Improving Wind Turbine Performance with Principal Component Analysis (PCA)

By Andrew Brody & Tom Anderson

Intro

Fleet-level asset analytics for wind turbines often involve managing and analyzing each turbine individually, which can lead to fragmented insights. However, by shifting to a holistic approach that considers the entire fleet as a single entity, operators can uncover broader patterns and regional trends, leading to more comprehensive insights. This holistic analysis enhances decision-making, allowing for optimized maintenance schedules and improved overall fleet performance, ultimately transforming the way turbines are managed and operated.

Methods

- Reducing Dimensionality with Moving Window PCA (MWPCA)
- Fleet-Level Anomalies Detection
- Integrating Environmental and Operational Data
- Proactive Risk Management

Results

- Identifying Key Performance Drivers
- Optimizing Maintenance and Operations
- Visualizing Fleet Performance
- Understanding Complex Relationships

Discussion

- Multivariate analysis on turbine performance across the fleet
- Multivariate analysis is used to detect systemic issues across fleet of turbines
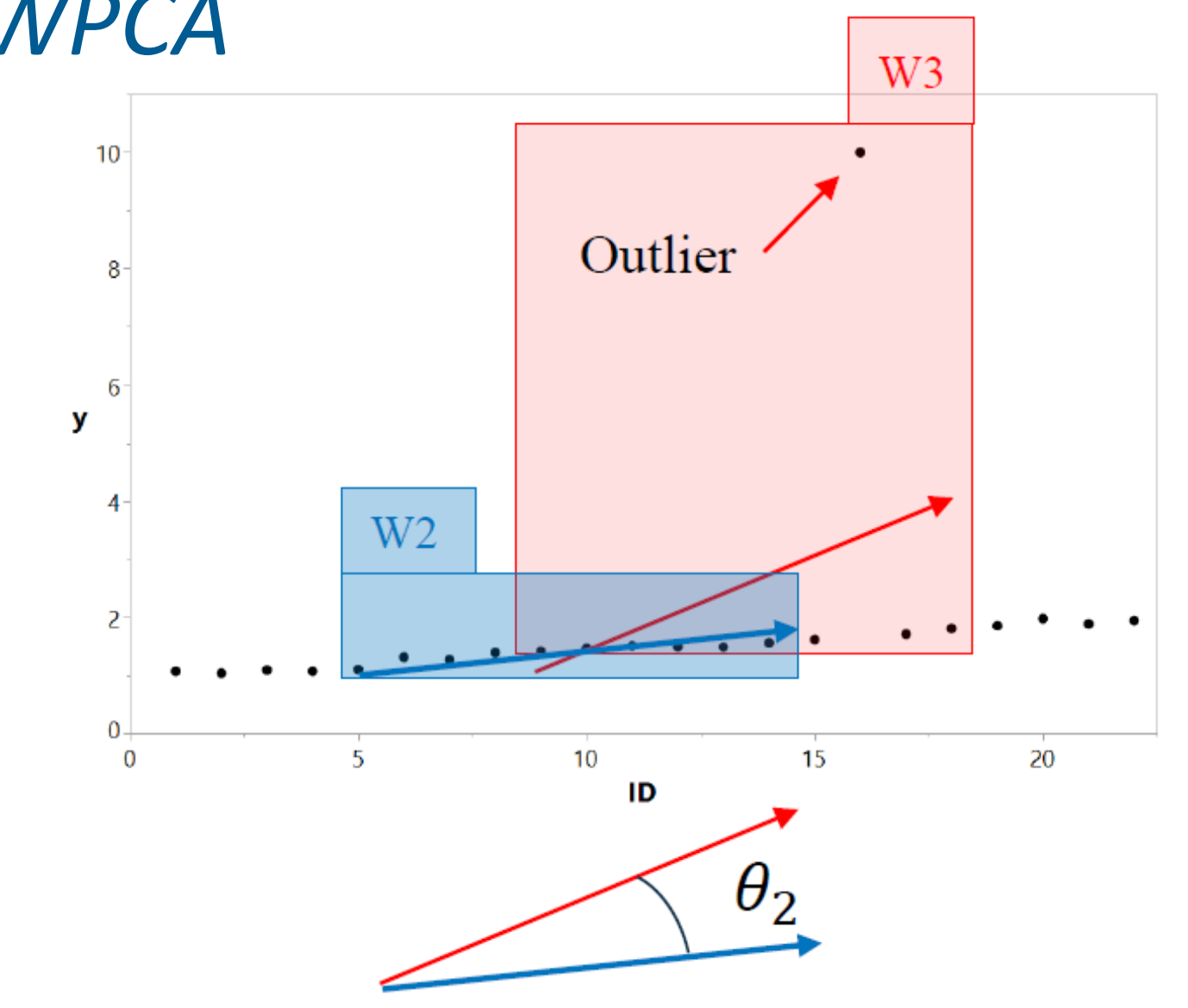- PCA & Multivariate analysis is applied to optimize operational efficiency.

