Software development for hard algorithmic problems

Section 3: NNs for Wind Speed Prediction

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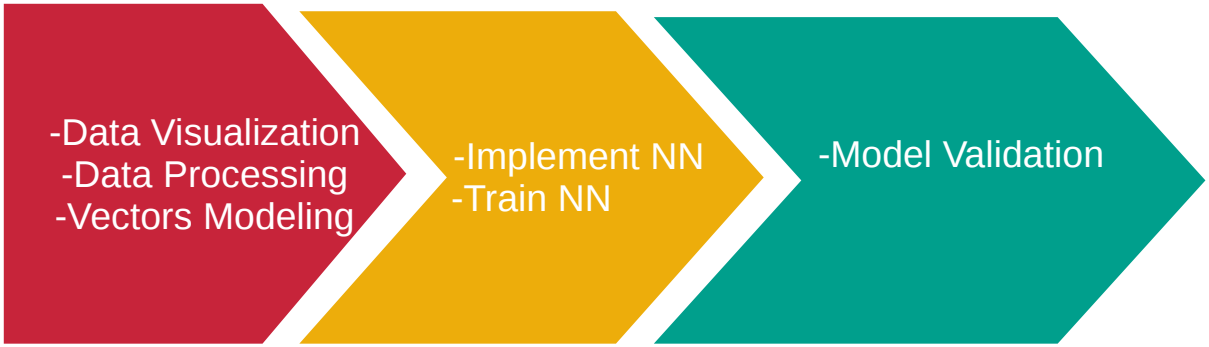
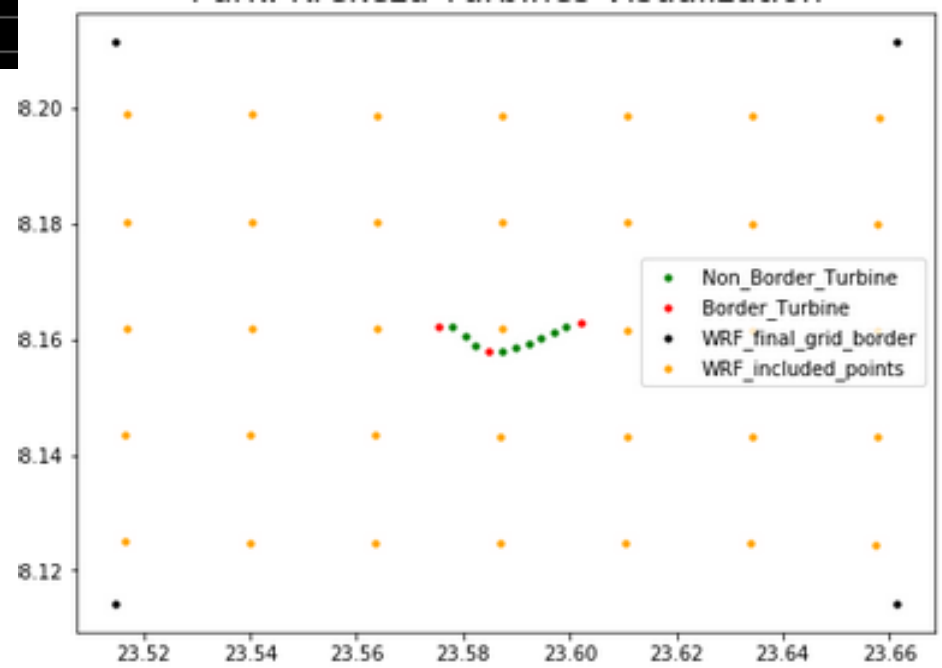
Problem



- Aim: hourly wind speed prediction (m/sec), for all turbines of specific wind farm.
- Regression problem.
- Input: WRF numerical predictions.
- NN architectures using spatial and temporal info.

Weather Research Forecasting



- A NWP (Numerical Weather Prediction) method.
- Offers meteorological variables, e.g. wind speed / direction, density, temperature, ...
- … at every point of orthogonal grid.

Data Processing / Modeling

- For given park, WRF grid available per hour.
- Each point holds 22 WRF features.
- Grids of 6x6 or 6x7 points (height x width)
- Pack consecutive grids: input is time-series of grids.
- Time-window: 6 (12) hourly frames.
- Aim: capture both spatial and time-related info.

