rumble

Mountain bike predictive analytics from your smartphone

Spring 2019

Luke Evans
Adam Letcher
Colby Carter
Jesse Calvillo

Problem & Opportunity

$6B / year

US Bike industry value

20M / year

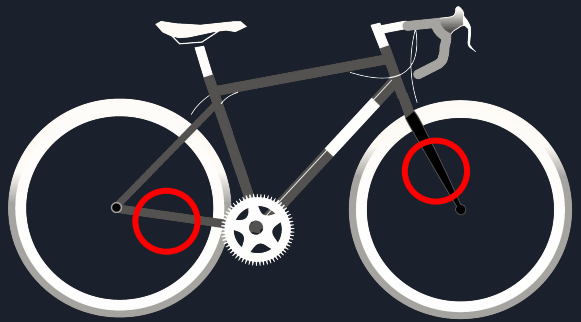
Bikes sold in the US

- Bicycle components will wear down and eventually fail
- Professional repairs are expensive and time-consuming
- Riders are enthusiastic but lack skills and information to do early maintenance

Rumble Solution

Rumble will use ***smartphone readings*** and ***machine learning*** to provide riders with predictions on health of components. Before or after a ride:

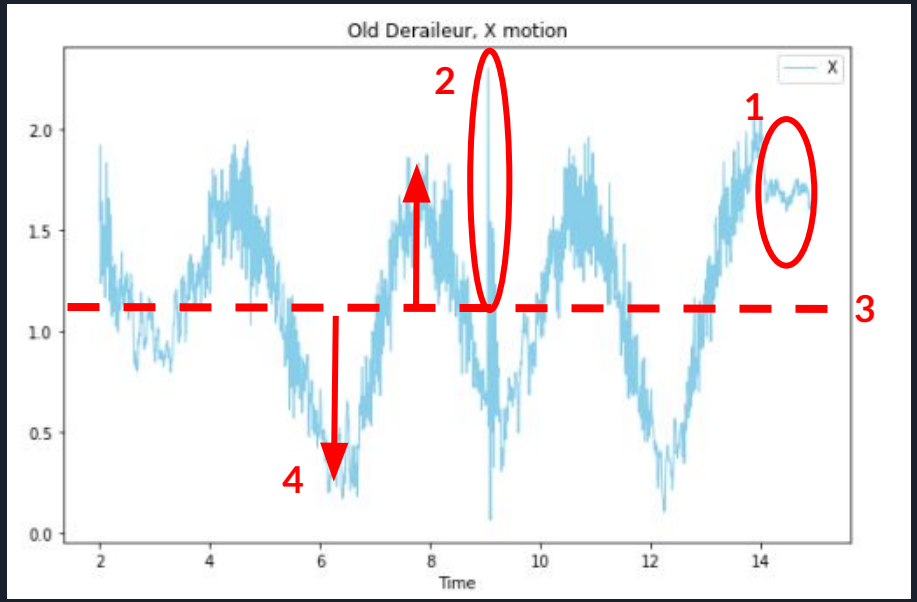
- Guides user through process
- Identifies problem areas
- Connects them to resources



Feature Engineering & Extraction

Feature Engineering & Extraction
Time Domain

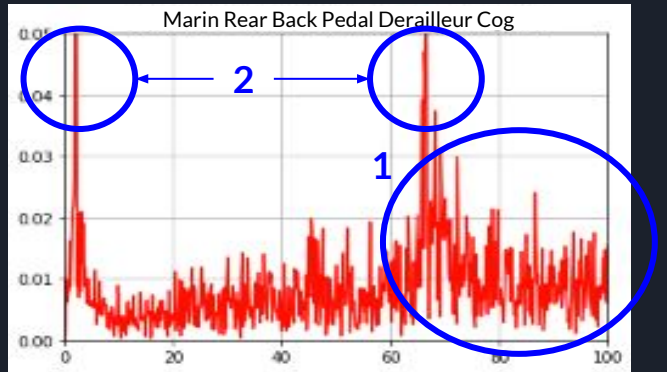
1. **Trim noise**
2. **Outliers**
3. **Average power**
4. **Variance & skew**



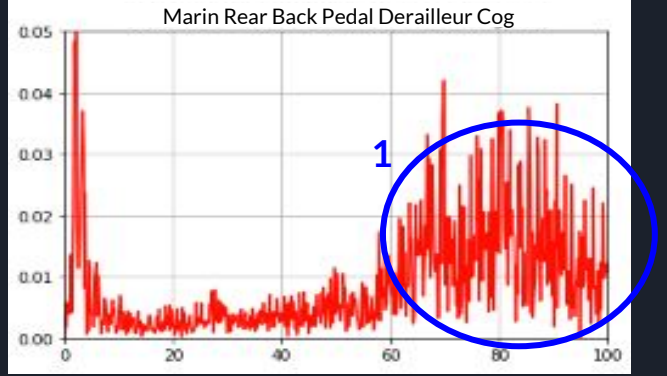
Feature Engineering & Extraction
Frequency Domain

