Universidad Politécnica de Valencia

Escuela Técnica Superior de Ingeniería Informática

XA3: Model-agnostic methods

Evaluación y Despliegue de Modelos

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May 2025

Forecasting Bike Rental Demand from Environmental Variables

In the context of urban mobility planning, anticipating the volume of bike rentals based on exogenous variables can significantly improve operational efficiency. We developed a predictive model using Random Forests trained on daily bike rental data. To understand how specific features influence the model's predictions, we generated Partial Dependence Plots (PDPs) and a 2D surface plot to analyze both individual and joint feature effects.

Individual Feature Effects

Days Since Launch (`instant`):

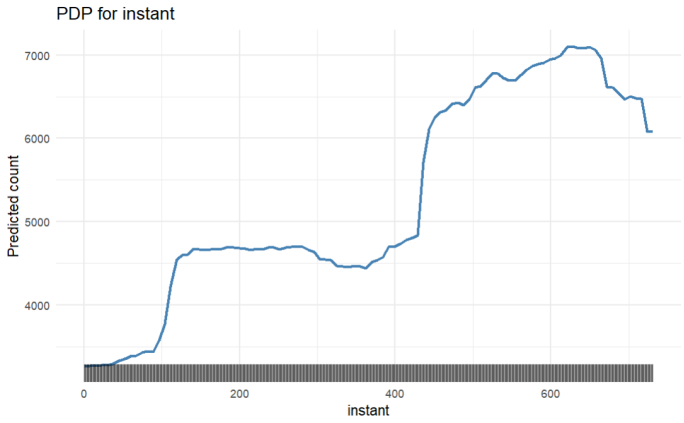

Figure 1: Predicted bike rentals over time since system launch

The plot reveals an increasing trend in predicted rentals over time, particularly after day 400. This suggests strong adoption growth and possibly seasonality patterns or operational improvements.

Temperature:

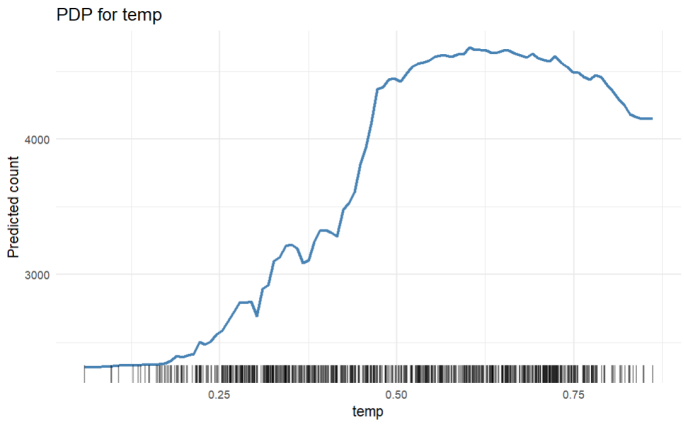

Figure 2: Predicted rentals vs. normalized temperature

Temperature shows a strong positive correlation with predicted rental volume, particularly up to 0.6 (normalized scale). Beyond that point, the effect begins to saturate or decline slightly, which may be due to excessively hot days deterring users.

Humidity:

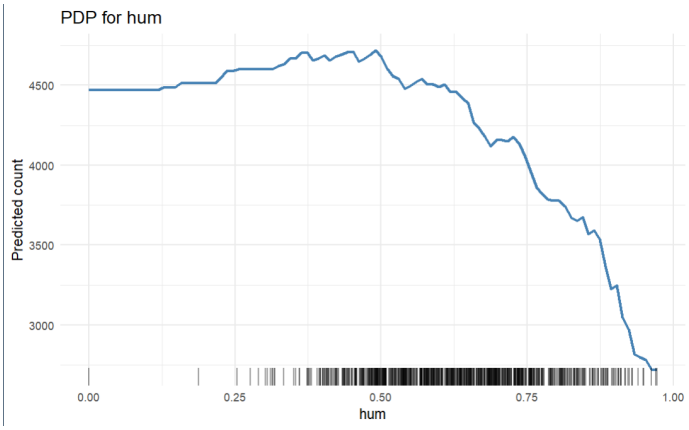

Figure 3: Predicted rentals vs. humidity

Humidity has a clear non-linear effect. While low to mid humidity shows relatively stable predictions, the model forecasts a sharp drop in rental volume beyond a humidity level of 0.7. This suggests discomfort in high-humidity conditions significantly reduces demand.

Wind Speed:

Figure 4: Predicted rentals vs. wind speed

Higher wind speeds are associated with decreased rental predictions. The downward trend is quite steady, especially for wind speeds above 0.15 (normalized). High wind likely reduces perceived safety and comfort.

Interaction Between Temperature and Humidity

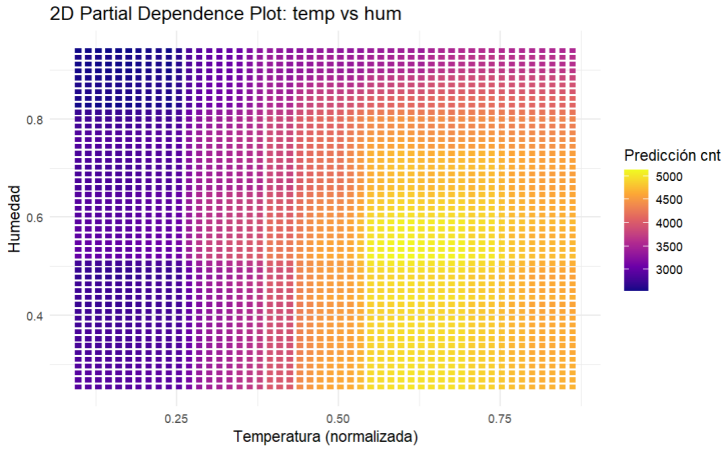

Figure 5: 2D Partial Dependence Plot: temperature vs. humidity

This heatmap provides a joint analysis of how temperature and humidity together affect predicted rentals:

- The most favorable conditions (yellow zone) for high demand occur at high temperature (around 0.6–0.75) and mid humidity (around 0.5).

- High humidity, regardless of temperature, consistently reduces predictions.
- Conversely, low temperature and high humidity correspond to the lowest predicted values (dark purple zone).

These insights are valuable for anticipating dips in demand and optimizing resource allocation based on weather forecasts.