



Contribution ID: 33

Type: Oral Presentation

Proactive Equipment Monitoring Using Vanilla LSTM for Predictive Maintenance at iThemba LABS

Thursday 10 July 2025 09:40 (20 minutes)

iThemba LABS operates complex scientific equipment including particle accelerators where unexpected failures can disrupt critical experiments for extended periods. We present a predictive maintenance framework based on Vanilla LSTM networks that analyzes multivariate time-series sensor data to anticipate equipment failures. The model was trained on operational data from 2021-2024, monitoring key parameters like voltage, vibration, and pressure across various systems. Our approach demonstrates significant improvements over traditional methods, achieving a 75% F1-score in failure prediction with up to 72 hours warning time. The framework includes an interpretable failure scoring system that helps technicians prioritize maintenance interventions. Practical implementation challenges at iThemba LABS, such as handling noisy sensor data in high-vibration environments, were addressed through careful feature engineering and model optimization. The methods developed are particularly relevant for physics laboratories and other facilities operating sensitive, high-value equipment.

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None

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Yes, I ACCEPT

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Session Classification: Applied Physics

Track Classification: Track F - Applied Physics