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How Seasonality Helps Predict Offenses in Barcelona



A study published in *PLoS ONE* reveals that property crime in Barcelona follows a marked and predictable seasonal pattern. Using a new methodology based on entropy and classification models, the authors show that the months with the highest tourist activity concentrate the greatest volume of thefts, whereas in winter the crime level tends to decrease. However, distinct seasonal patterns emerge across districts, which do not always align with the overall trend.

Crime against property is not only a police matter, but it also shapes the way people use and perceive the city. When incidents rise, residents modify their daily routines, tourists change their activities, local businesses feel the impact and fear of crime appears.

To understand when these offenses are most likely to occur, our recent study introduces a two step methodology that combines Colwell's entropy based seasonality measure, with machine learning (ML) classification.

Firstly, seasonality was quantified using Colwell's "Contingency". Originally developed for ecological time series, this measure captures how strongly an outcome (here, the low / medium / high crime level) depends on the position within the annual cycle. Contingency was

computed for each of Barcelona's ten municipal districts using monthly police records from the 2010-2018 period, and significant positive values were found city wide. This confirmed that the distribution of crime levels varies markedly from month to month, that is, property crime follows a seasonal pattern as already suggested by Adolphe Quételet with his "thermal laws".

Secondly, the monthly crime level was predicted. We compared several off the shelf classifiers considering both "accuracy" and the "Mean Absolute Error" (MAE) as metrics. "Naive Bayes" emerged as the top performer, reliably assigning each month to its crime tier using only the calendar month (and dummy variables for weekdays) as predictors.

The research findings reveal a city-wide pattern: the highest crime counts recur each July, while the lowest crime rate typically appears in February. This aligns with both the high and low season in tourism, respectively.

However, the research also points to district contrasts. When districts are grouped into "maritime" (Ciutat Vella, Sants-Montjuïc and Sant Martí), "inner core" (Eixample and Gràcia) and "outer" (Les Corts, Sarrià-Sant Gervasi, Horta-Guinardó, Nou Barris and Sant Andreu) areas, distinct seasonal signatures emerge: maritime districts, an area where several major tourist attractions are concentrated, mirror the whole city, peaking in mid summer; inner core districts show three smaller peaks in spring, summer, and autumn; finally, outer districts, zones with lower reliance on seasonal tourism, peak between late autumn and early winter.

After analysis, we interpret that these findings are consistent with Cohen and Felson's "Routine Activity Theory" and studies from other cities: warm weather and tourism increase pedestrian volumes, lower informal surveillance, and create fertile conditions for opportunistic theft. Cold months have the opposite effect.

Our research is relevant since this two-step recipe is simple, data light, and transferable to any phenomenon that may oscillate over time and can be binned into qualitative states. Moreover, this research is also important for practitioners because the Naive Bayes model offers a quick to deploy early warning tool: using only the calendar, for each municipal district it flags months when reinforcing policing or prevention campaigns could be most effective.

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References

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