Visualizing the Effects of Maintenance on Train and Yard Performance

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Topics

- Introduction and Background
- Graph Visualizations
- LSA Text Mining
- New Visualizations
- Prediction Models
Introduction and Background

• A U.S. freight railroad asked the question: What impact are maintenance activities having on our train and yard performance?
• To answer these questions we analyzed their:
  – Nightly reports of all activities occurring in geographic areas proximate to a major classification yard
  – Train performance metrics, and
  – Customer service metrics
• The analytical tools utilized were:
  – Graph Visualizations
  – LSA Text Mining
• Based on these analyses, predictive models may be developed to improve maintenance, yard and train performance
GRAPH VISUALIZATIONS
Visualization of switching trains for a large yard

- Misses by train and shipper
- Large number of misses with short line RRs
- 2016
- Yards, Trains and Customers are Nodes
- Misses are edges
Major Class Yard
Misses

Data shown as a network
Linked weather data to LSM

NEW VISUALIZATIONS USING TABLEAU
Visualizing Effects of Maintenance

Misses and Weather

Weekly Maximum Misses and Weather for 2016

[Graph showing weekly maximum precipitation, snow, and misses with corresponding dates and values]
Train XYZ Performance and Weather

Visualizing Effects of Maintenance
Visualizing Effects of Maintenance

Dashboard with LMS and TMS data
Analysis by Area

TEXT MINING
LSA Analysis

Railroad Area 4
10 topics

Topic 5: Welding gang activities
Topic 3: Maintenance gang activities
Topic 5: Red Letter Defects
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LSA Analysis

Area 4
15 topics

Topic 1: Welding gang
Topic 4: Weed Spraying
Topic 15: Sperry Car defects
Text Mining Insights

• Identified frequently occurring maintenance activities and locations
Alternative method to Topic Modeling

TEXT CLUSTERING
Text Clustering

Area 4 Text clustered into 4 groups
Clustering output

- Four clusters worked best
- Need to examine the texts from each group to see what each cluster represents
Jigsaw Text Clustering

Location and maintenance words in List View

Created list of maintenance words and locations

For each daily entry, the locations and types of maintenance are automatically identified
Jigsaw Document View

Daily maintenance entry with locations and maintenance type automatically identified.
Using LSA Output for Predictions

Accident Texts → LSA → Automatically Generated Categories

(groups of words)

C1 → C2 → C3 → C4 → C5 → Etc....

For Each Accident: w(C1), w(C2), w(C3),....
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Proposed Prediction Model

- Sentiment Analysis
- Ranking of maintenance word impact
- LSA Weights
- Measures of Effects on Operations
- Train Performance
- Switching Performance
- Planned Activities
- Predict effect of maintenance activities on operations
- Revise activities
- Trained Model

Location
Predictive Modeling

Visualizing Effects of Maintenance

- Track Segments
- Accident Data
- Track Characteristics from Inspection Reports and Accident Databases
- Surrounding Land Use
- Weather and Climate
- Highway Data at Grade Crossings

GIS

Find Spatially Related Groups of Accidents Using Clustering Algorithms

Spatial Regression

Identify Track Segments for Further Investigation

Regression Models relating track segment characteristics to track condition and land use

LDA

Category probabilities

Combine probabilities

Combine GIS Output with Probabilities from LDA and Numeric Data to Rank Track Segments

Rank Track Segments for Maintenance Intervention

Calculate numeric changes in track segment condition over time

Calculate accident probabilities

Accident Data

Track Segments

Text

Track Inspection Reports, Maintenance Records, etc.

Numerical data from inspection reports

Track telemetry car data

Records of maintenance interventions
Conclusions

• Possible to identify major topics in a railroads maintenance records using text mining
  – LSA
  – Text Clustering

• LSA model also outputs weights that can be used for predictive modeling

• Proposing a predictive model to identify maintenance activities that will affect operations
Questions?