Short-term wind forecasting

Francesca Tagliaferri, Ignazio Maria Viola
School of Engineering, The University of Edinburgh, Edinburgh EH9 3JL, UK;
f.tagliaferri@ed.ac.uk

INSTITUTE FOR ENERGY SYSTEMS

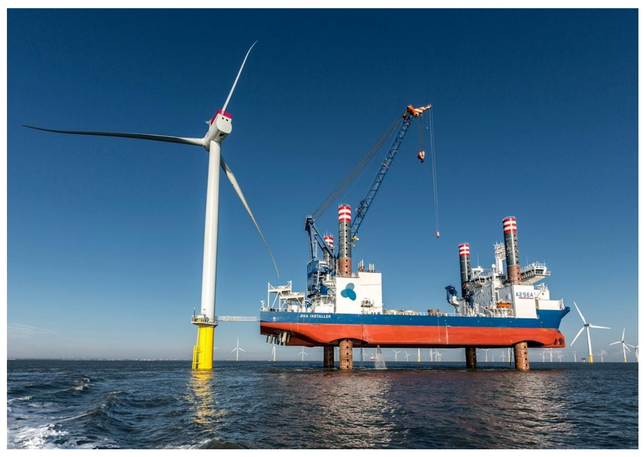
Motivation

Why do we need accurate and reliable forecasts?

- **PREDICTABILITY –** accurate forecasts together with understanding of resource–device interaction, to predicted design performance.
- **SURVAIVABILITY –** can benefit from advances in forecasting extreme events
- **CONTROL** - operate and maintain devices for the necessary service periods determined by weather access.

Issues to take into account:
Different techniques are available for different time scales
We might want to forecast just some events
A long database of weather data might not be available for the location of interest

THIS went well…but it can be dangerous if we don't know how the wind is going to behave during installation!



Method

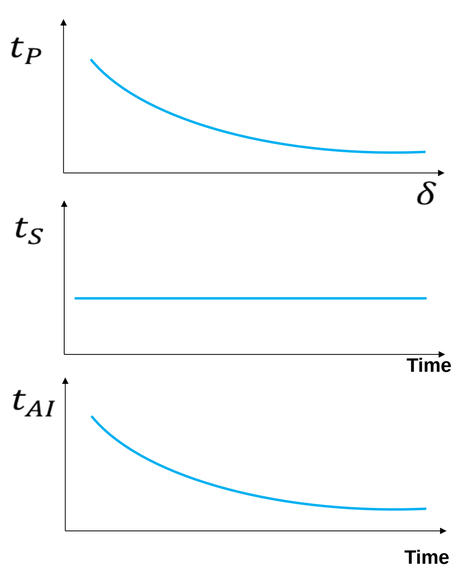
Artificial Neural Networks (ANN) – computational models inspired by the human brain. Able to adapt their structure to the data.

Combination of different forecasts:

1) **Numerical weather prediction software** – good for weather systems at global scale.
2) **Statistical forecasts** – using techniques such as regression and Markov chains, good when big sets of consistent data are available.
3) **Artifical Intelligence** – like ANN, able to recognise patterns in noisy signals.

How trustworthy are the different forecasts?

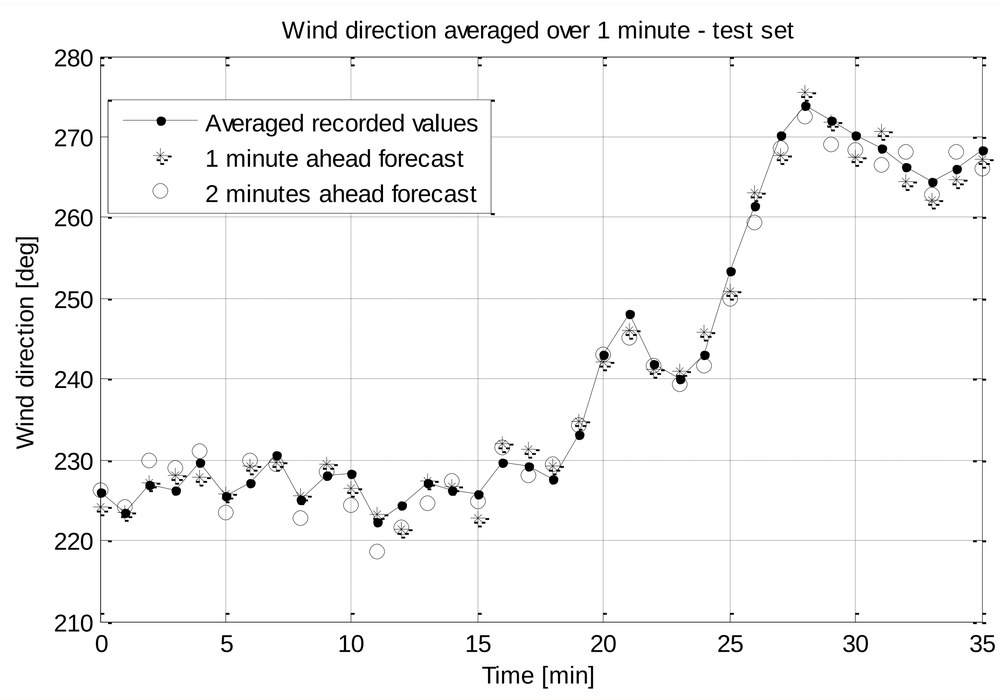
1. **Physical forecasts**
2. **Statistical forecasts**
3. **A.I. forecasts**



Forecasts of different kind can be combined according to their reliability, assessed in real time, and updated with new collected data.

Results

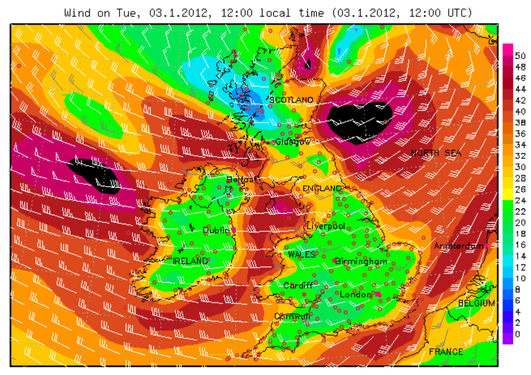
As an example, we show a forecast for wind direction made using an ANN. The model takes as input the wind direction recorded for the past 6 minutes, processed with a moving average over 5 minutes, and gives as output the average wind direction for the next first and second minutes.
The results of the forecast are extremely reliable: the average error is 1.7 degrees for a 1-minute ahead forecast and 2.1 degrees for a 2-minutes ahead forecast.



Conclusions

Reliable wind forecasts are needed for safe and effective exploitation of wind energy.

Reliable forecasts can improve predictability, survivability and the control of offshore wind turbines.



Artificial Neural Networks allow real time wind forecasting, with a reliability that decreases with time.
We tested ANN models for short term wind speed and direction forecasting with the following uncertainty:

Minutes ahead [min]	1	2	10	20	30	40	50	60
Uncertainty [%]	1	1.5	5	7	11	15	18	21

Wind forecasts obtained using different techniques can be combined according to their reliability in order to obtain an improved forecast.

References

Tagliaferri F. Viola I. M. Feedforward neural networks for very short term wind speed forecasting, Marine & Offshore Renewable Energy

Tagliaferri F. Viola I. M., Dow R. J. ANN wind forecasts for safety at sea and yacht racing tactics NAV2012 International Conference on Ships and Shipping Research

Tagliaferri F., Viola I.M., Flay R.G.J. Wind direction forecasting with Artificial Neural Networks, submitted to Ocean Engineering