Final Competition

GROUP-C

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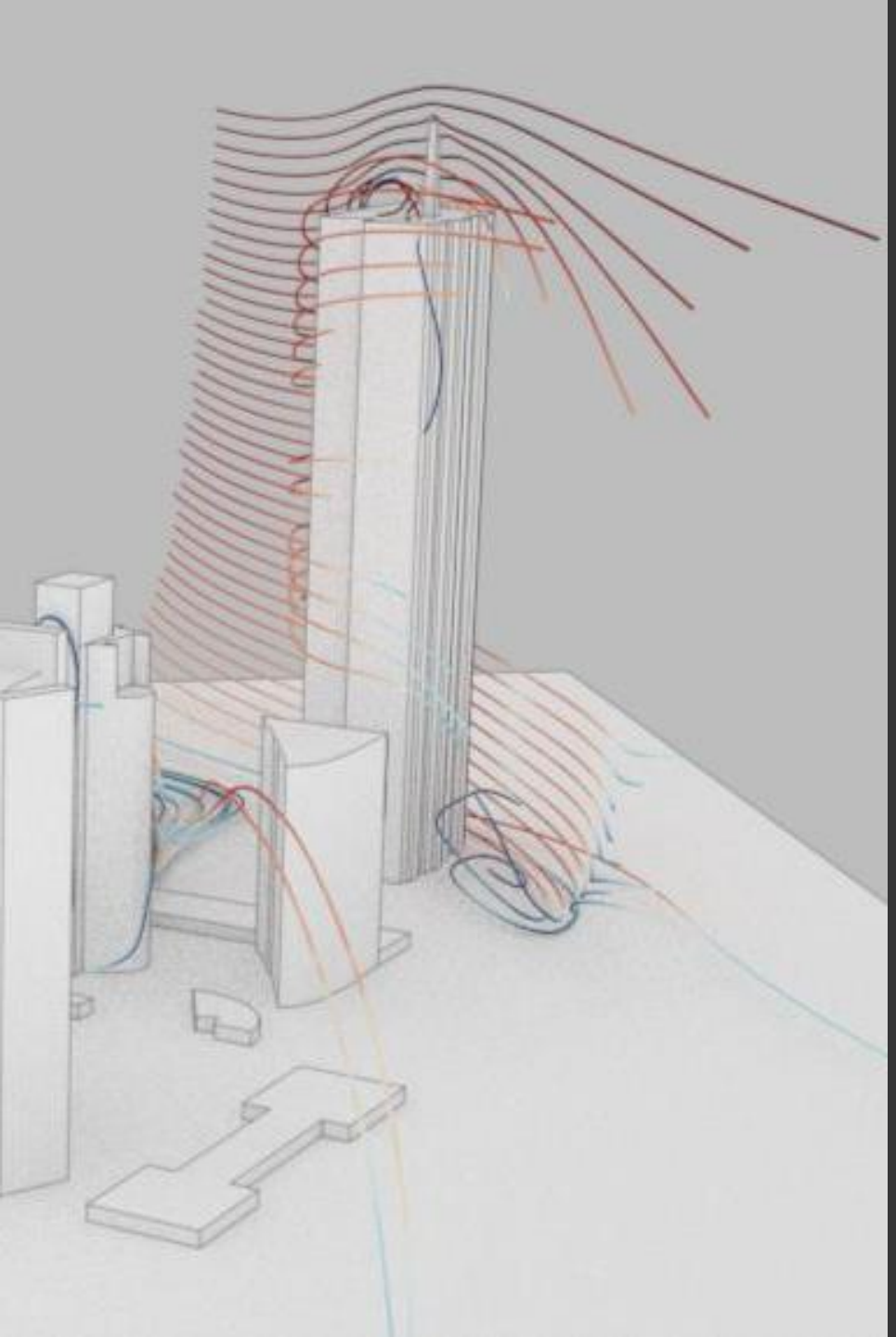
Data Engineering SS2021 - 13.07.2021



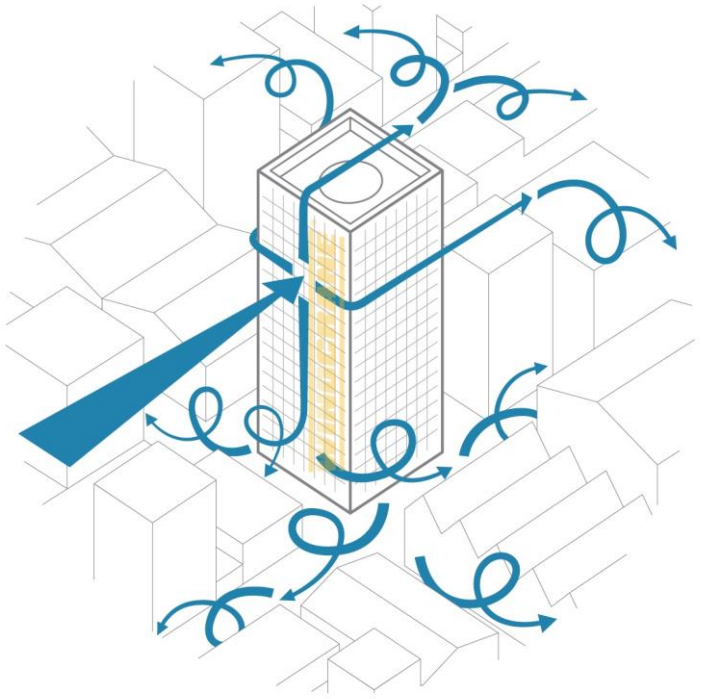
Objective

To predict:

Wind speed

Wind direction

Determination Lateral Loads

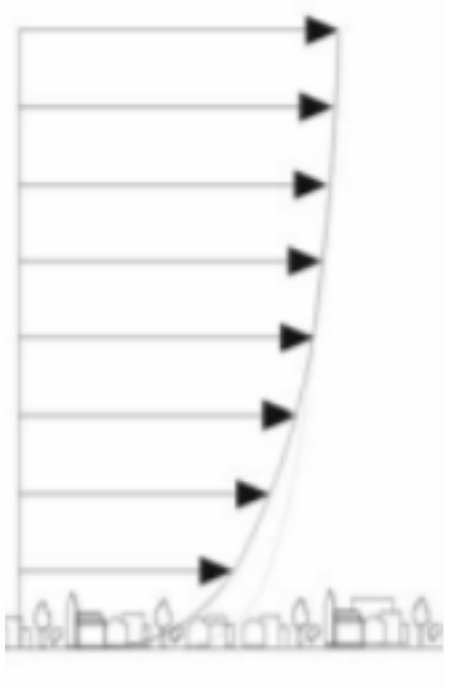


- Wind speeds at heights 2m, 5m, 10m, 50m, 80m

Approximating wind distribution function with the help of the data points

Calculating the dynamic pressure and the resistance force

Determination Lateral Loads



$$q = \frac{1}{2}\rho v^2$$

$$F_w = \int c_w \, q \, dA$$

- wind speed depends on height- Lateral loads on building

- q: dynamic pressure [N/m^2]
- ρ: density of air [kg/m^3]
- v: wind speed [m/s]

- F_w: resistance Force [N]
- c_w: resistance Coefficient [-]

Data mining

Data set 1:

nc –structure? data?

```
..@ data    :Formal class '.SingleLayerData' [package "raster"] with 13 slots
.. .. ..@ values    : logi(0)
.. .. ..@ offset    : num 0
.. .. ..@ gain      : num 1
.. .. ..@ inmemory  : logi FALSE
.. .. ..@ fromdisk  : logi TRUE
.. .. ..@ isfactor  : logi FALSE
.. .. ..@ attributes: list()
.. .. ..@ haveminmax: logi FALSE
.. .. ..@ min       : num Inf
.. .. ..@ max       : num -Inf
.. .. ..@ band      : int 1
.. .. ..@ unit      : chr "m/s"
.. .. ..@ names     : chr "mean.wind.speed.at.10.m.height"
..@ legend  :Formal class '.RasterLegend' [package "raster"] with 5 slots
.. .. ..@ type      : chr(0)
.. .. ..@ values    : logi(0)
.. .. ..@ color     : logi(0)
.. .. ..@ names     : logi(0)
.. .. ..@ colortable: logi(0)
..@ title   : chr(0)
..@ extent  :Formal class 'Extent' [package "raster"] with 4 slots
.. .. ..@ xmin: num 0.5
.. .. ..@ xmax: num 720
.. .. ..@ ymin: num 0.5
.. .. ..@ ymax: num 938
..@ rotated : logi FALSE
..@ rotation:Formal class '.Rotation' [package "raster"] with 2 slots
.. .. ..@ geotrans: num(0)
.. .. ..@ transfun:function ()
```

```
dimensions:
  x = 720;
  y = 938;
  time = UNLIMITED;   // (31 currently)
  bnds = 2;
variables:
  double lon(y=938, x=720);
    :standard_name = "longitude";
    :long_name = "longitude coordinate";
    :units = "degrees_east";
    :_CoordinateAxisType = "Lon";

  double lat(y=938, x=720);
    :standard_name = "latitude";
    :long_name = "latitude coordinate";
    :units = "degrees_north";
    :_CoordinateAxisType = "Lat";

  double time(time=31);
    :standard_name = "time";
    :long_name = "time";
    :bounds = "time_bnds";
    :units = "hours since 2010-1-1 00:00:00";
    :calendar = "proleptic_gregorian";
    :axis = "T";

  double time_bnds(time=31, bnds=2);

  double datum(time=31);
    :long_name = "Date and time in UTC";
    :units = "YYYYMMDDHH";
    :_FillValue = 9999.0; // double
    :missing_value = 9999.0; // double

  short FF(time=31, y=938, x=720);
    :standard_name = "wind_speed";
    :long_name = "mean wind speed at 10 m height";
    :units = "m/s";
    :coordinates = "lat lon";
    :add_offset = 0.0f; // float
```

FF_201001_daymean.nc	FF daily gridded dataset	Local File
datum	Date and time in UTC	1D
FF	mean wind speed at 10 m height	Geo2D
lat	latitude coordinate	Geo2D
lon	longitude coordinate	Geo2D
time	time	1D
time_bnds	time bnds	2D

Data mining

Data set 1:

Years : 1995 – 2012

Location : Entire Germany 1km X 1km

Hourly data

1 Month data = 2.8 GB

2.8 GB X 12 months X 18 years X 10 features = 6,048 GB

Data points = 18 years x 12months x 30 days x 24 hours x 720 km x 938 km = **100,000,000,000**

