RUSH! Targeted Time-limited Coupons via Purchase Forecasts

Carnegie Mellon University
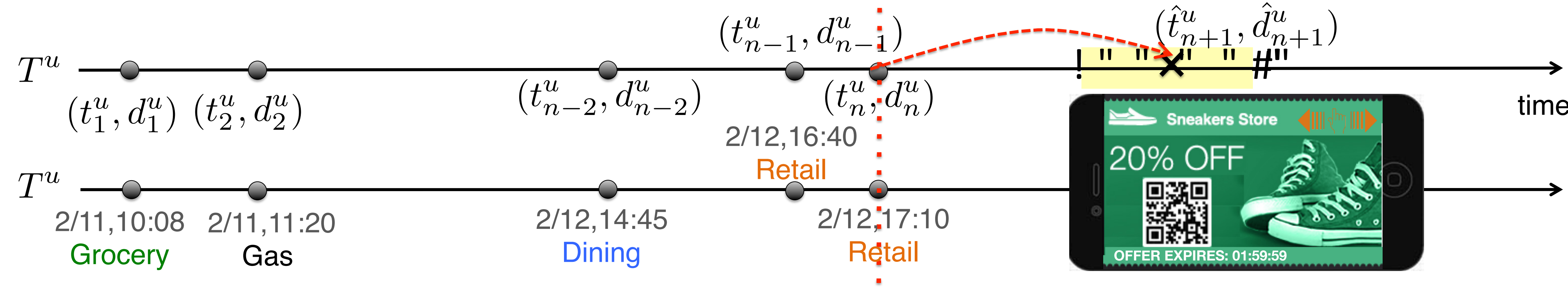
Emaad Manzoor*   Leman Akoglu

Software at
bit.ly/kdd17rush
emaad@cmu.edu

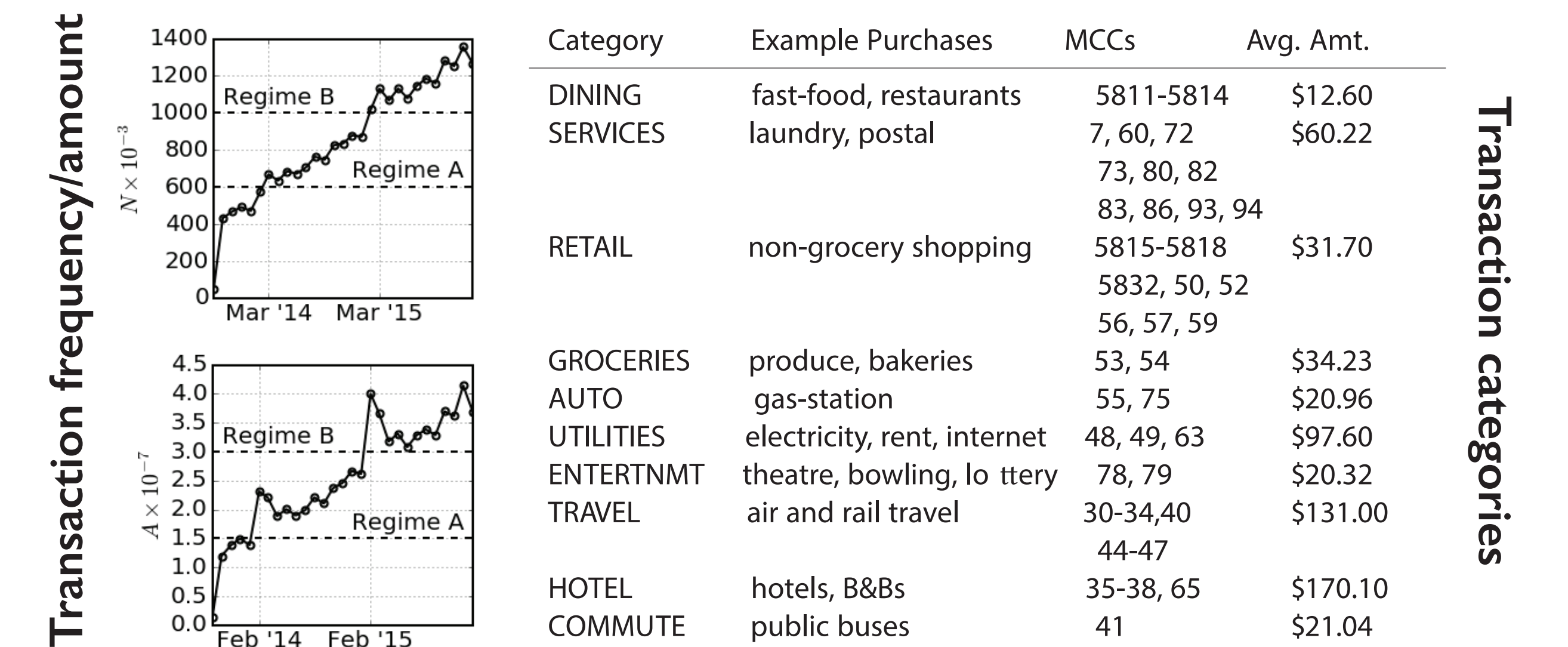**RUSH!** delivers personalized, time-limited discount coupons via continuous-time forecasts of consumer purchases.

