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AVEVA WORLD MILAN, MAY 2026

AI Safety on the Electric Power Grid

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Agenda

AI Safety on the Electric Power Grid

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- The Evolving Grid
- A Risk of AI Models of the Grid
- Researching Model Drift with US DOE & INL
- Testing and Validating Drift Measurement
- Benefits of a Quantifiable Measurement of Drift

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The Evolving Grid

More Complex, and More Demanding

The electric grid is the backbone of our modern world, but it's facing unprecedented challenges:

- **Surging Demand**: Massive growth from data centers and the adoption of electric vehicles
- **Changing Supply Mix**: An increase in distributed and intermittent renewable energy like wind and solar
- **Increasing Exposure to New Risks**: The digitization of the grid creates a larger attack surface for cyber threats

Artificial Intelligence will be a key tool for managing the complex grid of the future - but its deployment must be done safely and responsibly.

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A Hidden Risk of AI Models of the Grid

A Changing Grid Can Lead to Post-Deployment Model Drift

Because the grid is changing over time, what was true when the model was originally trained might no longer be true today.

This means the model isn't representative of the actual system anymore, and is called **model drift**.

What is drift?	Drift occurs when a model's predictions become less accurate over time, as the live data the model sees begins to shift away from the data it was trained on.
Why is it a risk for the grid?	Models must be able to be trusted in order to be valuable. Consider two examples: • **Load forecasting**: Consistent errors can lead to inefficient energy purchasing (financial impact), or insufficient power generation (risk of grid instability) • **Predictive maintenance**: A drifting model could miss early warnings of equipment failure (unplanned outages), or trigger false alarms (wasted maintenance costs)

Key Takeaway: An AI model for a critical system cannot be considered "set and forget." Its health and reliability must be continuously monitored to ensure accurate results.

Researching AI Safety & Resilience for the Grid

Detecting and Measuring Model Drift

To address the challenge of detecting and measuring model drift, **AVEVA** partnered with the **U.S. Department of Energy's Idaho National Laboratory (INL).**

- **Program**: This research was conducted under INL's Artificial Intelligence Management and Research for Advanced Networked Testbed Hub (AMARANTH) program.
- **Goal**: Develop and validate a quantitative, model-agnostic methodology to detect and measure an AI model's resilience to drift. Use this to estimate a model's remaining effective 'lifetime' in a production environment.
- **Technology**: The study centered on measuring drift using AVEVA's Predictive Analytics platform, as well as several common open-source AI/ML algorithms, using real-world grid data.

AVEVA™ Predictive Analytics

U.S. DEPARTMENT of ENERGY

Idaho National Laboratory

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Our Framework for Model Drift

