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DS 4002

Reconstructing Turbulence Fields Using Convolutional Autoencoders: A Practical Case Study
GitHub Repository: https://github.com/Alexlozano1023/DS4002-CS3-CAE-Case-Study
Target Audience: Second-Year Data Science Student

Overview

In this case study, you will take on the role of a junior data scientist working with scientific simulation data. Your task is to apply a Convolutional Autoencoder (CAE) to reconstruct turbulence fields from a curated subset of Navier–Stokes simulation outputs. Autoencoders are widely used for compression, anomaly detection, and scientific visualization, and this case study introduces you to one of their most practical applications.

Your Mission

You will load a small turbulence dataset, train a CAE to learn meaningful representations of fluid-dynamics patterns, and generate side-by-side reconstruction visuals to evaluate how well the model captures spatial structure. Your goal is not to build the perfect model, but to understand how CAEs work, why they are useful, and how to communicate model results clearly.

Deliverable

Your final output will be a set of reconstruction visuals, accompanied by a short written interpretation explaining what the CAE was able to reconstruct well, where it struggled, and why these behaviors make sense. All instructions, data, and scripts have been provided in the GitHub repository.

Purpose

This case study is designed to prepare you for real-world deep learning tasks where you must preprocess data, run a structured workflow, analyze outputs, and present findings professionally.

Good luck — and welcome to applied autoencoders.