

Course: INFO-629-686 - FA 25-26

Assignment 5 alternate: Demo of an AI application that entails two different instances of AI tasks.

Student: Anthony Parone

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1. Value: describe the value to potential users and organization.

A telecommunication company who wants to determine if a customer might churn (leave) could leverage this application. It combines predictive analytics with actionable business intelligence. This combination enables proactive customer retention, reduces revenue loss, and optimizes marketing resource allocation by targeting high-risk customers with data-driven interventions.

2. Data or knowledge source: What is the data, knowledge or both that you used for this demo? Please provide links to selected sources or describe the method you utilized to acquire or synthesize data or knowledge.

Data Source: Telco Customer Churn dataset from Kaggle containing 7,043 customer records with 21 features including demographics, service subscriptions, contract details, and churn status.

Link: <https://www.kaggle.com/datasets/blastchar/telco-customer-churn>

Knowledge Source: Claude Sonnet 4 LLM (via Anthropic API) provides business domain knowledge for interpreting predictions and generating retention strategies.

3. AI complex task and AI method: indicate the two AI tasks and the two AI methods in your application demo in the following form: The first AI task is _____ and the AI method is _____; the second AI task is _____ and the AI method is _____. Provide source library and a link to your code with required instructions to run it.

The first AI task is **classification** and the AI method is **Random Forest Classifier**; the second AI task is **natural language generation** and the AI method is **Claude Sonnet 4 Large Language Model via Anthropic API**.

Source Libraries:

- scikit-learn 1.3.0+ (Random Forest)
- anthropic 0.39.0+ (Claude API)
- lime 0.2.0.1 (model explainability)

Instructions:

1. To run the notebook, go to <https://mybinder.org/> and enter the following values:
 - GitHub URL: <https://github.com/thesaucygiant/2025.info269.a5.parone/>
 - File to Open: parone-a5.ipynb
2. Once the notebook opens, click the triangle at the top of the screen to run the application. You will need to supply an Anthropic API Key. Once entered, proceed to the next notebook cell.

4. Provide a set of at least two examples of inputs and outputs using your application by describing the two AI tasks in each. Make sure you provide a meaningful input.

Example: 1

Input: Configuration & Prompt

Configuration:

- Gender: Male
- Senior Citizen: No
- Partner: No
- Dependents: No
- Tenure: 3 months
- Contract: Month-to-month
- Paperless Billing: Yes
- Payment Method: Electronic check
- Phone Service: Yes
- Multiple Lines: No
- Internet Service: Fiber optic
- Online Security: No
- Online Backup: No
- Device Protection: No
- Tech Support: No
- Streaming TV: Yes
- Streaming Movies: Yes
- Monthly Charges: \$85.00
- Total Charges: \$255.00

Prompt:

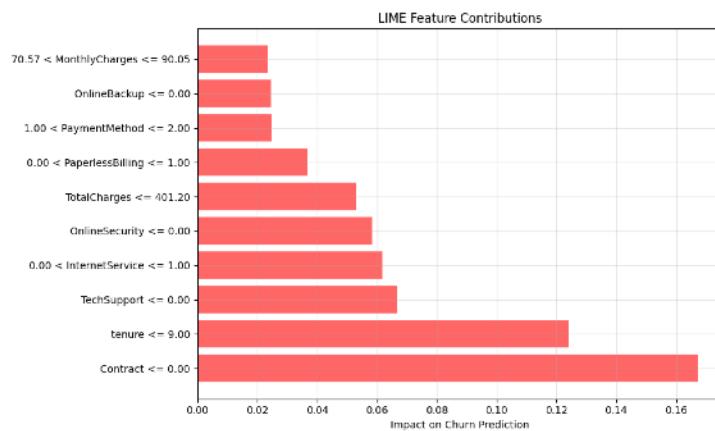
- Prediction: CHURN
- Probability: 84%
- Lime Text: (Feature and weights for the lime analysis below)
- Please provide:
 1. A clear explanation of why this customer is predicted to churn (or stay)
 2. The top 3 risk factors (if churning) or retention factors (if staying)
 3. Specific actionable recommendations for this customer

Output: Classification

- Prediction: WILL CHURN
- Churn Probability: 83%
- Risk Level: HIGH RISK

Output: LIME and LLM

- LIME Analysis: Top 10 features influencing this prediction:
Positive values = push toward CHURN
Negative values = push toward RETENTION



- Claude Prediction Analysis

1. Why This Customer is Predicted to Churn

This customer has an **83% probability of churning**, primarily due to a combination of service dissatisfaction and early-stage relationship factors. The prediction is driven by their lack of contract commitment, short tenure with the company, and absence of key support services that typically enhance customer loyalty.

