OPEN DATA SCIENCE CONFERENCE

#ODSC

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Bayesian Hieratical Model for Predictive Analytic

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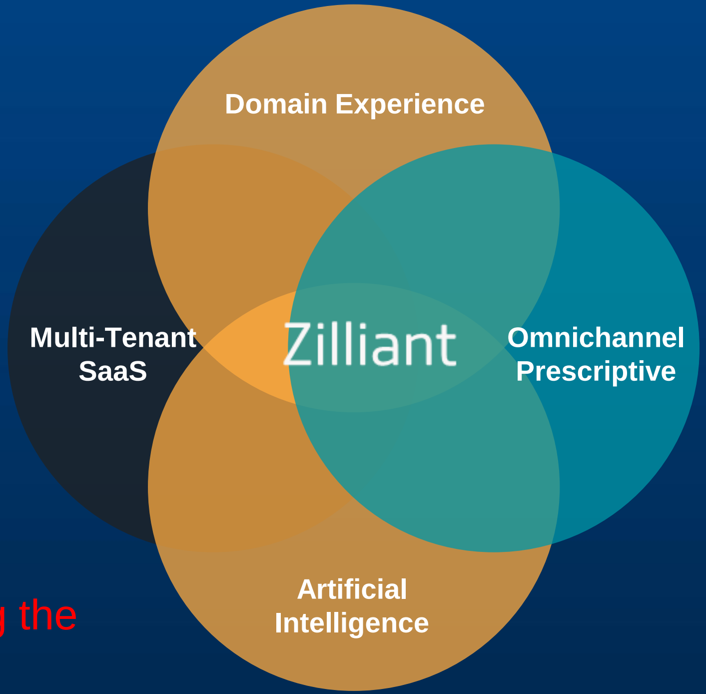
About Zilliant

- Founded in 1998
- Headquartered in Austin, Texas
- 200 employees & contractors
- Serving B2B Distribution, Manufacturing & Industrial Services
- 120+ customers around the world. 100’s of implementations
- Investors: ABS Ventures, Houston Ventures, Trellis Partners,
- and Goldman Sachs



The world’s leading AI-enriched SaaS platform for maximizing the lifetime value of B2B customer relationships.

About Zilliant

Zilliant IQ

Converting Strategic Insights into Account Specific Action Plans

Ex. Data In

- Product Master
- Customer Master
- Transaction Data
- Win / Loss Data
- 3rd Party Data
- Competitor Price Data

Zilliant IQ – Multi-Tenant SaaS Platform

Cloud Infrastructure: Highly Scalable – Secure – Collaborative – In-Memory Reporting

Action IQ – Actionable Intelligence & Sales Guidance

- Account Potential
- Account Health
- Dashboards & Collaboration
- Action Plans & Campaigns
- Quotes
- Agreements

IQ Engines – AI & Prescriptive & On-Demand Insights

- Cart IQ
- Cost IQ
- Price IQ
- Profit IQ
- Sales IQ

Zilliant IQ Anywhere – Integration & Omnichannel Activation

Omnichannel Activation

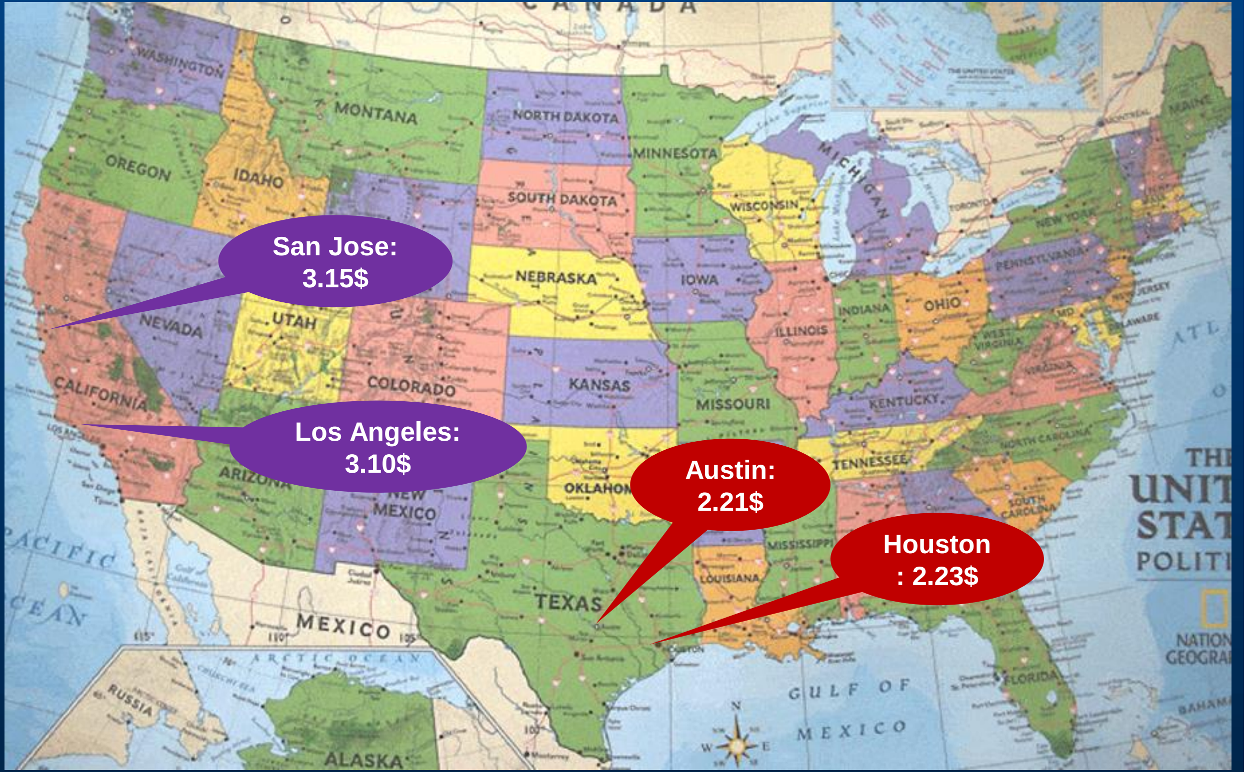
Zilliant Apps.