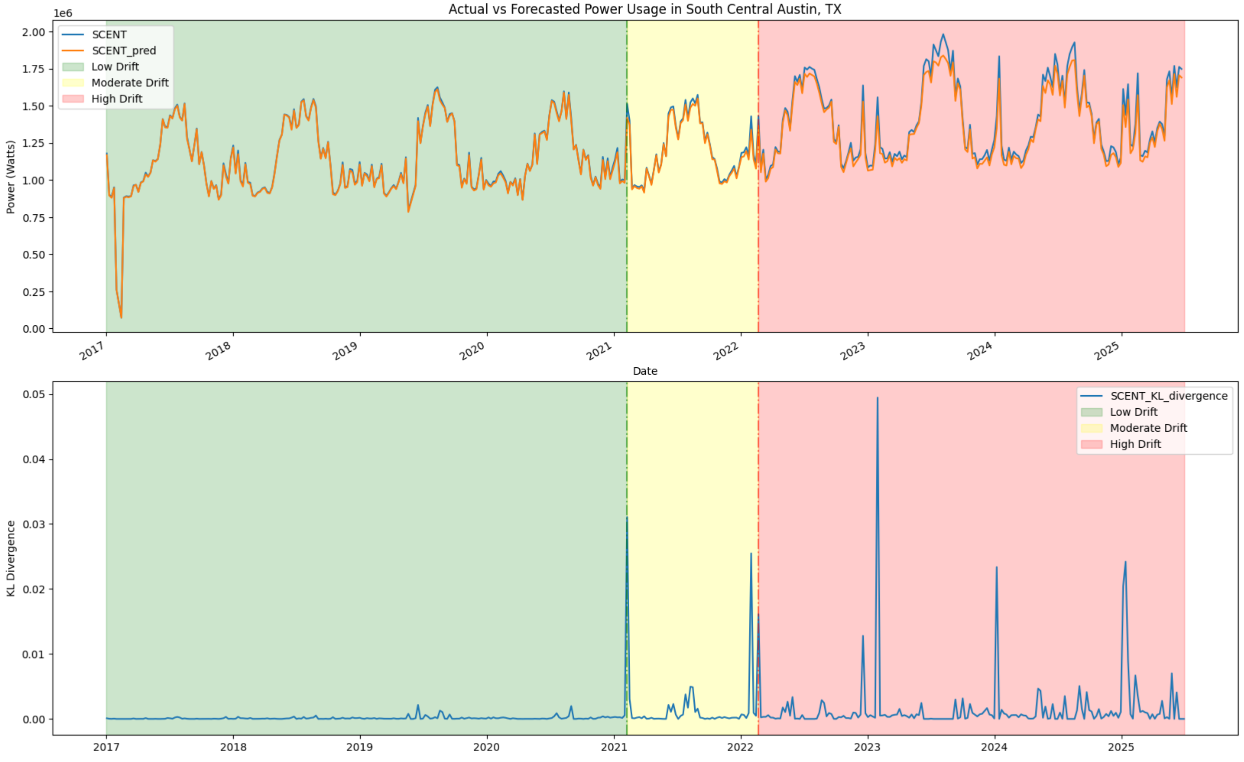
Quantifying Model Drift & Useful Lifetime

- **The Metric**: Use KL-Divergence to measure the cumulative difference between the model's actual and predicted values
- **The Concept**: Use the drift value to categorize a model's health into three zones, giving operators a clear signal for when action is needed
  - **Green Zone (Low Drift):** The model is stable and reliable
  - **Yellow Zone (Moderate Drift):** A warning the model is degrading and retraining should be planned
  - **Red Zone (High Drift):** The model is no longer considered reliable and should be retrained

> This helps answer the common question, "How do I know if I have a good model?"

$$D_{KL}(p(x)||q(x)) = \sum_{x \in X} p(x) \ln \frac{p(x)}{q(x)}$$

Kullback-Leibler Divergence (or KL-Divergence) measures how much a "new" probability distribution *Q* differs from a known "good" probability distribution *P*, letting you know if underlying data distribution has changed



