CERIS : Civil Engineering Research and Innovation for Sustainability

AI-4-MUFF – Artificial Intelligence on the Management of the Degree of Readiness in Urban Firefighting

Summary

In Portugal, the allocation of technical, human and financial resources to the fire brigades in charge of the urban fire response, despite considering the existing risk in an urban area and the rapid response, it is also motivated by the local population's willingness to have a satisfactory response in the case of an accident, and by the dynamics and culture of each one of the communities. These reasons have compelled to a large number of fire brigades in regions with more population (that are implicitly areas of a greater number of accidents). However, the National Authority for Emergency and Civil Defense (in Portuguese named Autoridade Nacional Emergência e Proteção Civil - ANEPC) considers that this distribution of resources does not guarantee an efficient and equitable intervention throughout the country or a timely response to those living in areas with lower demographics. While the public funding of fire brigades is only a part of the total corporate budget (the percentage varies considerably by the corporation), prudent management of public and private financial resources should be made. This raises the research question that this AI-4-MUFF project intends to answer. "How to ensure effective preparedness to fight urban fires by making efficient use of human resources (fire-fighters), fire-fighting equipment, and financial resources?" Although ANEPC has data on all occurrences of urban fire in the last 10 years, there were no studies of a scientific nature that allow a systematic and integrated analysis of the available data multiplicity and create knowledge that supports decision making. In this research project, through the application of data science and artificial intelligence methodologies, it was developed knowledge in the scientific area of the fight against urban fires, but also contributed to better management of resources of the public administration. It was, therefore, analyzed whether the investment done in human, equipment and financial resources translated into an adequate response in case of emergency by the Portuguese Fire Brigades in all its area of activity. The main objective of AI-4-MUFF was to develop a decision support tool to support ANEPC decision-makers and local fire brigades to make more technically and comprehensive decisions, but also to contemplate the policy component of the decision considering the communities and municipalities contexts. Using the Research Team knowledge, this project developed a System for Supporting the Strategic Decision to Combat Urban Fires supported by empirical evidence, through the application of Machine Learning techniques, and the interconnection of multi-objective optimization models and agent-based simulation environment (Agent-based Model simulation). Within the scope of the project, this tool was parameterized for ANEPC and for a limited set of municipal and pilot fire company. This analysis allow a better public funding scheme to the response to urban fires, considering a certain set of human resources (number and qualification), equipment (number and configuration), and possibly a better location of fire brigades. The expected results of the AI-4-MUFF are from the scientific point of view: 1) a conceptual model for the management of urban fires based on Theory-building using Machine Learning techniques applied to the existing data considering its multiplicity and heterogeneity; 2) a decision support model that integrates a multi-objective optimization model and an agent-based simulation model, in order to solve the trade-offs that may emerge from the results of the optimization model and simultaneously consider the uncertainties of the phenomenon of urban fire. From the point of view of benefit to the public entities, a functional prototype of the system of Support to the Strategic Decision to the Combat of the multi-level urban Fire was developed parametrized for the ANEPC, pilot municipalities, and corporations of firemen, validating in a real environment. To achieve these results, the project relied on the knowledge and experience of the Research Team in the areas of forest and urban fire management, application of Machine Learning techniques to data sets, cluster analysis, mathematical modelling of the multi-objective decision and simulation of complex systems. In addition, the project team included an investigator from ANEPC which allowed adjusting the investigation to the problem of the urban fires. There was the manifest interest of ANEPC and authorization to use its database within the scope of this project, as well as, availability to facilitate the collection of other data, together with other relevant entities.

Project Reference

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Leading Institution

NOVA.ID.FCT – Associação para a Inovação e Desenvolvimento da Faculdade de Ciências e Tecnologia da Universidade Nova (Portugal)

Partners

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Project Website

https://ai4muff.pt/