- Predicting Failures 1 year out.
- Create short list of turbines to monitor.
- Produce findings missed by Field Technicians.
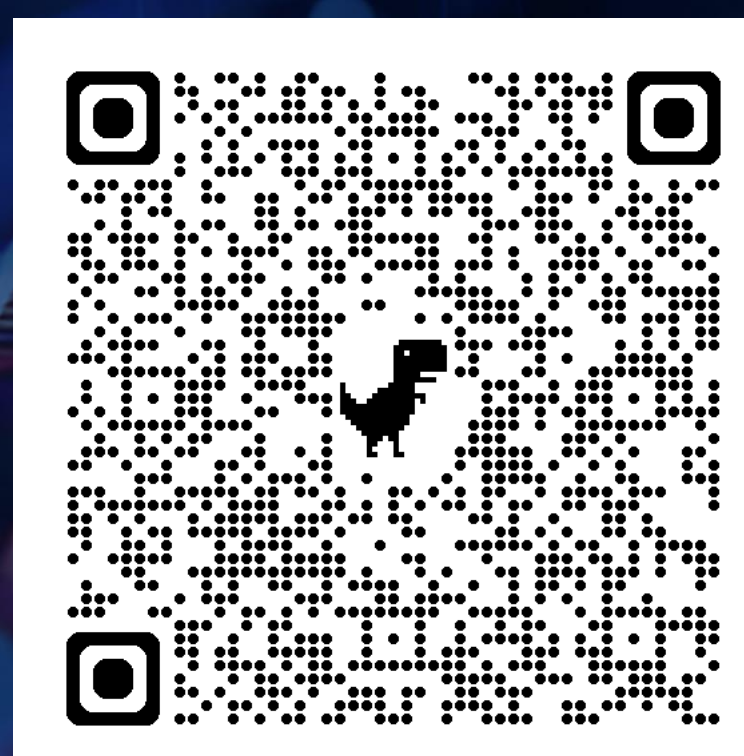- MWPCA requires no training data.
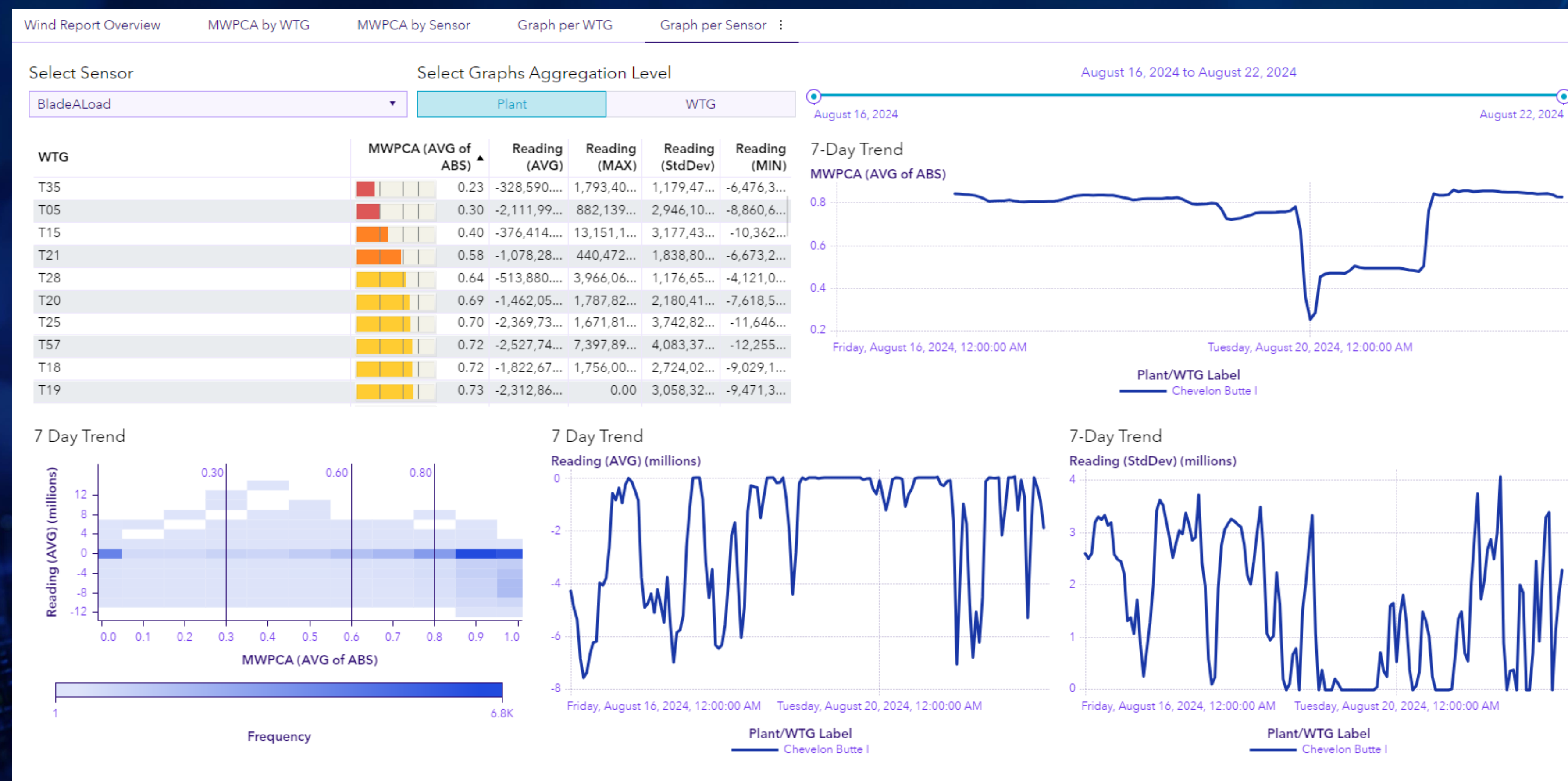
MVP Model Result
