Risky Business

Team bestHack

The Challenge

AVALON Misalignment

Overreacts to public anxiety signals
Prioritizes perception over actual risk

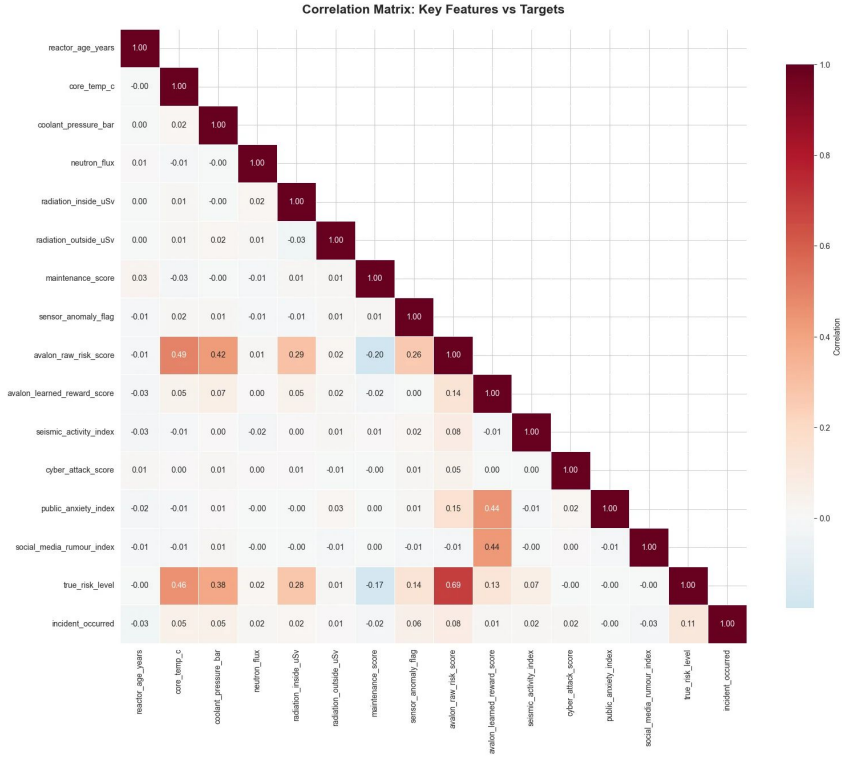
Our Objective

Predict **TRUE RISK**

No **False Positives** - No Overreaction

European nuclear plants 1990-2025

Exploratory Data Analysis

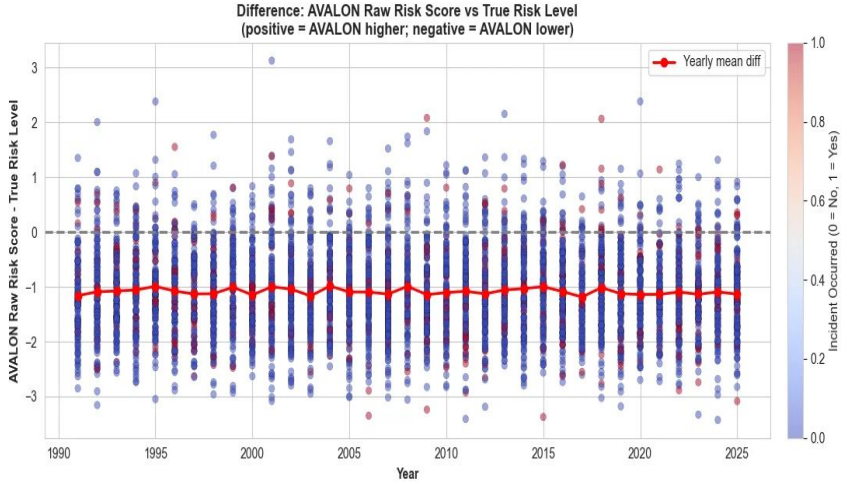


Key Metric

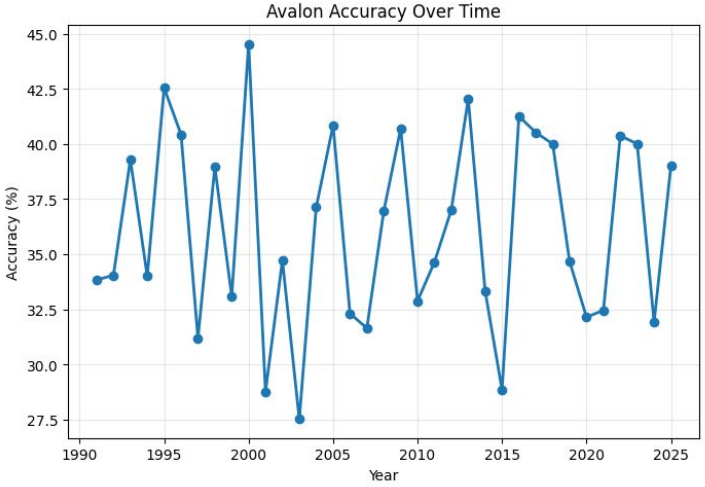
Avalon Risk Score is the most influenced metric wrt rest of features