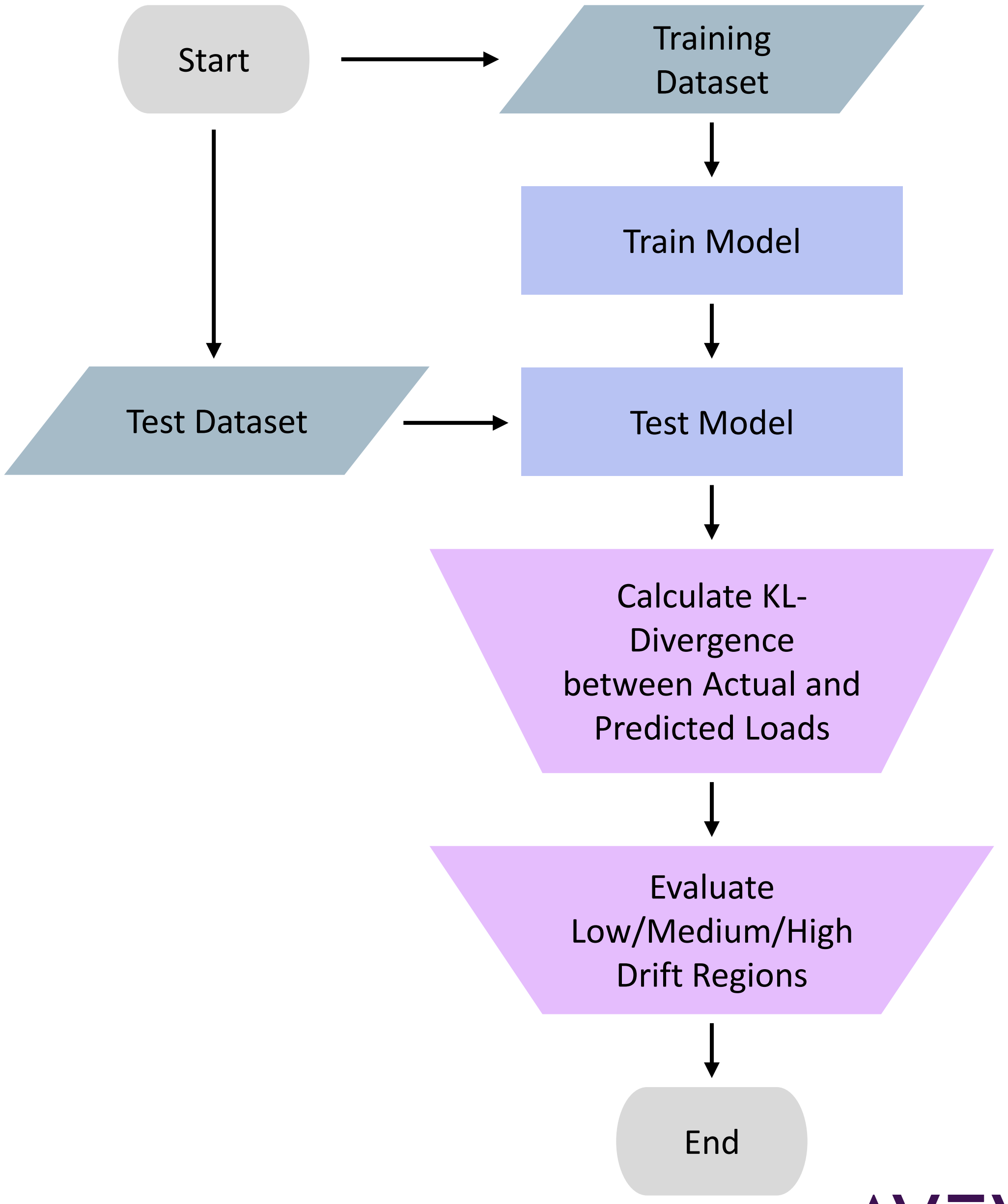
Top: Actual vs. Predicted loads for Austin, TX
Bottom: KL Divergence measurement

