An ML Exploration: Predicting Property Values with Stacking Ensemble Models

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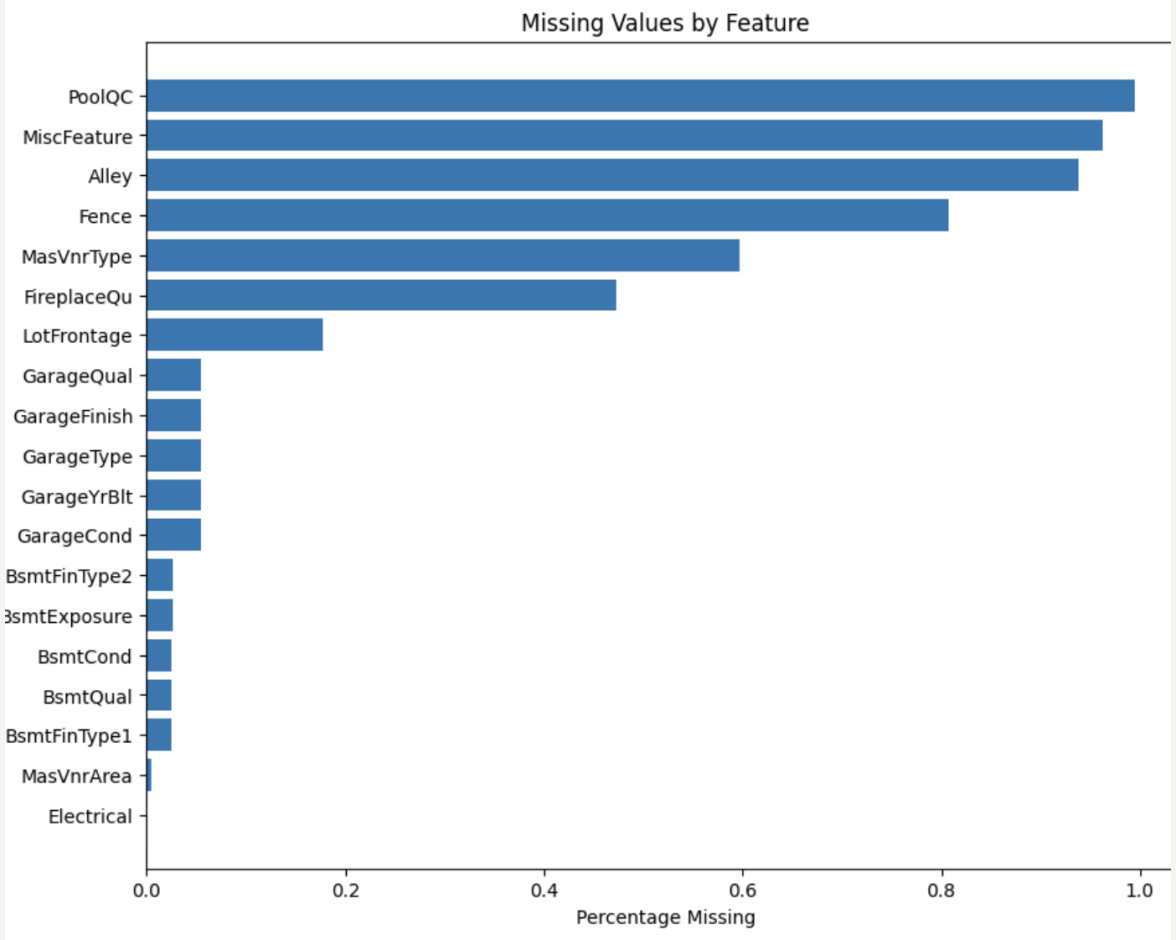
Business Context

- **Challenge**: Real estate valuation traditionally relies on manual appraisals, which is slow, inconsistent, and difficult to maintain and standardize.
- **Solution**: Automated ML valuation system predicting prices with high accuracy
- Accurate real estate valuation is essential for:
  - Price new listings
  - Reducing days on market
  - Preventing underpricing revenue losses
  - Improving investment decisions

Data Foundation



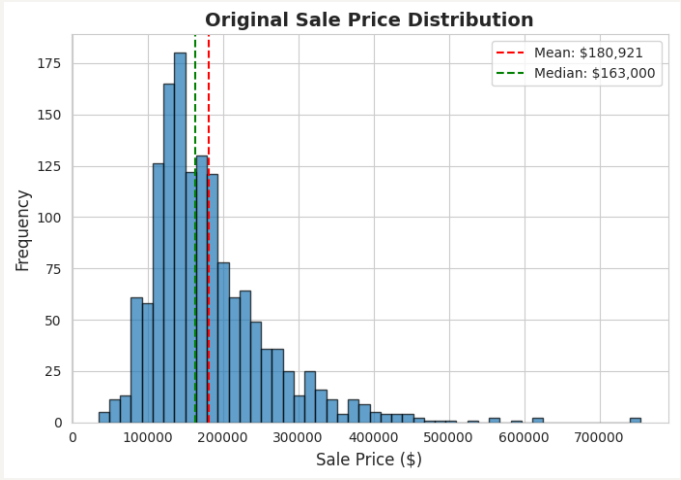
- Source: The Ames Housing dataset about residential properties in Ames, Iowa
- Scope: 1,460 training properties + 1,459 test properties (81 features)
- Missing Values: Reflects the absence of a particular property feature, not random missingness