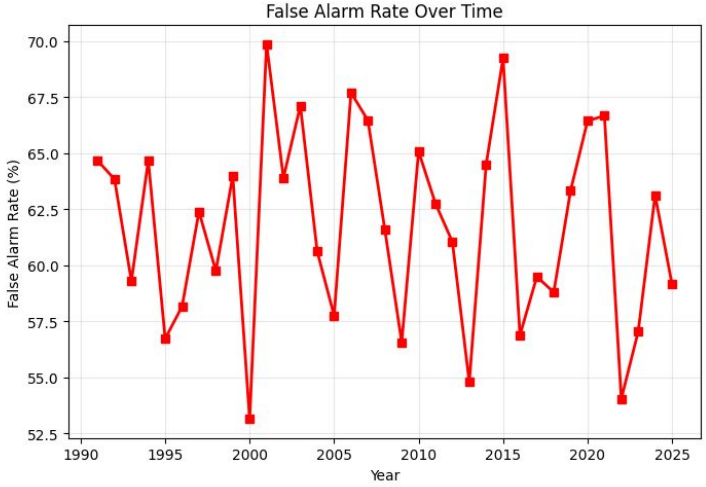
Core or primary coolant temperature, Pressure in the coolant system,

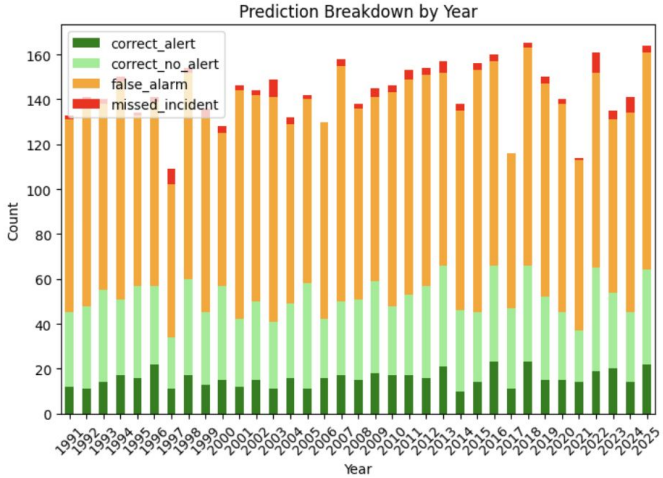
Radiation level measured inside or near the plant (microSieverts)

