Ayoub Elkhader

Artificial Intelligence & Data Science Engineer

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Profile

AI and data science engineer (ENSAM Meknès) completing a Master of Applied Science in Engineering at UQAR (dual degree, December 2026). I build AI solutions for engineering: large language models (LLMs), computer vision, signal processing and industrial data analytics. Author of 2 papers submitted to international journals (Elsevier, Wiley) and an oral presentation at ECSC 2026; 8 open-source projects on GitHub, all with automated tests. I don't have every answer, but I know how to find it, validate it and turn it into a working solution.

Education

Master of Applied Science (M.A.Sc.) in Engineering, thesis-based 2024 – Dec. 2026
Université du Québec à Rimouski (UQAR), Rimouski, QC
Thesis by articles: generation and geometric verification of exploded views of CAD assemblies with AI. Supervisor: Prof. Raef Cherif.

State Engineering Degree in Industrial Engineering, AI & Data Science option 2020 – 2025
École nationale supérieure d'arts et métiers (ENSAM), Meknès, Morocco · dual degree with UQAR
Key courses: machine and deep learning, statistics, operations research, Six Sigma, production management.

Technical skills

- **AI**: LLMs (LoRA fine-tuning, tool-calling agents, LangChain, NVIDIA NIM API), PyTorch, TensorFlow, scikit-learn
- **Computer vision & signals**: OpenCV, U-Net segmentation, YOLOv8, MediaPipe, infrared thermography (FLIR radiometric data), spectral and order analysis of vibration
- **Data & statistics**: pandas, NumPy, statistical testing (McNemar, bootstrap), Power BI, Tableau, advanced Excel
- **Programming & tools**: Python, SQL, R, MATLAB, C/C++/C#, Java, Git, GitHub Actions, pytest, Docker, FastAPI, LaTeX
- **Engineering**: Lean Six Sigma, SPC, operations research, production management, predictive maintenance, vehicle dynamics, CAD (OpenCASCADE, SolidWorks, CATIA)

AI and data science projects

AI for generating exploded views of CAD assemblies 2024 – 2026
Master's research project, UQAR

- Fine-tuned an LLM (Qwen2.5-1.5B, LoRA) on 6,000 examples I generated: invalid outputs **15.3%** → **0%**, median error **191.6** → **2.8 mm**.
- Python pipeline over **1,895 real assemblies** from 4 public sources; benchmarked 3 LLMs on 750 cases and defined a new "geometric hallucination" metric (25–70% of outputs physically wrong).
- Statistical protocols (McNemar, Holm, bootstrap, 10 seeds): at equal budget, a simple baseline matched the LLM (51/51 vs. 42–44).
- Tool-calling LLM agent (NVIDIA NIM API): right tool in **100%** of 80 test cases, vs. 32.5% for a rule-based approach.

- Released as 4 open-source repositories: verifier, 3D studio, assistant, REST API.

Thermal condition monitoring of electrical machines 2026
Open source: thermal-condition-monitoring

- Built an analysis pipeline on **1,112 real thermal images** of motors and a transformer (3 public datasets); decoded FLIR radiometric data into temperatures within **0.3 °C** of the camera reading.
- U-Net segmentation of the expert region of interest: IoU **0.90** vs. 0.64 for thresholding on the transformer; short-circuit severity of unseen levels predicted with a mean error of about 1 level (Spearman 0.88).
- Showed that 97–100% within-session accuracy falls to 64–75% on an unseen load, because each fault was filmed in one session.

Predictive maintenance of car wheels from vibration 2026
Open source: tire-vibration-predictive-maintenance · extends my 2024 internship subject

- Physics-based simulator (quarter-car model, ISO 8608 roads, 160 vehicles, 2,400 drives) of 5 wheel conditions: tyre underinflation, imbalance, bulge, worn damper.
- Fault classification at **80%** on vehicles never seen in training (spectrogram CNN: 68%); sensorless tyre-pressure estimate with a 5-point mean error; slow-leak remaining useful life predicted with a 1.6-day median error at mid-leak.

Engineering projects ENSAM Meknès

- **Vision-based quality control**: defect detection on mechanical parts and plastic bottles (Python, OpenCV).
- **Ergonomics 4.0**: PPE detection (YOLOv8, 11 classes, 1,118 workshop images) and welder posture indicators (MediaPipe) on real welding-workshop data (ergonomie-4.0-ppe-detection).
- **LLMs for product design**: TRIZ contradiction assistant combining an LLM (Gemini), the contradiction matrix and human validation (llm-triz-dfx).

Publications and conference

- **Elkhader, A.**, Cherif, R. (2026). *A geometric verifier, not the language model, makes exploded views of real CAD assemblies interference-free.* Submitted to *Computer-Aided Design* (Elsevier).
- Cherif, R., **Elkhader, A.** (2026). *LLM-Based Generation of Exploded Views for Mechanical CAD Assemblies.* Submitted to *Structural Control and Health Monitoring* (Wiley), ECSC 2026 special issue.
- **Oral presentation**: ECSC 2026, France, August 25–27, 2026.

Professional experience

Predictive Maintenance Intern July – Aug. 2024
Smart Automation Technologies, Morocco (remote)

- Modeled the vibration response of a vehicle wheel (MATLAB) to simulate tyre faults (flat, puncture) and generate training data.
- Classified the faults with machine learning (SVC) and reviewed simulation tools (SIMULIA, MATLAB).

Mechanical Design Intern July – Aug. 2023
SN Sametal, Morocco

- Designed and sized a real steel-frame storage hangar.

Certifications, languages and interests

- **Certifications**: Supervised Machine Learning: Regression and Classification (DeepLearning.AI, Stanford); What is Data Science? (IBM), 2024
- **Languages**: French (fluent), English (fluent), Arabic (native)
- **Interests**: theatre, sports