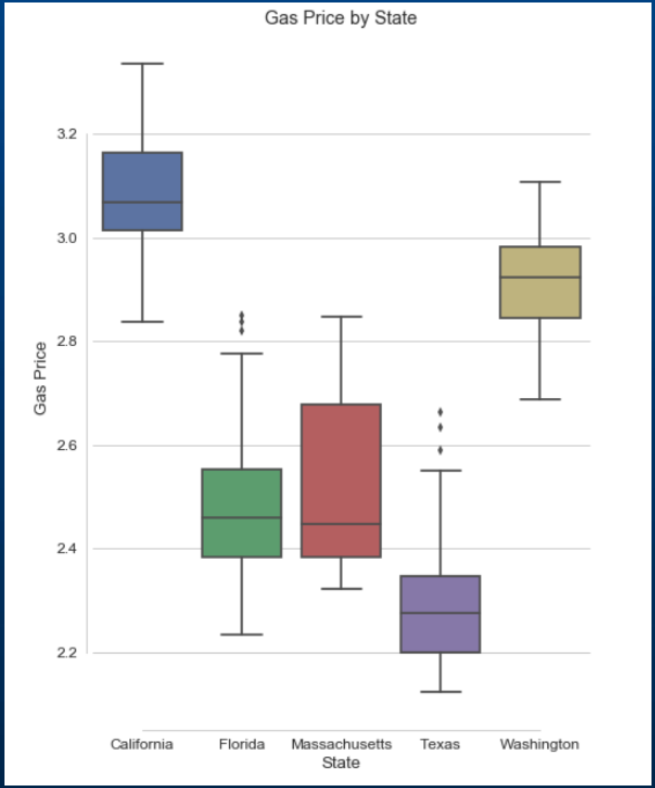
- Email
- Mobile
- Browser

Enterprise Integration…

- CRM / CPQ
- eCom
- Quoting Tools
- ERP

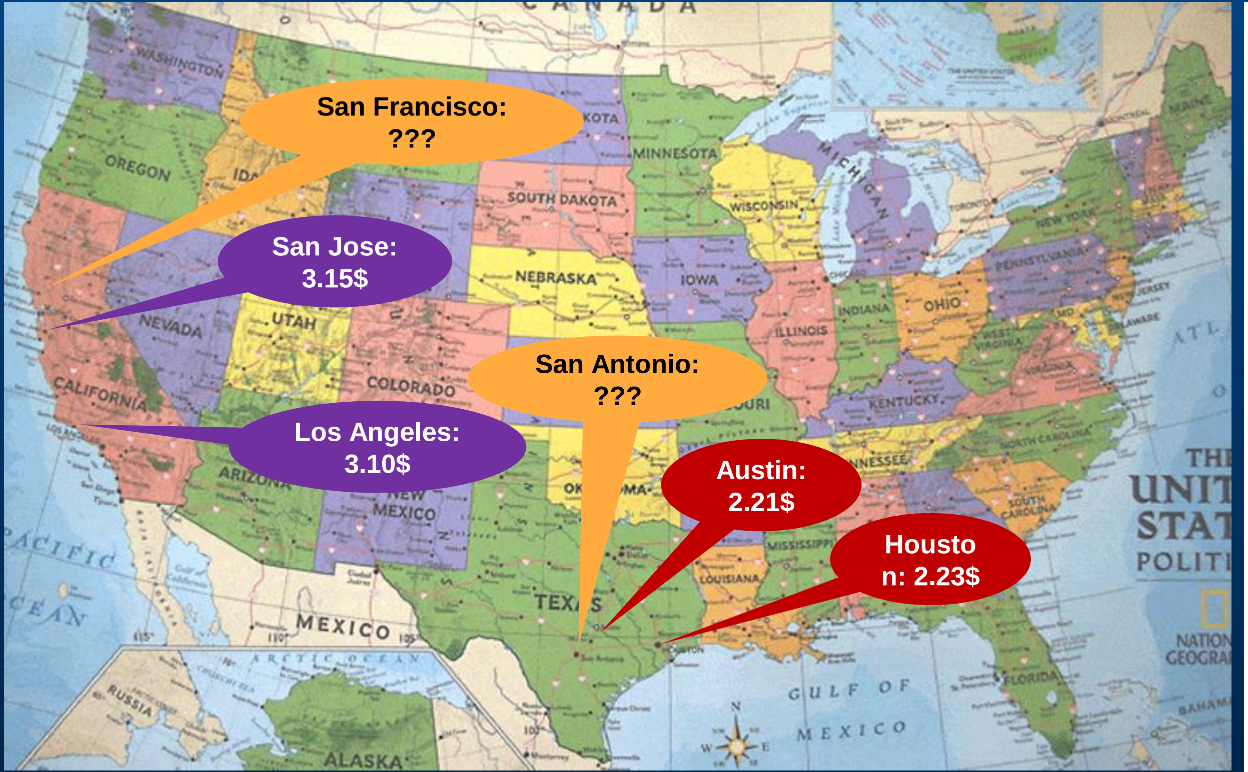
Gas Price:

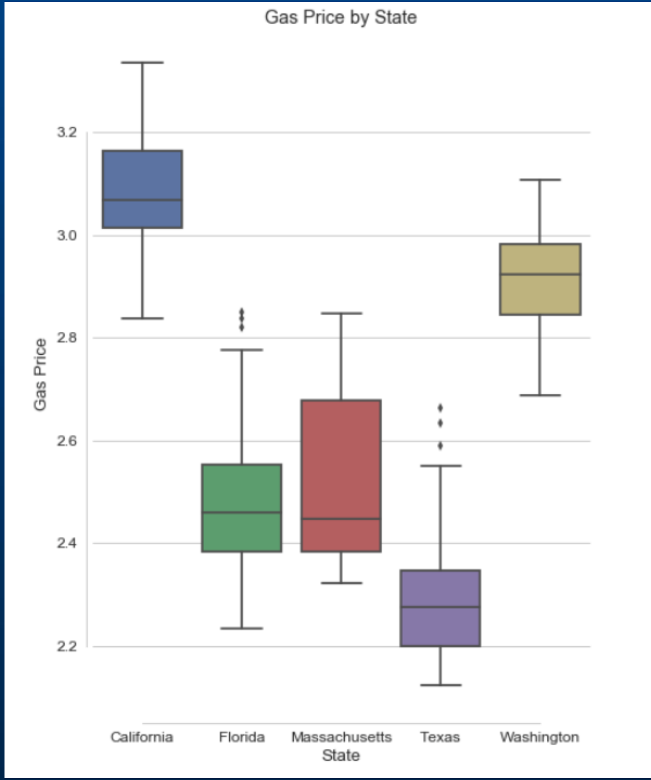




Source: https://www.eia.gov

Gas Price:





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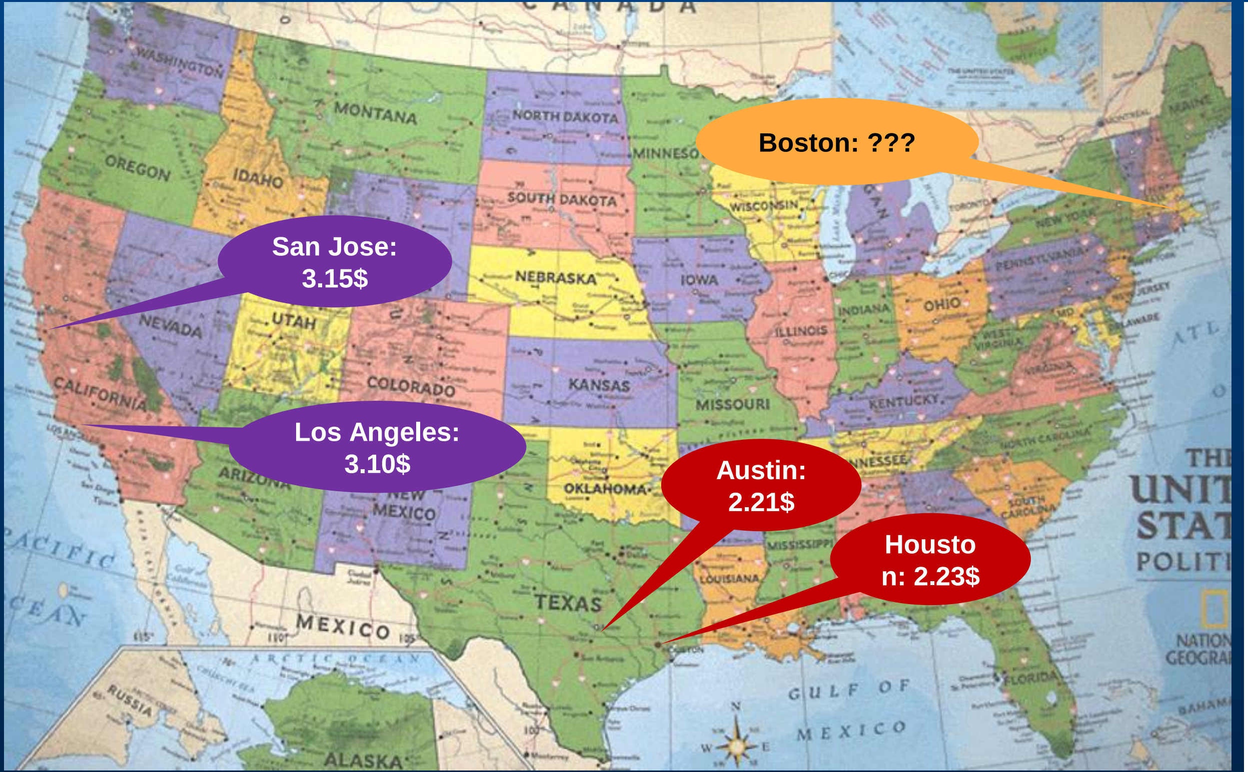
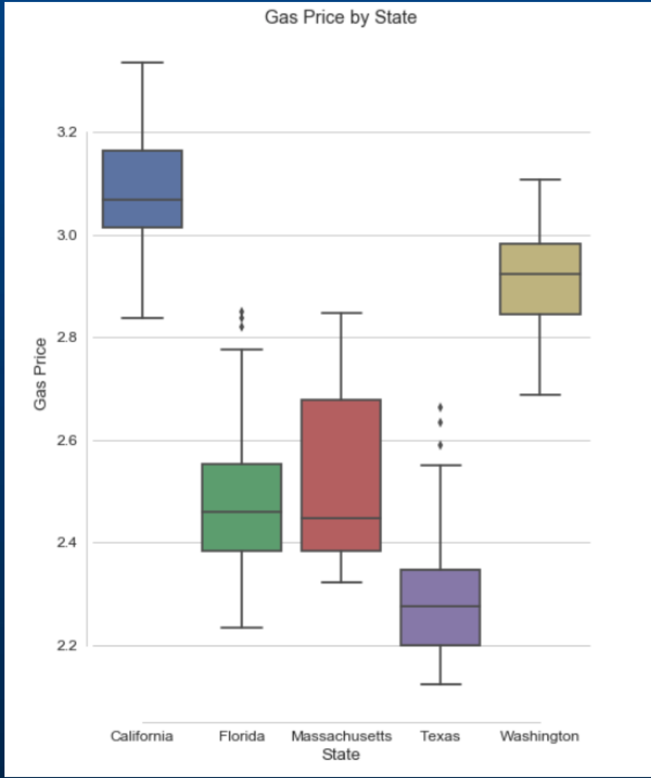
Gas Price:





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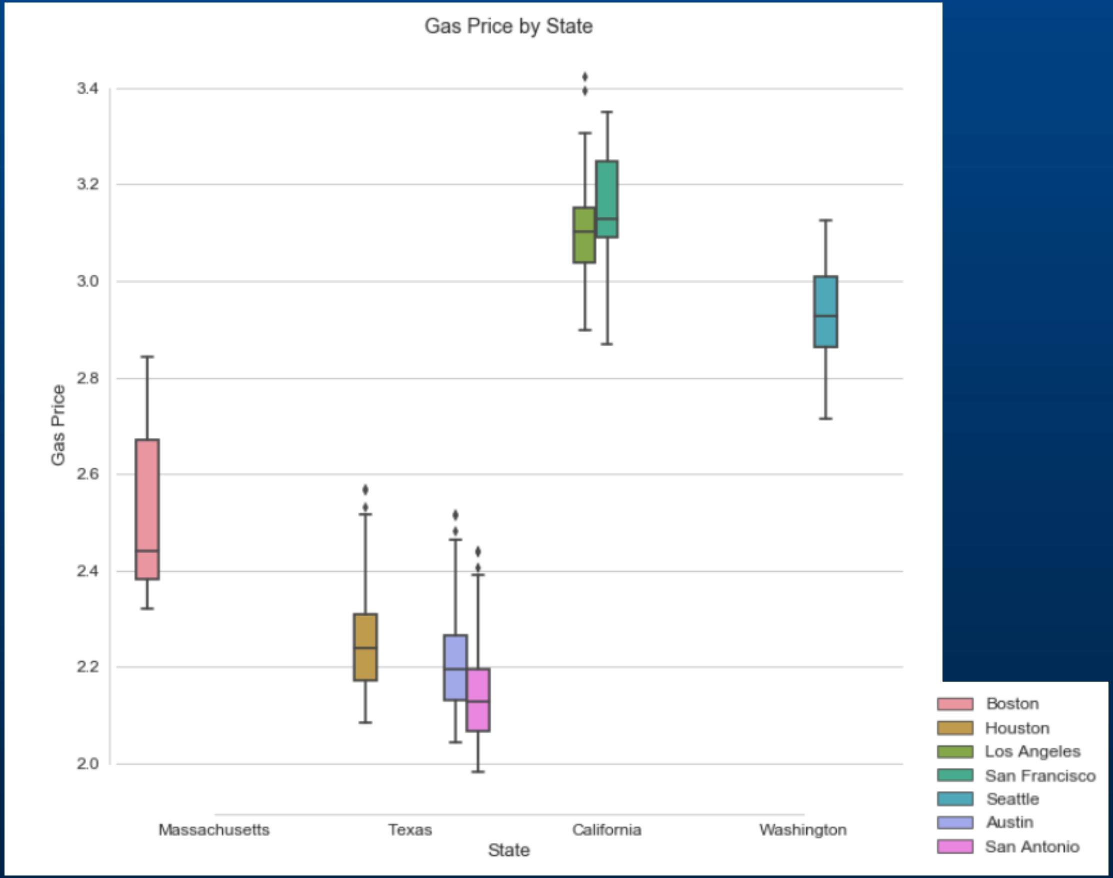
Source: https://www.eia.gov

Gas Price:



Source: https://www.eia.gov

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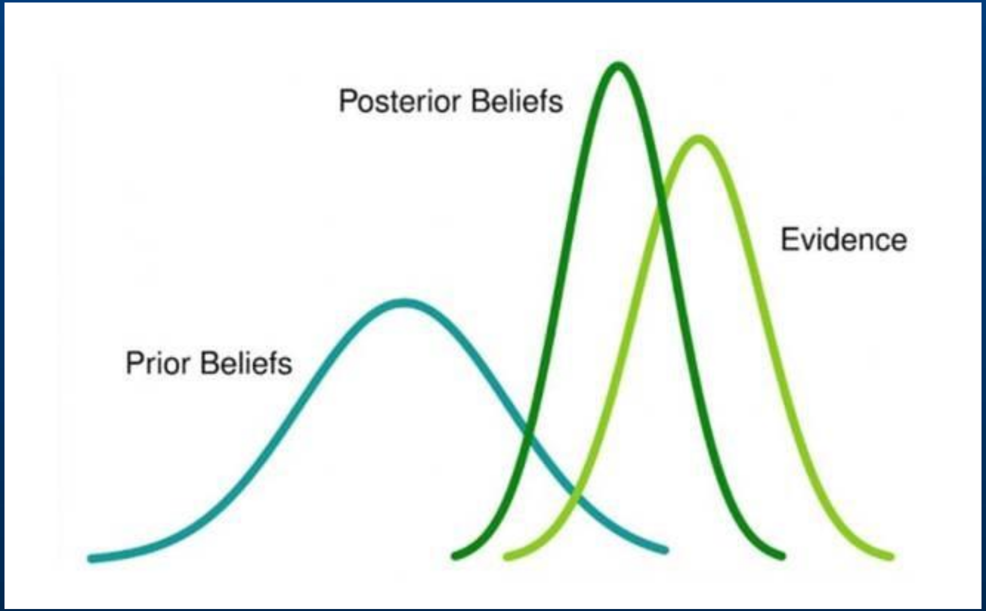
Gas Price:

San Antonio:

- Station 1: 3.5$
- Station 2: 3.8$

Source: https://www.eia.gov

Bayesian Models



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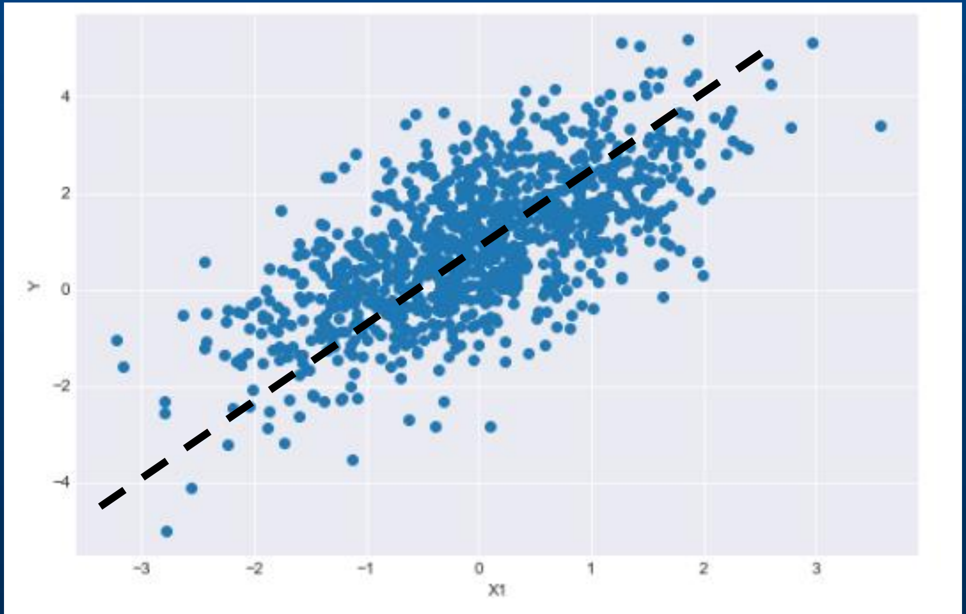
Bayesian Regression



Assumed relationship: $y = \alpha + \beta x$

Priors:

$$\alpha \sim N(0, 10)$$
$$\beta \sim N(1, 5)$$

What other assumption(s) we have?

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Bayesian Regression

1- What is the target variable? **Y which depends on Alpha and Beta**

2- What is assumed (potential distribution)? **Normal Distribution**

3- Define priors **Alpha and/or Beta distribution**

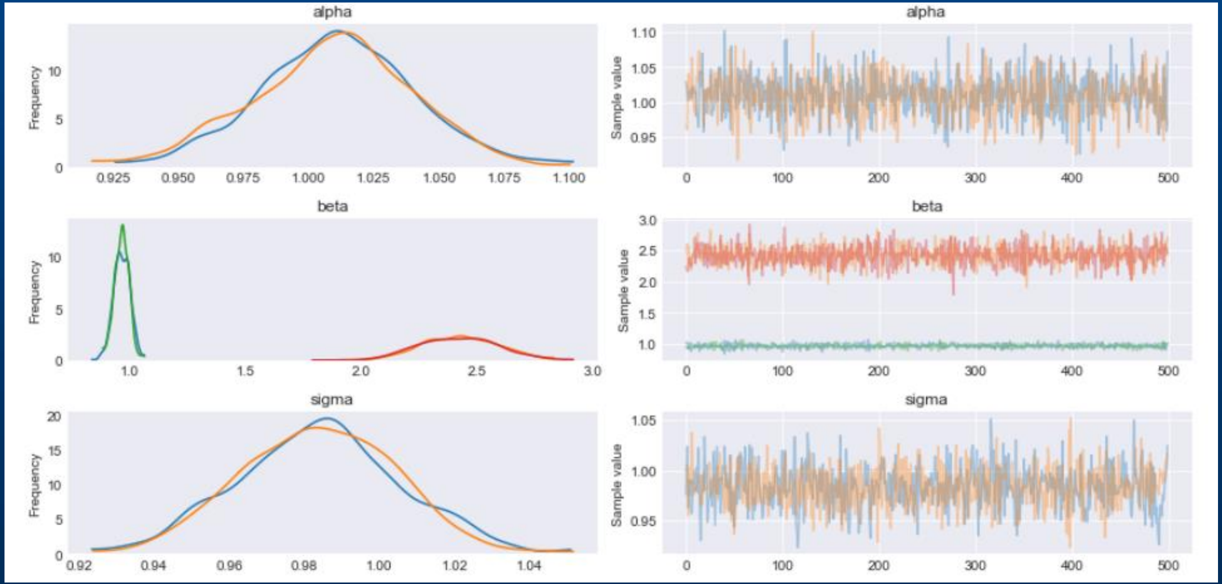
Bayesian Regression

```
regression_model = pm.Model()

with regression_model:


    alpha = pm.Normal('alpha', mu=0, sd=10)
    beta = pm.Normal('beta', mu=1, sd=5)
    sigma = pm.HalfNormal('sigma', sd=1)


    mu = alpha + beta*X1


    Y_obs = pm.Normal('Y_obs', mu=mu, sd=sigma, observed=Y)
```