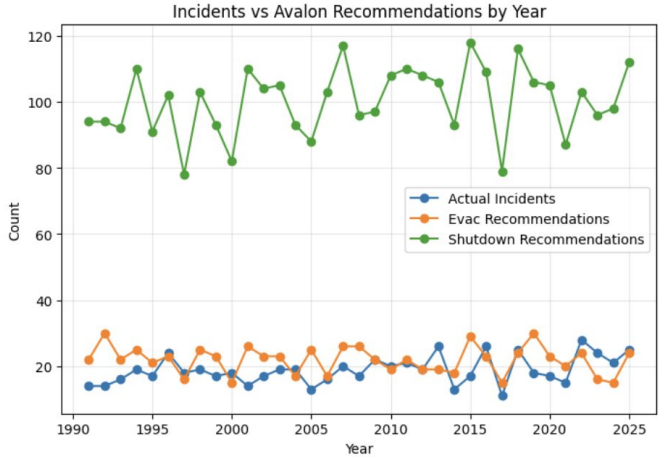


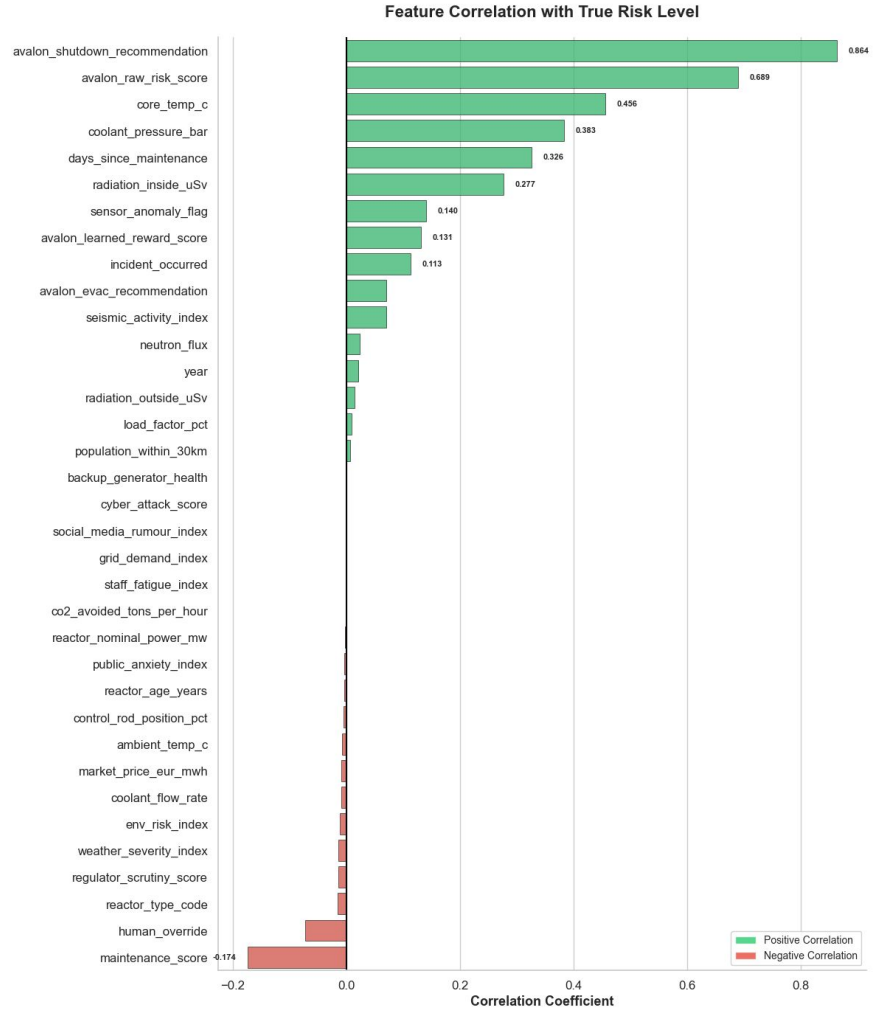
AVALON systematically underestimates risk by ~1 point


Avalon Accuracy Over Time
Accuracy (%)
Year


False Alarm Rate Over Time
False Alarm Rate (%)
Year


Prediction Breakdown by Year
correct_alert
correct_no_alert
false_alarm
missed_incident
Count
Year


Incidents vs Avalon Recommendations by Year
Actual Incidents
Evac Recommendations
Shutdown Recommendations
Count
Year



