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 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

Not Broken:

1. Average magnitude

2. Dominant frequencies

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

<table>
<thead>
<tr>
<th>Component</th>
<th>$N_{\text{broken}}$</th>
<th>SVM</th>
<th>Precision</th>
<th>Recall</th>
<th>F1-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotor</td>
<td>99</td>
<td>RBF</td>
<td>56.0%</td>
<td>84.8%</td>
<td>67.5%</td>
</tr>
<tr>
<td>Chain</td>
<td>71</td>
<td>RBF</td>
<td>68.7%</td>
<td>80.3%</td>
<td>74.0%</td>
</tr>
<tr>
<td>Wheel Bearings</td>
<td>64</td>
<td>RBF</td>
<td>56.8%</td>
<td>78.1%</td>
<td>65.8%</td>
</tr>
<tr>
<td>Steering Head</td>
<td>15</td>
<td>RBF</td>
<td>63.6%</td>
<td>93.3%</td>
<td>75.7%</td>
</tr>
<tr>
<td>Derailleur Cog</td>
<td>15</td>
<td>Ensemble (poly+RBF)</td>
<td>52.4%</td>
<td>73.3%</td>
<td>61.1%</td>
</tr>
</tbody>
</table>
Minimum Viable Product (MVP)

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