Create stochastic variables

Create deterministic variable

Bayesian Regression



	mean	sd	mc_error	hpd_2.5	hpd_97.5	n_eff	Rhat
alpha	1.009507	0.029933	0.000790	0.950972	1.065191	1515.745188	1.000558
beta__0	0.967910	0.032986	0.000856	0.905172	1.032044	1451.511508	0.999007
beta__1	2.420182	0.164576	0.004431	2.120133	2.747157	1641.803594	0.999708
sigma	0.983615	0.021083	0.000603	0.945488	1.024915	1201.344314	0.999019

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Flight Delay Prediction

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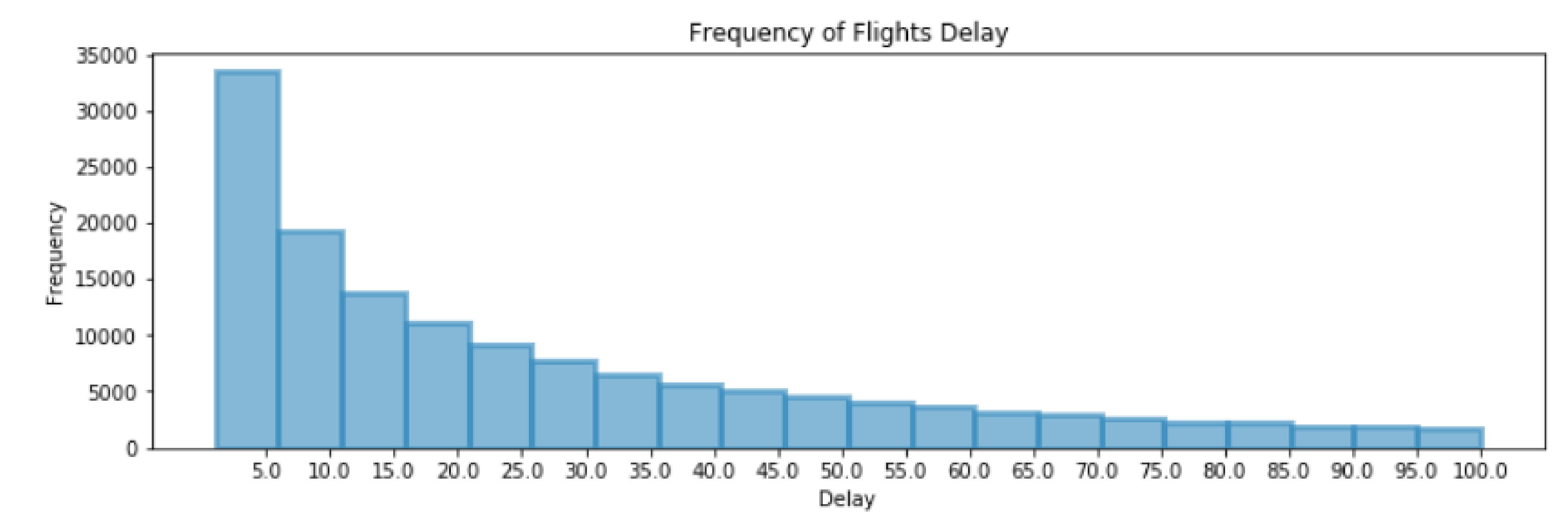
Flight Delay Prediction:

Evidence (IAH Airport)



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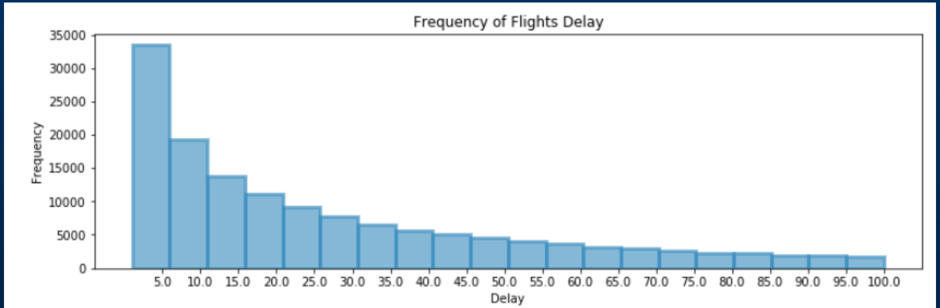
Source: http://stat-computing.org/dataexpo/2009/the-data.html

Modeling Step

1- What is the target variable?

2- What is assumed (potential distribution)?

3- Define priors



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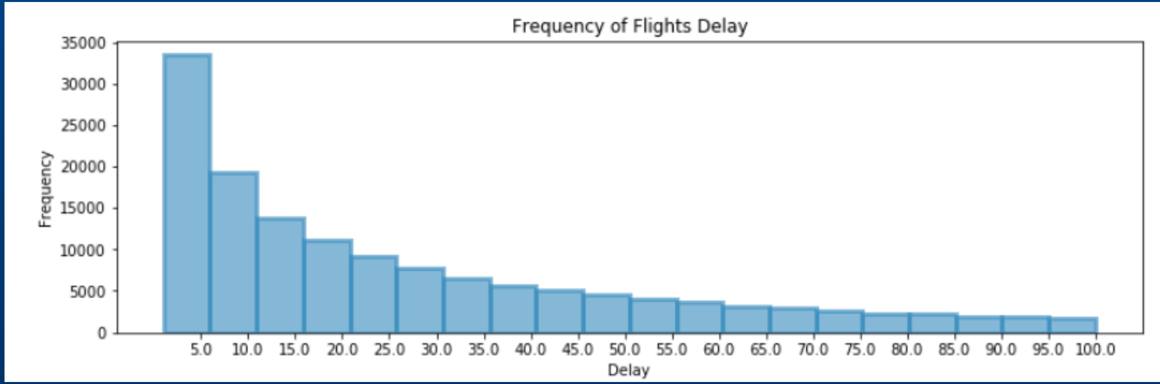
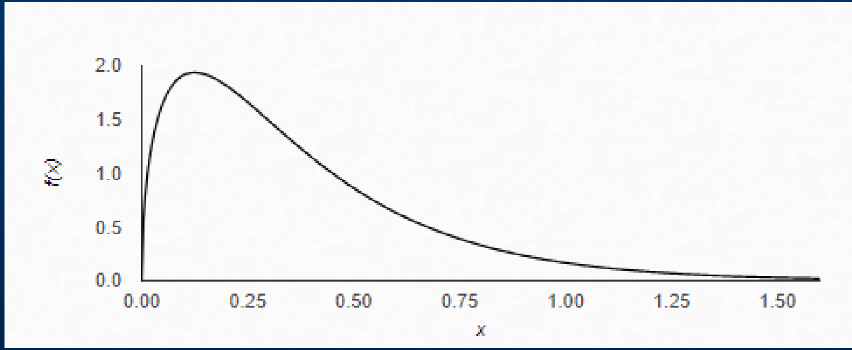
Flight Delay Prediction:



Evidence (IAH Airport)

$$f(x;\lambda) = \lambda e^{-x\lambda}$$



Prior Belief

Source: http://stat-computing.org/dataexpo/2009/the-data.html

Flight Delay Prediction:

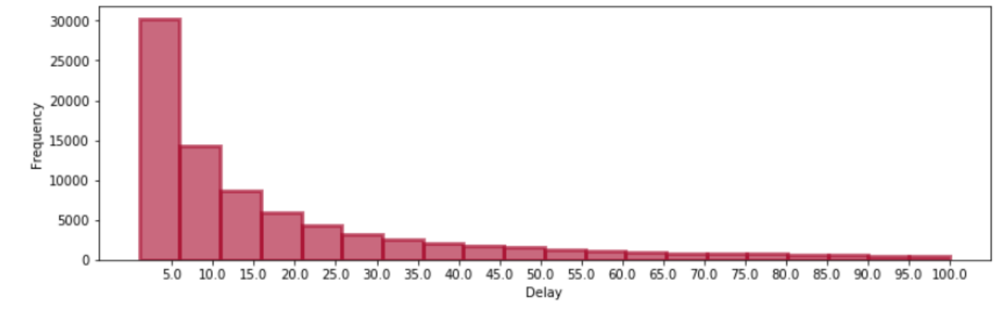
```
Flight_Delay = pm.Model()

with Flight_Delay:
    # Prior Distribution

    rate = pm.Gamma('rate', 2, 2)

    # Likelihood (sampling distribution) of observations
    Y_obs = pm.Exponential('Y_obs', rate, observed=x)
```