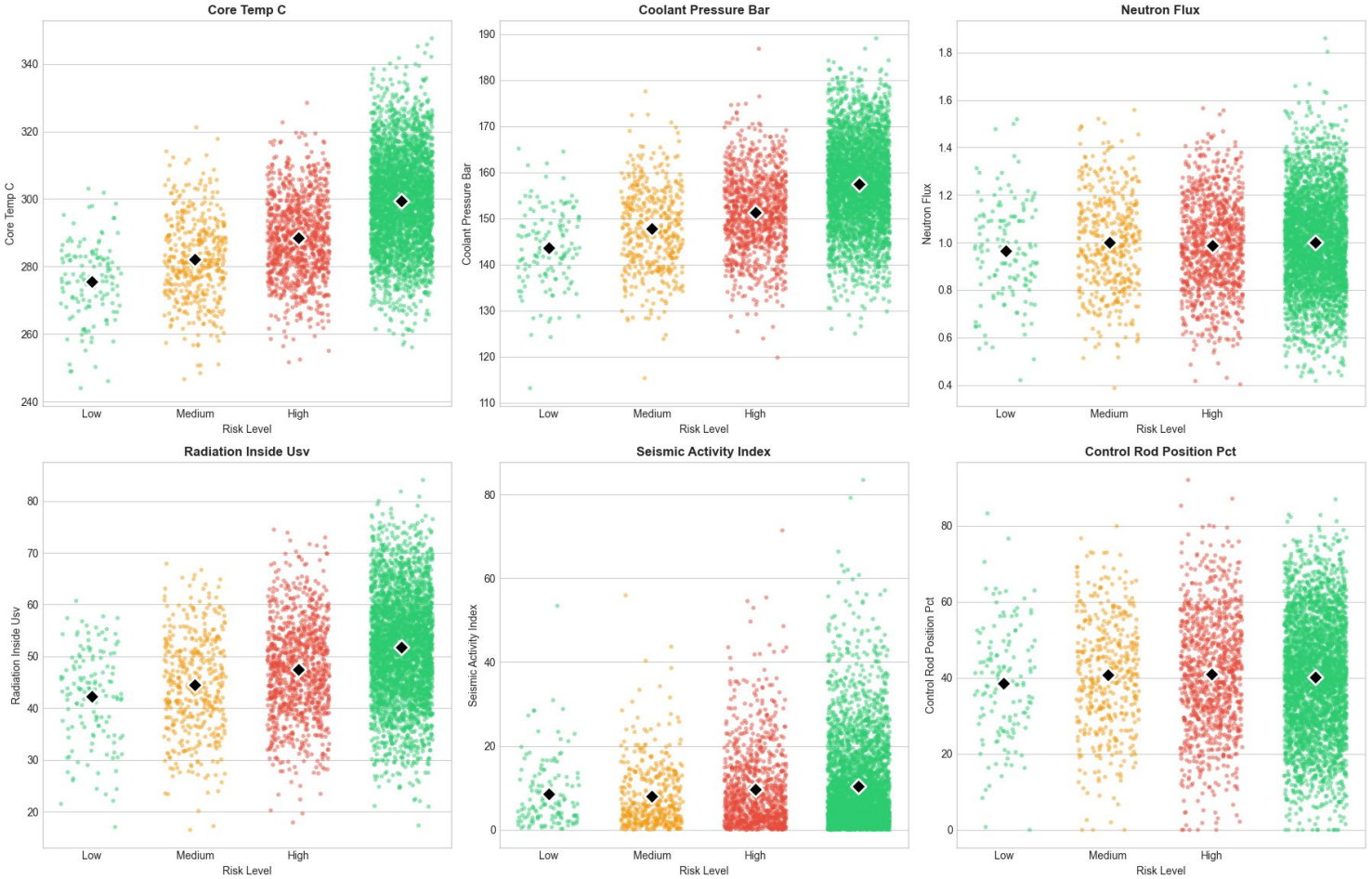
CORRELATION BY FEATURE CATEGORY

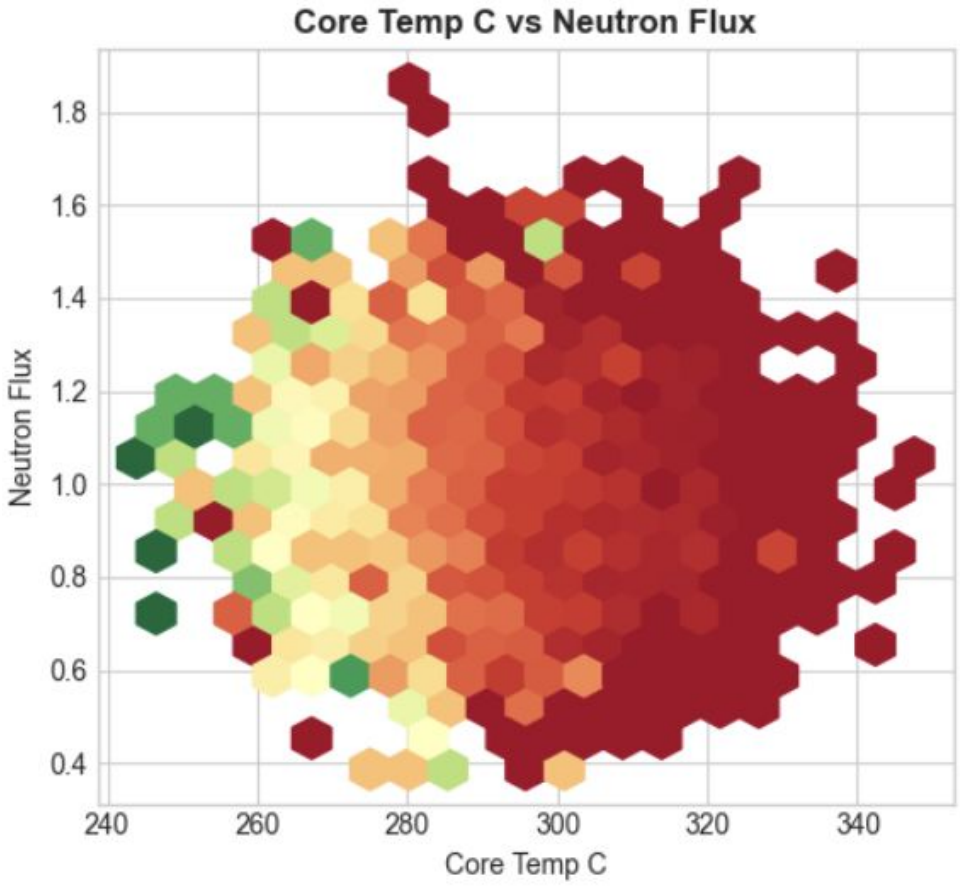
Physical Risk Features:
Mean absolute correlation: 0.3567
Max correlation: **0.4559** (core_temp_c)