20% OFF — Sneakers Store — OFFER EXPIRES: 01:59:59

2/12,16:40 Retail
2/11,10:08 Grocery 2/11,11:20 Gas 2/12,14:45 Dining 2/12,17:10 Retail

Why digital coupons?

$4.2B in consumer spending

0.6% of all coupons are digital

30x more likely to be redeemed

Challenges

Continuous-time temporal forecasts

Joint purchase category prediction

Non-stationary consumer behavior

Sparse consumption timelines

Evaluation from a financial perspective

Data

Prepaid accounts from partner bank

Near-complete transaction logs

Fine-grained transaction times

VISA MCC category mapping

February 2014 — 2015 time-frame

7,719 bank customer accounts

2,808,360 timestamped transactions

10 merchant categories

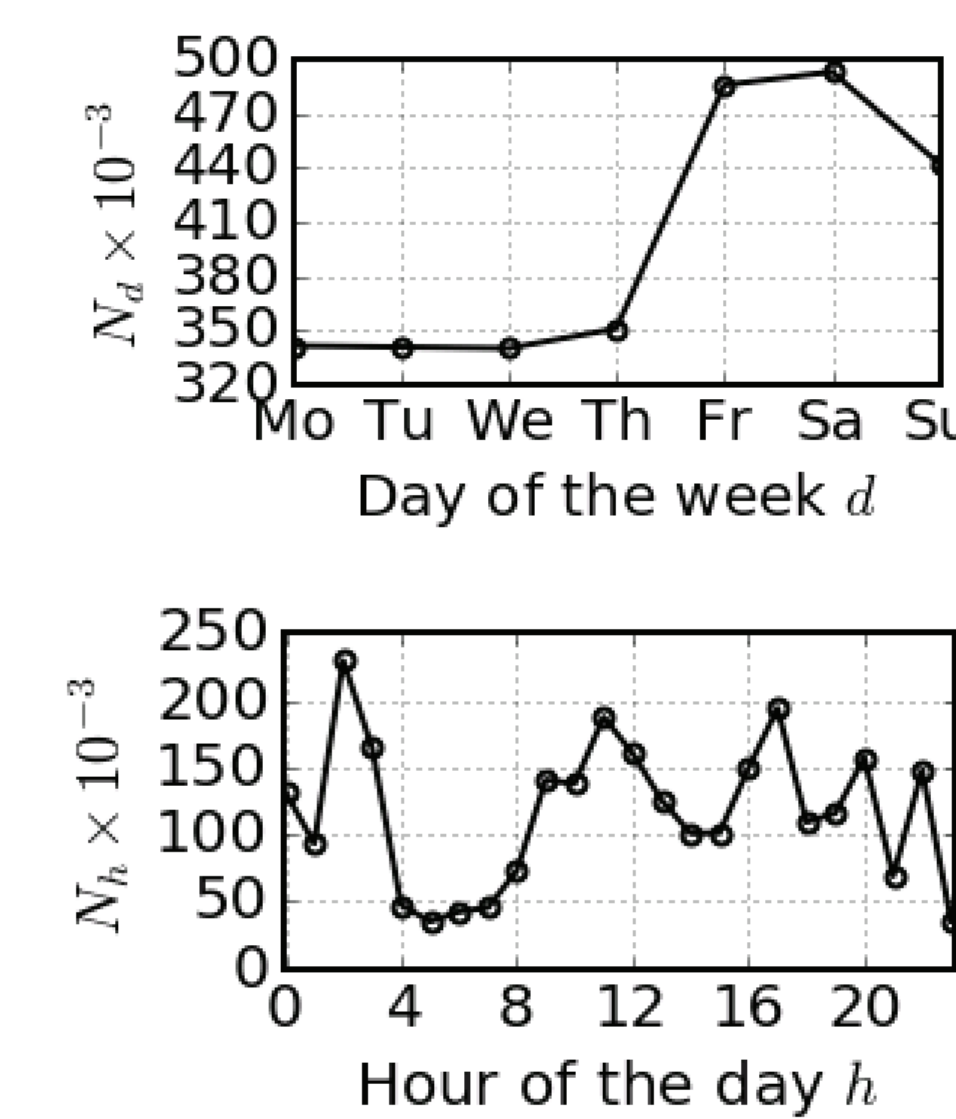| Category	Example Purchases	MCCs	Avg. Amt.