Prior Distribution of target variable

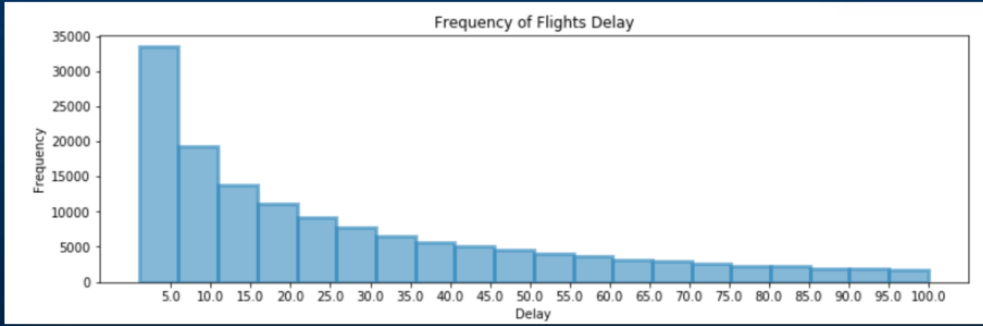
Relationship between

Flight Delay Prediction:

Evidence (ORD Airport)



Evidence (IAH Airport)



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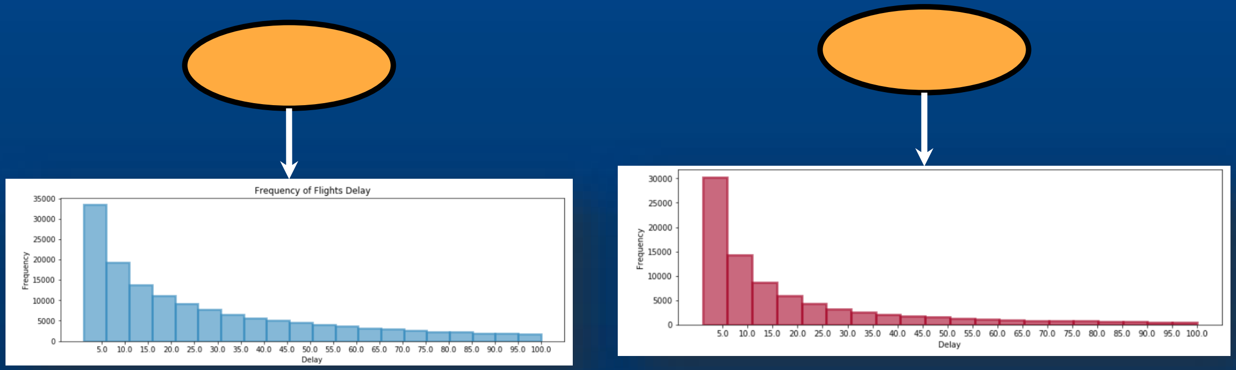
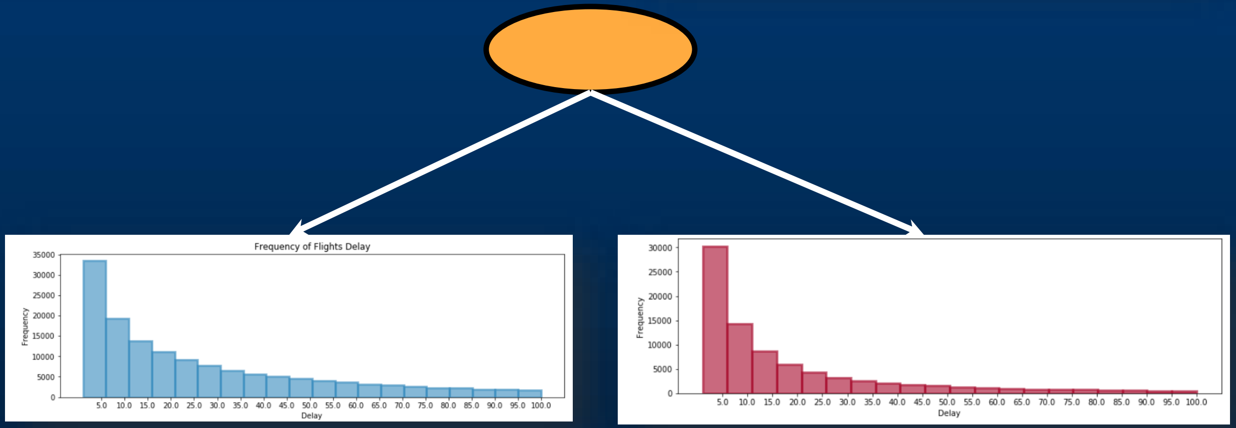
Flight Delay Prediction:



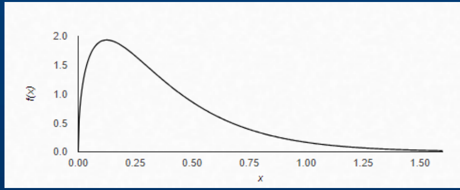
Every one has its own model!



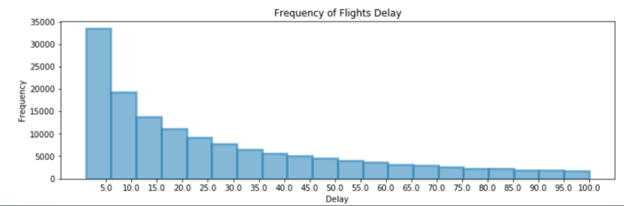
All have one model!

Flight Delay Prediction:

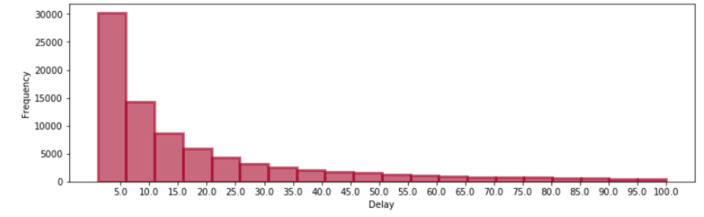
$$Gamma(\alpha_1, \beta_1)$$



$$f(x; \lambda_1) = \lambda_1 e^{-x\lambda_1}$$



$$f(x; \lambda_2) = \lambda_2 e^{-x\lambda_2}$$



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Flight Delay Prediction:

```python
Flight_Delay = pm.Model()

with Flight_Delay:
    # Prior Distribution
    rate = pm.Gamma('rate', alpha, beta,shape=2)


    rate_hat=rate[airport]
    # Likelihood (sampling distribution) of observations
    Y_obs = pm.Exponential('Y_obs', rate_hat, observed=Delay)
```

Artificial Intelligence – A Definition for B2B

The capability of a machine to imitate intelligent human behavior

What if your best…

Sales Person

Pricer

Buyer

Product Manager

Financial Analyst

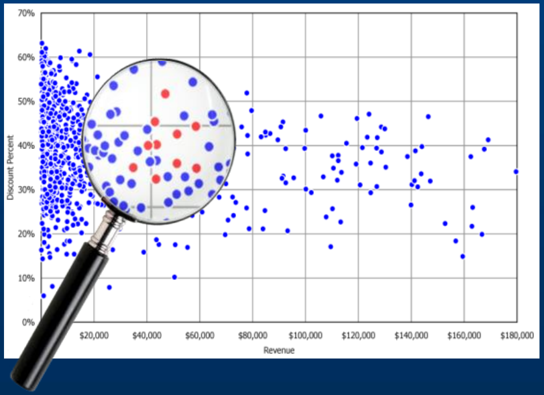
…could evaluate every customer relationship, every day and recommend action?

How would that impact customer lifespan, revenue and profit?

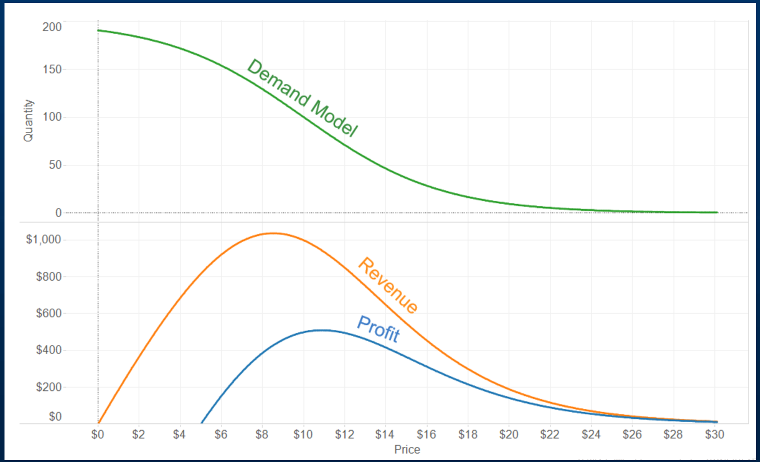
Price Optimization

Machine learning for market segmentation, price sensitivity, and price optimization.

