Handling High Dimensional Variables: A Practical Example

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Discussion Topic

- The problem
- Techniques for handling high dimensions
- Comparisons of different techniques
- Conclusions

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The Problem

- Data Analysis
  - Where am I penetrated in a state?
  - What tend to the be the characteristics of places where I am more highly penetrated?
- Action
  - Where am I under-penetrated?
  - What are my most likely scenarios for successful expansion?

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ZIP Code Level Data

- Vehicle registration data
- Company vehicle counts
- ZIP Code Level Demographics
  - Age
  - Population density
  - Persons per household
  - Marital status
  - Urban vs. rural
  - Education

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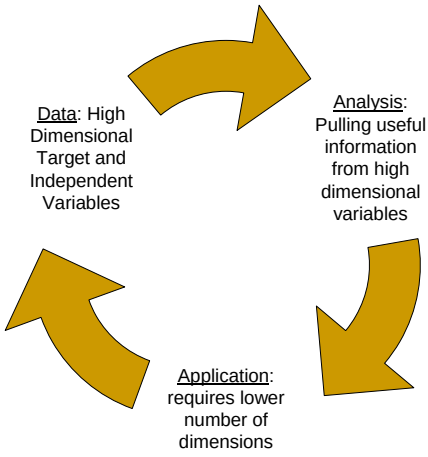
The Problem With High Dimensional Variables



- How do I understand trends in the data?
- How do I make this information actionable for the business units?

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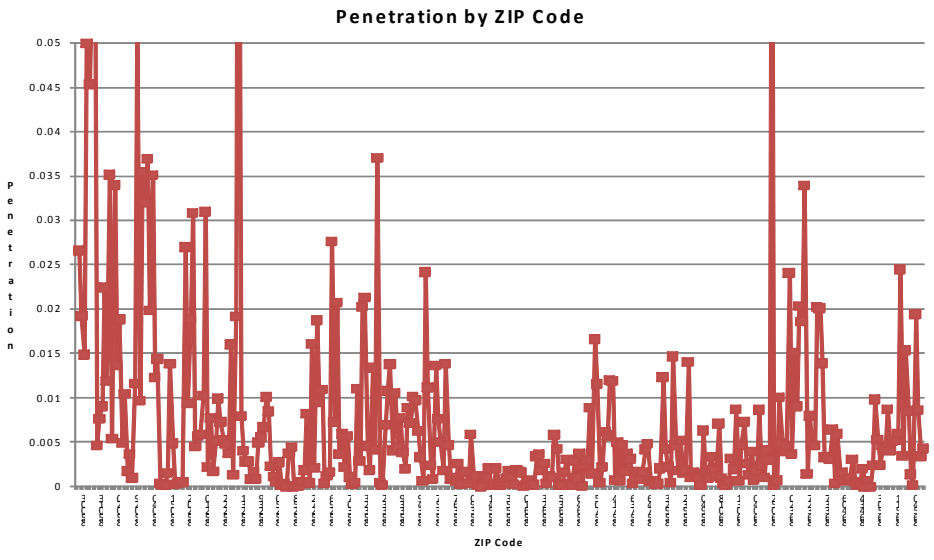
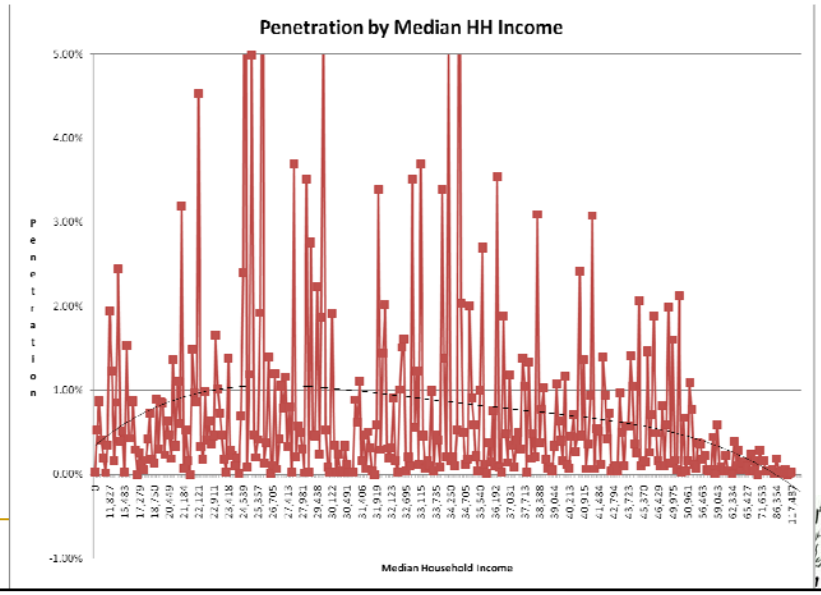
High Dimensional Target