DINING	fast-food, restaurants	5811-5814	$12.60
SERVICES	laundry, postal	7, 60, 72 73, 80, 82 83, 86, 93, 94	$60.22
RETAIL	non-grocery shopping	5815-5818 5832, 50, 52 56, 57, 59	$31.70
GROCERIES	produce, bakeries	53, 54	$34.23
AUTO	gas-station	55, 75	$20.96
UTILITIES	electricity, rent, internet	48, 49, 63	$97.60
ENTERTNMT	theatre, bowling, lottery	78, 79	$20.32
TRAVEL	air and rail travel	30-34,40 44-47	$131.00
HOTEL	hotels, B&Bs	35-38, 65	$170.10
COMMUTE	public buses	41	$21.04

Modeling Purchase Behavior

$$\lambda^*(t) = \underbrace{\lambda_0}_{\text{base rate}} + \underbrace{\mu(t)}_{\text{time-variation}} + \underbrace{\sum_{t' \in \mathcal{H}_t} \beta e^{-\alpha(t-t')}}_{\text{self/cross-excitation}}$$

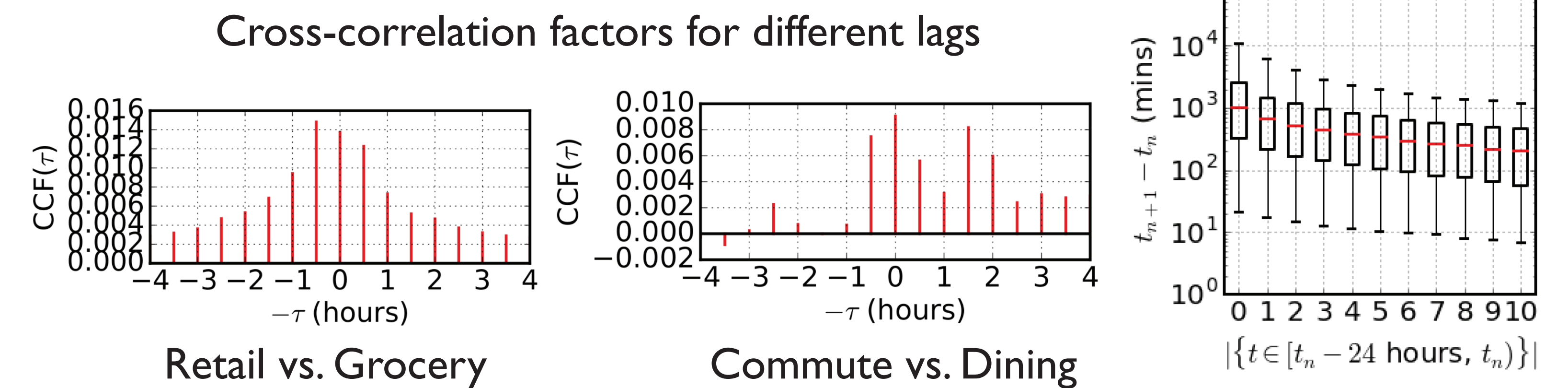Intensity leads to loglikelihood that is **concave**

