What's a customer worth?

Etsy

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Some Etsy numbers

$525M Gross Merchandise Sales in 2011

19,000,000 members

800,000 active shops

15,000,000 items for sale

1.4B pageviews per month

~2M iPhone app downloads

This talk

What Customer Lifetime Value (CLV) is

A stochastic approach to estimating CLV

How we act against CLV at Etsy

What CLV is

What CLV is
Customer Lifetime Value in the open

"I know the customer lifetime value of my business is $200, so that's how much I can spend to acquire a customer"

What CLV is Customer Lifetime Value in the open

"I know the customer lifetime value of my business is $200, so that's how much I can spend to acquire a customer"

How many things are wrong with this?

What CLV is
Let me count the ways

1. Not all customers have the same CLV

What CLV is
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2. **CLV is a forward-looking concept, you can't *know* how much it is**

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2. **CLV is a forward-looking concept, you can't *know* how much it is**
3. **What we are really interested in is Residual Lifetime Value (RLV), not past spend**

What CLV is
Let me count the ways

1. **Not all customers have the same CLV**
2. **CLV is a forward-looking concept, you can't *know* how much it is**
3. **What we are really interested in is Residual Lifetime Value (RLV), not past spend**
4. **Comparing a future, uncertain quantity (CLV) to a current, certain one (CPA)**

What CLV is
Segmentation

Demographics?

What CLV is Segmentation

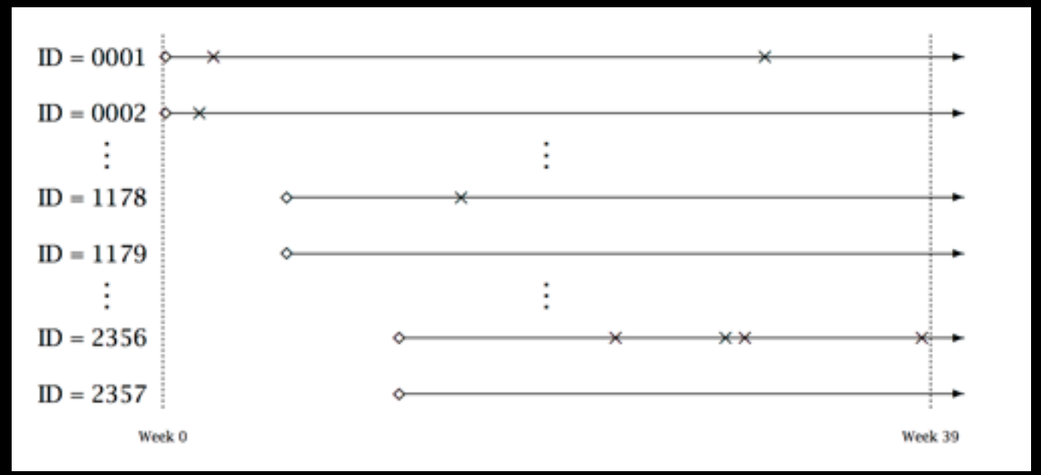
Demographics alone?

What CLV is
Segmentation: Behavior fist

Transaction log

Customer ID	Transaction Date	$ Amount
1001	2012-05-01	$30
1002	2012-05-01	$20
1003	2012-05-02	$50
1002	2012-05-03	$70
1001	2012-05-04	$10
1001	2012-05-05	$10
1004	2012-05-06	$100
…	…	…

Frequency and Recency



What CLV is
A definition

The present value of the expected sum of discounted cash flows of an individual customer.

***Individual-level* estimates:**

E(transactions) over next k time periods
E($) over next k time periods
P(returning)
...

Estimating CLV

Estimating Lifetime Value
A checklist

1. **What's the objective or the decision?**
2. **What do we want to model?**
3. **How do we model the behavior?**
4. **Deriving the mixture model**
5. **Fit the model to existing data**
6. **Predict**
7. **Check**
8. **Act upon your findings**

Estimating Lifetime Value
1. Objective

Model predictive statistics around *future* spend (RLV), in order to drive, e.g.:

Acquisition/Retention resource allocation

Individually targeted actions

Estimating Lifetime Value
2. What we want to Model

Future spend at the individual level

How many transaction/money will Alistair Croll spend over the next 2 years?