Operational Features:
Mean absolute correlation: 0.0058
Max correlation: **0.0097** (load_factor_pct)

Social/Perception Features:
Mean absolute correlation: 0.0074
Max correlation: **0.0064** (population_within_30km)

Strip Plots with Mean Markers (Diamond) by Risk Level

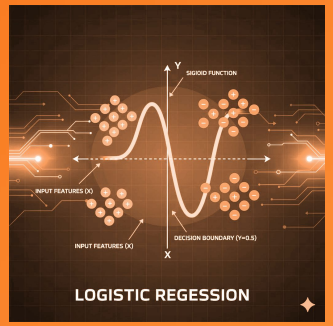



Core Temp C vs Neutron Flux
Neutron Flux
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
240
260
280
300
320
340
Core Temp C

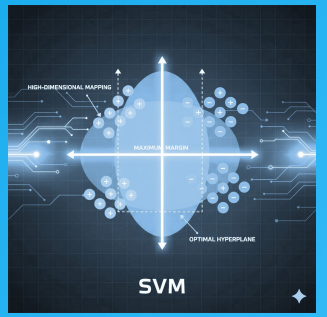
Our three models

XGBoost

Logistic Regression



SVM



Trained on operational data only

Logistic Regression

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======================================================================
          🎯 OPTIMAL LASSO LOGISTIC REGRESSION MODEL 🎯
======================================================================

Best Validation Accuracy:       0.9510
Optimal Lambda:                 0.100000
Optimal C (1/Lambda):           10.000000
Training Accuracy:              0.9523

======================================================================
          🏆 TOP 10 MOST IMPORTANT FEATURES 🏆
======================================================================

