FLAPWISE BENDING MOMENT PREDICTION OF WIND TURBINE USING MACHINE LEARNING

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Abstract

With the increase in wind turbine size, the reliability of a turbine becomes crucial for its overall operation. Structural health monitoring (SHM), which diagnoses the current state of the parts and assembly of a structure, ensures turbine availability by reducing downtimes. However, SHM requires a large number of signals to determine the conditions of a turbine. In addition, frequent breakdown of sensors is observed during turbine operations, while communication errors and missing data are also common during data acquisition. To overcome these issues, load prediction on wind turbines is required. This poster presents a discussion of various machine learning methods to predict loads on wind turbines.

Wind Turbine Mechanical Loads

The predicted value in this research is mean of flapwise bending moment which is a crucial load for wind turbines. The following channels are measured in a wind turbine field experiment.
- Rotor speed
- Power
- Flapwise bending moment of blade 1
- Edgewise bending moment of blade 1
- Shaft tilt bending moment
- Shaft yaw bending moment
- Tower normal bending moment
- Tower lateral bending moment
- Wind speed

7620 cells are used in this research. All the cells are classified as 'normal power production' state. 6532 cells are applied for training and validation. The rest 1088 cells are used to test the regression methods.

The analysis is implemented by Intel(R) core(TM) i5-4570 CPU @3.20GHz computer.

Flapwise Bending Moment Prediction

In order to predict the mean of flapwise bending moment, four types of machine learning algorithm are tested. To compare with machine learning, polynomial curve fitting is investigated as a traditional way.

1. Polynomial curve fitting

Conclusions

Polynomial curve fitting and four machine learning methods are tested. Neural network has the lowest prediction errors, but the analysis takes around 15 times longer than regularized linear model. Decision tree is less accurate than neural network, but it performs the second fastest analysis.

If a user only needs better accuracy, neural network is the best method. However, if the estimation time is also important, decision tree can be the better option. All four types of machine learning have lower prediction errors than the polynomial curve fitting.

<table>
<thead>
<tr>
<th>methods</th>
<th>Prediction error (%)</th>
<th>Duration (seconds)</th>
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<tbody>
<tr>
<td>Polynomial curve fitting</td>
<td>5.30</td>
<td>0.46</td>
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<tr>
<td>Decision tree</td>
<td>2.02</td>
<td>0.26</td>
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<tr>
<td>Gaussian process regression</td>
<td>1.33</td>
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<tr>
<td>Regularized linear model</td>
<td>2.24</td>
<td>1.28</td>
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<tr>
<td>Neural network</td>
<td>1.23</td>
<td>5.07</td>
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</tbody>
</table>

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