Estimating Lifetime Value
3. How we want to model it

At every moment, customer flips two coins:

The first coin determines if the customer lives or dies (e.g. forgets about Etsy).

The second coin determines if she buys or not.

Estimating Lifetime Value
4. How we want to model it

Customers have *their own, individual* live/die probabilities

Customers have *their own, individual* buy/not buy probabilities

Everyone has two unique coins.

Estimating Lifetime Value
4. Nasty Math

Survival process: exponential (one parameter!), latent parameters distributed gamma (two parameters)

Transaction process: Poisson process, latent parameters distributed gamma (two parameters)

Four parameters: fits in Excel.

Estimating Lifetime Value

5. Fit the model

Solve the double integral
MLE (maximize log likelihood)

$$L(r,\alpha,s,\beta \mid x, t_x, T)$$

$$= \frac{\Gamma(r+x)\alpha^r\beta^s}{\Gamma(r)}\left\{\left(\frac{s}{r+s+x}\right)\frac{{}_2F_1\left(r+s+x, s+1; r+s+x+1; \frac{\alpha-\beta}{\alpha+t_x}\right)}{(\alpha+t_x)^{r+s+x}}\right.$$

$$\left. + \left(\frac{r+x}{r+s+x}\right)\frac{{}_2F_1\left(r+s+x, s; r+s+x+1; \frac{\alpha-\beta}{\alpha+T}\right)}{(\alpha+T)^{r+s+x}}\right\}, \text{ if } \alpha \geq \beta$$

$$L(r,\alpha,s,\beta \mid x, t_x, T)$$

$$= \frac{\Gamma(r+x)\alpha^r\beta^s}{\Gamma(r)}\left\{\left(\frac{s}{r+s+x}\right)\frac{{}_2F_1\left(r+s+x, r+x; r+s+x+1; \frac{\beta-\alpha}{\beta+t_x}\right)}{(\beta+t_x)^{r+s+x}}\right.$$

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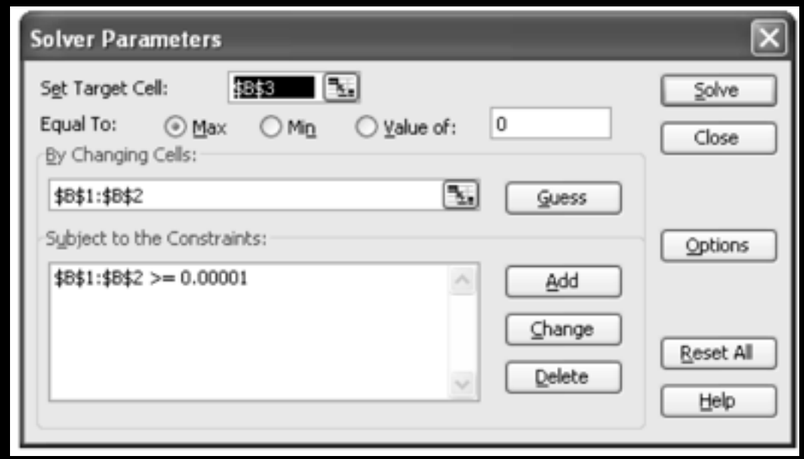
Estimating Lifetime Value
Fit the model



Excel

R (Buy Til You Die library)