High Dimensional Explanatory Variables



Techniques for Handling High Dimensional Variables

- Unsupervised
  - Clustering
  - Variable Clustering
  - Principal Components
- Supervised
  - Variable Selection
  - Traditional model development

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Clustering

- Observations placed into groups based on the input data
- Performs disjoint cluster analysis on the basis of Euclidean distances computed from one or more quantitative input variables and cluster seeds
- Objects in each cluster tend to be similar, objects in different clusters tend to be dissimilar
- Doesn't look at the target variable

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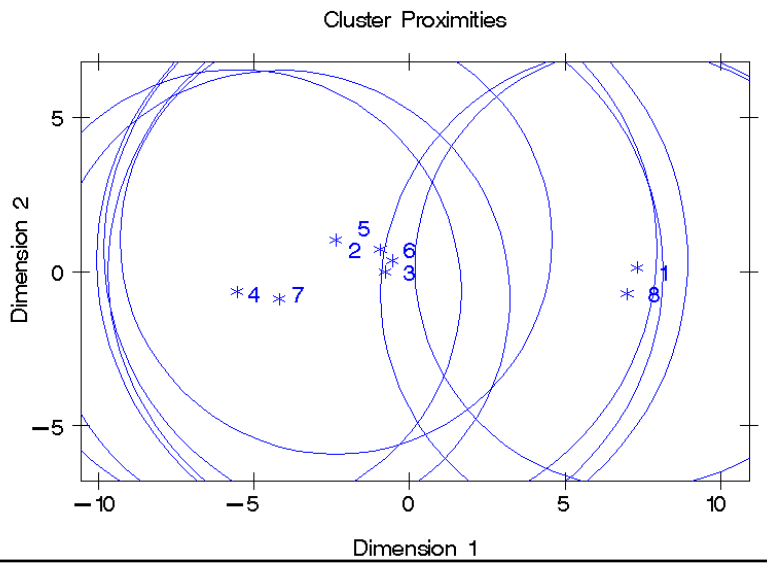
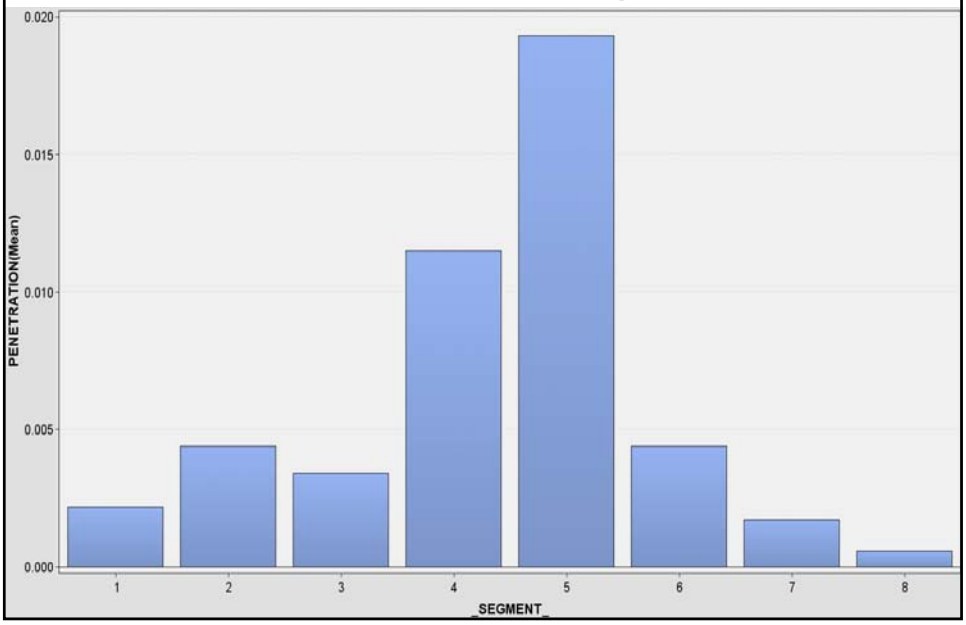
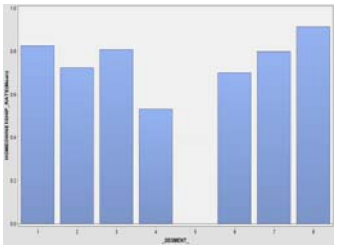
Cluster Distance Map