Exogenous time-variation

$$\mu(t) = \sum_{f_j \in \mathcal{F}} \mu_j f_j(t)$$

Feature index j	Binary Feature	$f_j(t)$
1-24	Hour of the day	t = 00-23
25	Day of the week	t = {Mo, Tu, We, Th}
26	Day of the week	t = Fri
27	Day of the week	t = {Sa, Su}
28	Day of the month	t = 1 (often pay-day)

Self and cross-excitation

Cross-correlation factors for different lags
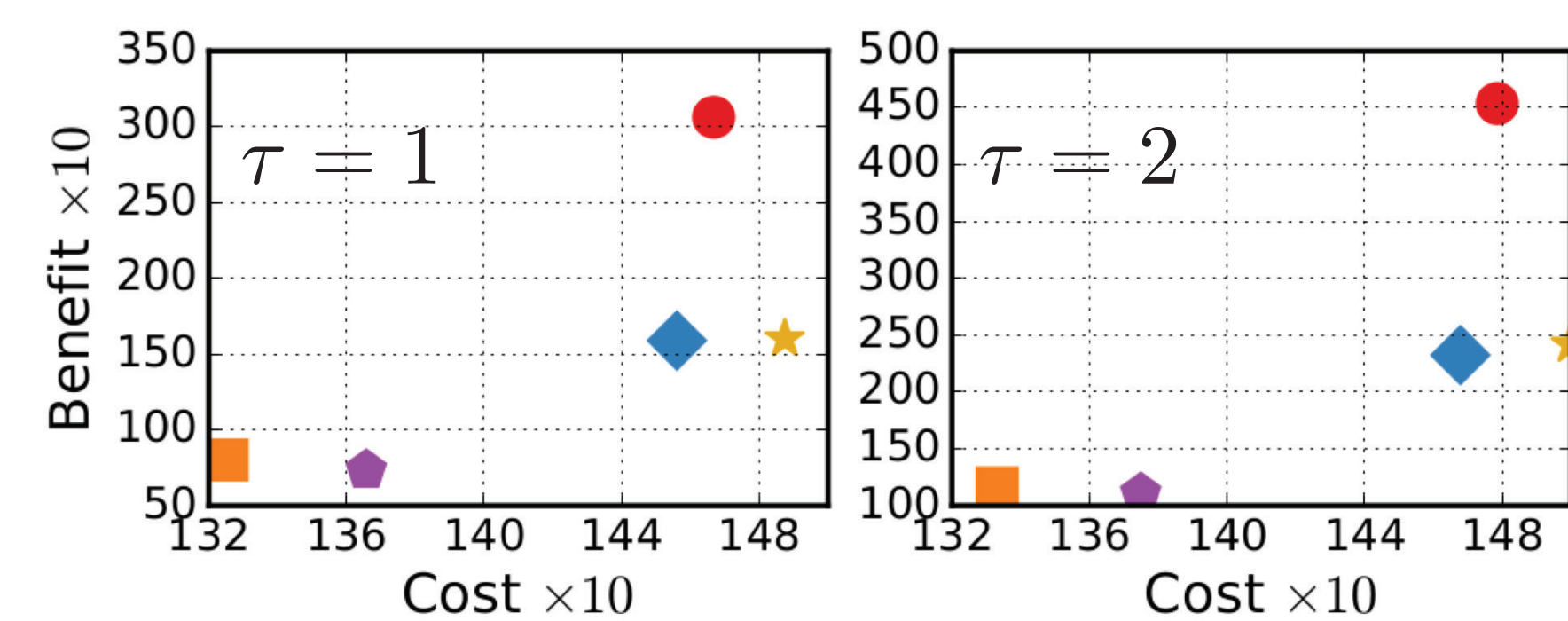