2. Top 3 Risk Factors

1. **No Contract Commitment (0.167 contribution)**
 - The customer appears to be on a month-to-month basis with no long-term contract
 - This flexibility makes it easy for them to leave without penalties
2. **Short Tenure ≤ 9 months (0.124 contribution)**
 - New customers (under 9 months) are historically more likely to churn
 - They haven't yet developed loyalty or fully integrated your services into their routine
3. **No Technical Support (0.067 contribution)**
 - Lack of tech support increases frustration when issues arise
 - Customers without support services are more likely to leave when problems occur

3. Actionable Recommendations

****Immediate Actions:****

- **Contract Incentive**: Offer an attractive discount (15-20%) to upgrade to a 12-month contract
- **Proactive Support**: Provide complimentary technical support for the next 3 months to improve their service experience
- **Customer Success Check-in**: Schedule a personal call within the next week to address any concerns and demonstrate value

****Medium-term Strategies:****

- **Bundle Optimization**: Offer discounted security services (OnlineSecurity, OnlineBackup) to increase service stickiness
- **Payment Method Migration**: If they're using check/mail payments, incentivize switching to automatic payments with a small monthly discount
- **Digital Engagement**: Since they use paperless billing, engage them through digital channels with usage tips and value demonstrations

****Success Metrics to Track:****

- Contract conversion within 30 days
 - Support ticket resolution satisfaction
 - Service utilization increase over next 90 days
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Example: 2

Input: Configuration & Prompt

Configuration:

- Gender: Female
- Senior Citizen: Yes
- Partner: Yes
- Dependents: No
- Tenure: 68 months
- Contract: Two year
- Paperless Billing: No
- Payment Method: Bank transfer
- Phone Service: Yes
- Multiple Lines: Yes
- Internet Service: DSL
- Online Security: Yes
- Online Backup: Yes
- Device Protection: Yes
- Tech Support: Yes
- Streaming TV: Yes
- Streaming Movies: Yes
- Monthly Charges: \$68.00
- Total Charges: \$122.00

Prompt:

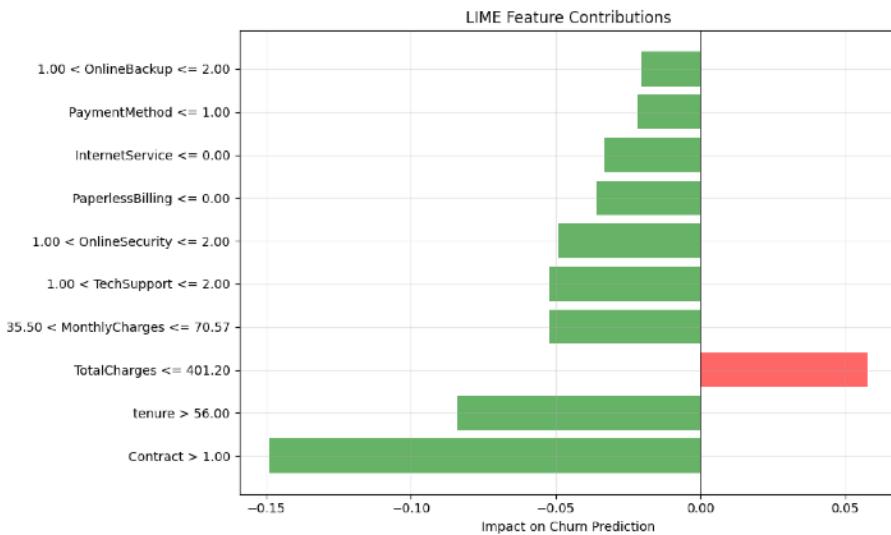
- Prediction: WILL STAY
- Probability: 89.7%
- Lime Text: (Feature and weights for the lime analysis below)
- Please provide:
 1. A clear explanation of why this customer is predicted to churn (or stay)
 2. The top 3 risk factors (if churning) or retention factors (if staying)
 3. Specific actionable recommendations for this customer

Output: Classification

- Prediction: WILL STAY
- Churn Probability: 10.3%
- Risk Level: LOW RISK

Output: LIME and LLM

- LIME Analysis: Top 10 features influencing this prediction:
Positive values = push toward CHURN
Negative values = push toward RETENTION



- Claude Prediction Analysis

1. Why This Customer is Predicted to **STAY**

This customer has a **very low 10.3% churn probability**, meaning they are predicted to remain with the company. The prediction is driven by several strong retention factors that significantly outweigh the minor risk factors.

