Brewing a better shot: IoT predictive maintenance for Mastrena II espresso machines

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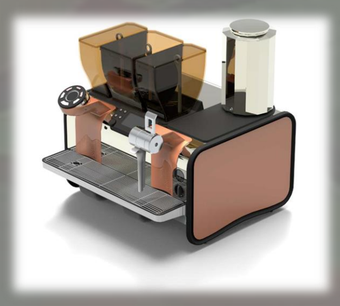
Problem overview

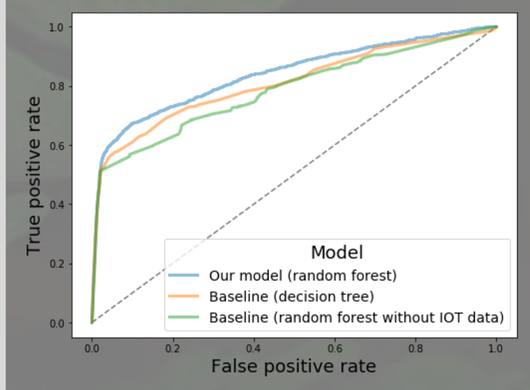
- Data from **3500 US Mastrena II** espresso machines
- Granular **telemetry data** logs every shot pulled after May 2019
- **Service logs** track all maintenance visits



Objectives

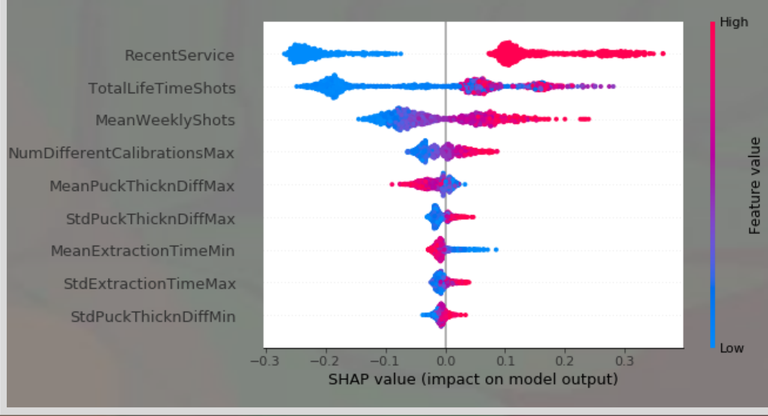
- **Reduce** unnecessary **service visits**
- **Identify** genuine **service visits** before they **become an issue**
- Gain **insights** about Mastrena II operation, informing **future projects**

Model Results



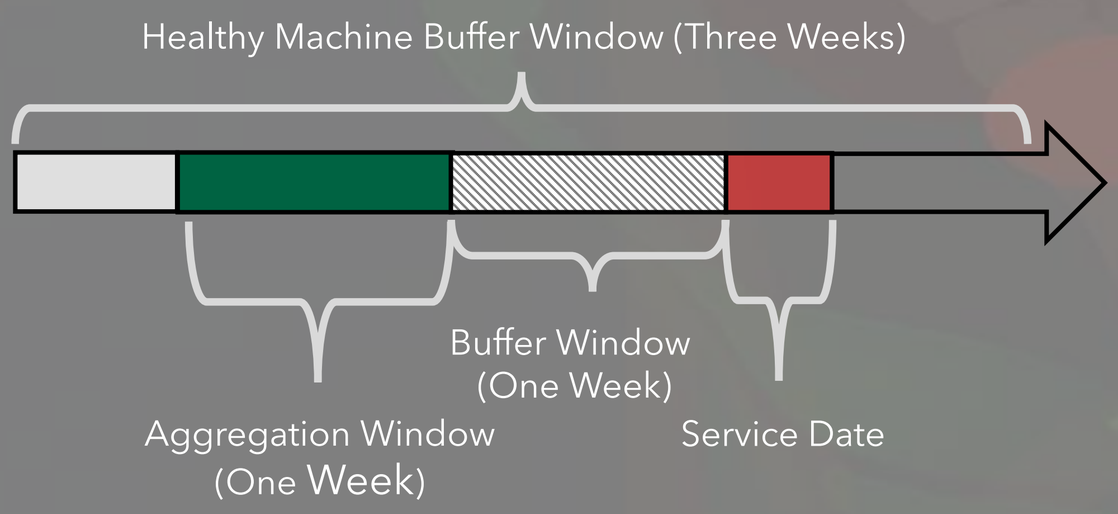
- Our model demonstrates **strong predictive performance**
  - 0.82 out-of-sample average one-versus-rest AUC exceeds target of 0.75
  - Random forest outperforms other models (e.g. decision trees)
- IOT telemetry data adds value to the prediction, with an **8% boost** in the AUC relative to a 'no IOT data' baseline

Key Insights



- **Recent services** and **machine utilization** are the strongest indicators of service requirements
- **Puck thickness** and **extraction time** are the most insightful IOT data
- **Mean** (recipe accuracy) and **variance** (consistency) statistics are most useful descriptive statistics