Python / Cython

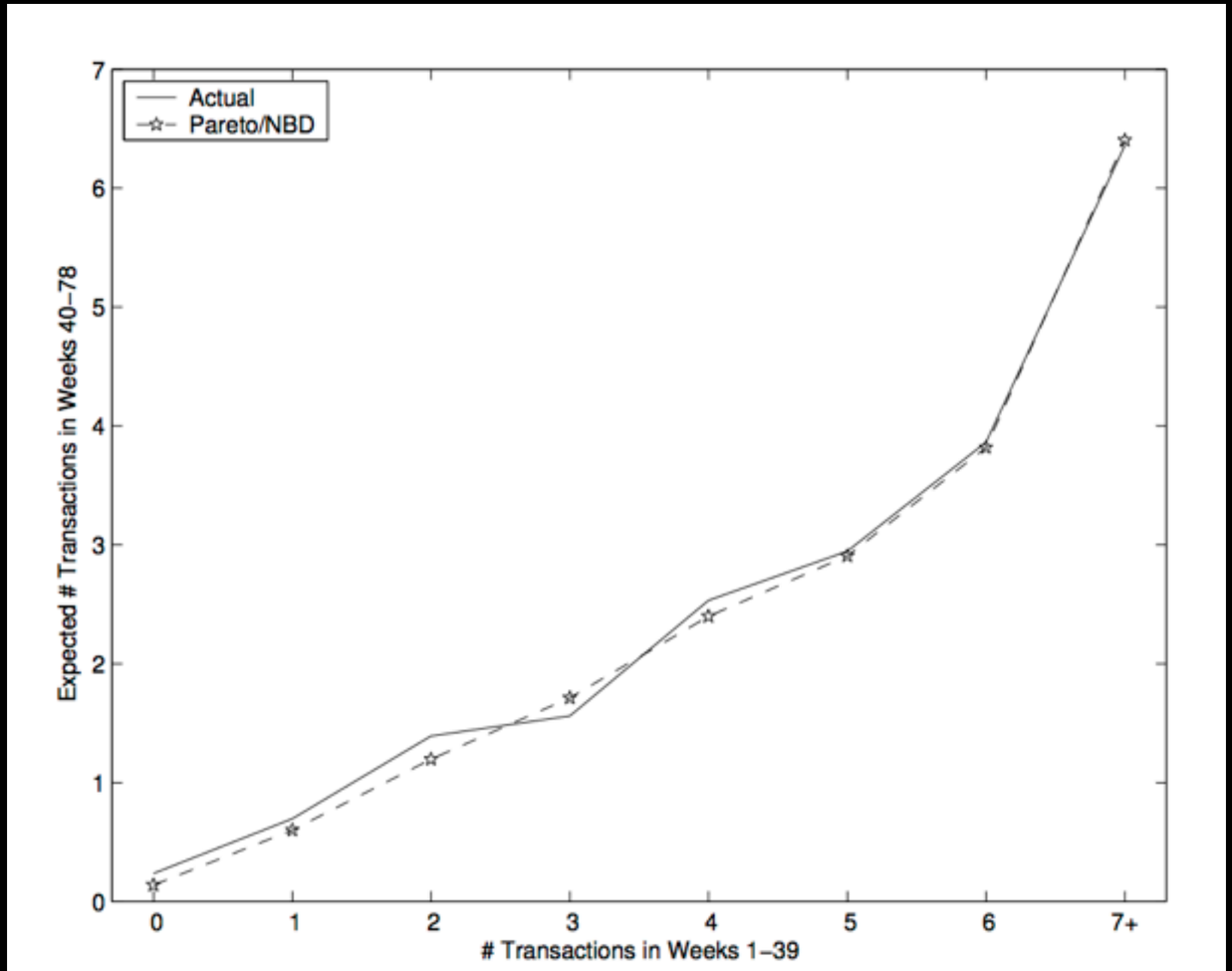
...

