Unit 1: Predictive Maintenance and IoT Analytics

Case Study: The Manufacturing Downtime Problem

A large automotive manufacturer, AutoCorp, operates a massive assembly line with hundreds of robotic arms and stamping machines. Unplanned machine downtime is a major issue, costing the company approximately $50,000 per hour in lost production and repair costs. They have installed thousands of IoT sensors on their equipment to collect real-time data on vibration, temperature, and energy consumption. Currently, the maintenance team performs scheduled maintenance every three months, which often results in unnecessary work on healthy machines or, conversely, failure to catch a problem before a catastrophic breakdown. AutoCorp wants to transition from time-based maintenance to a Predictive Maintenance system using the collected data to maximize machine uptime and reduce costs, similar to the approach taken by companies like Toyota.

Questions:

1. Data & Model: What specific type of machine learning model (e.g., classification, regression, time-series) would you recommend AutoCorp build using the IoT sensor data to predict a machine failure, and what key data features (sensor readings) should be prioritized in this model?
2. Business Impact: If a successful predictive model reduces unplanned downtime by 30%, resulting in 100 fewer hours of downtime per year, what is the estimated annual cost saving for AutoCorp, and what non-monetary benefits would the new system provide to the maintenance team?

Unit 2: Customer Segmentation using RFM Analysis

Case Study: The E-Commerce Loyalty Challenge

Bookworm Bliss is an online retailer specializing in rare and collectible books. They have a large customer base but find their mass email marketing campaigns are

becoming ineffective, leading to declining open and conversion rates. The company wants to implement RFM (Recency, Frequency, Monetary) Analysis to better segment its customers and personalize its marketing efforts. They have historical transaction data including the date of each purchase, the number of orders per customer, and the total lifetime spend for each customer. Their goal is to identify their most valuable customers for a special loyalty program and to re-engage customers who are at risk of churning.

Questions:

1. Segmentation Strategy: Describe the profile of a "Loyal Customer" (high value for retention) and a "Hibernating Customer" (at-risk of churn) in terms of their RFM scores (e.g., R=5, F=5, M=5). What distinct marketing action (e.g., special discount, personalized content, survey) would you recommend for each of these two segments?
2. Performance Measurement: After implementing RFM-based personalized emails for six months, how would you use analytics to measure the success of the new strategy? Name and define two key metrics, in addition to email open/conversion rates, that would demonstrate improved customer engagement and retention, as discussed in the context of RFM analysis.

Unit 3: Market Basket Analysis & Cross-Selling

Case Study: Supermarket Sales Optimization

QuickStop Groceries wants to increase the average transaction value in its stores. They have collected transaction data (baskets) for millions of purchases. They suspect customers who buy certain staple items often purchase complementary, higher-margin specialty items, but they need data to confirm this. They plan to use Market Basket Analysis to discover strong association rules and optimize their product placement and in-store promotions.

Questions:

1. Metric Interpretation: A Market Basket Analysis reveals the following rule: {Whole Wheat Bread} {Organic Jam}. The rule has a Support of 0.05, Confidence of 0.75, and a Lift of 1.25. Explain the practical meaning of the Confidence and Lift metrics in this context, and what the Lift value tells the store about the relationship between these two products.
2. Actionable Insight: The analysis also finds a very strong rule: {Diapers, Wipes} {Formula}. How can QuickStop Groceries use this rule to change the *physical layout* of the store and create a promotional *pricing strategy* to maximize the sales of all three items?

Unit 4: Marketing Campaign Optimization using A/B Testing

Case Study: Subscription Service Landing Page

StreamVerse, a new video streaming service, is launching a new marketing campaign to drive free trial sign-ups. They have designed two versions of their primary sign-up landing page:

- Page A (Control): Features a standard sign-up form and a clear "Start Free Trial" button.
- Page B (Treatment): Features a single, large image of their most popular exclusive show, a slightly shorter sign-up form, and the same "Start Free Trial" button.

They decide to run an A/B Test for one month, sending 50% of their web traffic to Page A and 50% to Page B, with the primary goal of maximizing the trial sign-up rate.

Questions:

1. Hypothesis & Metric: Formulate the Null Hypothesis () and the Alternative Hypothesis () for this A/B test. What is the single most critical key

performance indicator (KPI) that StreamVerse must measure to determine which page is more successful?

2. Conclusion & Next Steps: After one month, the sign-up rate for Page B is 2% higher than Page A, and the statistical analysis shows this difference is significant. What conclusion should StreamVerse draw from this test, and what is the logical *next* element of the landing page they should consider testing (and why)?

Unit 5: Social Media Listening and Sentiment Analysis

Case Study: Crisis Management for a Beverage Brand

SparklePop, a well-known soda company, is facing a potential public relations crisis after a negative news report questioned the sustainability of its packaging. The company noticed a sudden, sharp increase in negative mentions across social media platforms. They quickly launched a Social Media Listening and Sentiment Analysis initiative to monitor the situation in real-time. The analysis is capturing keywords related to "packaging," "waste," and "environment," and is classifying the incoming posts as "Positive," "Negative," or "Neutral."

Questions:

1. Analysis & Action: As the analytics head, what specific metric (e.g., Volume of Negative Posts, Sentiment Score Trend) would you report to the CEO as the *most urgent* piece of information, and how would this metric immediately inform the company's PR and marketing response strategy?
2. Tool & Value: Describe the primary technique (e.g., rule-based, machine learning) that the sentiment analysis tool uses to classify the social media posts. Beyond crisis response, explain one other long-term benefit of continuously leveraging social media sentiment analysis for product development or marketing campaigns.

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