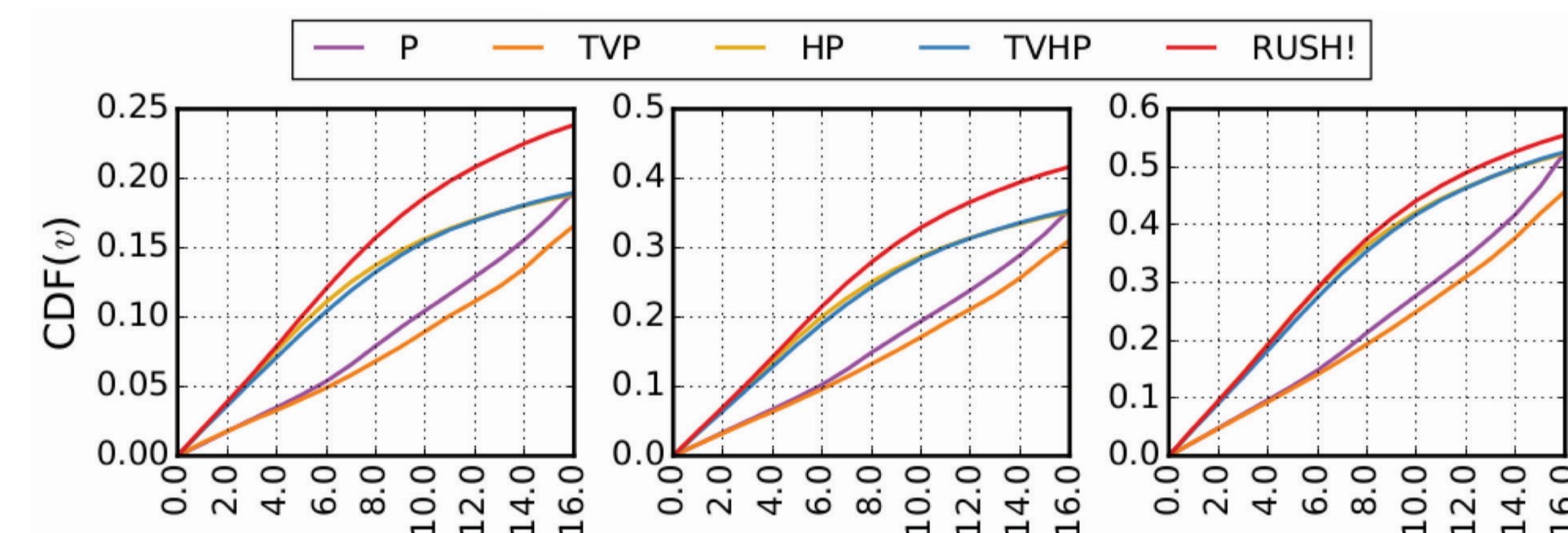Retail vs. Grocery   Commute vs. Dining

