Weather Variability on Store Performance: Improving Resilience for Retail Businesses

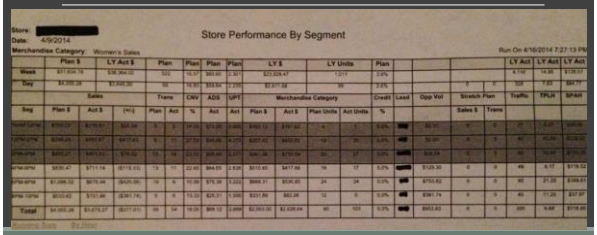
MILLERSVILLE UNIVERSITY
TIM LOFTUS

The Opportunity

- Largest private sector employer contributing $2.5 trillion to annual U.S. GDP (1/5 of the economy)
- Sales fluctuate due to disruptors like financial crises, wars, natural disasters, and weather
- *The Effects of Weather on Retail Sales* by Martha Starr-McCluer (2000) found weather immediately effects consumer spending and can explain changes in spending during future periods

My analysis was able to predict within $300 of actual store volume

Personal Store Performance


Store Performance By Segment

Application: Meeting User Needs

- Investigate weather impacts on customer behavior *and* worker productivity
- Utilize collected business metric data (conversion, ADS, traffic) and climate data from store location (Lancaster, PA)
- Perform a set of multiple linear regression analyses to serve as a predictive process in forecasting daily volume
- Provide a risk assessment for store management to incorporate into their daily focus

Analysis

Regression Model: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k$

BUSINESS METRICS (PREDICTED VARIABLES)

- Customer-Controlled
  - Traffic
- Seller-Controlled
  - Conversion
  - ADS

WEATHER PARAMETERS (PREDICTOR VARIABLES)

- CDD
- HDD
- Average Dew Point Temperature
- Average Humidity
- Average Wind Speed
- Average Visibility
- Total Liquid Precipitation Amount
- Total Snowfall Amount

Implementation: April 10, 2015

- Forecasted Weather Variables:

CDD	HDD	Dew Pt.	Humidity	Visibility	Wind	Precip.	Snowfall
0	8	52	83	5	11	0.56	0.00

- Predicted Outcomes:

Conversion	ADS	Traffic
16.9%	71.94	478

- Calculated Volume = $5,811.46

Outcome

- Company Planned Volume: **$8,839.00**
- Predicted Volume: **$5,811.46** (-34% to Plan)
- Business Strategy
  - Increase conversion to 18%
  - Maximize sales & Maintain ADS
  - Reduce spending by cutting payroll hours by 30% (12 hours)
- Actual Volume: **$6,094.29** (-31% to Plan)
- Reduced losses by 10%
- Effectively managed payroll
  - Flexibility

Amanda Mitchell

M.S. Integrated Science Applications Geoinformatics

Capstone Experience:
Science Technology Corporation

CHIMERA - Community Hyper-spectral Infrared Microwave Earth Retrieval

How can we meet users needs?

Many problems in science and engineering require fitting data to a model or fitting equation. The fit can be performed with certain assumptions about the model.

A linear fit assumes that the fitting equation, y = f(x), can be expressed as a linear operator – that is

$$Y = GA$$

This is also called regression and least squares fitting.

Where G is a matrix that describes the fitting equation for the set of independent data points, x(i), that corresponds to y(i). In other words, G is our forward model.

A is a vector that contains the coefficients that we want to solve for.

Eigenvalue Decomposition and Principal Components

- The German word *eigen* means "self-" or "unique to", or "belonging to".
- You can model a set of data using these unique eigenvalues as opposed to using an entire data set
- We can extract the significant numbers eigen-functions from our data using principal components
- Then we can effectively remove the noise in the observations
- We then can find a regression operator to statistically predict the coefficients of a model.
- Amazingly, we do not need to know any of the physics that relate the measurements to the parameters of interest.

Conclusion

- Cuts down processing power
- Saves time
- Saves money
- Ignoring noise, making data extremely accurate

THANK YOU!