Estimating Lifetime Value
Predict

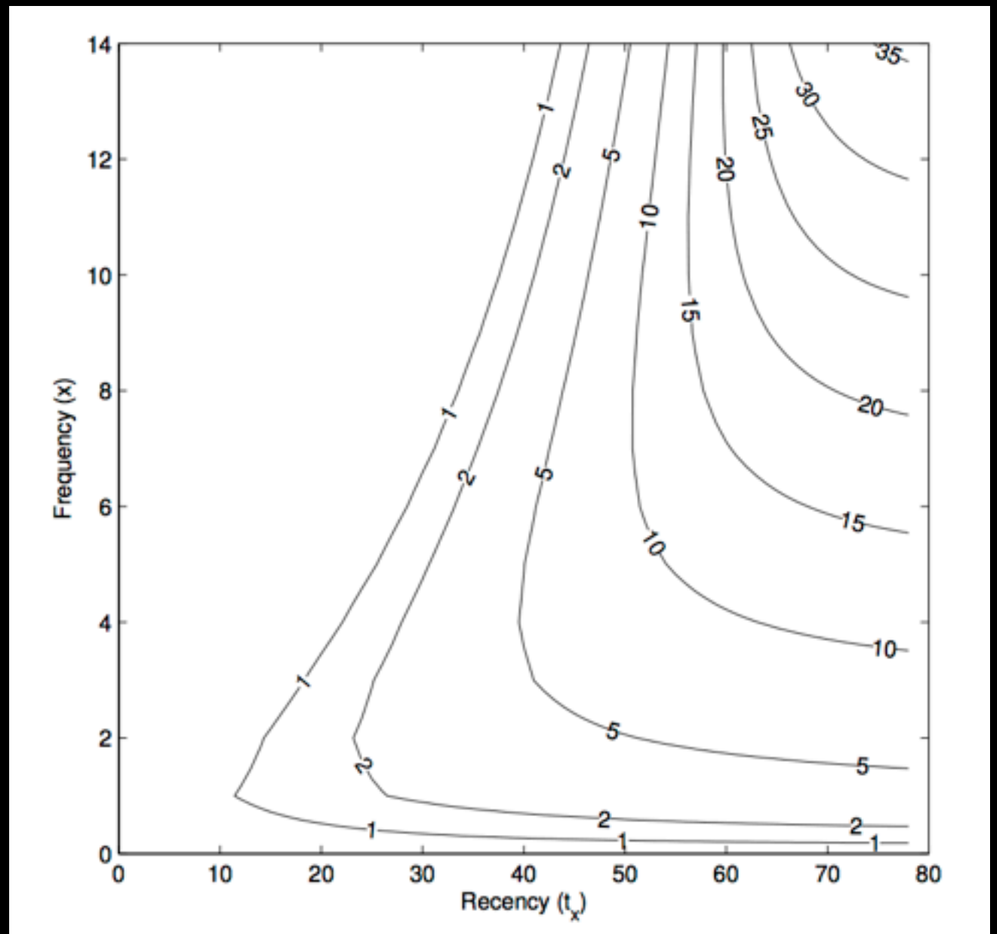
Pareto/NBD predicts the discounted expected number of future transactions

Multiply by the average monetary value of transaction and margin to get RLV

Estimating Lifetime Value
Conditional Expectations



Estimating Lifetime Value
Isovalue RF Curves



Estimating Lifetime Value
Segmentation and Allocation

Bin recency and frequency for behavioral-based segmentation

		Recency			
	Frequency	0	1	2	3
M=0	0	$4.40			
M=1	1		$6.39	$20.52	$25.26
	2		$7.30	$31.27	$41.55
	3		$4.54	$48.74	$109.32
M=2	1		$9.02	$28.90	$34.43
	2		$9.92	$48.67	$62.21
	3		$5.23	$77.85	$208.85
M=3	1		$16.65	$53.20	$65.58
	2		$22.15	$91.09	$120.97
	3		$10.28	$140.26	$434.95

		Recency			
	Frequency	0	1	2	3
M=0	0	$53,000			
M=1	1		$7,700	$9,900	$1,800
	2		$2,800	$15,300	$17,400
	3		$300	$12,500	$52,900
M=2	1		$5,900	$7,600	$2,300
	2		$3,600	$26,500	$25,800
	3		$500	$37,200	$203,000
M=3	1		$11,300	$19,700	$3,700
	2		$7,300	$45,900	$47,900
	3		$1,000	$62,700	$414,900

