Predicting the firemen interventions: a concrete case study

Christophe Guyeux

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Abstract

In two recently accepted articles [3, 6], the authors used the database of all firefighters' interventions in Doubs, France, to show that it was possible to predict the number of interventions based on well-chosen explanatory variables. The database provided included all interventions since 2006, including the date and time of intervention, its purpose, location and potential victims. This database has been enriched with explanatory variables conditioning human activity, and therefore the occurrence of accidents and then firefighters' interventions: meteorological, epidemiological, calendar and ephemeral data, public holidays... In the latest models, there were 850 such variables, and a selection of models led to the choice of extreme gradient boosting [1], based on decision trees, and long short-term memory [4], a recurrent neural network, the latter being able to learn the number of interventions for a given hour, knowing the values of the explanatory variables mentioned above.

The approach mentioned above has a major flaw, making it unusable in its current state in practice for firefighters, because we need to know the values of the explanatory variables (meteorological, epidemiological, etc.) of a given hour to predict the number of interventions. As a result, only the past hours, for which the feature values are known, are available for predicting the number of interventions. The objective of this work is to explain how to adapt this work in order to be able to make predictions of firefighters' interventions in the future, at a time when the features are inaccessible. We will first start changing the target value from "number of interventions per hour corresponding to the explanatory variables" to "number of interventions per hour +1", "per hour +2", etc., and study the evolution of the error with the prediction horizon. We will then implement techniques based on the history of the features, such as duplicating for the coming year the values of the variables of the past year, or the average of previous years, to see the evolution of the prediction error compared to the previous method. Some variables can be calculated accurately in the future, such as the daily time of dawn and dusk or the phases of the Moon, and therefore the prediction of future interventions can be made partly on exact features, and partly on approximate features (by average, etc.). Finally, we will try to predict first the evolution of the explanatory variables, then that of the target variable, by looking at each feature as a

time series [2], and by using well-known techniques (*e.g.*, ARIMA [5]) or more recent ones like Prophet [7]. The best coupling between methods for constituting future explanatory variables and machine learning techniques will thus be determined and compared with a pure time series analysis of interventions, leading to an effective decision-making aid solution for the Doubs fire brigade.

References

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