Modeling Wind Turbine Performance with windnrg

Andrew Clifton
National Renewable Energy Laboratory

Second Author
Plus Affiliation

Abstract

The **windnrg** package includes a variety of functions that are designed to analyze and display wind turbine power performance data. The package also includes methods to model the turbine performance as a function of inflow conditions, including industry-standard approaches, proposed new standard methods, and research tools. Utility functions are also included to quantify and thus compare the accuracy of the different methods. This package accompanies results that were previously published in Clifton, Kilcher, Lundquist, and Fleming (2013b) and Clifton, Daniels, and Lehning (2013a).

At the time of writing, **windnrg** is only available upon request to the author and is supplied without warranty.

Keywords: power curves, wind turbine modeling, machine learning, R.

1. Introduction

This vignette describes how the **windnrg** package can be used to analyze wind turbine performance data and create different turbine performance models.

2. Obtaining and installing the package

The **windnrg** package is currently a developer test version. It is not available through the repositories at CRAN. To request a copy of the code, please contact andrew.clifton@nrel.gov.

Install **windnrg** and load the package like any other package. To do this in an R client, set the working directory, detach any existing copies of the package, and load the new one:

```
setwd(".")
library("windnrg")

## Error:  there is no package called 'windnrg'
```

windnrg requires the **randomForest** and **ggplot2** packages.

```
## Loading required package:  ggplot2
## Loading required package:  randomForest
## randomForest 4.6-7
## Type rfNews() to see new features/changes/bug fixes.
```

3. Turbine performance data set

This vignette uses the `WindPACT1500kW` data set included in the **windnrg** package. The `WindPACT1500kW` data set is a combination of inflow wind and turbine power data from simulations of the Wind Partnership for Advanced Component Technologies 1.5 MW wind turbine. The turbine is described in Poore and Lettenmaier (2003); Malcolm and Hansen (2006). The inflow was simulated using the stochastic wind field modeling tool, Turbsim, to create realistic wind fields for a neutral atmosphere that were then used to force a simulated turbine in the aero-elastic simulator FAST. Data from the inflow simulations and the turbine simulations were post processed using MATLAB to extract 1,524 observations of inflow and turbine response. The process is described in more detail in Clifton *et al.* (2013b) and Clifton *et al.* (2013a).

The following variables are included in the `WindPACT1500kW` data set:

`ws.HH` hub-height wind speed (m/s)

`Ti.HH` Turbulence intensity at hub height (%)

`Shear` The exponent of the power law fit to the velocity profile

`ws.eq` A rotor-equivalent wind speed (m/s)

`RSS` A metric describing the difference between the meaasured velocity profile and an ideal power-law profile

`power.mean` The mean power under these conditions (kW)

`power.std` The standard deviation of power under these conditions (kW)

4. Preparing the data

4.1. Loading the data

The `WindPACT1500kW` data are loaded using the `data()` function:

```
data(windnrg::WindPACT1500kW)

## Warning:  data set 'windnrg::WindPACT1500kW' not found

data.in <- WindPACT1500kW

## Error:  object 'WindPACT1500kW' not found
```

We now have all of the variables listed above in a data frame, `data.in`. To see what's in there, we'll look at the first 3 rows of the data frame:

```
data.in[1:3,]

## Error:  object 'data.in' not found
```

References

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Affiliation:

Andrew Clifton
Turbine Modeling and Wind Resource Group
National Wind Technology Center
National Renewable Energy Laboratory
Golden, Colorado, United States of America
E-mail: andrew.clifton@nrel.gov
URL: http://http://www.nrel.gov/wind/