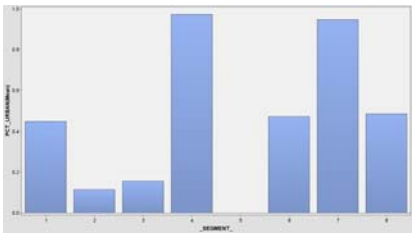
Penetration by Cluster Segment



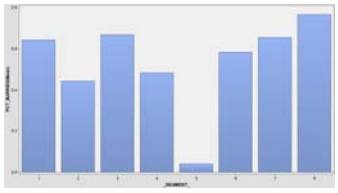
Correlation of Cluster with Independent Variables



Homeownership Rate



Percent Urban



Percent Married

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Variable Clustering

- Divides variables into clusters
- Resulting cluster is a linear combination of variables in cluster
  - First principal component
- Attempts to explain the maximum variance in the inputs

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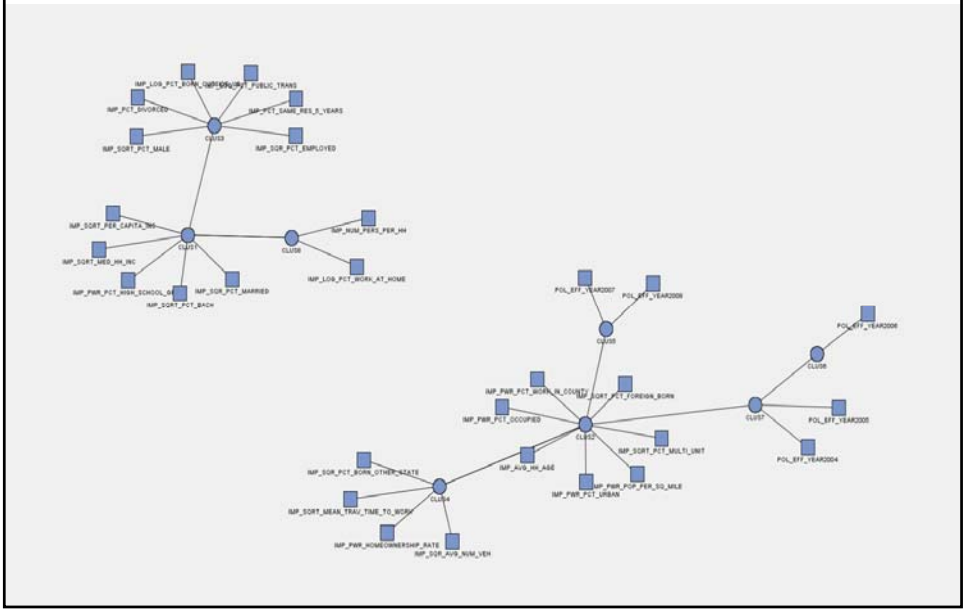
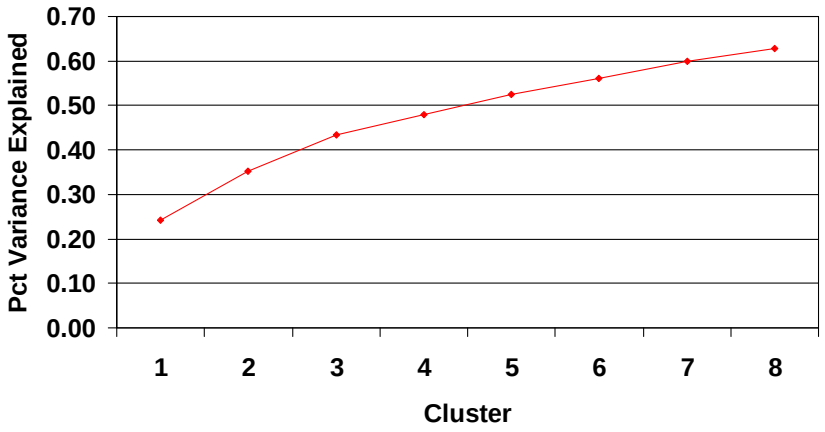
Variable Clustering