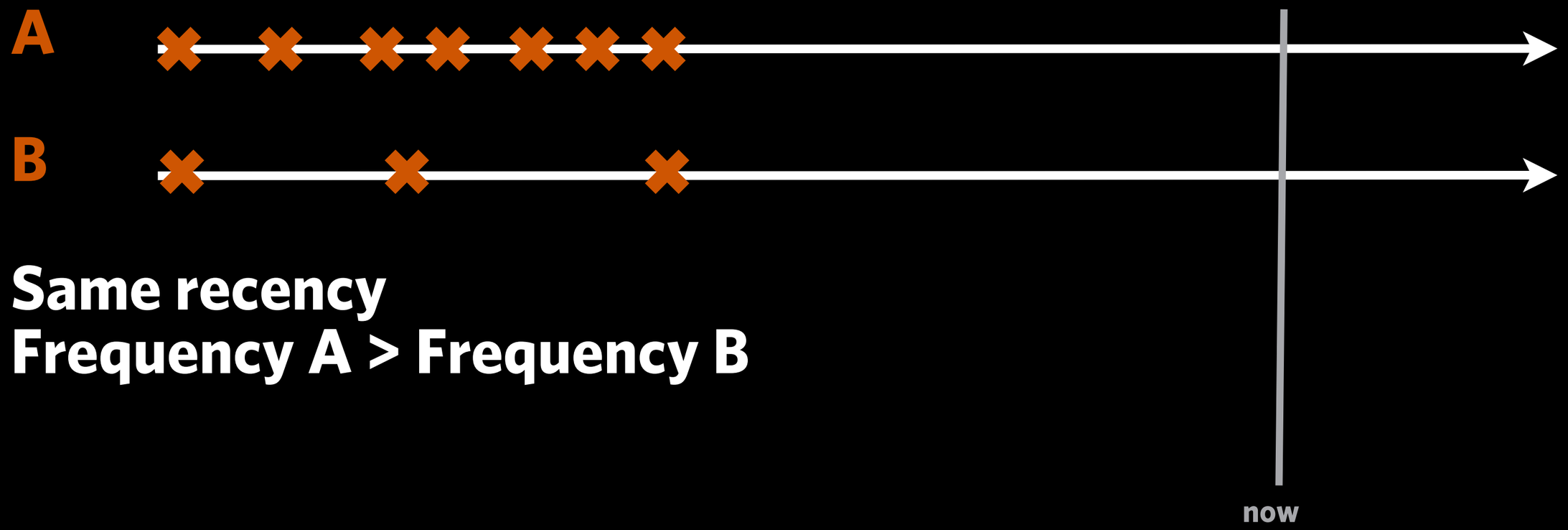
Estimating Lifetime Value
Check your model

Don't use (only) in-sample fit

Out of sample fit
Divvy up your training set
Remove random observations

Simplicity and Consistency of the story

Estimating Lifetime Value
Who has the highest RLV?



Same recency
Frequency A > Frequency B

Estimating Lifetime Value
Who has the highest RLV?

B has higher RLV

A has higher propensity and thus more likely to have ‘died’