2. Top 3 Retention Factors

1. Long-term Contract Commitment (-0.149)

- The customer has a contract longer than 1 year (likely 2-year contract)
- This is the strongest retention factor, showing high commitment to the service

2. High Tenure (-0.084)

- Customer has been with the company for over 56 months (4.7+ years)
- Long-standing customers typically have established usage patterns and switching costs

3. Moderate Monthly Charges (-0.052)

- Monthly charges between \$35.50-\$70.57 represent good value perception
- Not in the high-price bracket that often triggers churn

3. Actionable Recommendations

Retention & Growth Strategy:

****🎯 Primary Focus: Customer Expansion****

- **Upsell premium services**: Since they're paying moderate amounts and are highly loyal, introduce premium features or higher-tier plans
- **Loyalty rewards**: Recognize their 4+ year tenure with exclusive benefits or discounts on additional services

****📋 Secondary Actions:****

- **Proactive engagement**: While churn risk is low, maintain regular check-ins to ensure continued satisfaction
- **Contract renewal preparation**: Start early discussions about contract renewal terms 6+ months before expiration
- **Referral programs**: Leverage their loyalty by incentivizing referrals to similar long-term, stable customers

****⚠ Minor Risk Mitigation:**

- Address the slightly higher total charges ($\leq \$401.20$) by ensuring they understand the value they're receiving for their spend

This customer represents an ideal profile for expansion opportunities rather than churn prevention efforts.

5. Testing and evaluation: Provide the metric description and formula, the result, and the number of instances used for the two AI tasks.

AI Task 1: Classification (Random Forest)

Number of Instances: 2,113 test instances (30% of 7,043 total customers)

Confusion Matrix:

- **True Negatives (TN):** 1,209 - Customers correctly predicted to stay
- **False Positives (FP):** 343 - Customers incorrectly predicted to churn (they actually stayed)
- **False Negatives (FN):** 149 - Customers incorrectly predicted to stay (they actually churned)
- **True Positives (TP):** 412 - Customers correctly predicted to churn

Metrics:

1. Accuracy = $(TP + TN) / (TP + TN + FP + FN)$ → Result: 0.7672 (76.72%)

Description: This metric shows the overall correctness of the model across all 2,113 test instances.

2. Precision = $TP / (TP + FP)$ → Result: 0.5457 (54.57%)

Description: Measures how reliable the model is when it predicts churn - only 54.57% of churn predictions were correct, meaning there are false alarms.

3. Recall = $TP / (TP + FN)$ → Result: 0.7344 (73.44%)

Description: This measures how many at-risk customers the model successfully catches - it identified 73.44% of actual churners.

4. F1-Score = $2 \times (Precision \times Recall) / (Precision + Recall)$ → Result: 0.6261 (62.61%)

Description: A single score that balances both Precision and Recall.

5. ROC-AUC = Area under receiver operating characteristic curve → Result: 0.8400 (84.00%)

Description: Measures the model's ability to distinguish between churners and non-churners across all possible classification thresholds. A score of 0.84 indicates strong discriminative ability - the model has an 84% probability of ranking a random churning customer higher than a random non-churning customer.

AI Task 2: Natural Language Generation (Claude LLM)

Number of Instances: 2 custom-configured customer instances (as shown in examples above)

Evaluation Method: Qualitative assessment of generated insights based on:

1. **Relevance** - Claude's recommendations directly address the LIME-identified risk/retention factors. However, the model made assumptions about service dissatisfaction based on the absence of tech support features rather than actual service complaints, which represents a limitation in the LLM's interpretive approach.
2. **Actionability** - The generated insights mirrored some of the tactics used in Comcast. What I liked is that Claude used the features provided by the customer and used them to explain the actions it was recommending to reduce churn. I also noticed the format changed on the response between example 1 and 2.