Feature Engineering

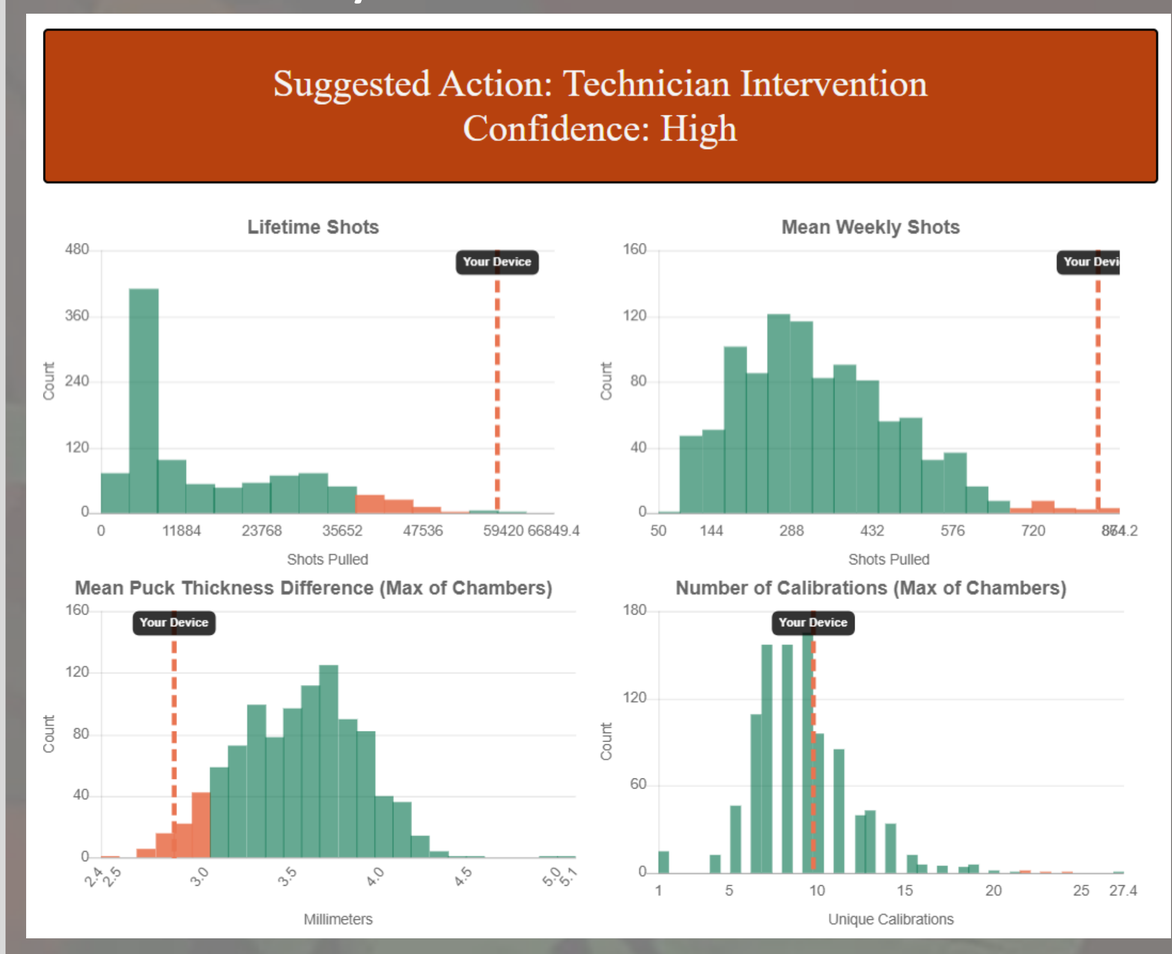


- For each service date, create **interpretable features** by computing **descriptive statistics** over a weekly window
- **Randomly sample** healthy machines based on an **optimized sampling ratio** to reduce variance

Model Design

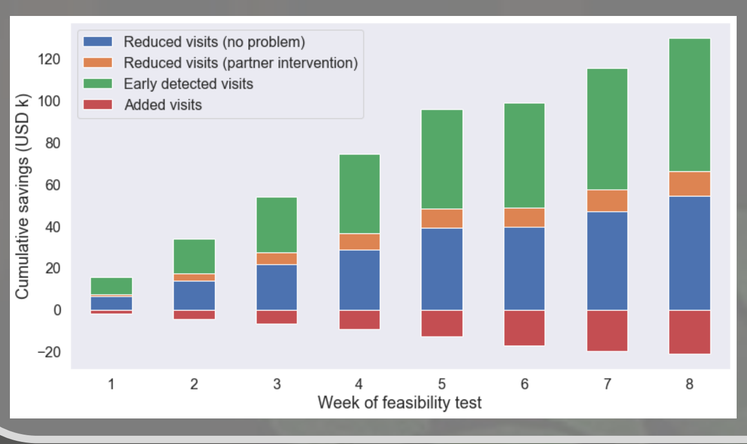
- Two-stage random forest classifier
  1. Predict **action** (faulty) or **no action** (healthy)
  2. If action, predict **technician maintenance** or **cleaning**
- Automated process to **select features**, tune **decision thresholds**, and estimate optimal **sampling probability**

Dynamic Dashboard



- Make weekly predictions (with suggested action and confidence) for **any store/device** in the US
- **Dynamically plot histograms** chosen machine against all others for the **most features important** to the prediction based on the SHAP values

Business Impact



- Feasibility testing shows tangible savings
  - **83%** reduction in 'no problem' visits
  - **45%** of required technician interventions detected early
- When scaled to US stores, we estimate **total cost savings of USD 30M+** over the lifetime of the Mastrena II machines

Special thanks to Dr. Chris Dorr and Prof. Alex Jacquillat for their mentorship throughout this project

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