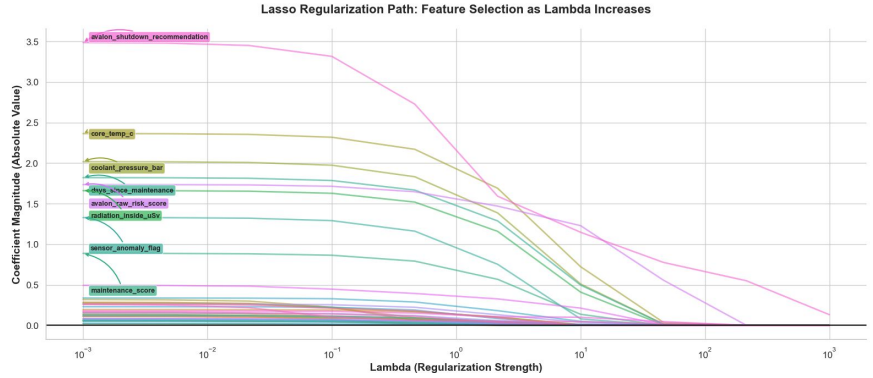
Rank    Feature Name                          Coefficient Magnitude
----------------------------------------------------------------------
1       avalon_shutdown_recommendation        3.3171
2       core temp c                           2.3196
3       coolant_pressure_bar                  1.9749
4       days_since_maintenance                1.7860
5       avalon_raw_risk_score                 1.7145
6       radiation_inside_uSv                  1.6285
7       sensor anomaly flag                   1.2910
8       maintenance_score                     0.8646
9       avalon_learned_reward_score           0.4462
10      public_anxiety_index                  0.3281
