + Quality
- Customer behavior: known + unknown
- Competitors' strategies: rule-based + data-driven
- Competitors' strategies: known + unknown
- Student teams play against each other

Start Simple: First Steps

- Customer behavior is known (& only price matters)
- Understand event data (csv file) and join relevant data
- Create suitable explanatory variables
- Apply logistic regression (via Python)
- Check/verify your demand learning results
- Compute sales probabilities & expected profits

Market Situations Raw Data

amount,merchant_id,offer_id,price,prime,product_id,quality,shipping_time_prime,shipping_time_standard,timestamp,triggering_merchant_id,uid
...
1,4MRZ5eoIHSGs1GvLio2XKGksUFZIlTOcdy24mbnwq5c=,14304,18.0,True,3,2,1,5,2017-05-29T09:34:39.895Z,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,32
2,lsP4d66epeRdGEIB51N3sRN3Gy0R0b8qK+4rxc/EYqM=,14509,17.8,True,3,1,1,5,2017-05-29T09:34:39.895Z,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,31
1,hPjEe9kUnPadEcs0jO1HLUL5maZPb6umcWgcbCxHzdo=,14511,17.6,True,3,3,1,5,2017-05-29T09:34:39.895Z,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,33
1,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,14267,13.4,True,3,4,1,5,2017-05-29T09:34:39.895Z,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,14
3,4MRZ5eoIHSGs1GvLio2XKGksUFZIlTOcdy24mbnwq5c=,14345,13.5,True,3,3,1,5,2017-05-29T09:34:40.669Z,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,13
1,4MRZ5eoIHSGs1GvLio2XKGksUFZIlTOcdy24mbnwq5c=,14303,9.0,True,1,4,1,5,2017-05-29T09:34:40.669Z,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,14
2,4MRZ5eoIHSGs1GvLio2XKGksUFZIlTOcdy24mbnwq5c=,14329,18.0,True,1,2,1,5,2017-05-29T09:34:40.669Z,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,12

Note: First entry “amount” represents an inventory level and can be ignored.

Market Situations Raw Data (Selection)

merchant_id	price	product_id	quality	timestamp
A	18.0	3	2	2017-05-29T09:34:39.895Z
B	17.8	3	1	2017-05-29T09:34:39.895Z
C	17.6	3	3	2017-05-29T09:34:39.895Z
D	13.4	3	4	2017-05-29T09:34:39.895Z
A	13.5	3	3	2017-05-29T09:34:40.669Z
A	9.0	1	4	2017-05-29T09:34:40.669Z
A	18.0	1	2	2017-05-29T09:34:40.669Z

Recall notation: A seller's offer price a within a market situation $\vec{s}$ for a specific product

$(a, \vec{s}) = (\texttt{our price (A), timestamp, our quality, comp. price+quality})$

Observable Sales Events Raw Data

amount,consumer_id,http_code,left_in_stock,merchant_id,offer_id,price,product_id,quality,timestamp,uid

1,d8qShGJytuE3neTbo1N8M6HvOtyx9mXpfjB++YXk6uY=,200,14,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,14179,20.8,1,1,2017-05-25T14:34:24.079Z,11
1,d8qShGJytuE3neTbo1N8M6HvOtyx9mXpfjB++YXk6uY=,200,14,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,14179,20.8,1,1,2017-05-25T14:34:25.780Z,11
1,d8qShGJytuE3neTbo1N8M6HvOtyx9mXpfjB++YXk6uY=,200,14,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,14179,20.0,1,1,2017-05-25T14:34:30.887Z,11
1,d8qShGJytuE3neTbo1N8M6HvOtyx9mXpfjB++YXk6uY=,200,13,DaywOe3qbtT3C8wBBSV+zBOH55DVz40L6PH1/1p9xCM=,14179,20.0,1,1,2017-05-25T14:34:32.000Z,11

amount,	merchant_id,	price,	product_id,	quality,	timestamp
1,	A,	20.8,	1,	1,	2017-05-25T14:34:24.079Z
1,	A,	20.8,	1,	1,	2017-05-25T14:34:25.780Z
1,	A,	20.0,	1,	1,	2017-05-25T14:34:30.887Z
1,	A,	20.0,	1,	1,	2017-05-25T14:34:32.000Z

To Do: Data Preparation & Demand Learning

- Join relevant raw data (market situation & sales events)
- Dependent variable: amount, i.e, number of sales (match intervals!)
- Explanatory variables: Create suitable features from raw data
- Example, e.g., **merchant_id = A, product_id = 1,** $x_t^{(1)}(a,\vec{s}) = 1$:

	y_t	$x_t^{(2)}(a,\vec{s})$	$x_t^{(3)}(a,\vec{s})$
observation	**amount,**	**price_rank,**	**quality_rank, ...**
1	. . .		
2	. . .		
...			

- Apply logistic regression or other regression/ML techniques

Exercise

- Create similar raw data (market situations & sales) as csv-file
- Or use a platform-generated csv-file
- Join dependent and explanatory variables
- Apply logistic regression (e.g., via Python's scikit-learn)
- Exploit regression results to compute expected profits for certain time intervals and various market situations

Hints

- Concentrate on market situations with own price updates
- Recall what kind of data will be available for a price update
- Verify your results using a known Customer Behavior, e.g., 60/30/10
- Check whether your probability estimations are correct
- Compare with best possible McFadden Pseudo R^2 of around 0.4

Next Steps

- *Derive* a simple data-driven strategy (max short-term profits)
- Extension A: Price + *Quality* (Customer behavior is known)
- Extension B: Customer behavior is *not known* (Price or Price/Quality)
- Measure the long-term *performance* in a duopoly setting
- Evaluate your strategy against (un)known rule-based strategies

Dynamic Pricing Challenge

- market: all firms sell one type of product (price + quality)
- controls: adjust price (# requests is limited)
- offers: all firms offer **one item at a time**, quality fixed+known
- reordering: results in costs; qualities of ordered items are randomized
- deal with: duopoly + oligopoly settings, consumer behavior unknown
- goal: maximize average long-term profits (revenues – order costs)

Overview

2	April 24	Customer Behavior
3	April 30	Pricing Strategies & DP, 1st Homework (market simulation)
4	May 8	Demand Estimation, 2nd Homework (demand learning)
5	May 15	Examples & Exercises
6	May 22	Introduction Price Wars Platform
7	**May 29**	**Dynamic Pricing Challenge**
8	June 5	no Meeting
9	June 12	Workshop / Group Meetings
10	June 19	Presentations (First Results)
11	June 26	Workshop / Group Meetings
12	July 3	Workshop / Group Meetings
13	July 10	Workshop / Group Meetings
14	**July 17**	**Presentations (Final Results), Feedback, Documentation (Aug/Sep)**