Validating the Framework

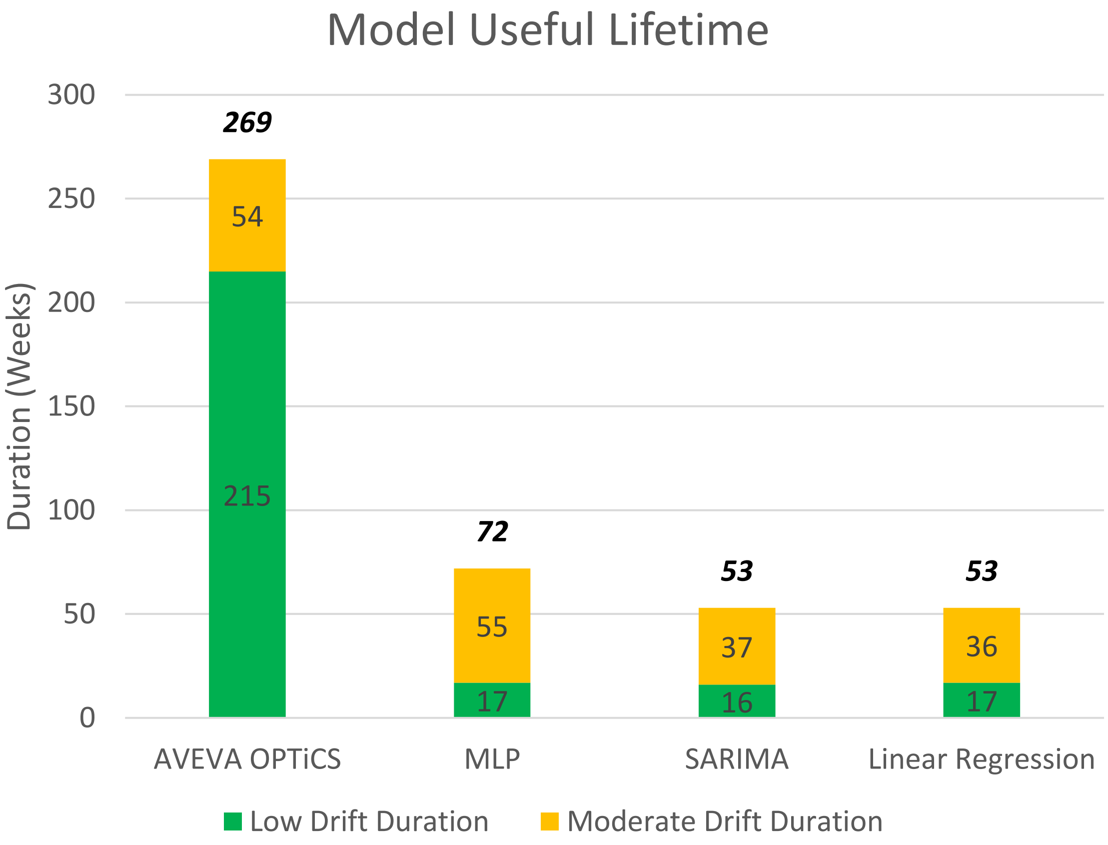
Measuring Drift on Real Data

Testing the Methodology:

- We applied our framework to real-world load data from the Texas power grid (ERCOT), and compared the amount of drift seen from various algorithm types
- Models were trained using the following algorithms:
  - **AVEVA Predictive Analytics**: OPTiCS algorithm
  - **Common Open-Source Models**: Multilayer Perceptron (MLP), Seasonal Autoregressive Integrated Moving Average (SARIMA), and Linear Regression
- Each algorithm was evaluated using the exact same datasets
  - Training Date Range: 2002-2016
  - Test Date Range: 2017-2025