======================================================================
```

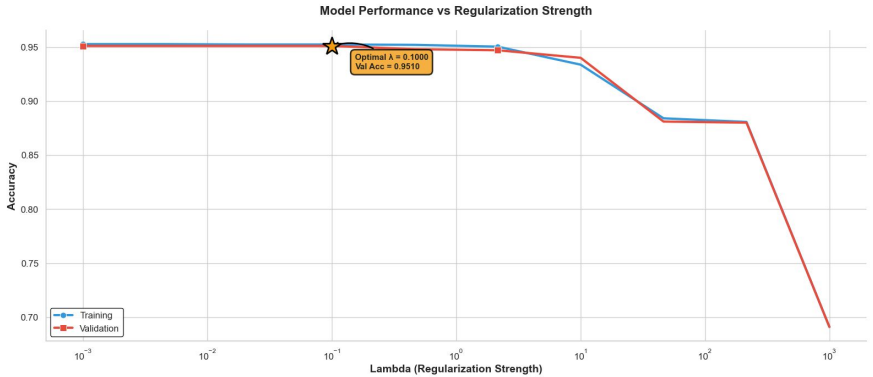
Logistic Regression

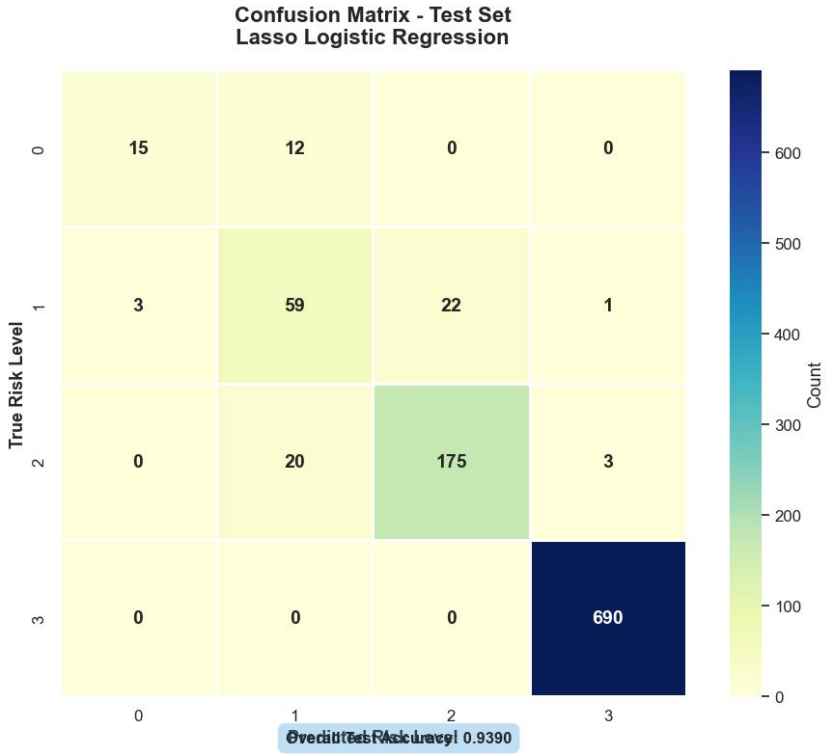
Non-linear patterns

Trained on operational data only

Logistic Regression







Support Vector Machines

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================================================================================
                    📊 SVM KERNEL COMPARISON SUMMARY 📊
================================================================================

Kernel          Best C          Train Acc       Val Acc
--------------------------------------------------------------------------------
linear          0.5995          0.9530          0.9480