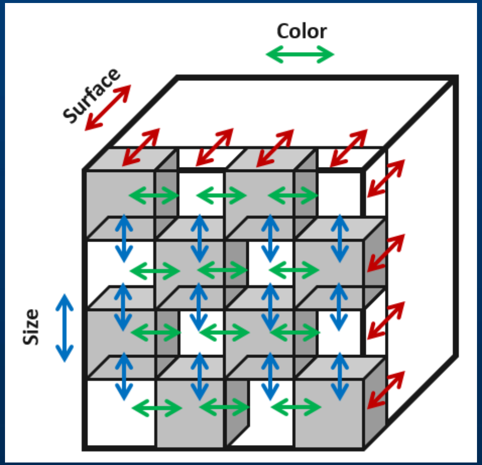
Segment Clustering



Convex Optimization



Pricing Constraints



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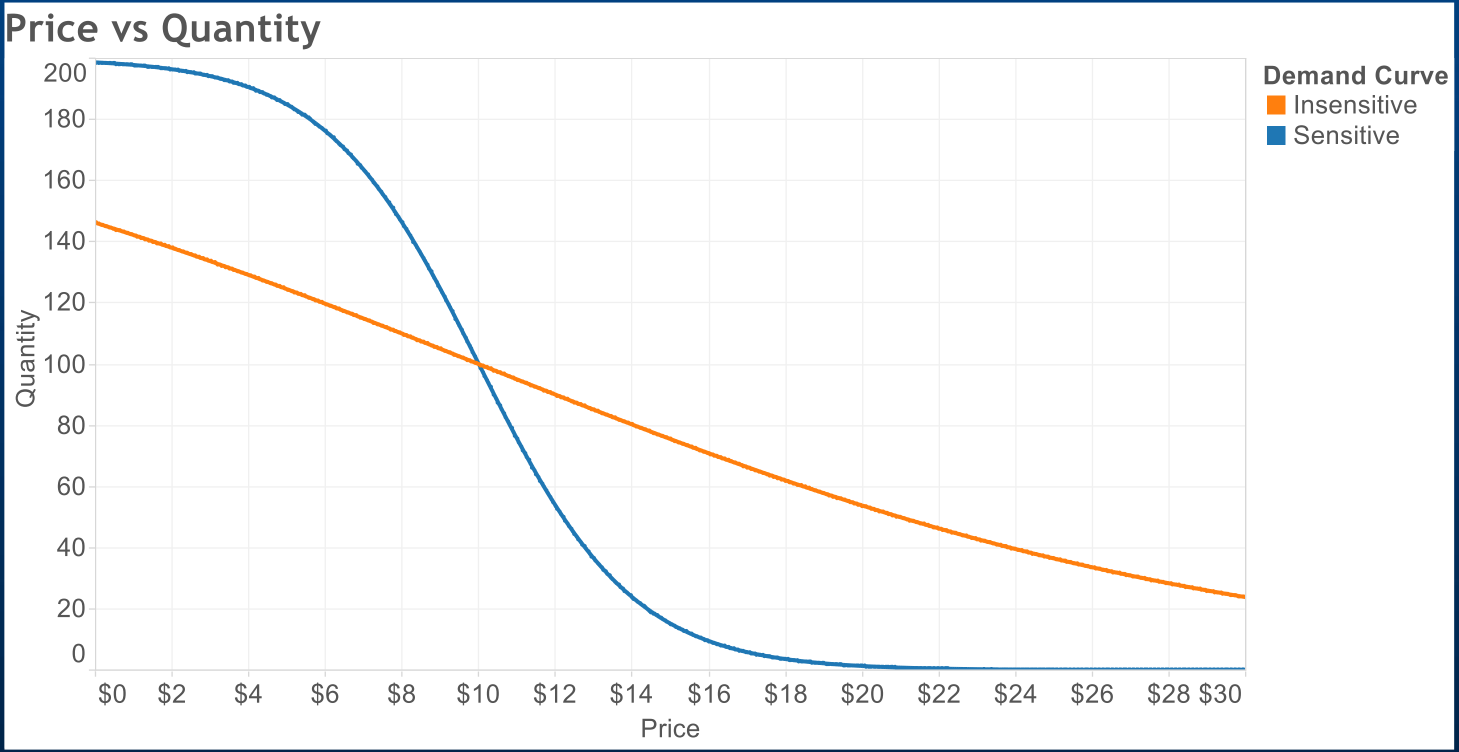
Price Elasticity



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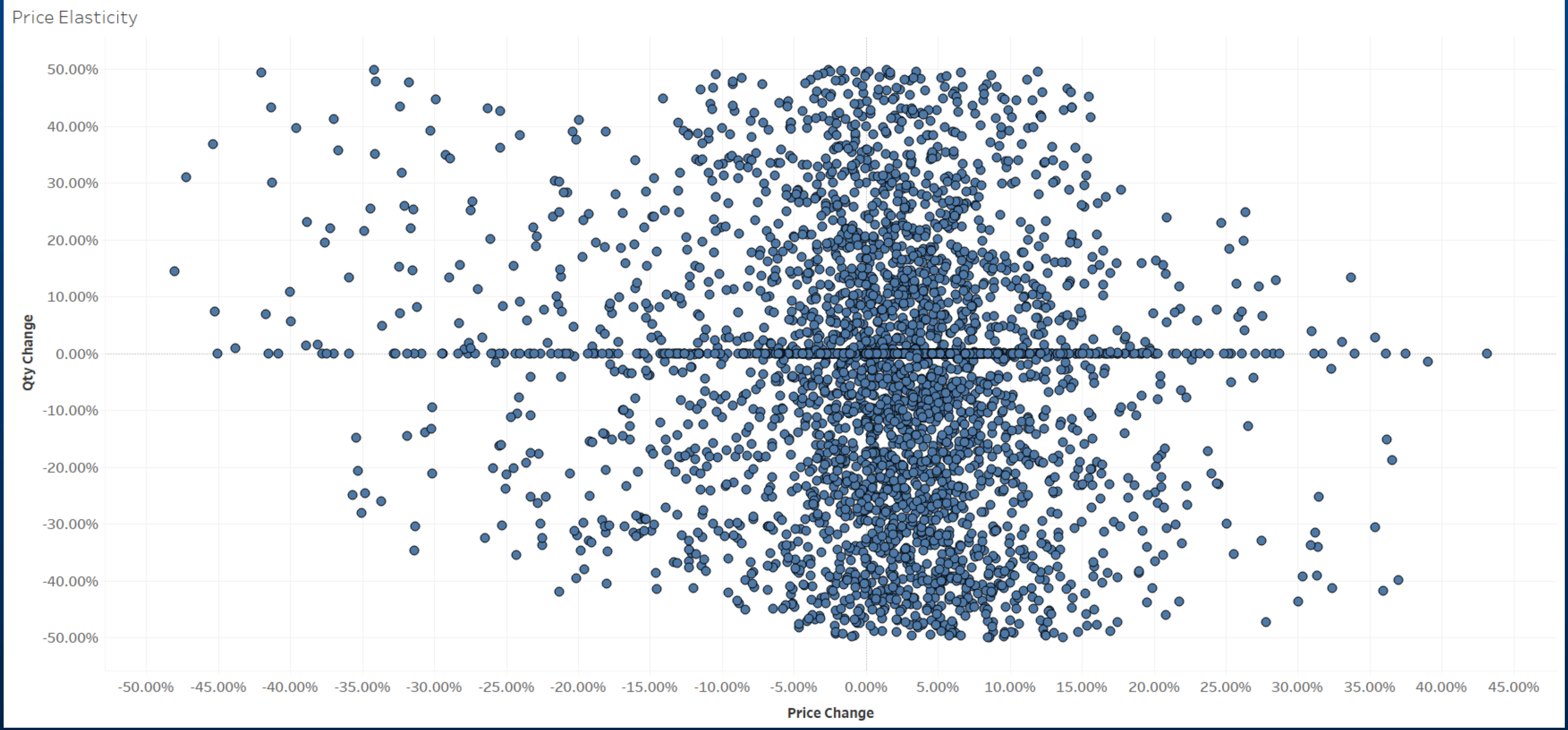
What we hope (like) to see

What we really see!