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Evaluation

Predictive loglikelihood
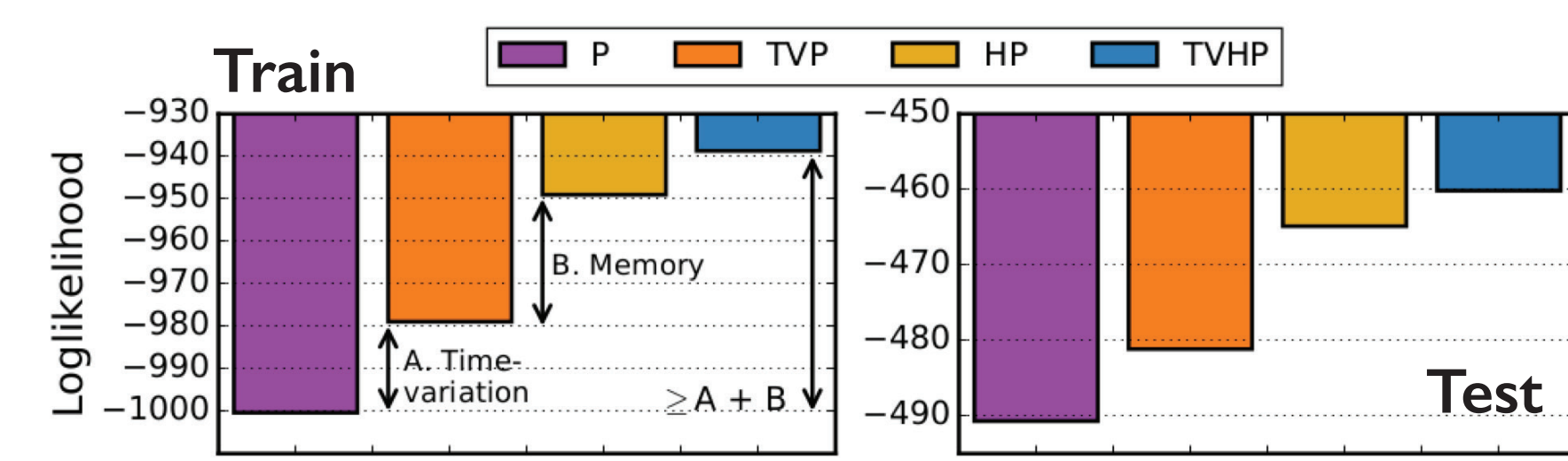