UNIVERSIDAD DE GRANADA

FACULTAD DE CIENCIAS

Propuesta TFG. Curso 2025/2026

GRADO: Grado en Matemáticas

CÓDIGO DEL TFG: 270-072-2025/2026

1. DATOS BÁSICOS DEL TFG:

Título: Machine Learning-Based Signaling Forecasting for Energy Optimization in Telco 5G Core Kubernetes Deployments

Descripción general (resumen y metodología):

With the growing number of connected devices and the deployment of 5G networks, telecom operators need to manage core network functions resources more efficiently. These functions, once virtualized and now increasingly migrated to cloud-native architectures based on containers and orchestrated through Kubernetes, generate a large volume of data that enables the application of forecasting and automation techniques. In the current context—where energy efficiency has become a strategic priority for tech companies across Europe, especially in countries like Germany—optimizing consumption in network deployments and data centers has become a key objective.
This work presents a practical case study within a telecommunications company in Germany, whose main goal is to deploy an energy-efficient 5G Core. A critical phase in this process is the management of resource scaling on which network functions operate. To address this challenge, a short-term time series forecasting system based on machine learning techniques is proposed, aimed at anticipating workload demand and enabling proactive scaling decisions.

Methodology:
1. Review of the state of the art in optimization and forecasting techniques applied to mobile networks and automated scaling strategies.
2. Contextualization of the problem through an introduction to the basic principles of the 5G Core and container orchestration tools, with particular focus on the role of Kubernetes.
3. Description of the dataset.
4. Theoretical and statistical presentation of the machine learning models selected for the study.
5. Exploratory data analysis to identify correlations, seasonality, and other relevant patterns.
6. Development of convenient feature engineering techniques to enhance the predictive performance of the models.
7. Interpretation of the obtained results, model comparison, and elaboration of conclusions.

Tipología: Estudio de casos, teóricos o prácticos, relacionados con la temática del Grado.

Objetivos planteados:

•Develop a short-term forecasting system to predict signaling in a cloud-based 5G Core environment.
•Perform exploratory data analysis and identify the most influential variables in signaling behavior.
•Compare the performance of different univariate and multivariate machine learning models, including a mathematical description of each.

•Demonstrate the use of statistical and machine learning techniques to solve a dynamic discrete resource allocation problem in a real business environment.
•Establish the methodological and collaborative foundations for an energy consumption reduction project, aiming to set a new benchmark in commercial 5G Core deployments.

Bibliografía básica:

[1] C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
[2] T. W. Anderson, An Introduction to Multivariate Statistical Analysis, 3rd ed., Wiley, 2003.
[3] S. Rommer, P. Hedman, M. Olsson, L. Frid, S. Sultana, and C. Mulligan, 5G Core Networks: Powering Digitalization, Elsevier, 2020.
[4] XGBoost documentation, Version 3.0.0, [Online]. Available: https://xgboost.readthedocs.io/en/release_3.0.0/ [Accessed: 26-May-2025].
[5] Suvrit Sra, S. Nowozin, and S. J. Wright (Eds.), Optimization for Machine Learning, MIT Press, 2012.

Recomendaciones y orientaciones para el estudiante:

No aplica.

Plazas: 1

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