Smart Underwriting: Data-Driven Home Inspection Insights

PURDUE UNIVERSITY | Mitchell E. Daniels, Jr. School of Business

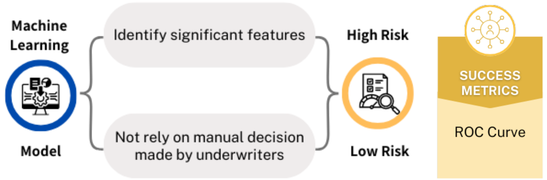
informs ANALYTICS CONFERENCE

BUSINESS PROBLEM

Home insurance inspections are vital in assessing the condition of a property to determine the viability and cost of insurance coverage. Underwriting teams currently rely on a **manual process** to select new properties for these crucial inspections based **on agents' reputation.** Due to the economic changes, the algorithm may not fit the current situation.

Challenge:
With **limited workforce**, cost control is an urgent issue. On customer side, **redundant inspections** may cause interventions, and high-risk properties' **inspection may be delayed**.

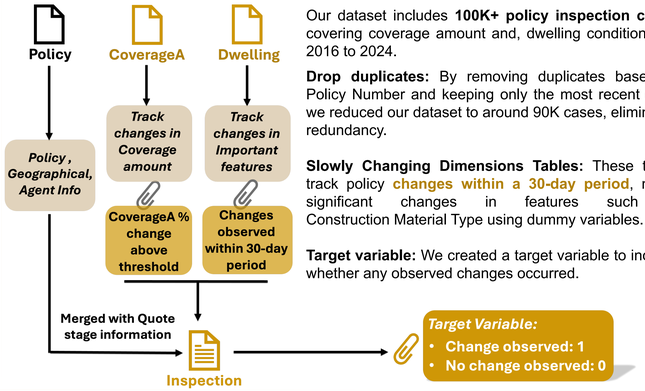
ANALYTICS PROBLEM



Current Algorithm:
- The company assigns an agent to the house. If the agent is on the waived list due to prior performance, the house may be exempt from inspection. If not, the house may need inspection.
- However, if the quoted price surpasses $X or falls below $Y, the inspection is still necessary.

Improvement:
- Enhance algorithm to distinguish well-conditioned houses from those needing further screening using inspection data.
- Utilize coefficient analysis for selecting critical features.
- Evaluate houses for elevated risk levels based on these features.
- Guide inspection decisions to prioritize at-risk houses.

DATA



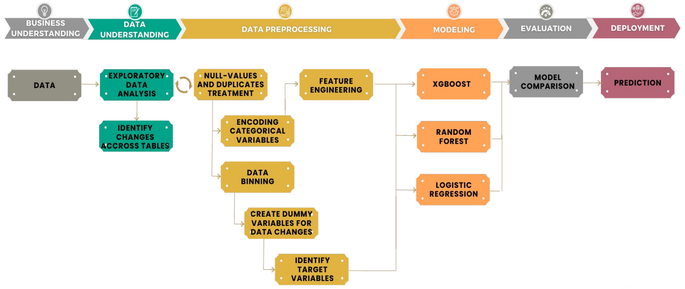
Our dataset includes **100K+ policy inspection cases**, covering coverage amount and, dwelling condition from 2016 to 2024.

Drop duplicates: By removing duplicates based on Policy Number and keeping only the most recent ones, we reduced our dataset to around 90K cases, eliminating redundancy.

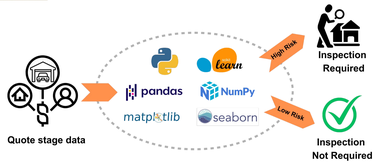
Slowly Changing Dimensions Tables: These tables track policy **changes within a 30-day period**, noting significant changes in features such as Construction Material Type using dummy variables.

Target variable: We created a target variable to indicate whether any observed changes occurred.

METHODOLOGY



The methodology we employ encompasses data preprocessing, feature engineering, and model evaluation to enhance the accuracy of our predictive models. This approach is meticulously designed to refine the predictive performance of models, ensuring they are both robust and precise.

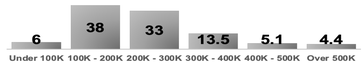


MODEL BUILDING

FEATURE ENGINEERING (BINNING)

COVERAGE AMOUNT

Categorizing houses based on insurance coverage value

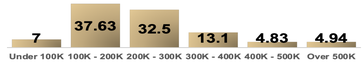


DEDUCTIBLE AMOUNT

Simplifying model's understanding of risk associated with varying deductibles

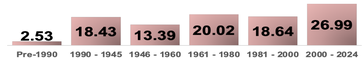
REPLACEMENT COST

Risk assessment based on potential replacement expenses



CONSTRUCTION YEAR

Accounting for variability in building standards & materials across years



ONE-HOT AND LABEL ENCODING OF CATEGORICAL VARIABLES

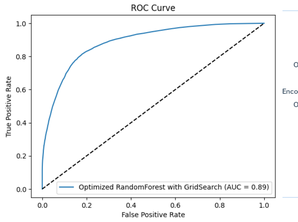
- Transformed categorical variables to enhance model learning.

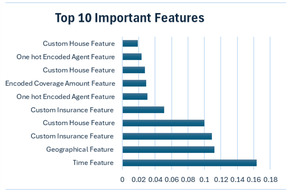
MODEL TRAINING AND EVALUATION

- **Data Splitting:** train (80%) / test (20%) split ratio allows for a sufficient amount of data to train the models while still reserving a sizable portion for independent evaluation.
- **Cross-validation and Hyper-parameter Tuning:**
  - Employed Stratified K-Fold cross-validation to ensure model robustness
  - Hyperparameters tuned to optimize performance.

MODEL SELECTION

- **Models with Best Result:**
  - Compared **Random Forest**, **XGBoost** and **Logistic Regression** to evaluate **Random Forest** as the top-performing models with ROC
- **Identified features based on importance calculated for High-Risk Properties.**





DEPLOYMENT AND BENEFITS

By following a data-driven approach to home inspection, insurance companies can effectively strategize and deploy **Random Forest** model with ROC score at **0.89**, indicating that there is a **89% chance** that the model will be able to distinguish between positive class and negative class. Hence, **optimizing essential underwriter inspections by 37% and reducing costs.**

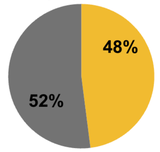
Example Case

Current	# of redundant inspections (Yearly Average) 5376
Updated	# of redundant inspections (Yearly Average) 591

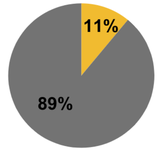
Average Cost Per Inspection
~$400

Estimated Average Savings
1.9MN/Year

Current yearly Inspection results



Expected yearly Inspection results



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