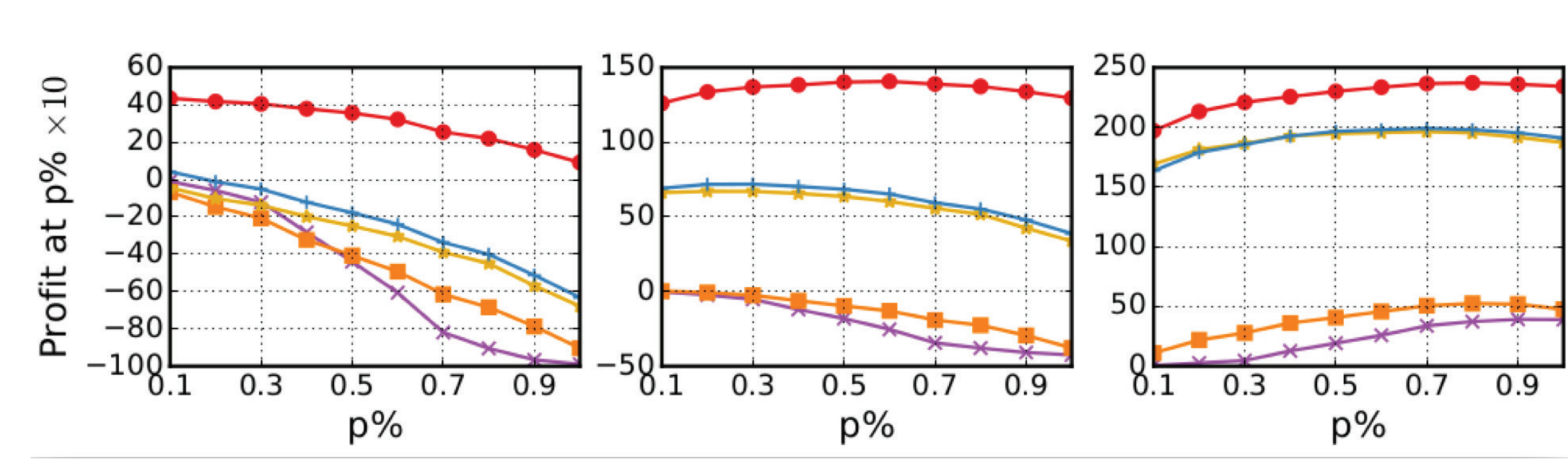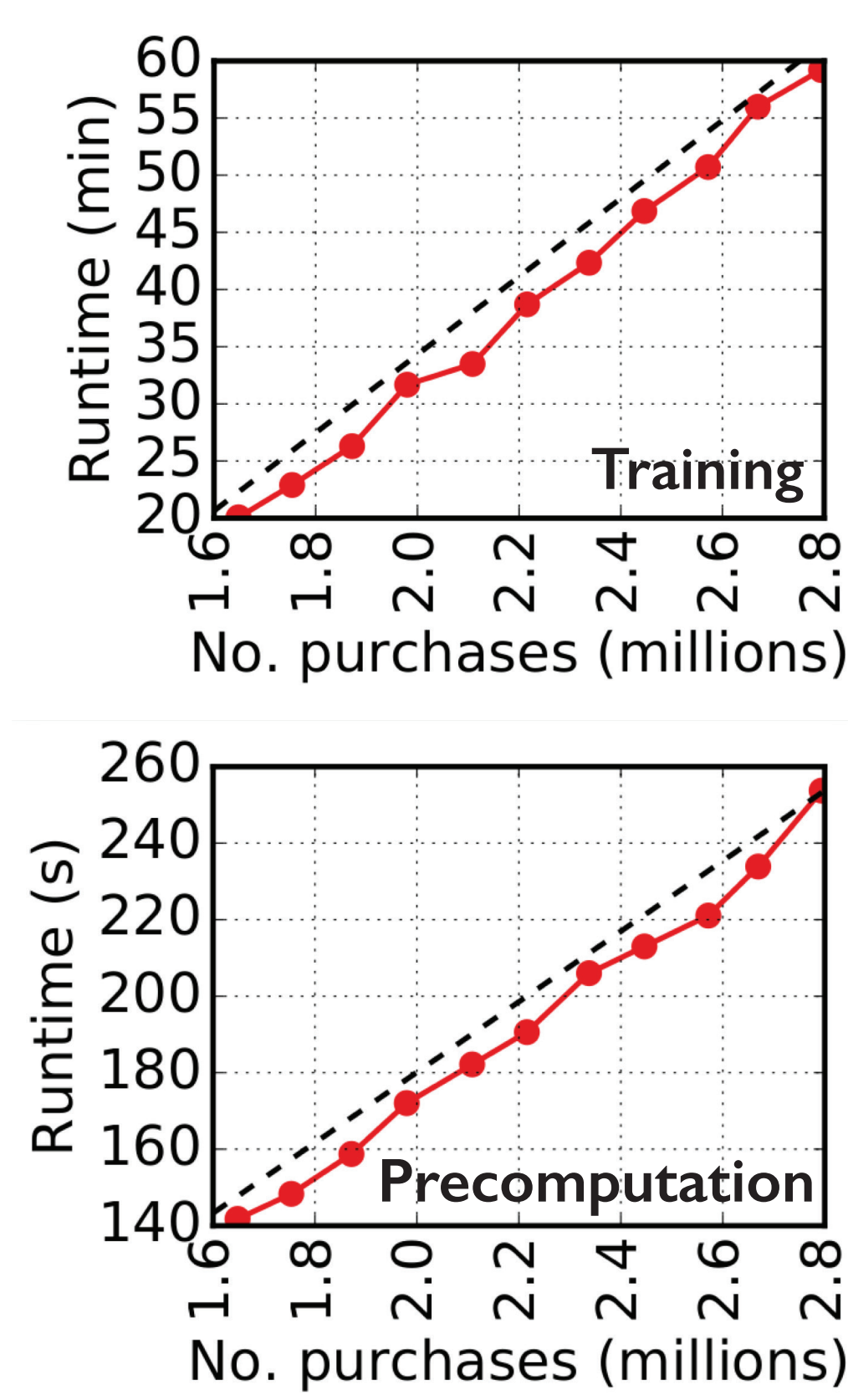