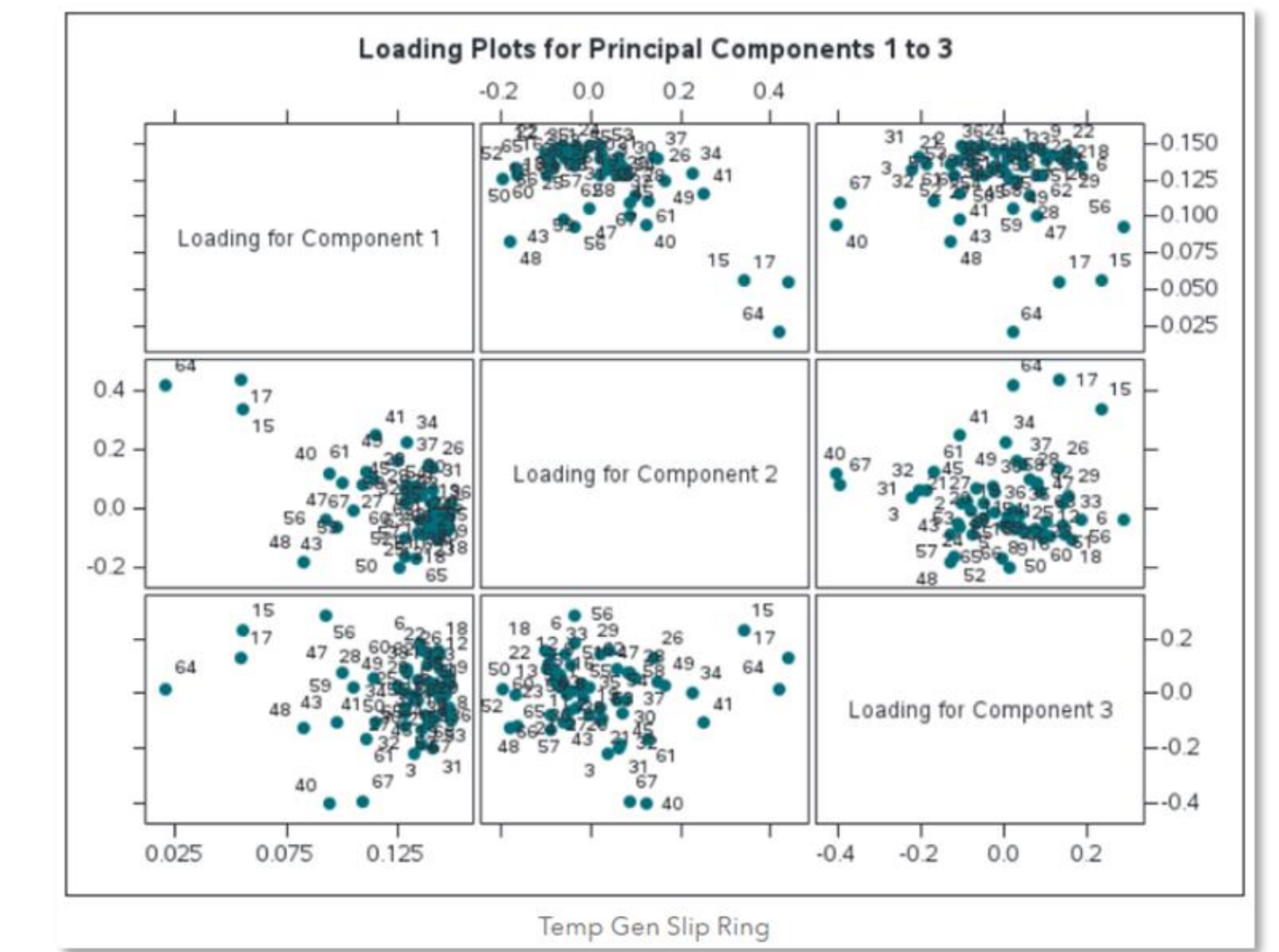
MWPCA

WTG	PCA (Avg)	Blade load		
		Avg (MM)	Max (MM)	Min (MM)
T35	0.23	-0.33	1.79	-6.48
T05	0.3	-2.11	0.88	-8.86
T15	0.4	-0.38	13.15	-10.36
T21	0.58	-1.08	0.44	-6.67
T28	0.64	-0.51	3.97	-4.12

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