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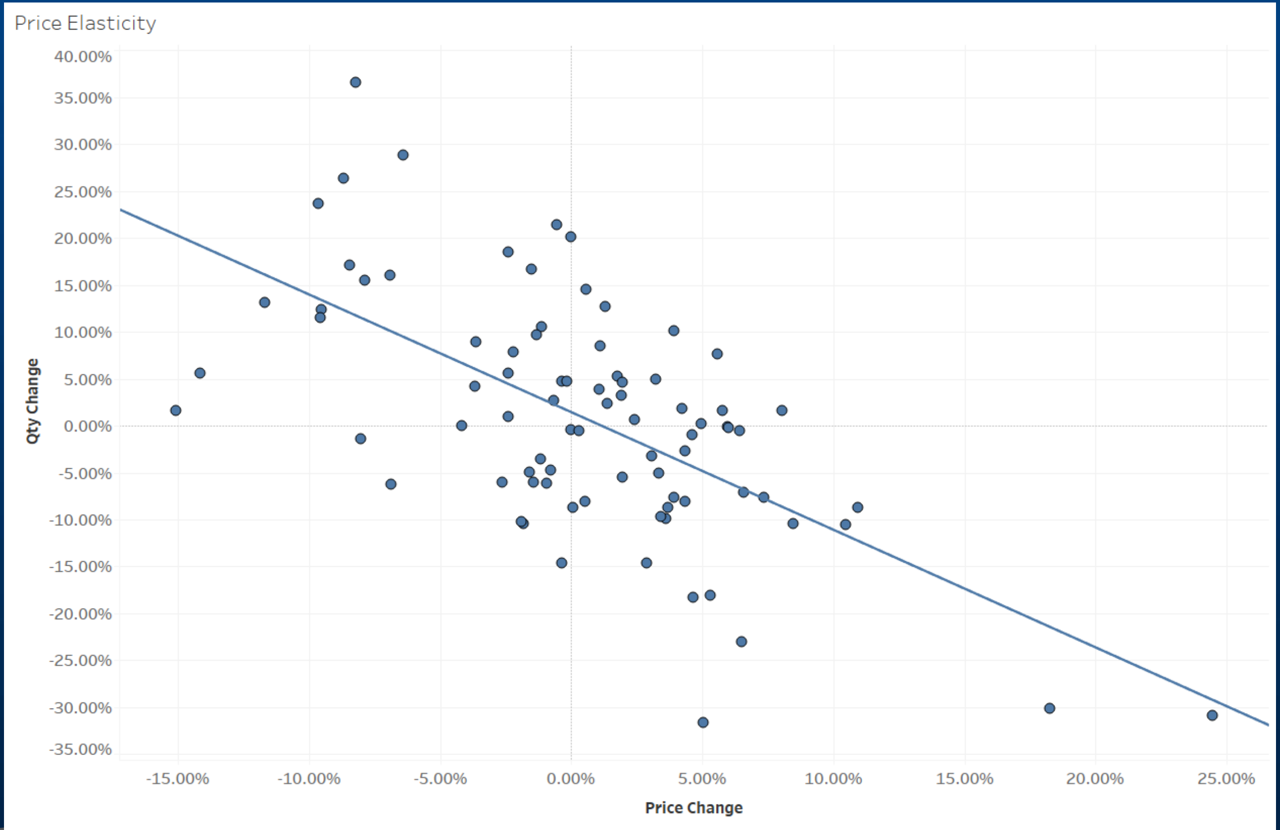
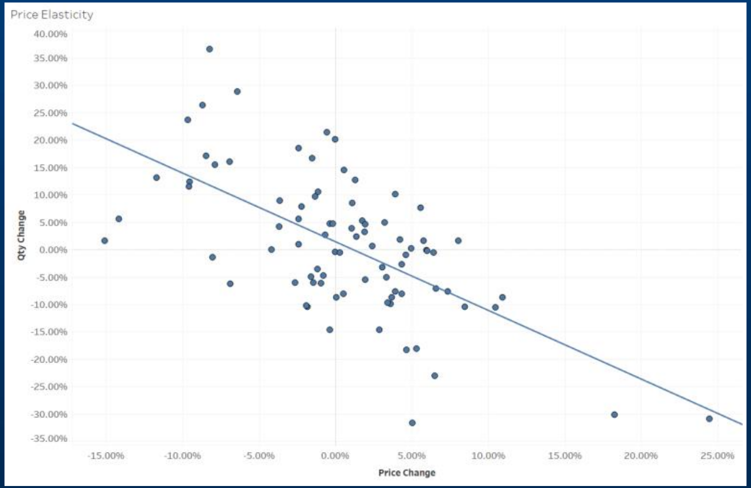
Fix it!



Price Elasticity
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
-5.00%
-10.00%
-15.00%
-20.00%
-25.00%
-30.00%
-35.00%
Qty Change
-15.00%
-10.00%
-5.00%
0.00%
5.00%
10.00%
15.00%
20.00%
25.00%
Price Change

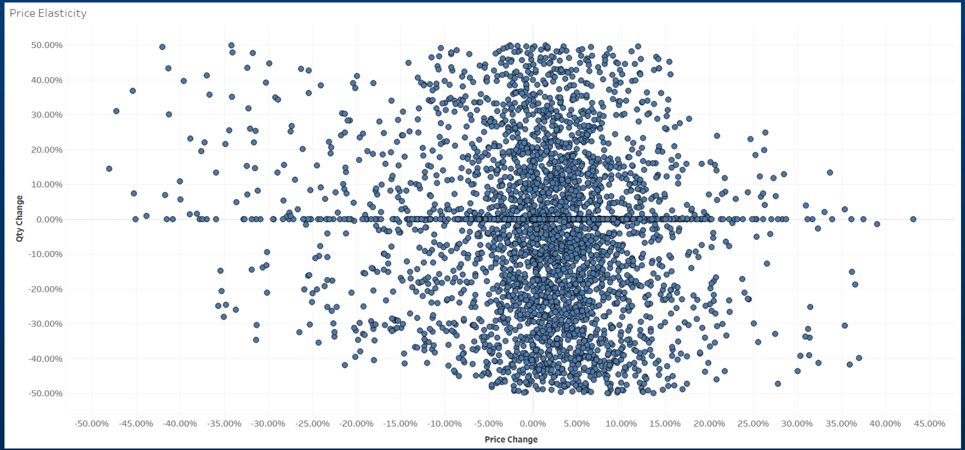
Why Hieratical Model?

Clean Data, Less Data Points



Vs.

Noisy Data, Many Data Points



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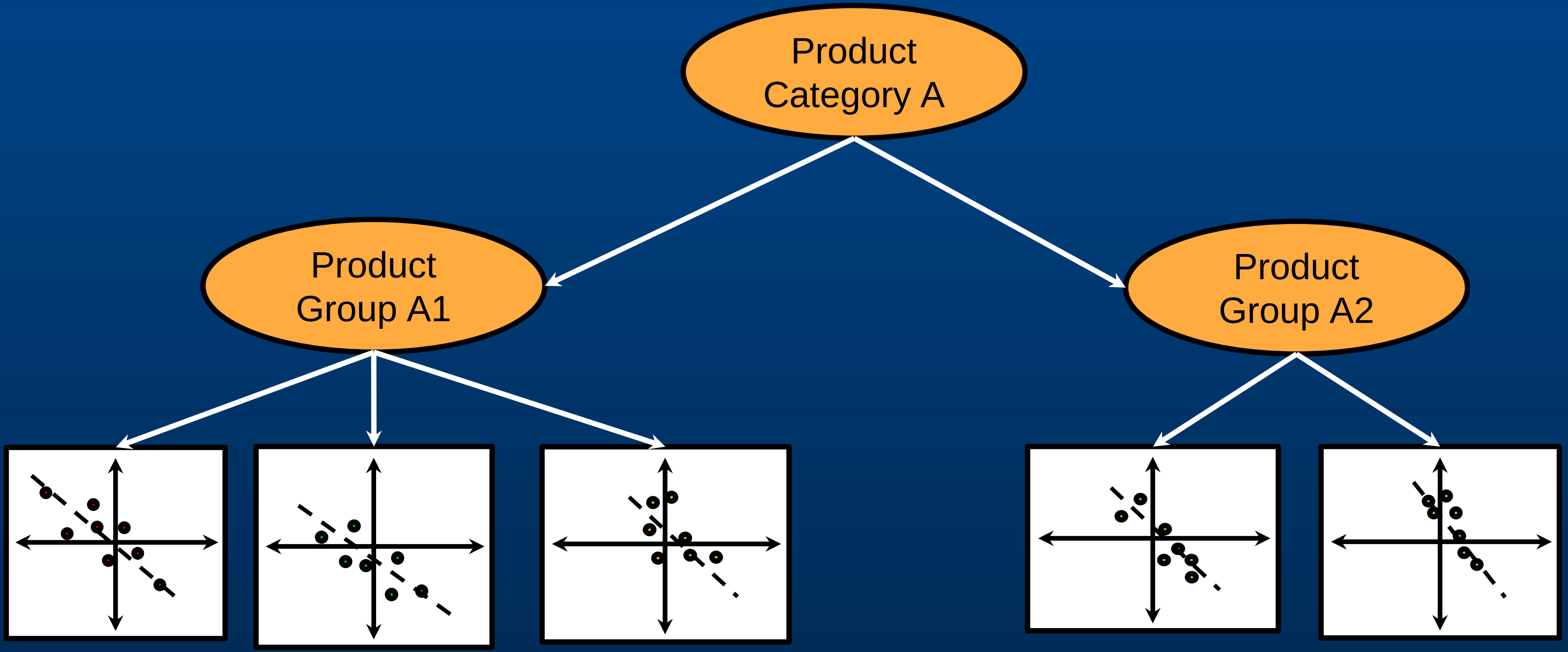
Why Hieratical Model?