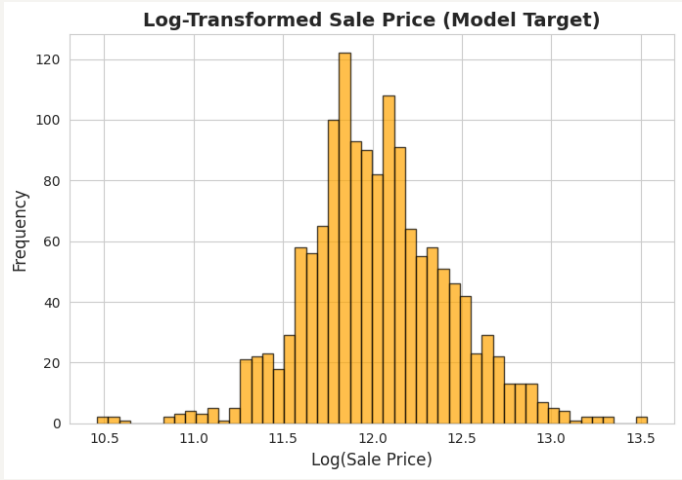
Encoding and Feature Engineering

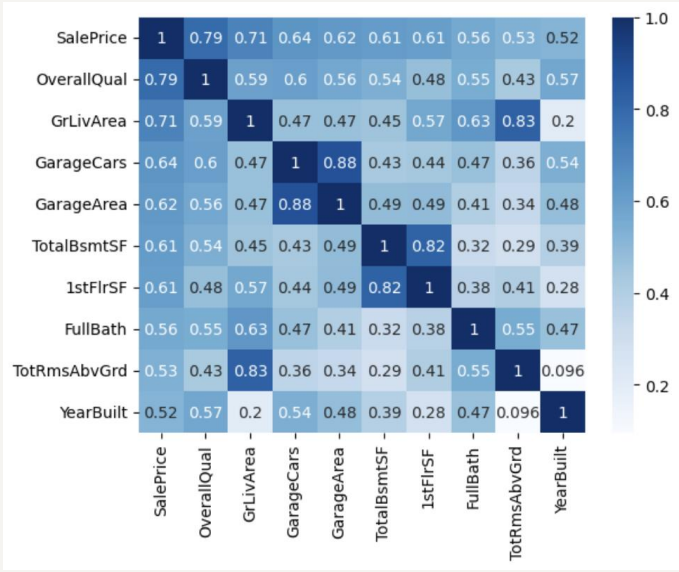
Distribution: Log Transformation to improve fit and standardize variance and reduce heteroskedasticity

Encoding: One-hot encoding

Feature Engineering: Created new features to capture housing structure and quality