Total profit

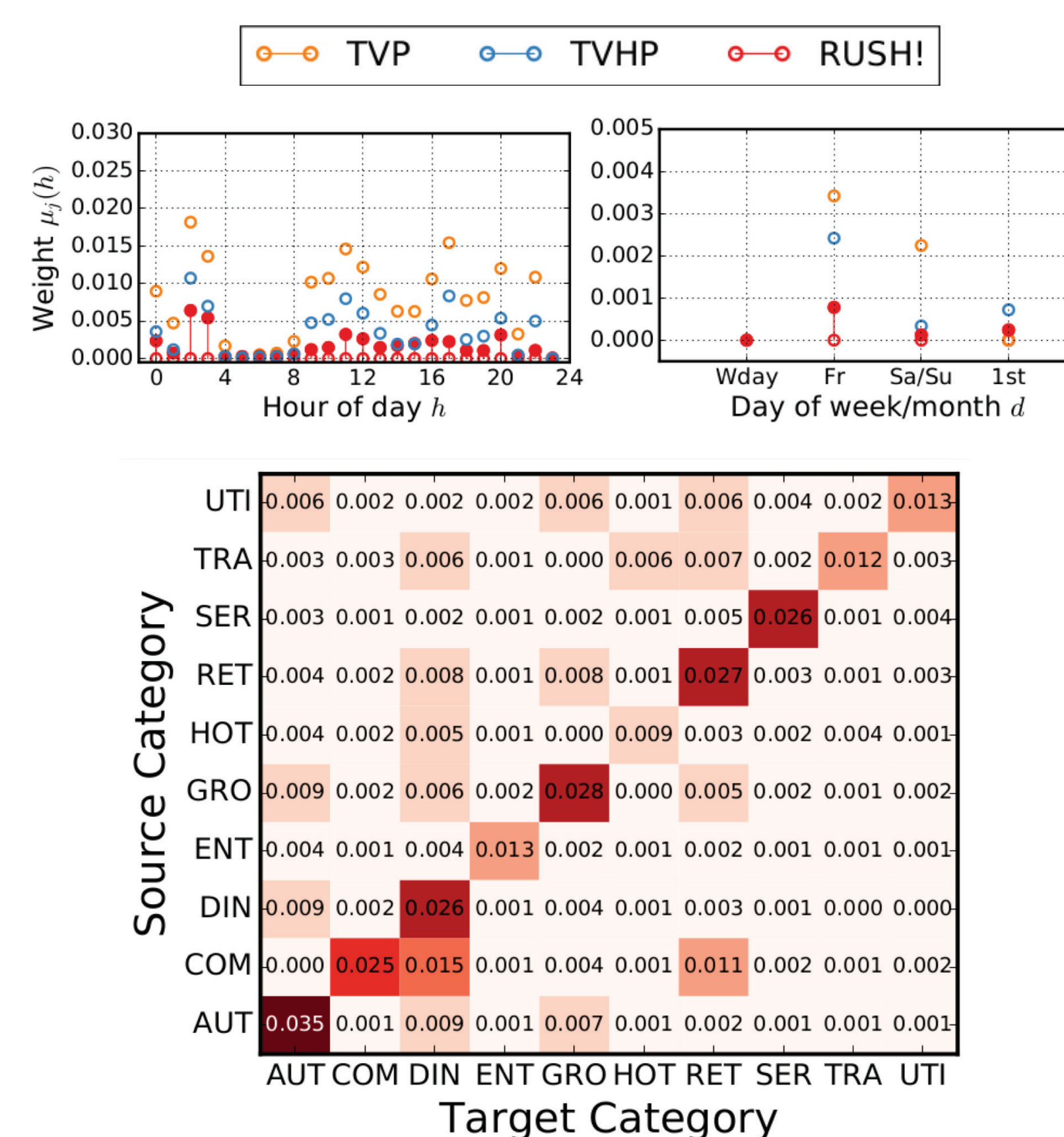## Absolute error CDF

Total profit, p% most confident coupons

Scalability

Interpretation

Future

Prediction intervals for duration

Coupon amount estimation

A/B testing & randomized experiments