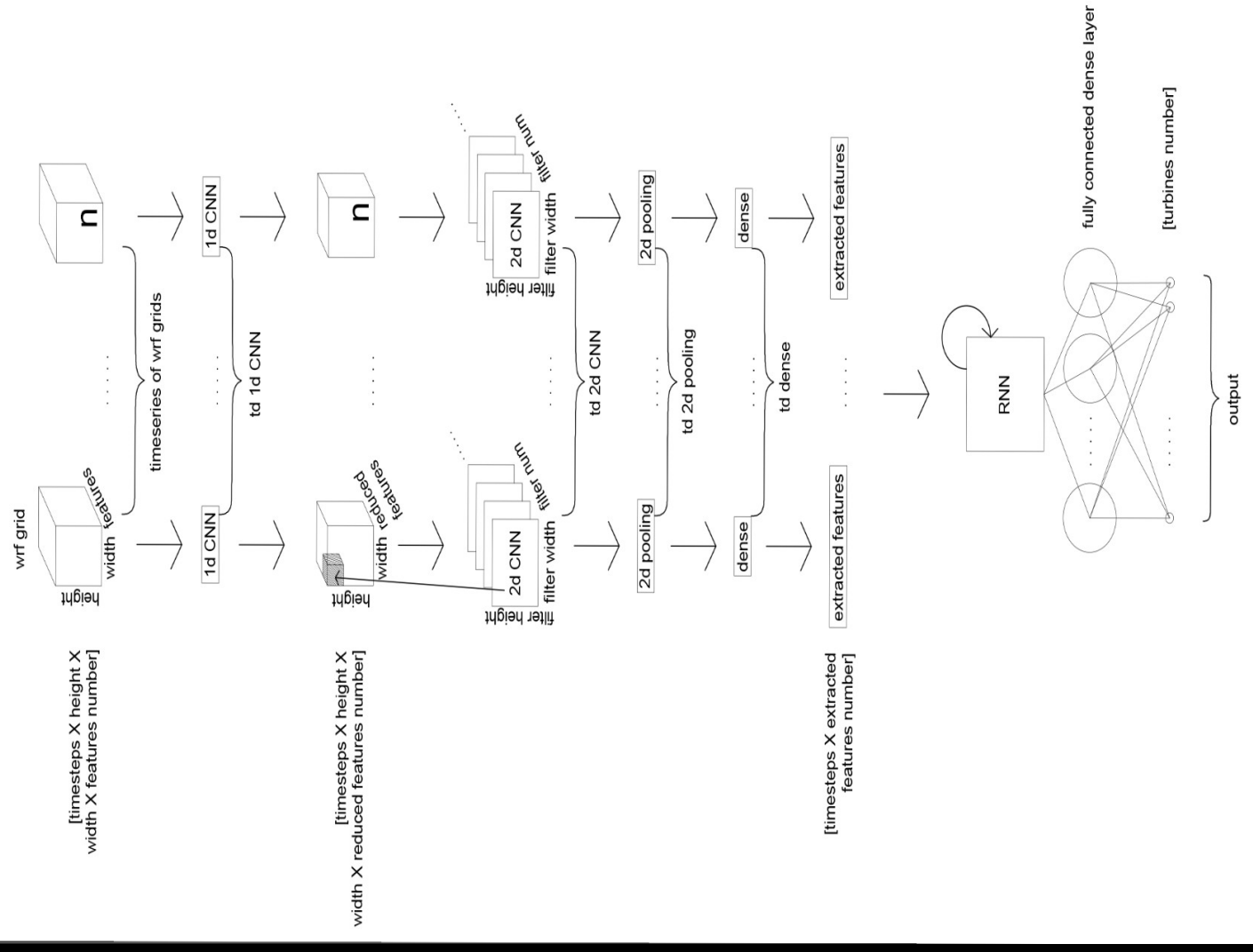
Neural Net Basic Info

- 4d Input: series of 6 (or 12) packed grids, each packed grid = height x width x #features.
- Target: actual wind vector, dim = #park-turbines, of last time-step of time-frame.
- Wish to improve WRF predictions of last step.

Model Architecture

- Convolutional (CNN) layer applies filters-kernels per grid capturing spatial patterns.
  Max pooling reduces grid to 3x3.
- Time distributed (td) dense layer applies a FC layer in each of 6 (or 12) temporal slices.
- Recurrent (RNN) layer processes series steps independently with “memory”, capturing time dependence between steps.

Model


wrf grid
height
width
features
timeseries of wrf grids
[timesteps X height X width X features number]
1d CNN
td 1d CNN
[timesteps X height X width X reduced features number]
reduced features
2d CNN
filter height
filter width
filter num
td 2d CNN
2d pooling
td 2d pooling
dense
td dense
extracted features
[timesteps X extracted features number]
RNN
fully connected dense layer
[turbines number]
output

Assignment

- Black box (N1) is deep network up to RNN and FC of 128 nodes.
- Last layers (N2) define shallow network with 64-node FC, output #turbines.
- Output of N1 = Input to N2: given.
  Output of N2 to be used for statistical evaluation.
  Output of 64-FC represents 6-hr wind (d=64).