1. **Average magnitude**
2. **Dominant frequencies**

Not Broken:

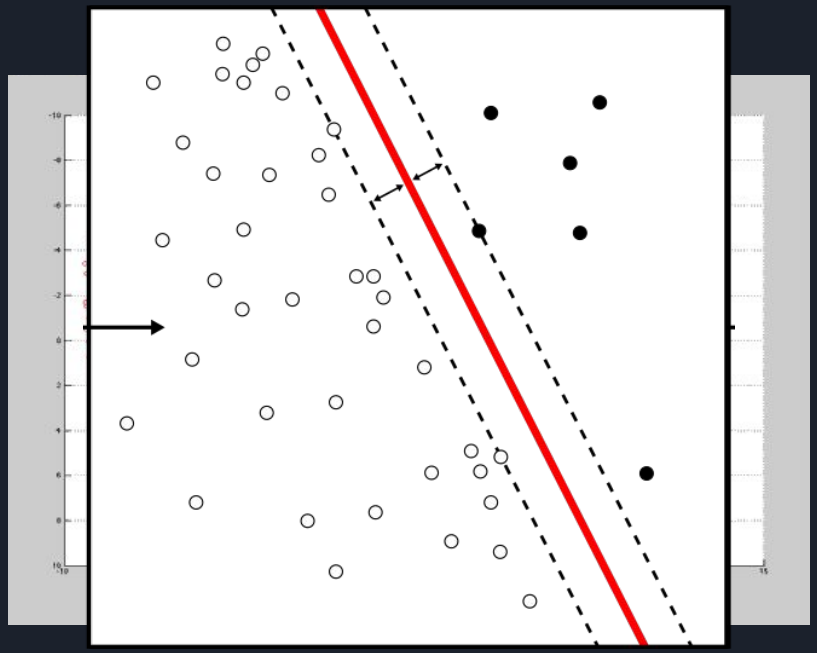


Broken:



Machine Learning Engine

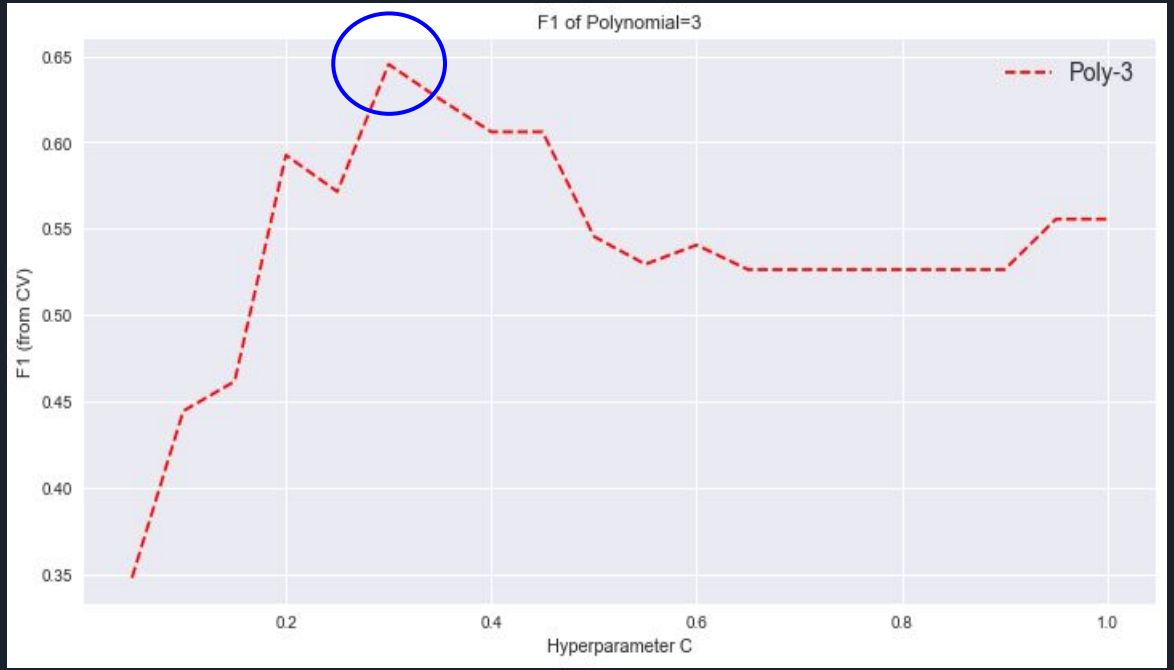
Support Vector Machines (SVM)