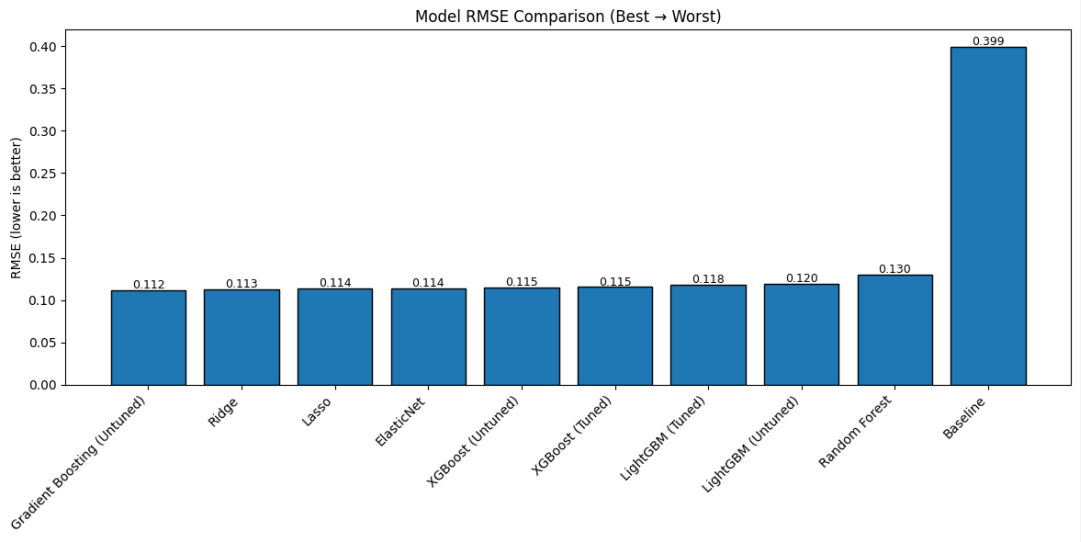




Model Comparison: Ensemble Approach

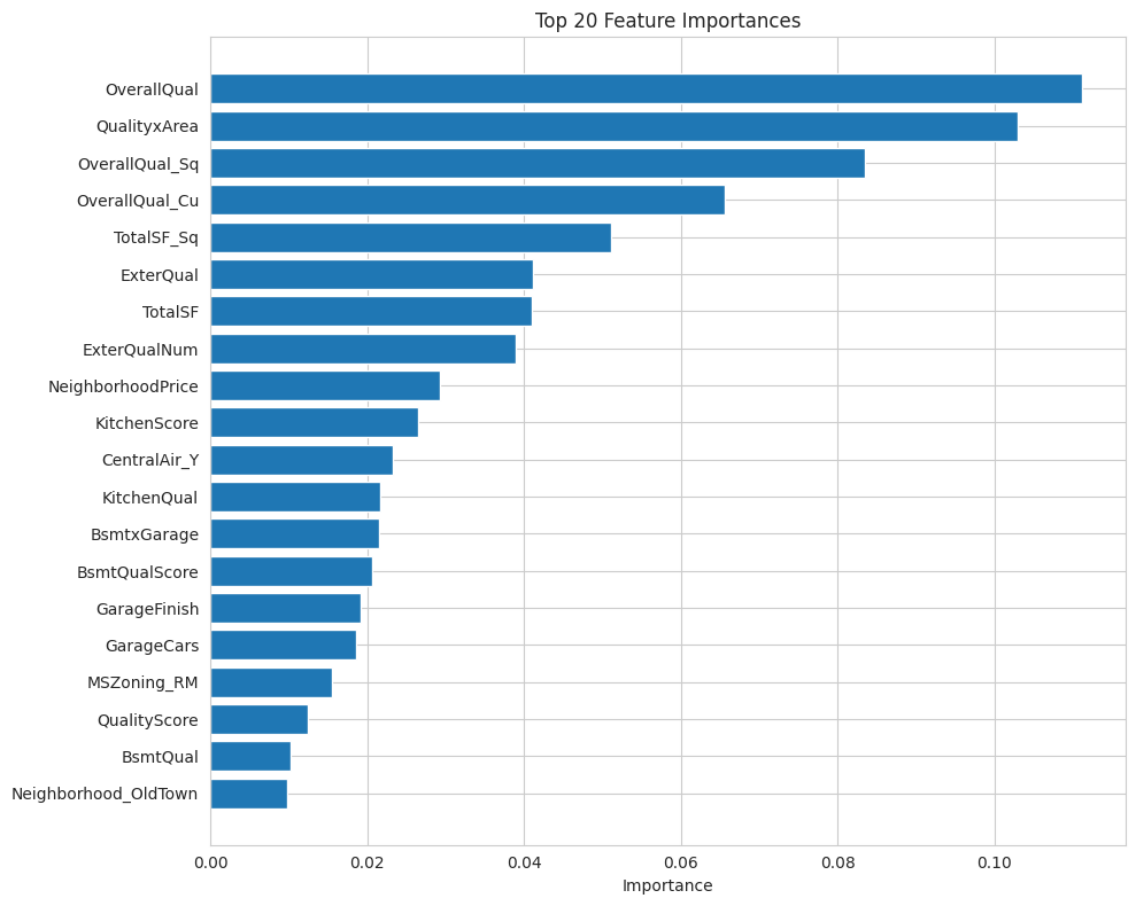
Model Evaluation Overview:

- Dummy Regressor Baseline
- Ridge, Lasso, ElasticNet: Strong linear baselines
- Random Forest: Captures non-linearity
- XGBoost + Ridge: Best overall performer
  - Gradient Boosting is the best base model overall
- XGBoost & LightGBM: Tuned via GridSearch CV
  - Stacking Regressor (Ridge + XGBoost) selected as final model due to: Best CV performance, 72% improvement over baseline,
  - Cross Validation: 5-fold cross validation to ensure generalizability



Key Drivers and Business Relevance

- **Quality Over Quantity**: Higher overall material and finish quality has a stronger impact on value
- **Space Optimization**: Focus on above-grade living area for higher market value
- **Garages**: Additional garage capacity homes are consistently valued higher
- **Kitchen Quality**: Higher-rated kitchen quality is strongly associated with higher home values.
- **Key Insight**: Renovations that improve materials, finish, living area, or garage capacity yield the highest ROI.



Key Modeling Insights & Takeaways

Model Key Findings:

- Gradient boosting outperforms linear models
- Engineered features meaningfully boost accuracy
- Ensemble models strengthen reliability
- Home quality and size remain the strongest drivers of price

Limitations:

- Geographic scope/ generalization
- Does not account for market cycles, interest rates, or economic conditions
- Fewer training examples for high-end properties

Kaggle Competition Placement (51/5703 - Top 1%)

51	Ritvik Vasikarla		0.00044	2	3d

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Business Impact

Direct Cost Savings: Automated valuations replace many manual appraisals, saving $400 per property

Reduced Mispricing Losses: 10% accuracy improvement on loan valuations

Operational Efficiency: Appraisal processing time drops 80%, enabling faster underwriting and listing decisions

Total Estimated Annual Value: Combined benefits deliver $1.2M in yearly business impact