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Bayesian Hieratical Model

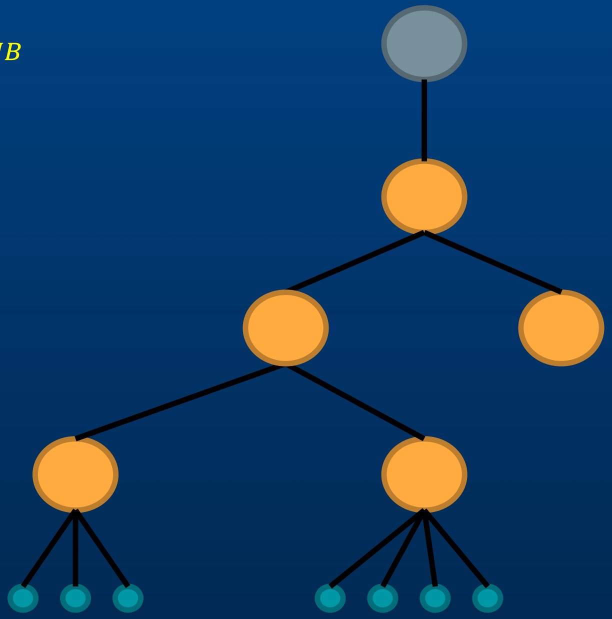
Hyperpriors: $\mu_\alpha, \mu_\beta, \sigma_\alpha, \sigma_\beta, \sigma_{\varepsilon LB}, \sigma_{\varepsilon UB}$

Level 0: $\mu_{\alpha,0}, \mu_{\beta,0}$

Level 1: $\mu_{\alpha,1}, \mu_{\beta,1}$

Level 2: α_j, β_j

Data: $\Delta Q_i, \Delta P_i$



$$\mu_{\alpha,k} \sim Normal(\mu_{\alpha,k-1}, \sigma_\alpha)$$
$$\mu_{\beta,k} \sim Normal(\mu_{\beta,k-1}, \sigma_\beta)$$

$$\alpha_j \sim Normal(\mu_{\alpha,2}, \sigma_\alpha)$$
$$\beta_j \sim Normal(\mu_{\beta,2}, \sigma_\beta)$$
$$\varepsilon_i \sim Normal(0, \sigma_\varepsilon)$$
$$\sigma_\varepsilon \sim Uniform(\sigma_{\varepsilon LB}, \sigma_{\varepsilon UB})$$

$$\boldsymbol{\Delta Q_i = \alpha_j + \beta_j \cdot \Delta P_i + \varepsilon_i}$$

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Zilliant ML Platform (Point and Click!)

Step 1- Define Hieratical Levels

Segmentation Trees: PSE

Segmentation Tree Name: PSE

Purpose: Time-Based Metrics

Segmentation Tree Levels

Use	Order	Attribute	Entity
☑	0	zProduct_Id	Transaction
☑	1	Customer_Program	Transaction
☑	2	CompetitiveRegion_Bin	Transaction
☑	3	zRegion	Transaction
☐	4	CustomerSpend_Bin	Transaction
☐	5	Customer_Loyalty	Transaction
☐	6	OrderSize_Bin	Transaction
☐	7	Price_Change_Group	Transaction
☐	8	Region	Transaction

Save Cancel

Step 2- Set Model Parameters

Regression Parameters

Enable Trace Debug	☐
Delta Days	180
Delta Lag Days	180
Max Price Delta (%)	50
Max Quantity Delta (%)	50
Transaction Threshold	20
MuA	0.0000
MuB	-1.0000
SigA	0.1000
SigB	0.2500
SigEpsHB	1.0000
SigEpsLB	0.0100
Number of Samples	10,000
Burn-in (%)	20
Calculation Time Limit (hours)	5.000
Attribute for Partitioning	1 | Customer_Program

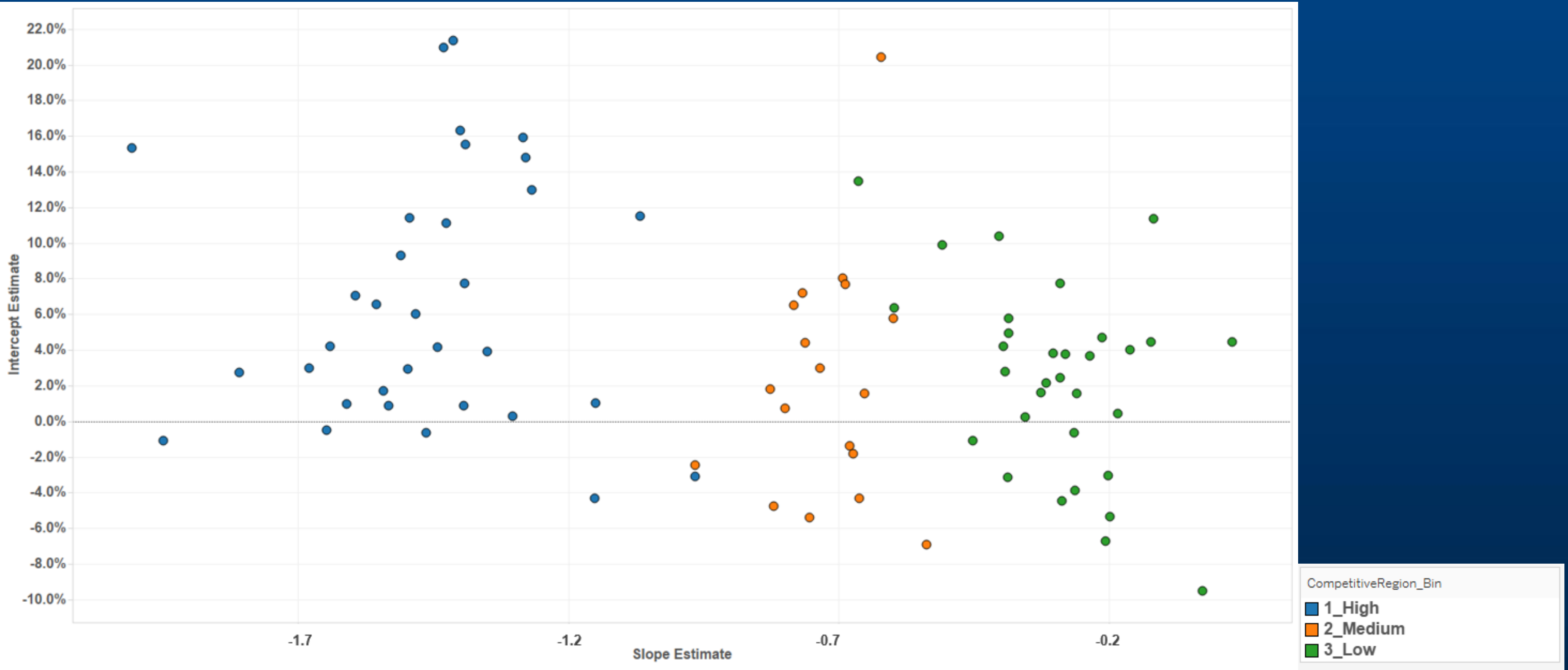
Step 3- Run the job!

Jobs

- Compute regression

Run Job

Output



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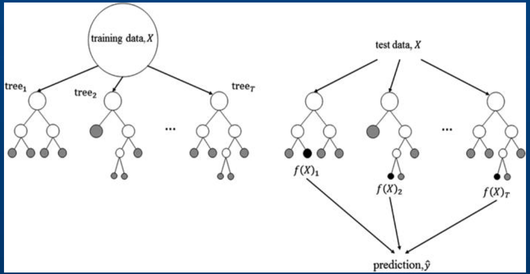
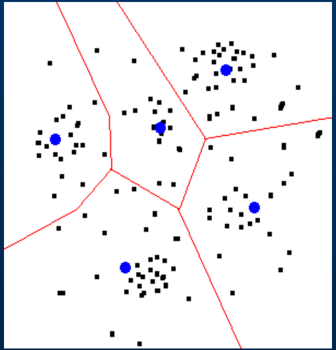
The Zilliant IQ Platform Brings Best-In-Class AI to B2B

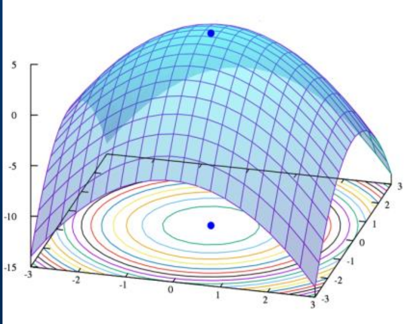
Random Forest



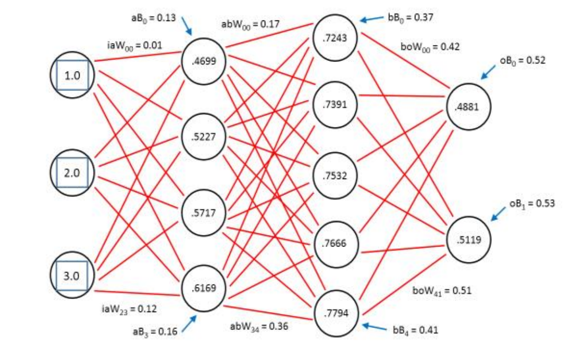
Clustering



Convex Optimization



Neural Network / Deep Learning



Association Rules

$$Rule:\ X \Rightarrow Y$$

$$Support = \frac{frq(X,Y)}{N}$$

$$Confidence = \frac{frq(X,Y)}{frq(X)}$$

$$Lift = \frac{Support}{Supp(X) \times Supp(Y)}$$

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Codes and Slides:

https://github.com/AmirMK/ODSC

Question and/or Discussion:

Amir.Meimand@Zilliant.com