Variable Clustering – Variance Explained



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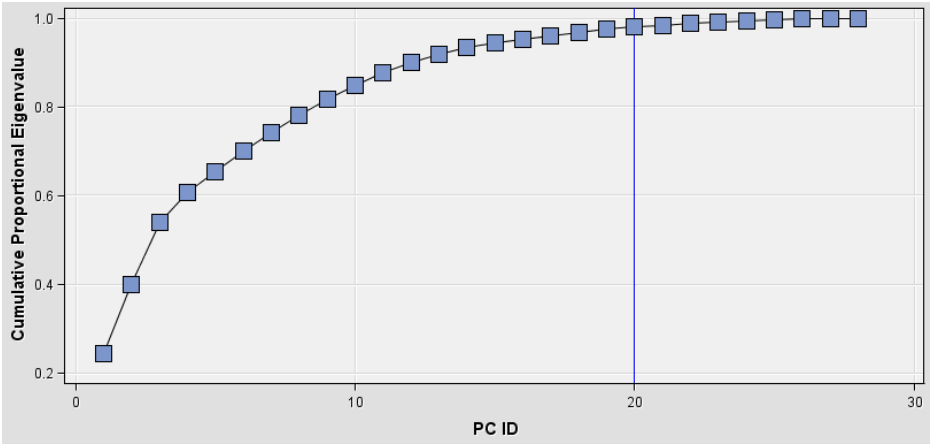
Principal Components Result



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Unsupervised Learning Methods

- Focus
  - Do not focus directly on the target (the dependent variables)
  - Focus is on putting observations of like independent variables together
  - If the independent variables are truly related to the dependent variable, then the clusters be related to the dependent variables
- Potential Applications
  - Claim fraud
  - Marketing targets
  - Underwriting selections

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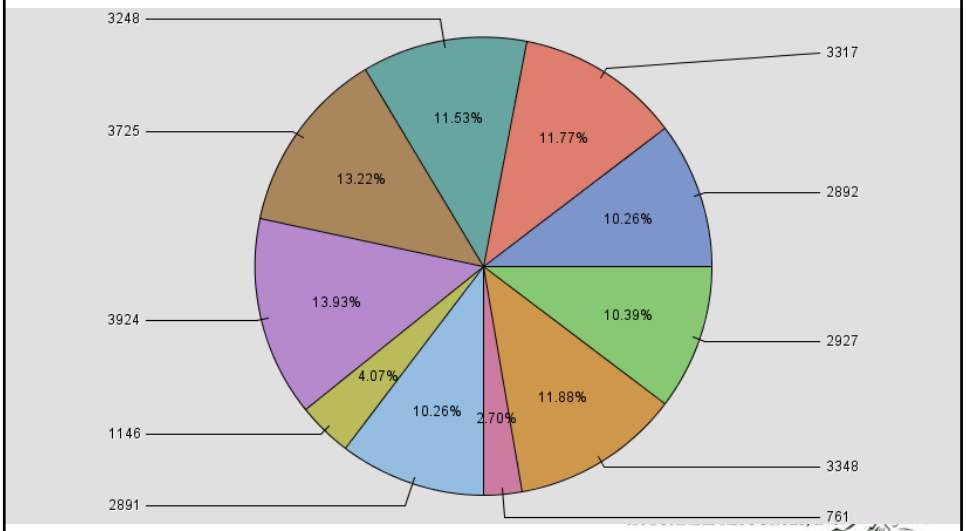
Identifying Anomalies - Segmentation