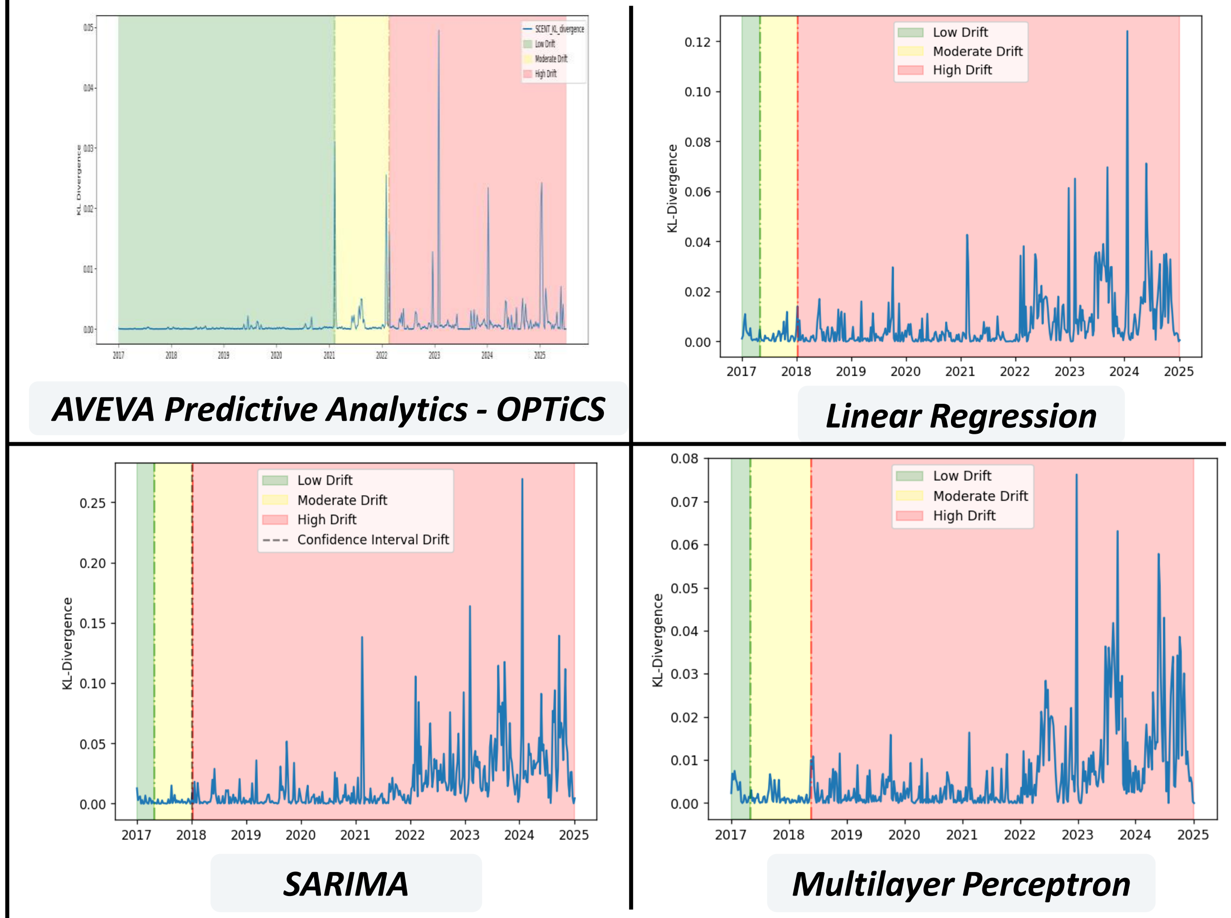


Comparative Study Results



Above: Comparison of the useful lifetime (low and moderate drift zones), measured in weeks after deployment

Key Observation: Algorithm choice has a significant impact on a model's resilience to drift.



Above: KL-Divergence measurements for the four algorithms tested, measured at a weekly resolution

From Research to Real-World Value

How the Drift Measurement Framework Can Help

Improve Efficiency & Reduce Costs

- **Enable 'Condition-Based Maintenance' for AI models**: Reduce workload by only retraining a model when necessary

- **Enhance Operational Stability**: Improve decision making by ensuring that critical models remain accurate

Build Trust & Transparency

- **Quantify AI Model Health**: Provide operators with a clear, data-driven 'model health score' to alert them of inaccurate models

- **Improve AI Governance**: Implement drift monitoring as part of the AI model governance process

Accelerate Adoption

- **Deploy A Framework for Trustworthy AI**: An algorithm-agnostic approach which is easy to implement at scale

- **De-Risk AI Projects**: Address questions around post-deployment model drift ahead of time

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AI Safety on the Electric Grid

Key Takeaways

- Surging demand, a changing supply mix, and increasing digital threats are adding **complexity** to the power grid
- AI tools which monitor the grid must be reliable and **trustworthy**
- Joint research between AVEVA and Idaho National Labs led to **a quantifiable way to measure model drift and alert operators to unreliable models**

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State your name and company.

Please remember to…

Navigate to this session in the mobile app to complete the survey.

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Thank you!

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