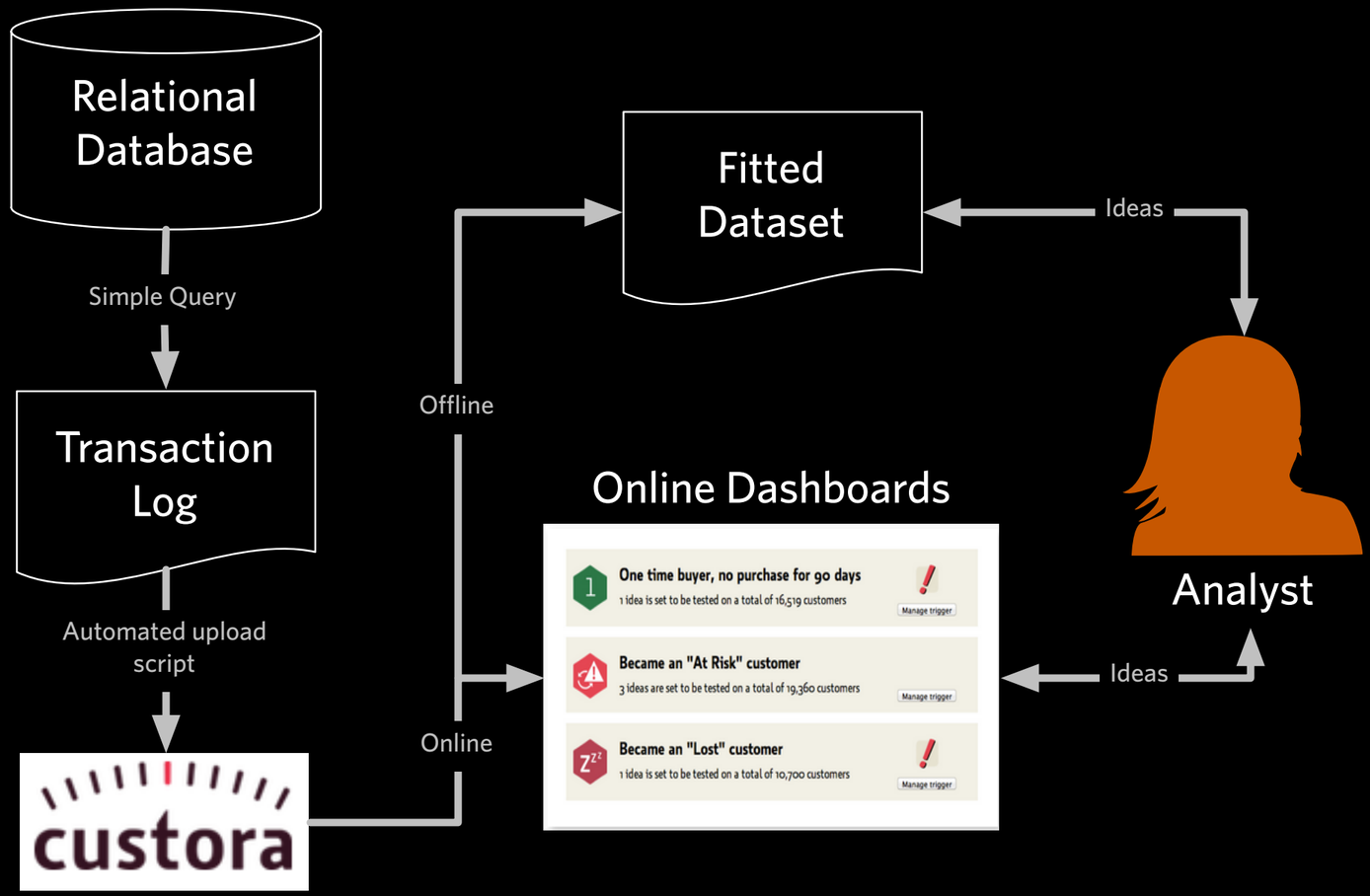
Estimating Lifetime Value
Covariates

Other information we have about customers can be brought in as a covariate

Is the customer mobile?
What categories they buy in?
Seasonality
Media/PR event
Etc.

Acting on CLV

Acting on CLV
Etsy Lifetime Value Stack



Acting on CLV
Customers of interest

Who are your best customers?

Recent high-profile customers

Old-time best customers about to churn or just churned

Acting on CLV
Retention campaigns

Sent an email to 7.5M customers who hadn't bought in 60 days or more

Set aside a 5% control group

Emailed customer bought 11¢ more over the next 15 days vs. control ($p < .05$)

Made $800K GMS directly, plus raised their RLV, total expected benefit $4-6M GMS

Acting on CLV
Future: Longitudinal customer treatments

Keep track of all treatments/controls at the customer level, together with their purchasing patterns

Trying bandit strategies in marketing (explore/exploit)

Acting on CLV
Fun stuff with fitted CLV datasets

Sum all RLV expectations across customers to value the company.

Look up and talk to your best customers.

Acting on CLV
Behavioral customer segmentation

Bronze/silver customers: reinforcement, nudges

Gold customers: premium services

Platinum customers: recognition

Three things to remember from this talk

Customers have their own individual CLV. There's no one figure.

Don't use in-sample fit to judge a marketing model.

Who are your best customers? Really, what are their names?

QUESTIONS?

Office Hours: tomorrow (Wed), 2:30-3pm, Rhinelander Room.

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