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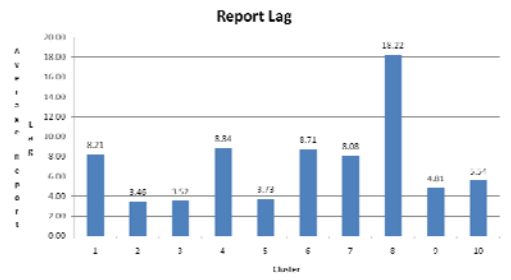
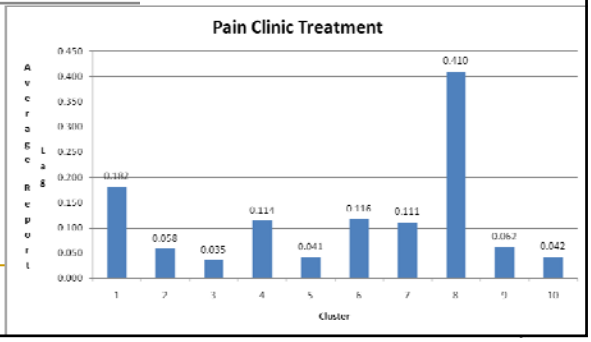
Differences in Clusters





Variable Selection

- Calculate the correlation coefficient
  - Exclude variables that do not meet criteria
- Forward stepwise regression sequentially adds variables that produce the largest incremental increase in explanatory power
- Process ends when no more variables can be added to produce a significant improvement

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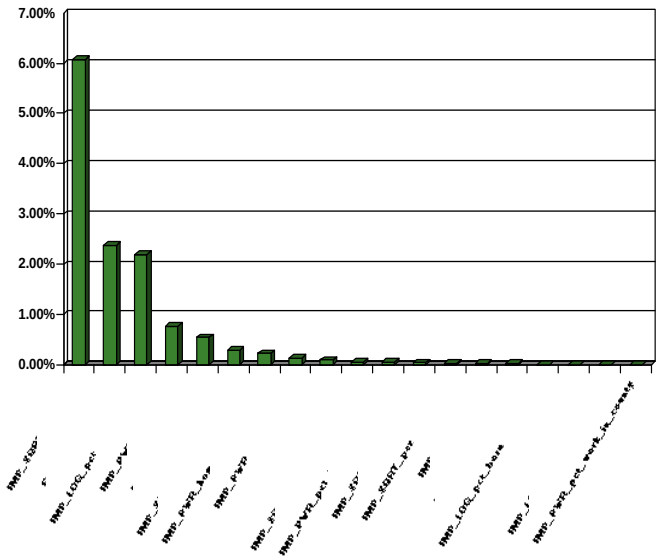
Variable Selection - Sequential R-squared



Final Comparison

- Comparison of models based on five sets of inputs
  - Clustering
  - Variable clustering
  - Variable selection
  - Principal components
  - Raw inputs
- Review numerous model comparison techniques

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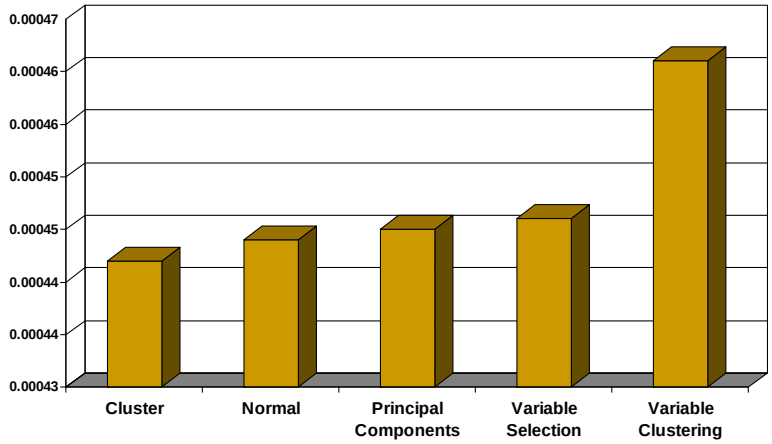
Comparison of Final Models



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Conclusions

- Using input variable information directly is generally preferable when building predictive models
- There are many cases when this is not feasible
  - Unknown target
  - Input variable with too many levels
  - Too many input variables
- Techniques for handling high dimensional variables still result in models that produce predictive results

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