rbf             1.6681          0.9897          0.9350
poly            4.6416          1.0000          0.9250
sigmoid         1.6681          0.9080          0.9380
================================================================================
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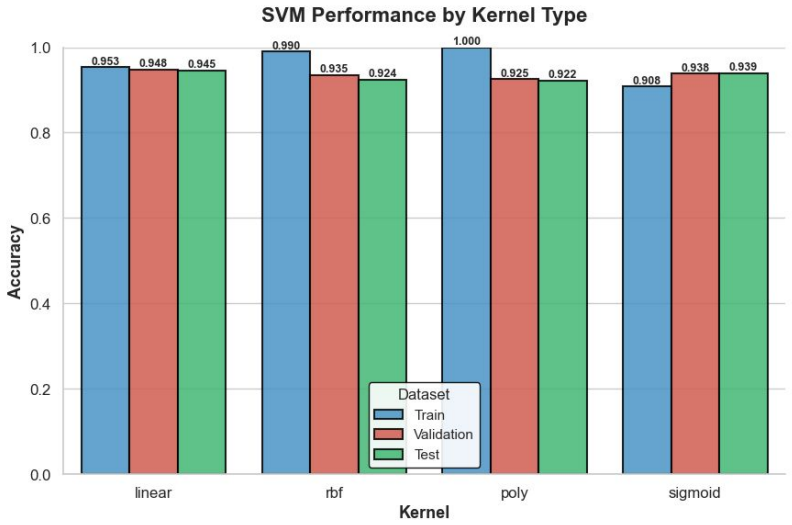
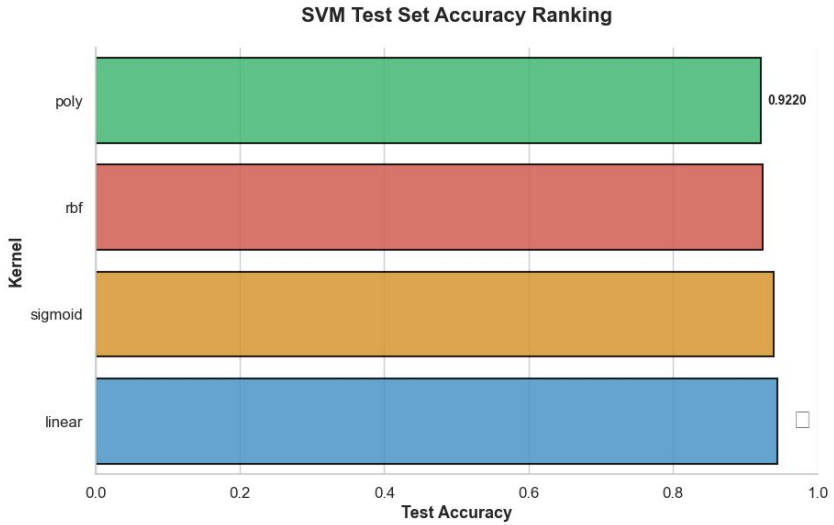
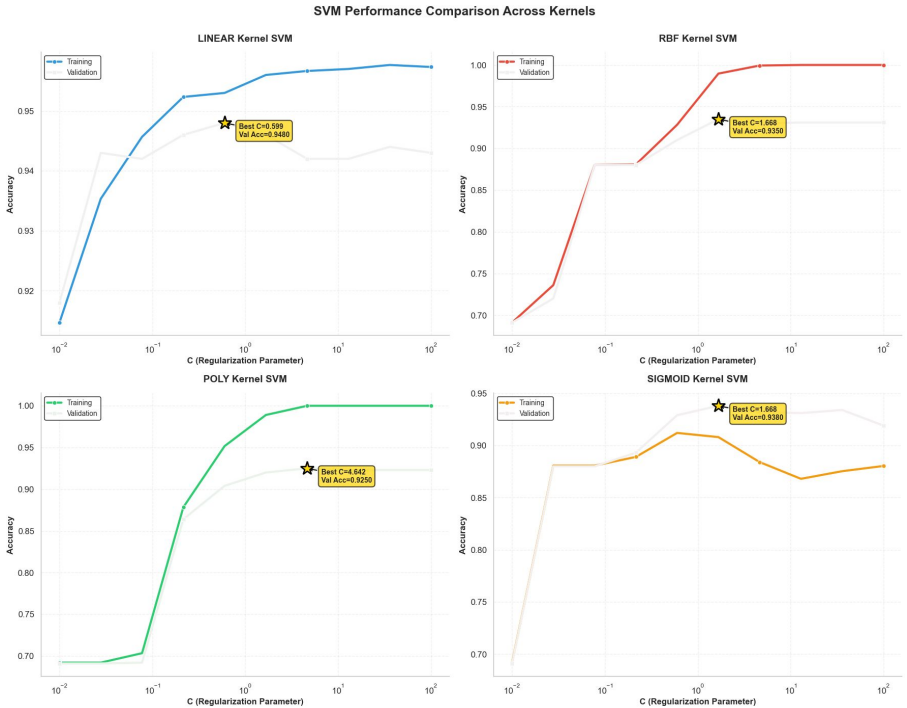
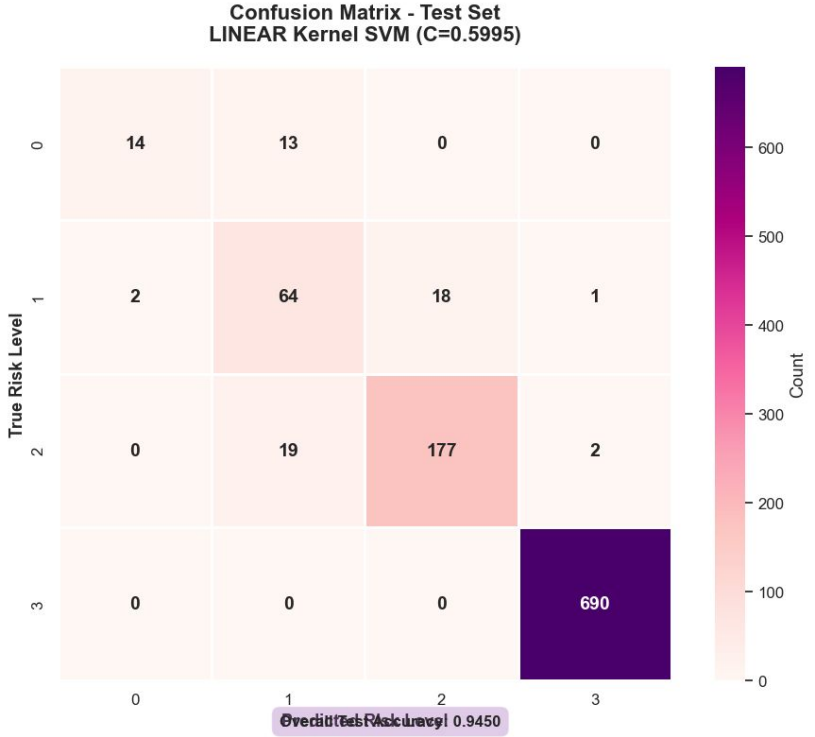


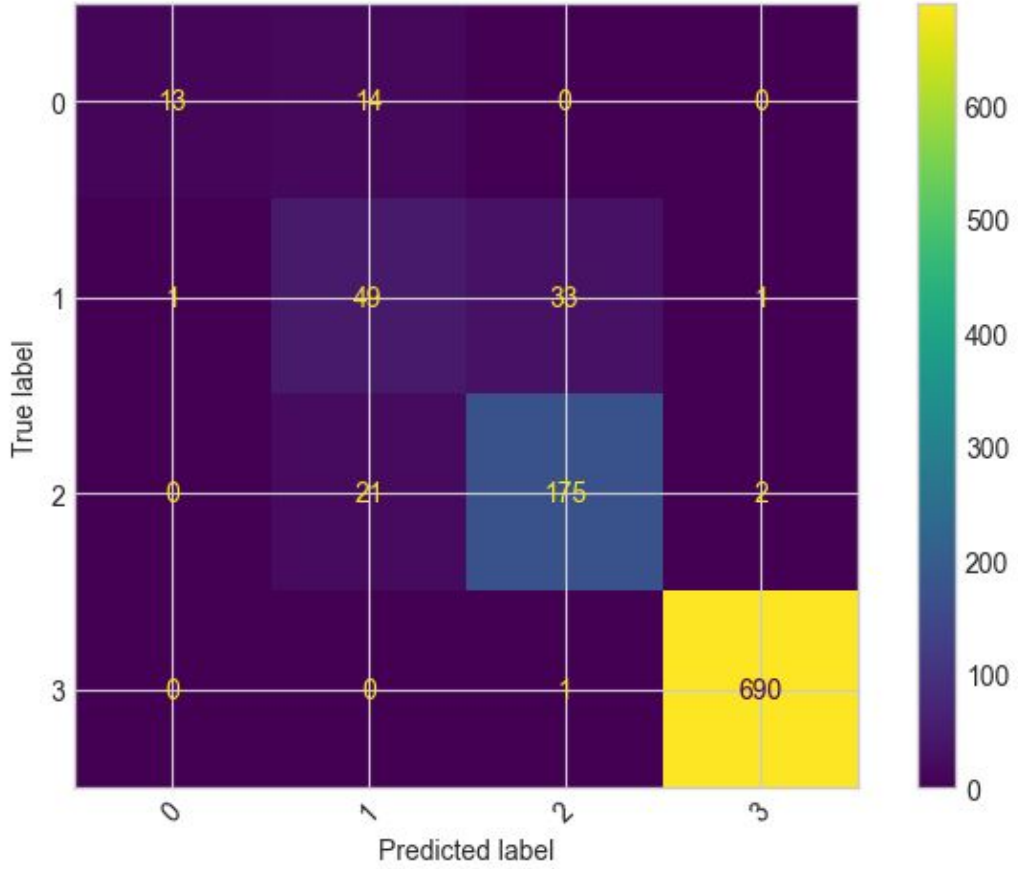


Support Vector Machines (Different Kernels)





XGBOOST

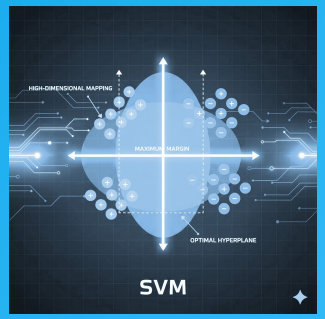


XGBoost

Real-time impatience

Best Model SVM

SVM (Linear)

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