1. Robust to small, imbalanced datasets and numeric features
2. Model different relationships
   a. Linear
   b. Polynomial Kernel
   c. Radial Basis Function (RBF)
3. Parameter tuning *C*
4. Evaluate generalization

Model Development Process: *Derailleur Cog Example*

1. *Broken DC* (N=15) vs. rest (320)
2. Balance SVM class weights
3. Select and scale key features
4. Train each SVM variant using leave-one-out cross-validation
5. Gridsearch over C
6. Select best performer/ consider ensembling



Evaluation of Component Models

Component	N_{broken}	SVM	Precision	Recall	F1-score
Rotor	99	RBF	56.0%	84.8%	67.5%
Chain	71	RBF	68.7%	80.3%	74.0%
Wheel Bearings	64	RBF	56.8%	78.1%	65.8%
Steering Head	15	RBF	63.6%	93.3%	75.7%
Derailleur Cog	15	Ensemble (poly+RBF)	52.4%	73.3%	61.1%

Minimum Viable Product (MVP)

1. **Capture cell phone readings**
2. **Upload to website**
3. **Make model predictions**

Viability

- Does it classify?
- Does it generalize?

Utility

- Is it simple to use?
- Is it valuable to the user?

MVP Testing Results

Derailleur Test

- Rumble correctly identified a derailleur problem
- Chain was incorrectly threaded through the derailleur

Back Wheel Bearing Test

- Rumble correctly identified a back wheel problem
- Bearings were corroded (even the bike shop gave the OK)

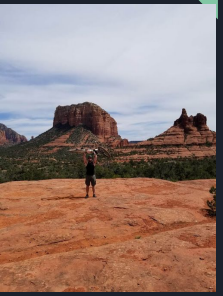
Future Development Roadmap

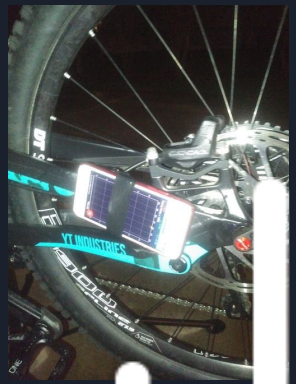
User Experience & Design

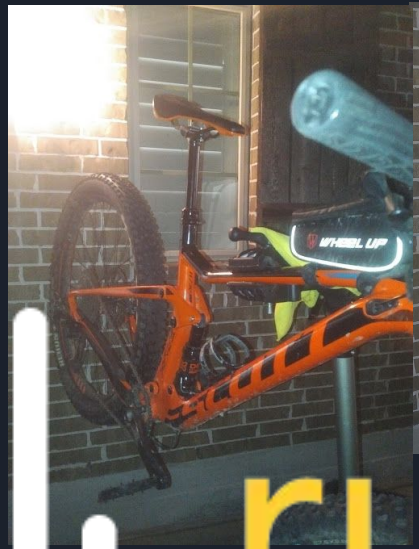
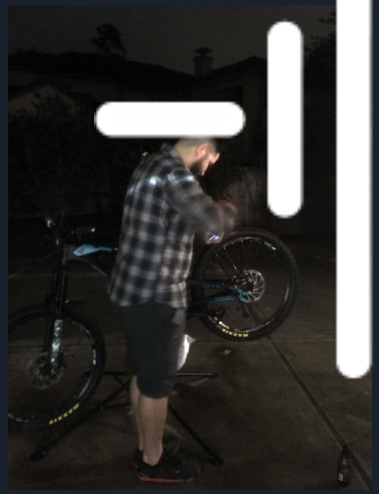
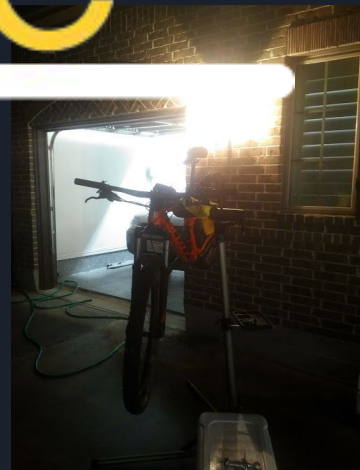
Models & Predictive Power

Community Development

Extension to Other Industries







rumble