Data mining

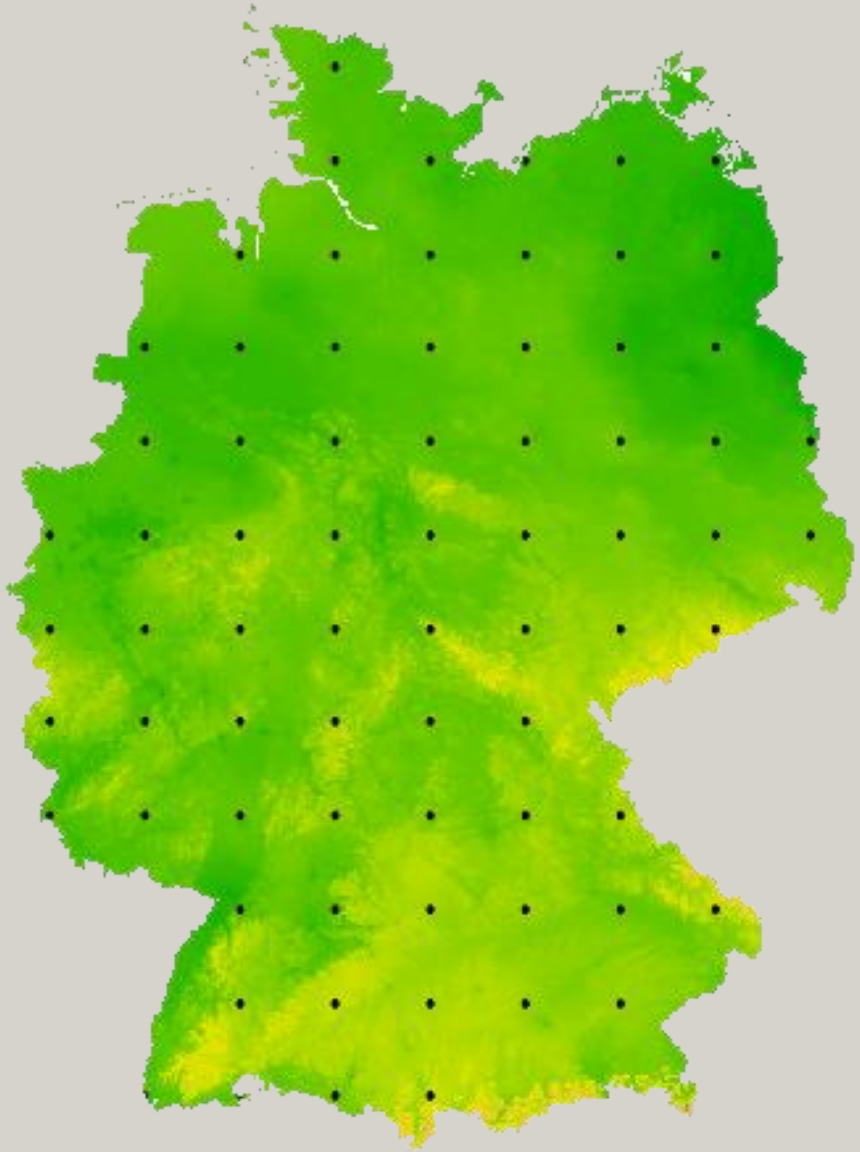
Data set 1:

Years : 2010 - 2012

Grid size : 20km X 20km

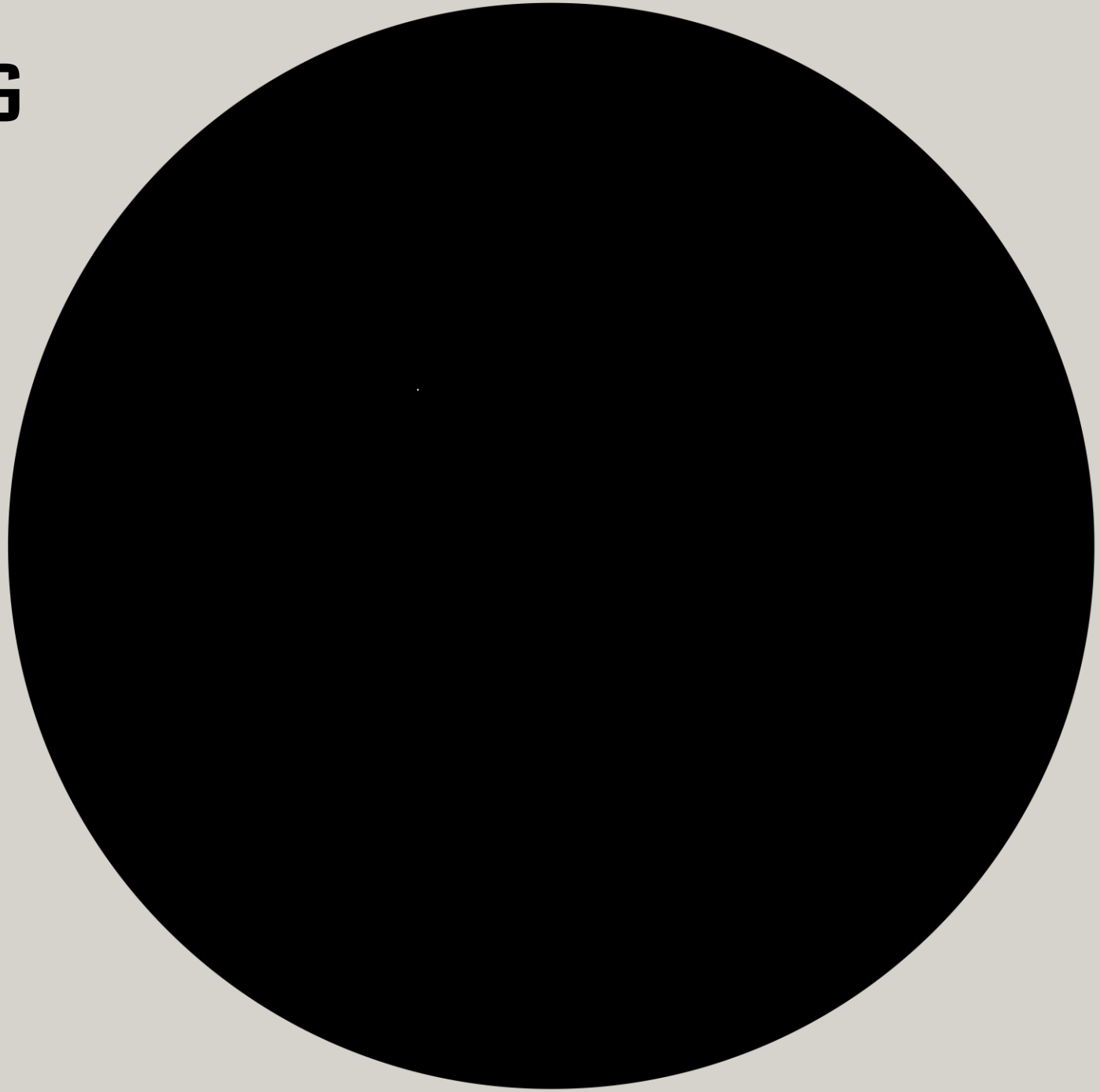
Time interval : 5 days

Data points : **364,695**



Data mining

Data set 1:

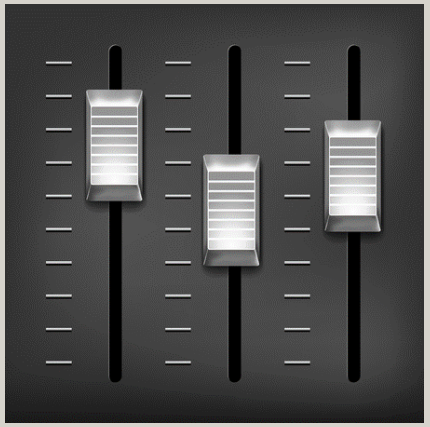


Data points : 365 k

Data points : 100 b

Data mining

Data set 1:



Time interval

Grid size

Data mining

Data set 1:

Location X , Y

Time

Air temperature

Cloud cover

Dew point

Humidity

Pressure

Radiation Direct

Radiation Downwelling

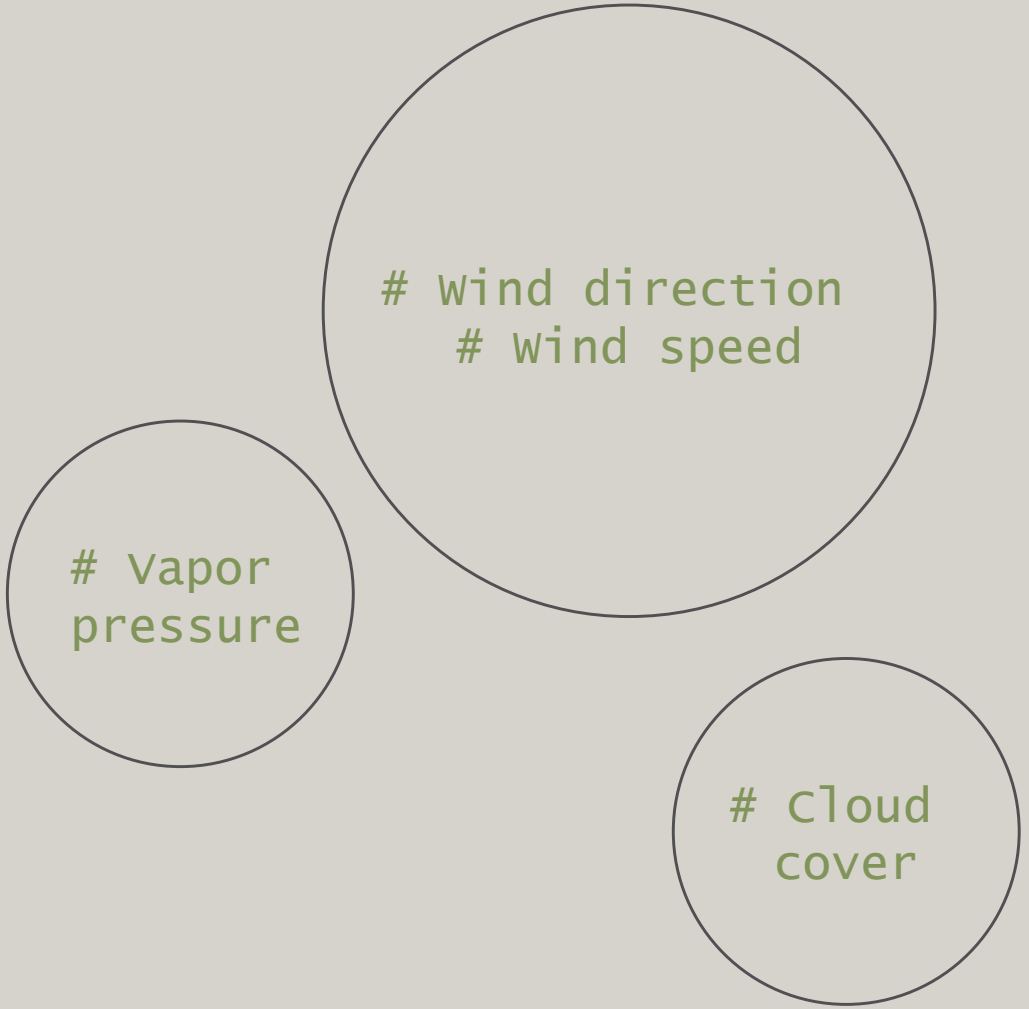
Radiation Global

Radiation Upwelling

Vapor pressure

Wind direction

Wind speed



Data mining

Data set 1:

Location X , Y

Time

Air temperature

Dew point

Humidity

Pressure

Radiation Direct

Radiation Downwelling

Radiation Global

Radiation Upwelling

Wind direction

Wind speed

Data mining

Data set 1:

Location X , Y

Time

Air temperature

Dew point

Humidity

Pressure

Radiation Direct

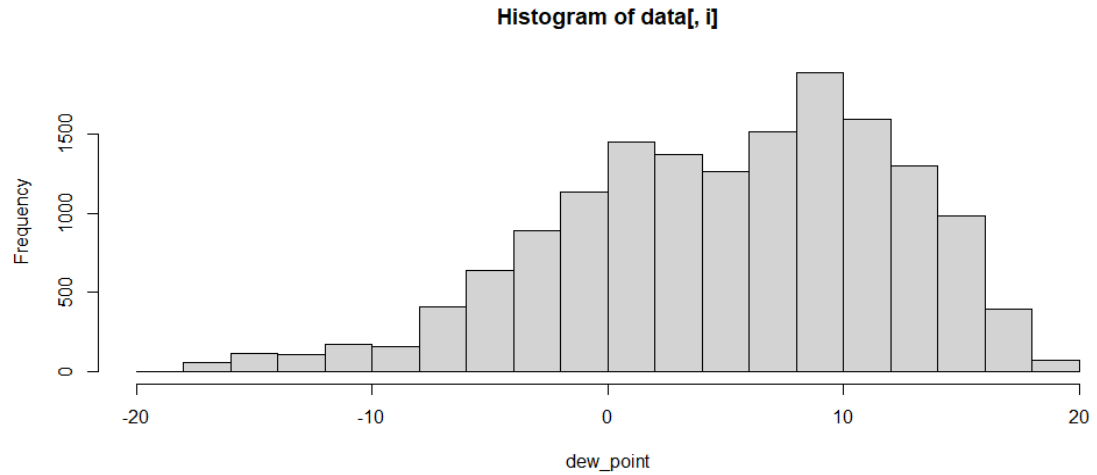
Radiation Downwelling

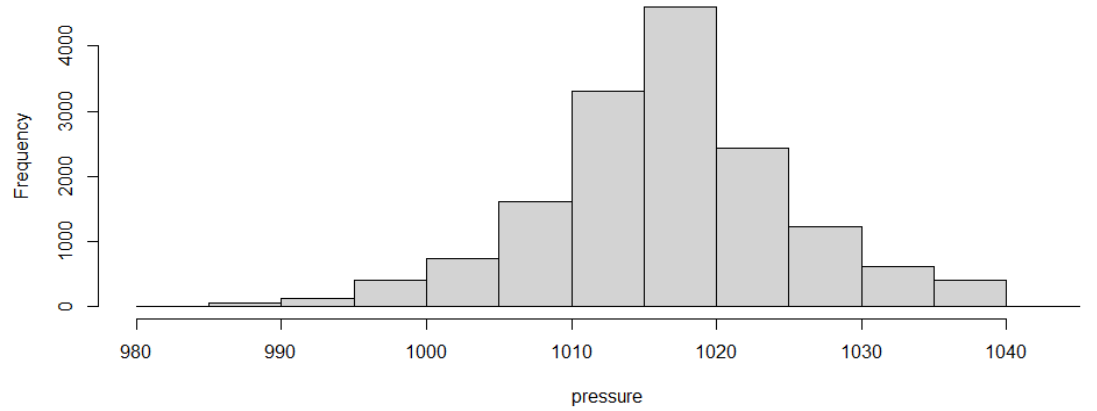
Radiation Global

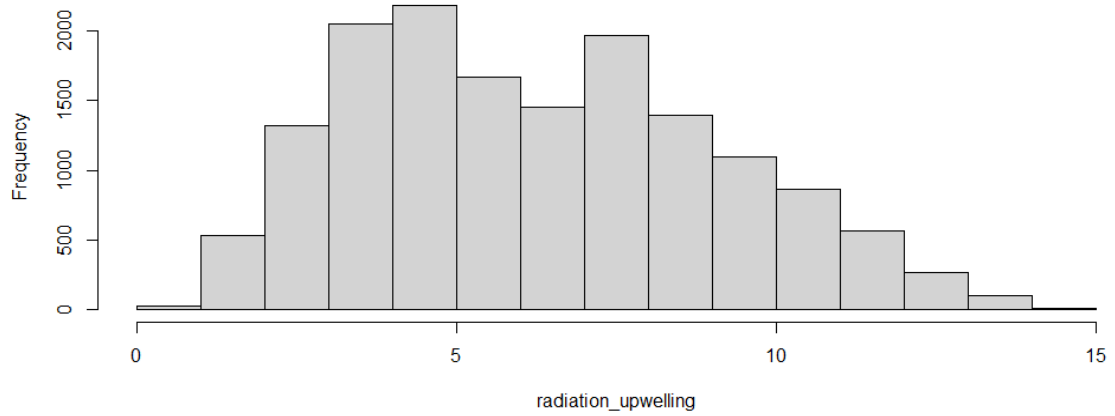
Radiation Upwelling

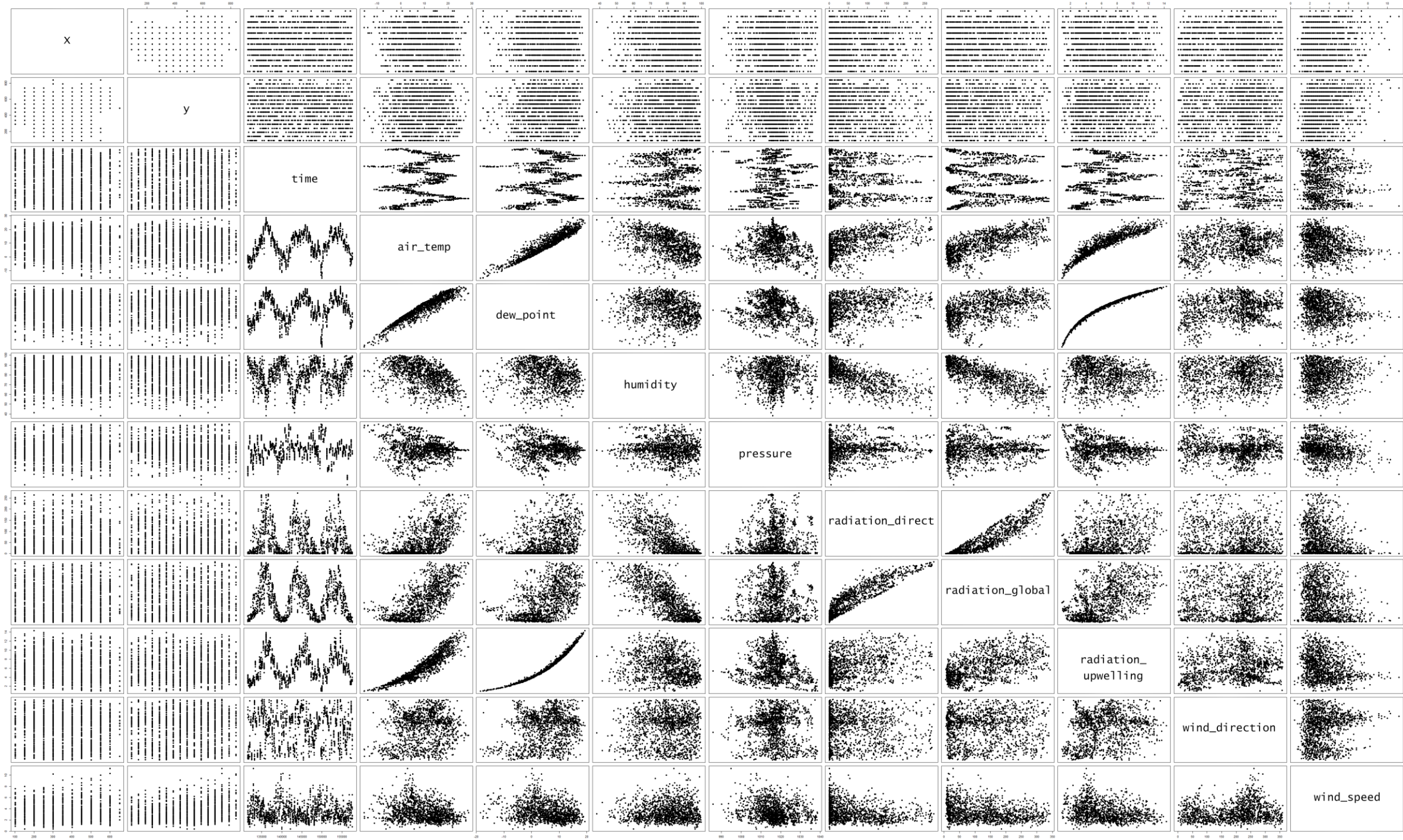
Wind direction

Wind speed








x
y
time
air_temp
dew_point
humidity
pressure
radiation_direct
radiation_global
radiation_
upwelling
wind_direction
wind_speed

Data mining

Data set 2:

Years : 2016 – 2020

Location : 39.9106^0 N, 105.2347^0 W

Minute wise data

Data mining

Data set 2:

Time

Air temperature : 2,50,80 m

Dew point

Humidity

Precipitation

Wind direction : 2,5,10,20,50,80 m

Wind speed : 2,5,10,20,50,80 m

Data mining

Data set 2:

Time

Air temperature

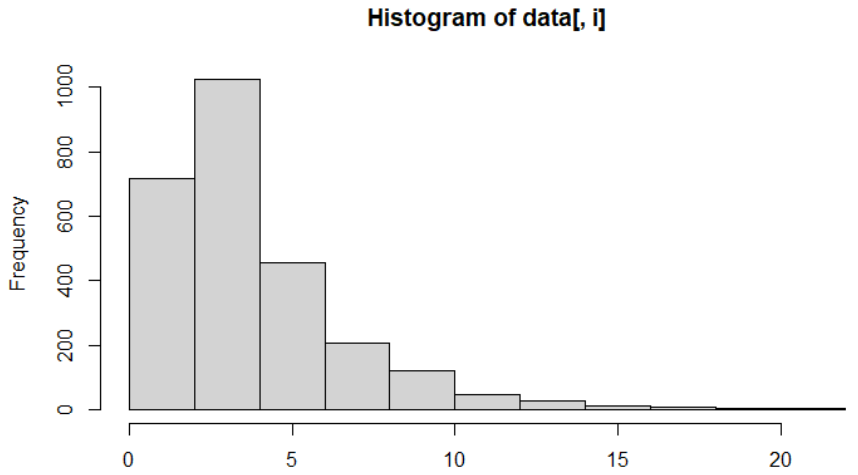
Dew point

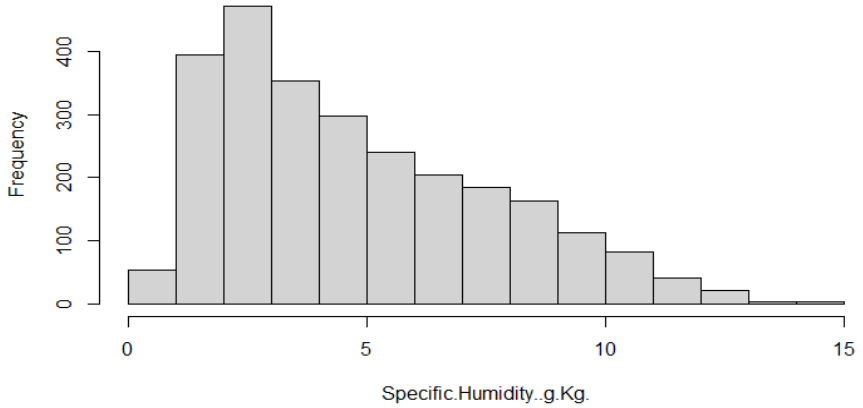
Humidity

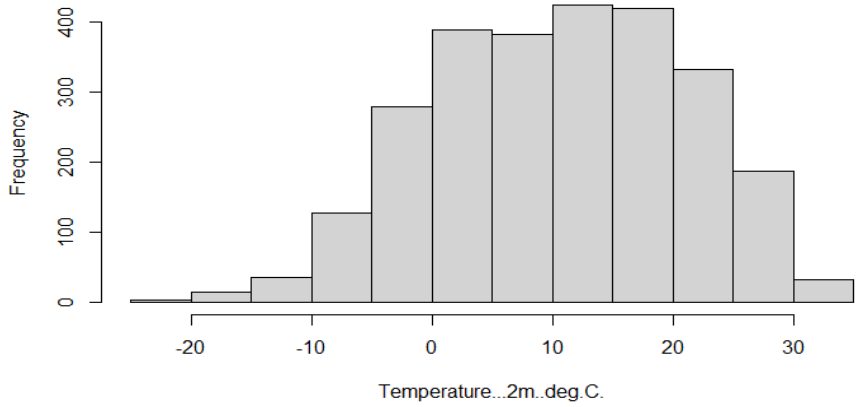
Precipitation

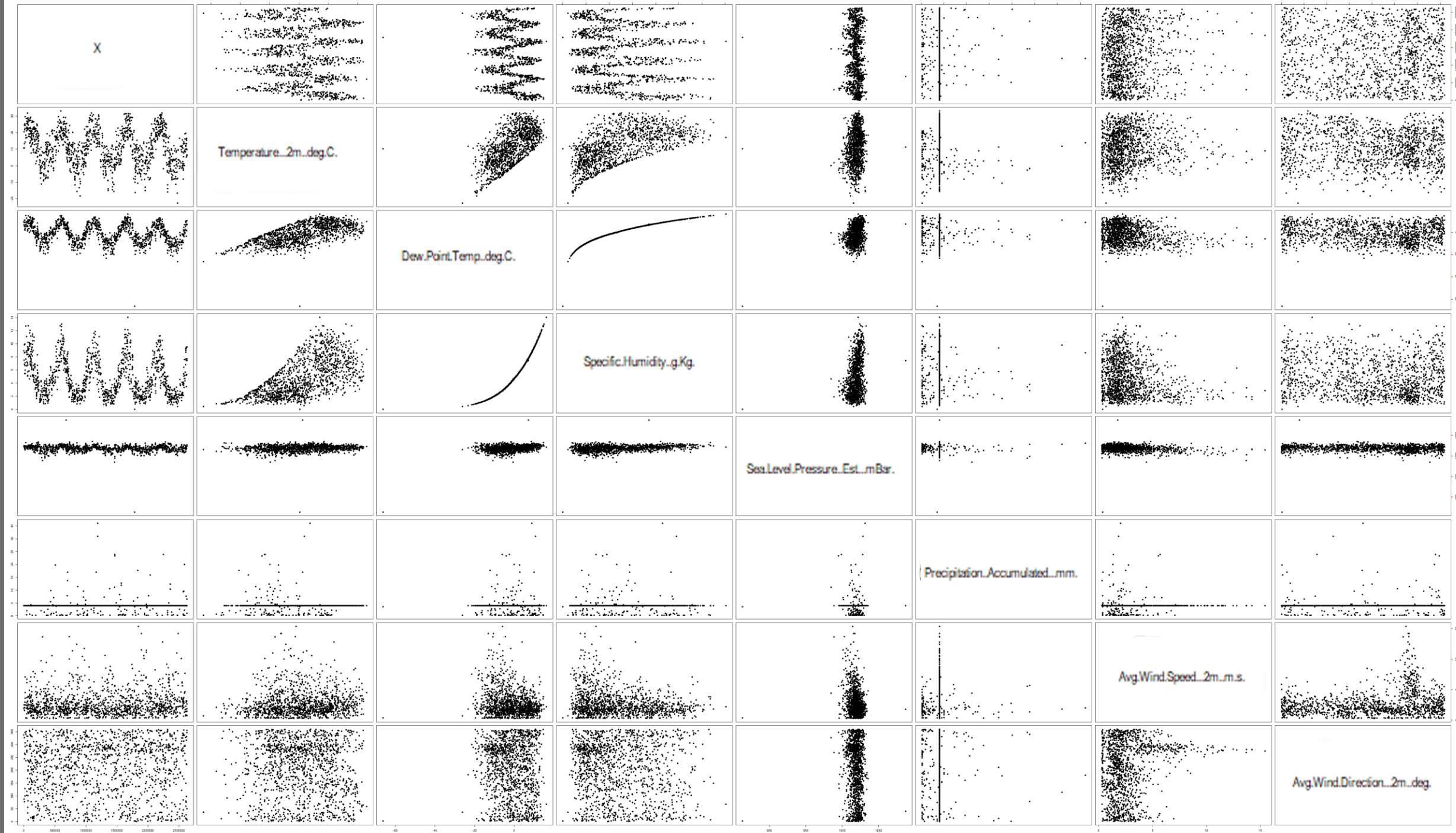
Wind direction

Wind speed








X
Temperature...2m..deg.C.
Dew.Point.Temp..deg.C.
Specific.Humidity..g.Kg.
Sea.Level.Pressure..Est...mBar.
Precipitation..Accumulated...mm.
Avg.Wind.Speed...2m..m.s.
Avg.Wind.Direction...2m..deg.

Data mining

Recursive Feature Elimination:

Air temperature

Dew point

Humidity

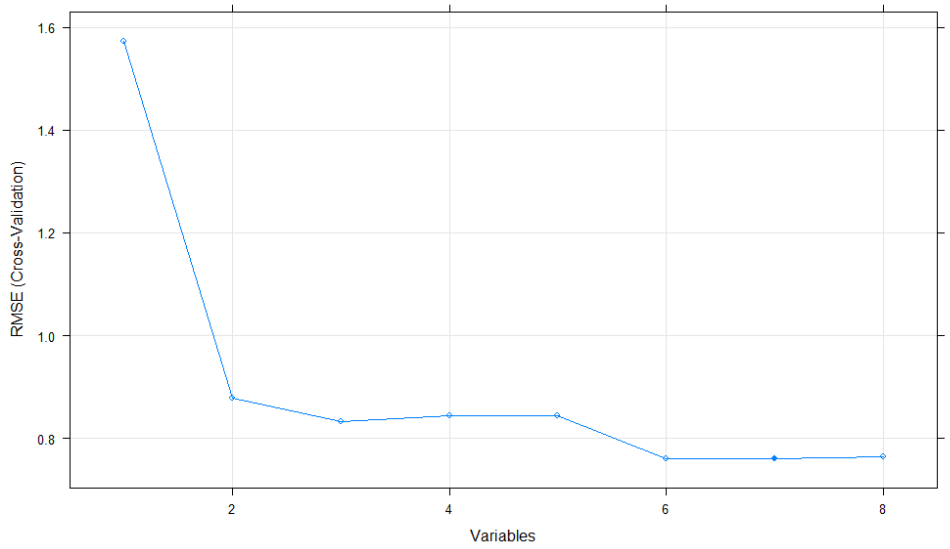
Pressure

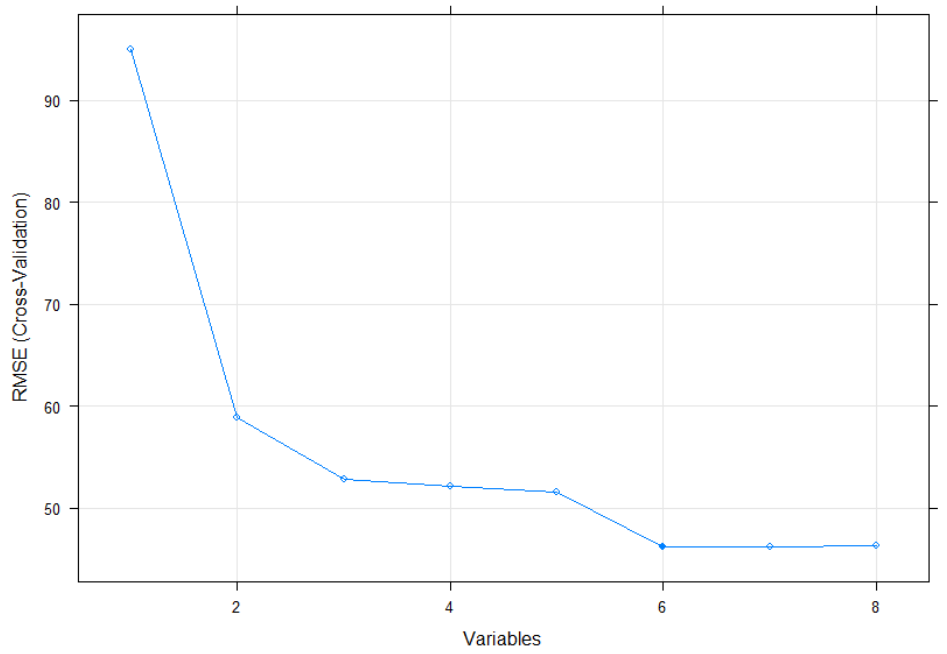
Radiation Direct

Radiation Global

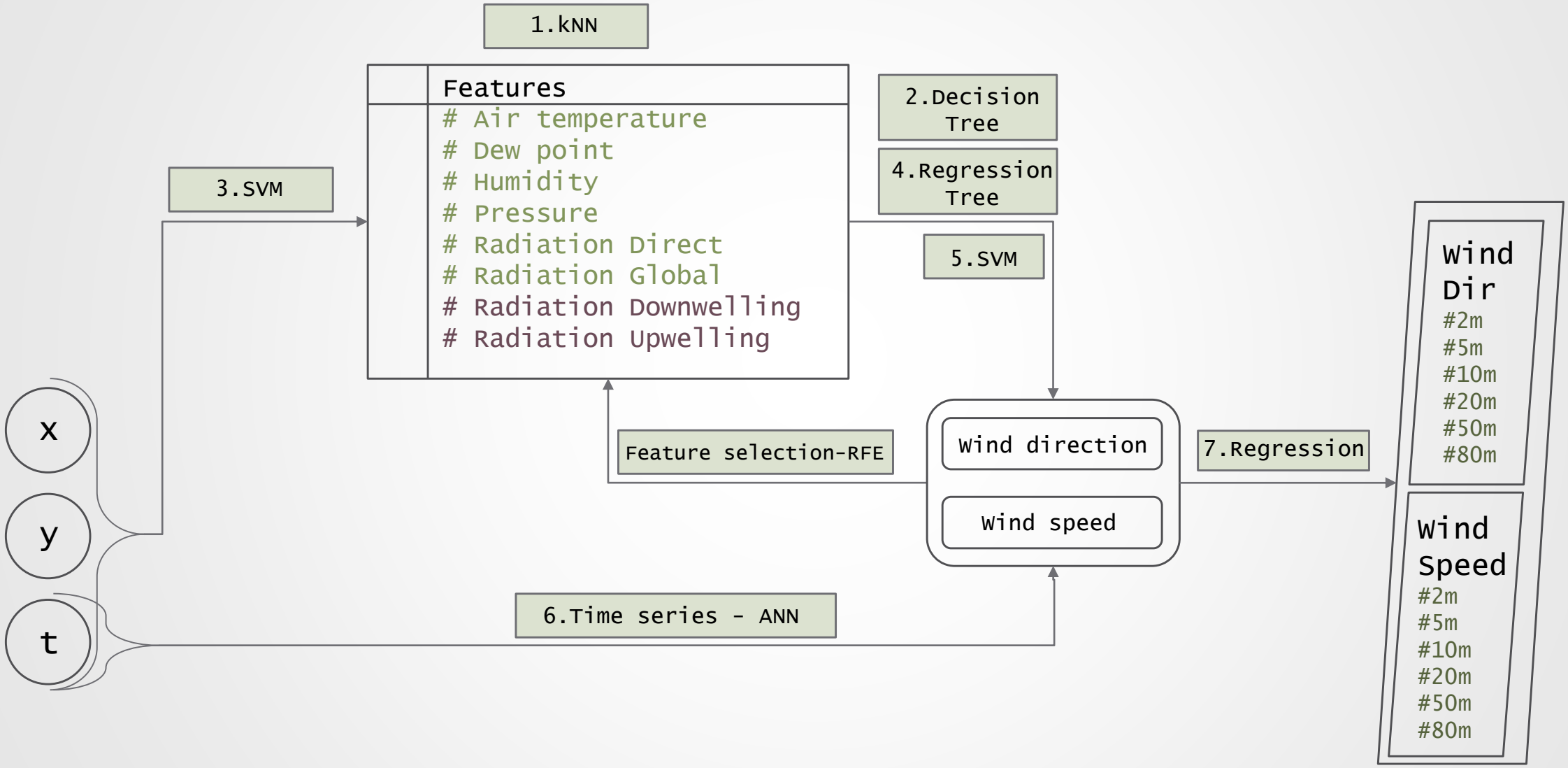
Radiation Downwelling

Radiation Upwelling





Overview


1.kNN
Features
Air temperature
Dew point
Humidity
Pressure
Radiation Direct
Radiation Global
Radiation Downwelling
Radiation Upwelling
2.Decision Tree
4.Regression Tree
3.SVM
5.SVM
x
y
t
Feature selection-RFE
Wind direction
Wind speed
7.Regression
6.Time series - ANN
Wind Dir
#2m
#5m
#10m
#20m
#50m
#80m
Wind Speed
#2m
#5m
#10m
#20m
#50m
#80m

Data Model -1

kNN:

Feature:

location – x,y

time

Air temperature

Dew point

Humidity

Pressure

Radiation Direct

Radiation Global

Labels:

Wind speed

Wind direction

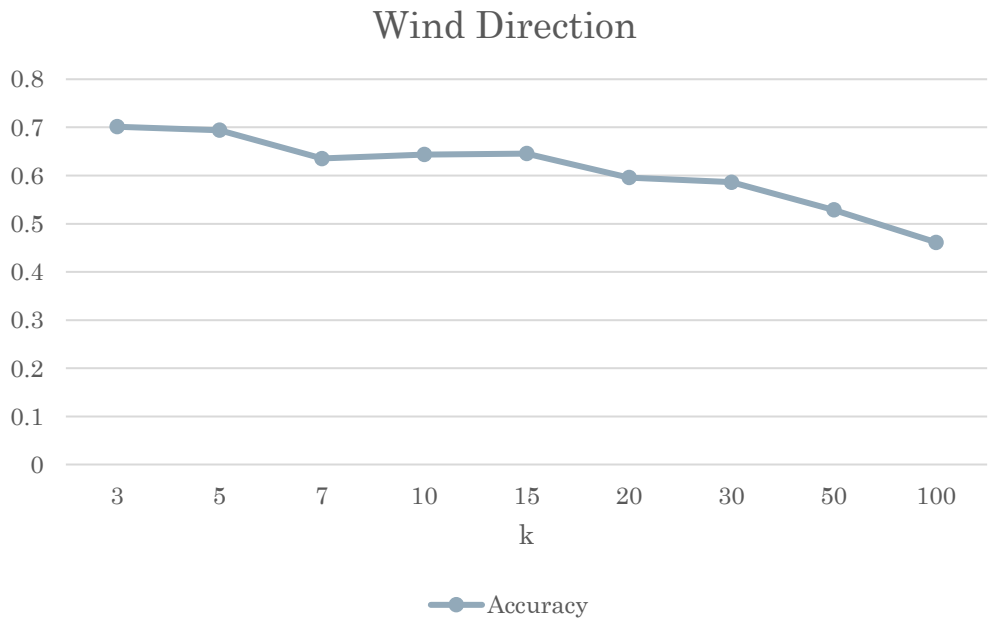
Data Model -1

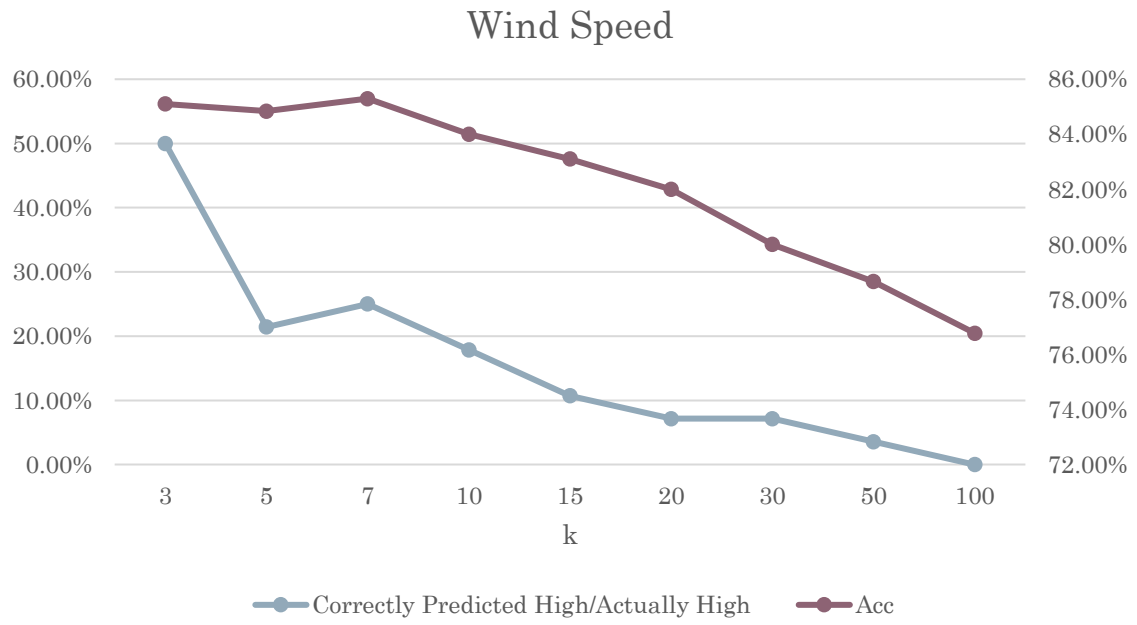
kNN:

Labels:

Wind speed

Wind direction





Data Model -2

Decision Tree:

Feature:

location – x,y

time

Air temperature

Dew point

Humidity

Pressure

Radiation Direct

Radiation Global

Labels:

Wind speed

Wind direction

Data Model -2

Decision Tree:

Feature:

location – x,y

time

Air temperature

Dew point

Humidity

Pressure

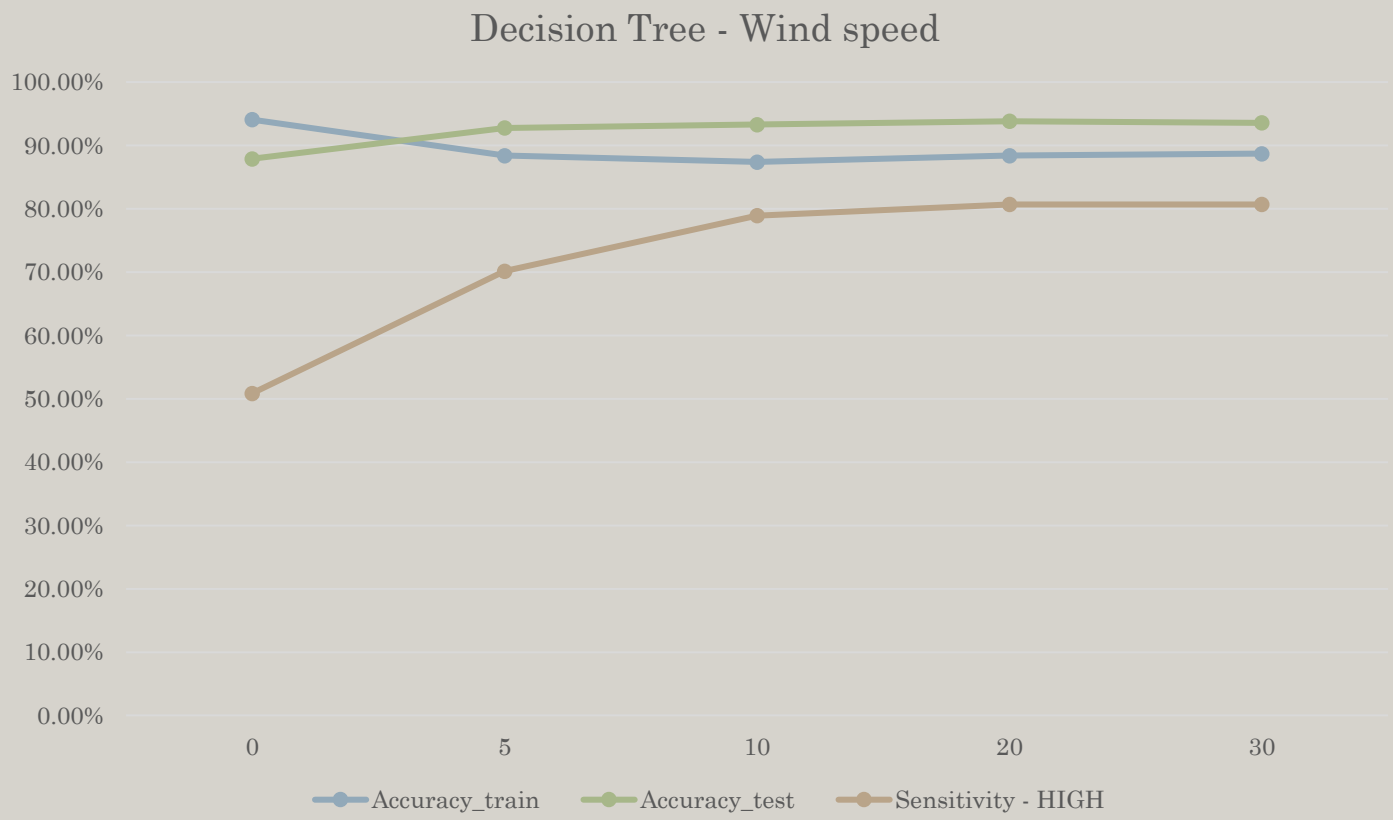
Radiation Direct

Radiation Global

Labels:

Wind speed

Wind direction



Data Model -2

Decision Tree:

Feature:

location – x,y

time

Air temperature

Dew point

Humidity

Pressure

Radiation Direct

Radiation Global

Labels:

Wind speed

Wind direction

100.00% y
100.00% time
100.00% air_temperature_mean
100.00% radiation_global
99.96% pressure
99.51% dew_point
98.70% radiation_upwelling
98.61% x
97.34% radiation_direct
92.98% humidity

Data Model -3

SVM:

Feature:

location – x,y

time

Labels:

Air temperature

Dew point

Humidity

Pressure

Radiation Direct

Radiation Global

Data Model -3

SVM:

Feature:

location – x,y

time

Labels:

Air temperature – Laplacian

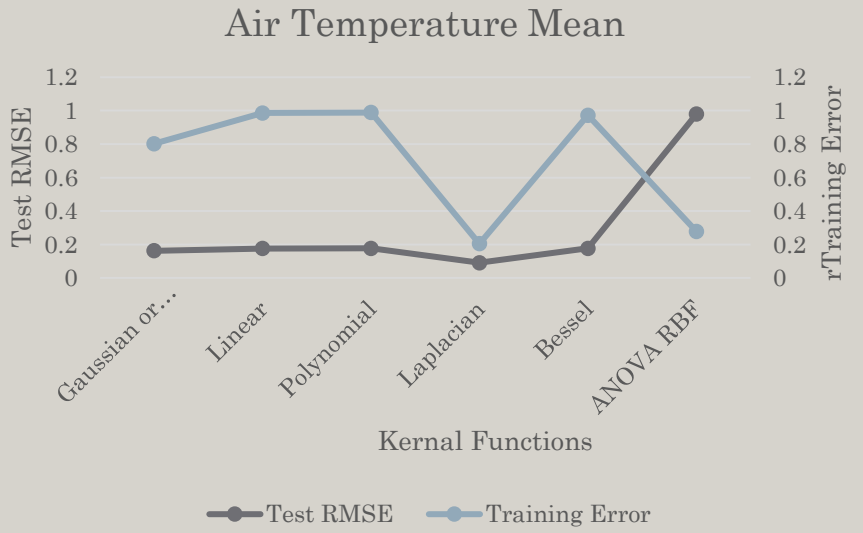
Dew point – Laplacian

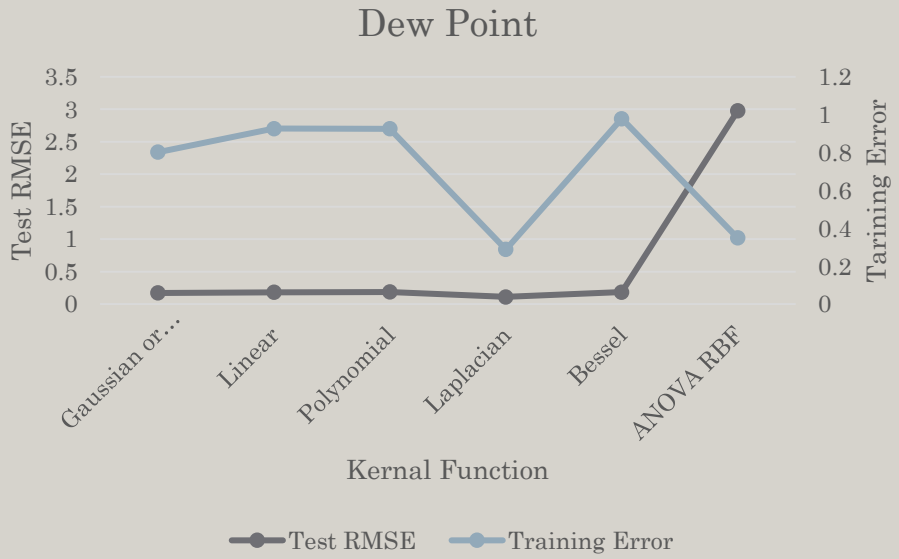
Humidity

Pressure

Radiation Direct

Radiation Global





Data Model -3

SVM:

Feature:

location – x,y

time

Labels:

Air temperature – Laplacian

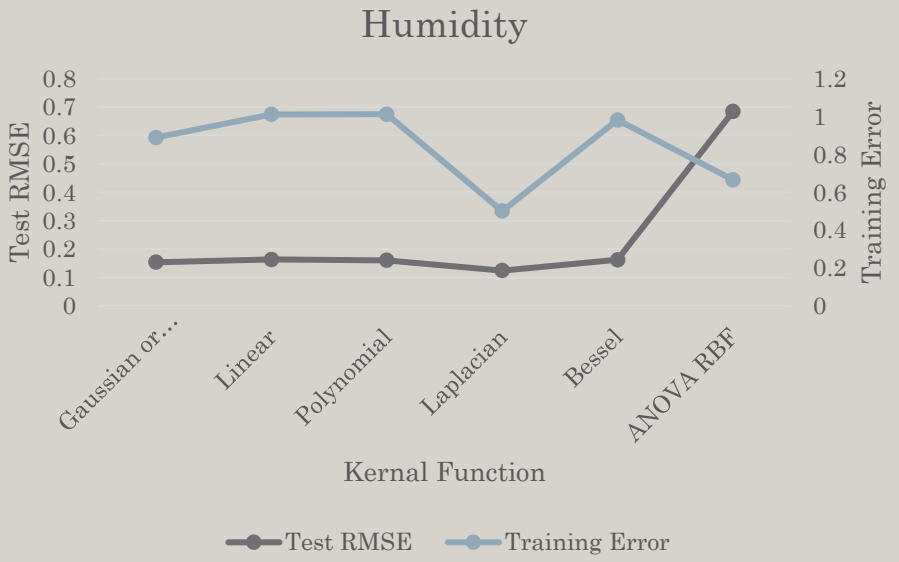
Dew point – Laplacian

Humidity – Laplacian

Pressure – Laplacian

Radiation Direct

Radiation Global



Data Model -3

SVM:

Feature:

location – x,y

time

Labels:

Air temperature – Laplacian

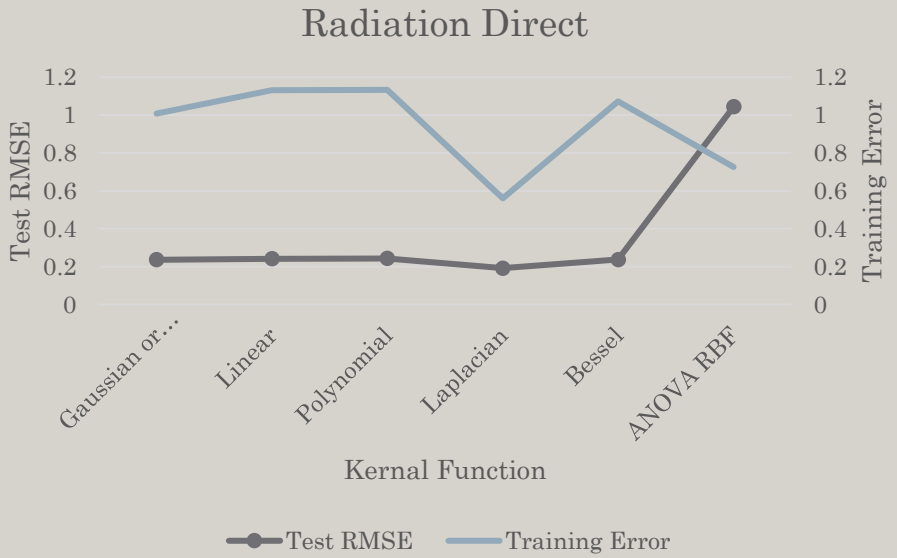
Dew point – Laplacian

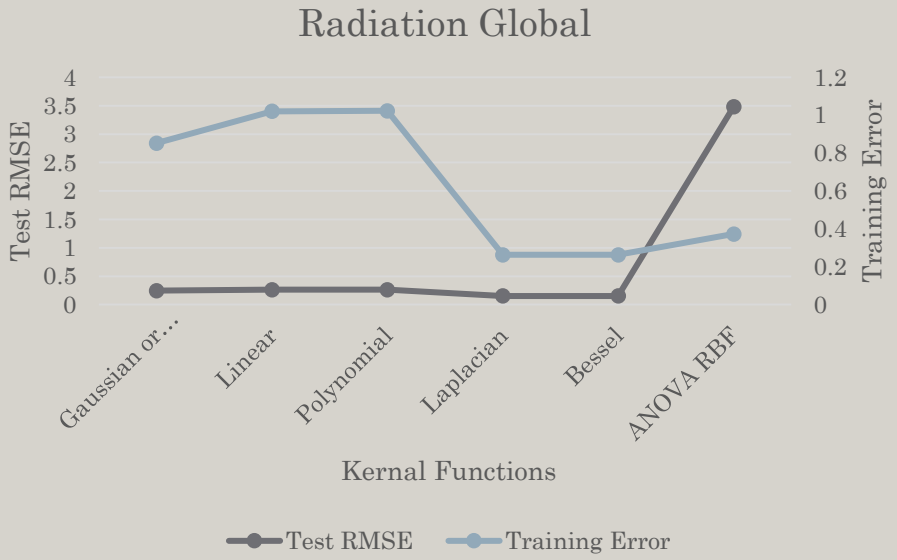
Humidity – Laplacian

Pressure – Laplacian

Radiation Direct – Laplacian

Radiation Global – Laplacian





Data Model -4

Regression Tree:

Feature:

Air temperature

Dew point

Humidity

Pressure

Radiation Direct

Radiation Global

Labels:

Wind speed

Wind direction

Data Model -4

Regression Tree:

Feature:

Air temperature

Dew point

Humidity

Pressure

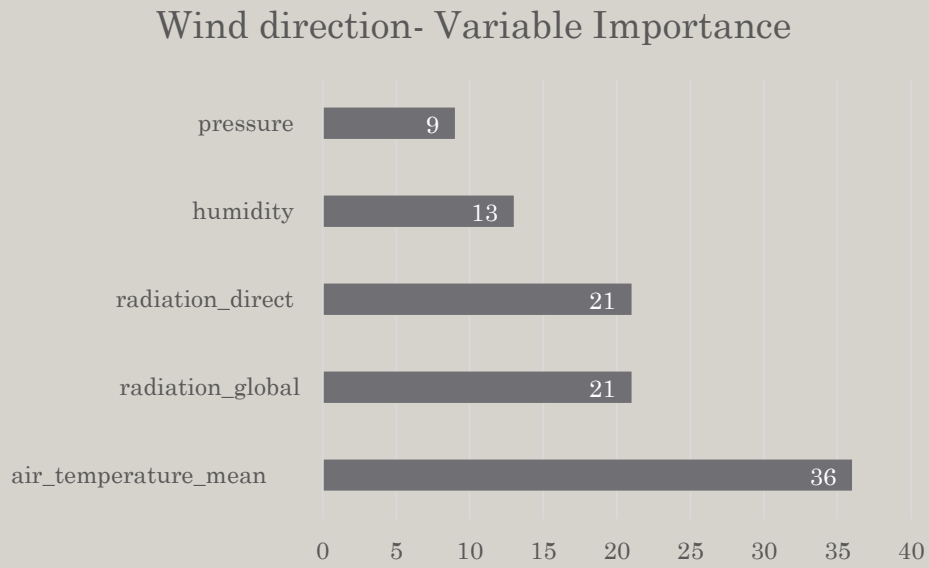
Radiation Direct

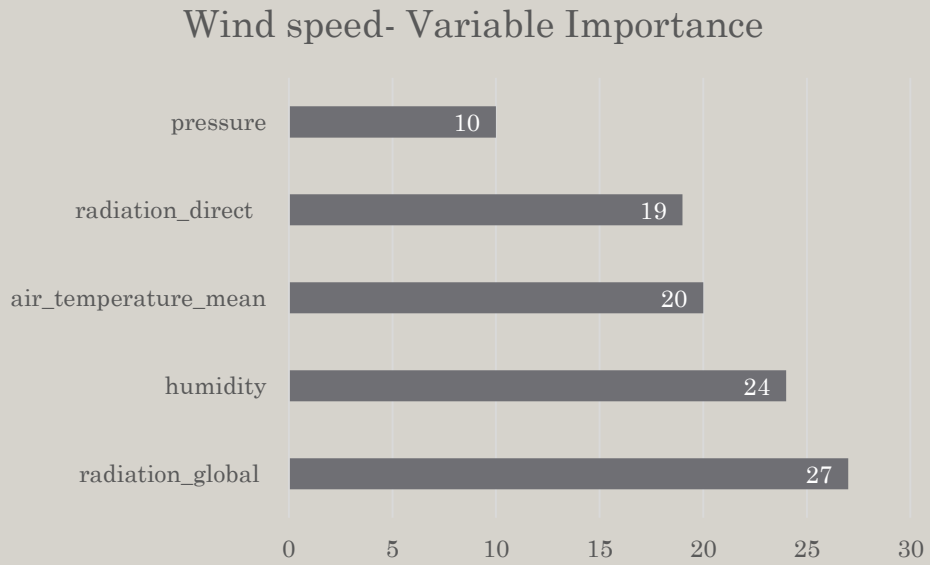
Radiation Global

Labels:

Wind speed

Wind direction





Data Model -5

SVM:

Feature:

Air temperature

Dew point

Humidity

Pressure

Radiation Direct

Radiation Global

Labels:

Wind speed

Wind direction

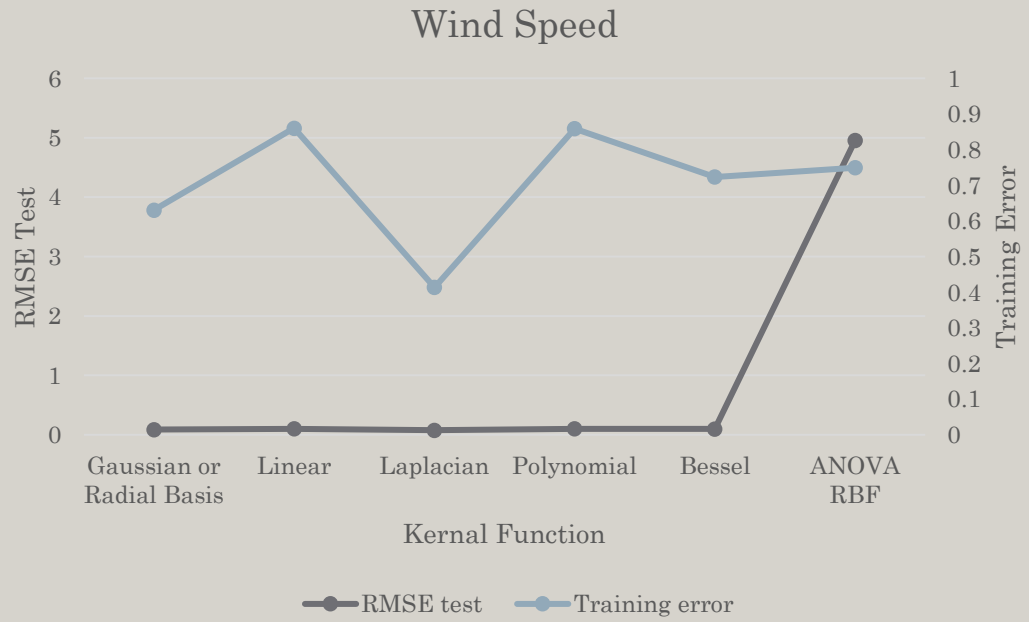
Data Model -5

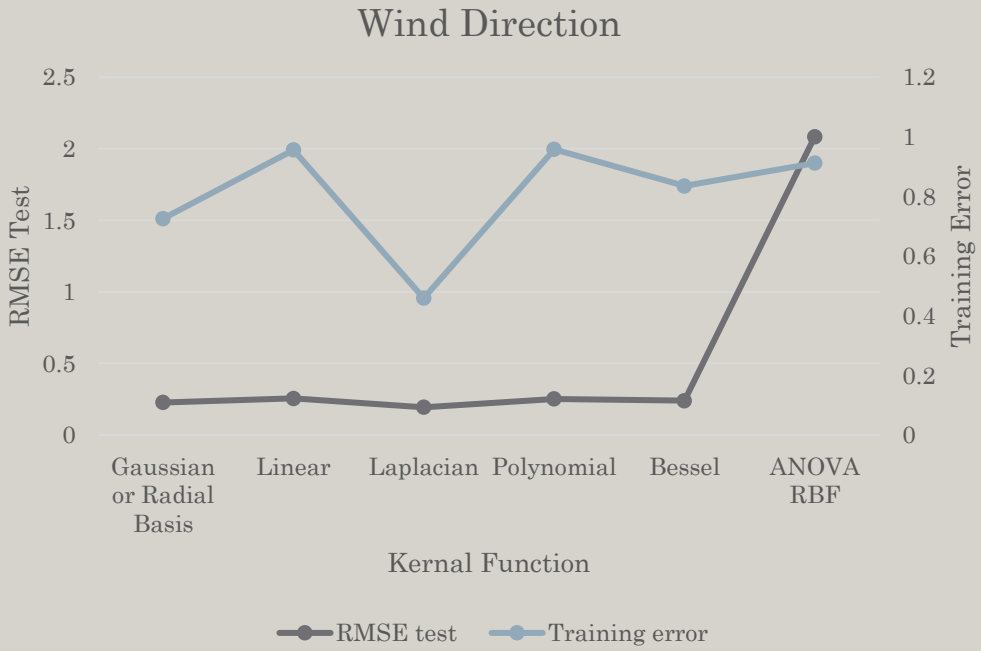
SVM:

Labels:

Wind speed - Laplacian

Wind direction - Laplacian





Data Model -6

ANN:

Feature:

time

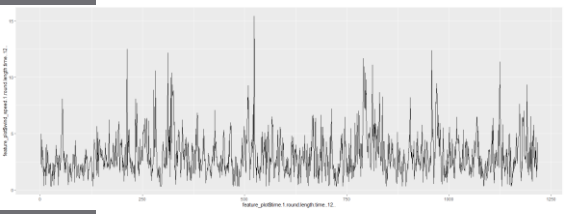
Labels:

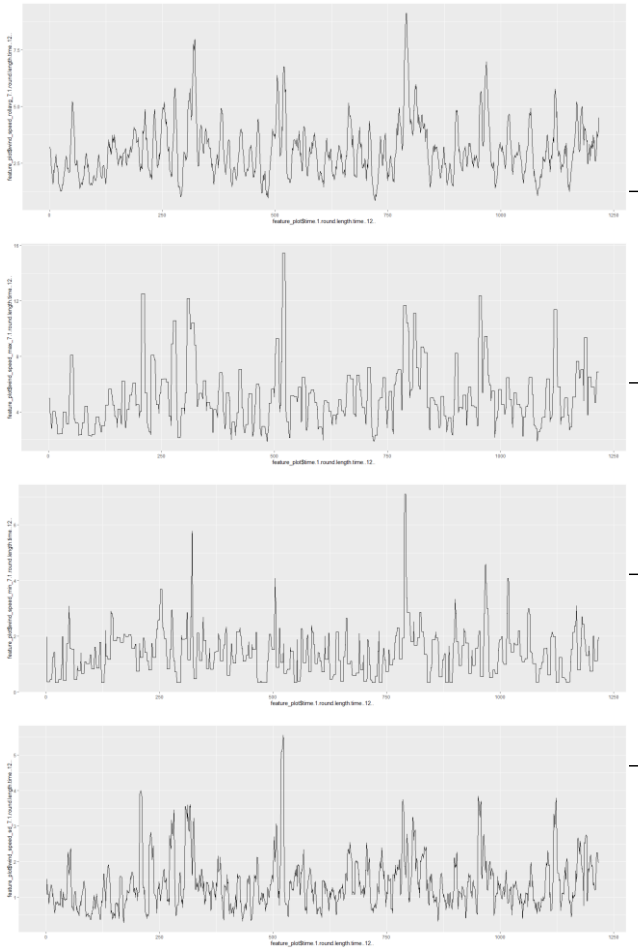
Wind speed

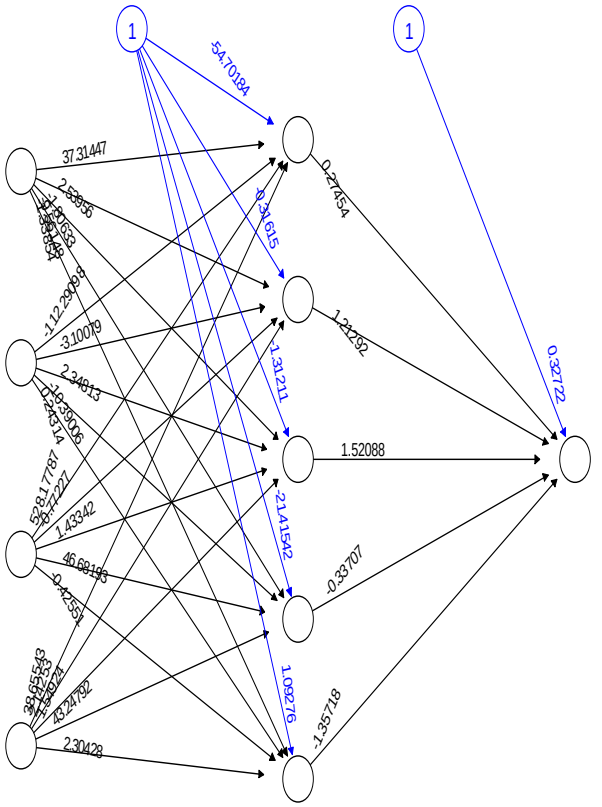
Wind direction

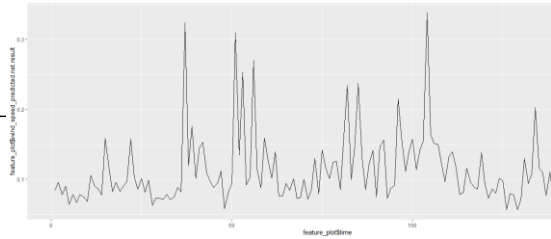
Data Model -6

ANN:









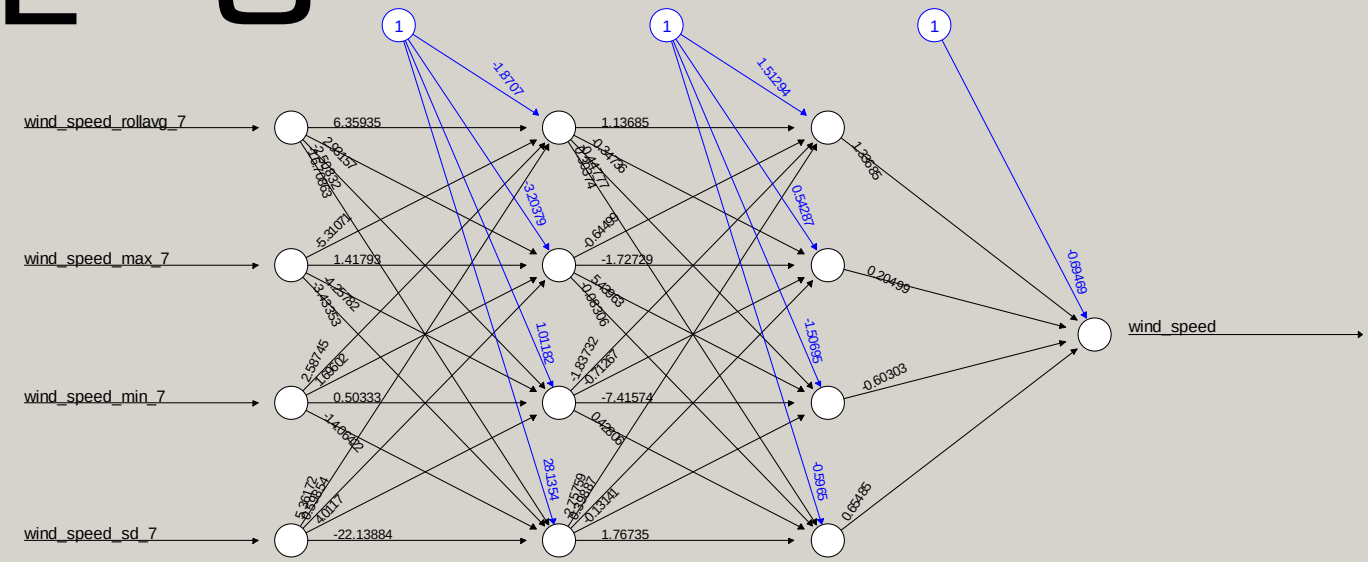
Data Model -6

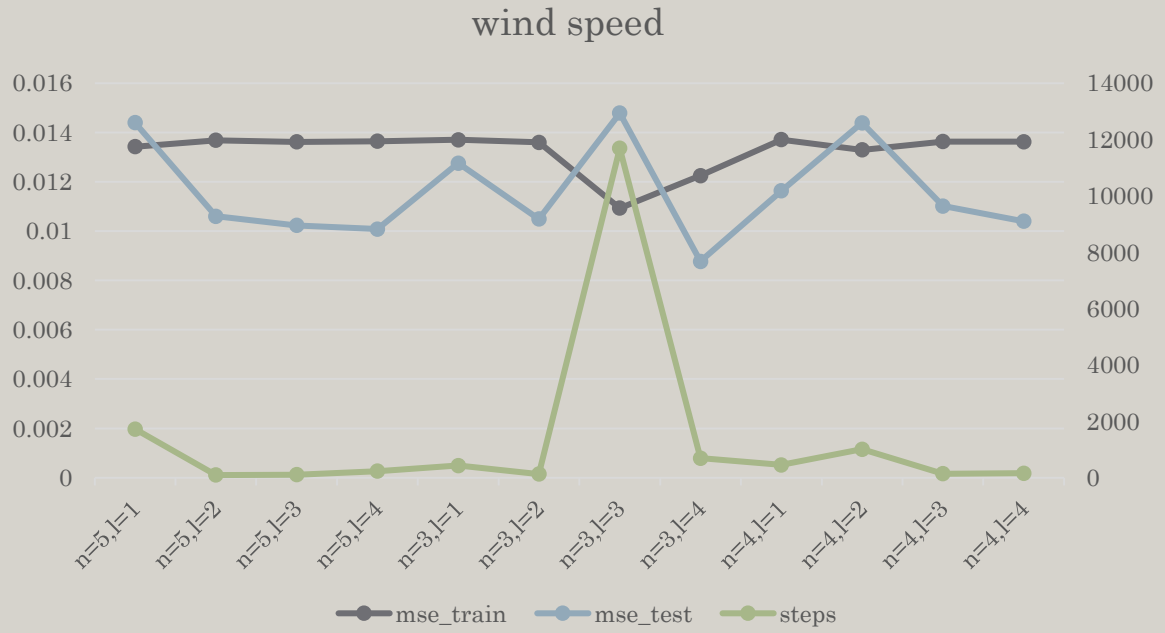
ANN:

wind speed

nodes – 4

layers – 2





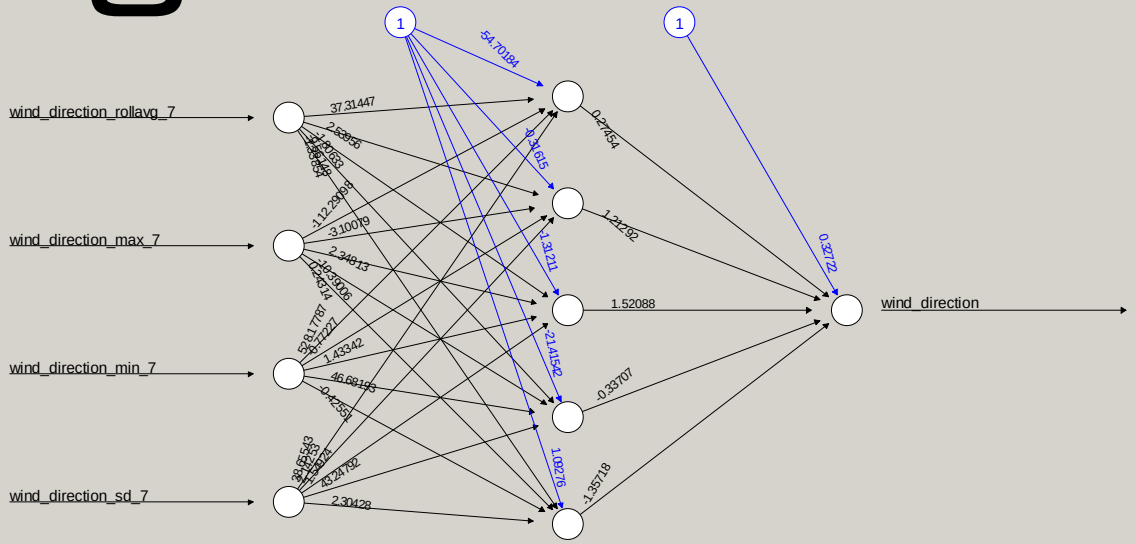
Data Model -6

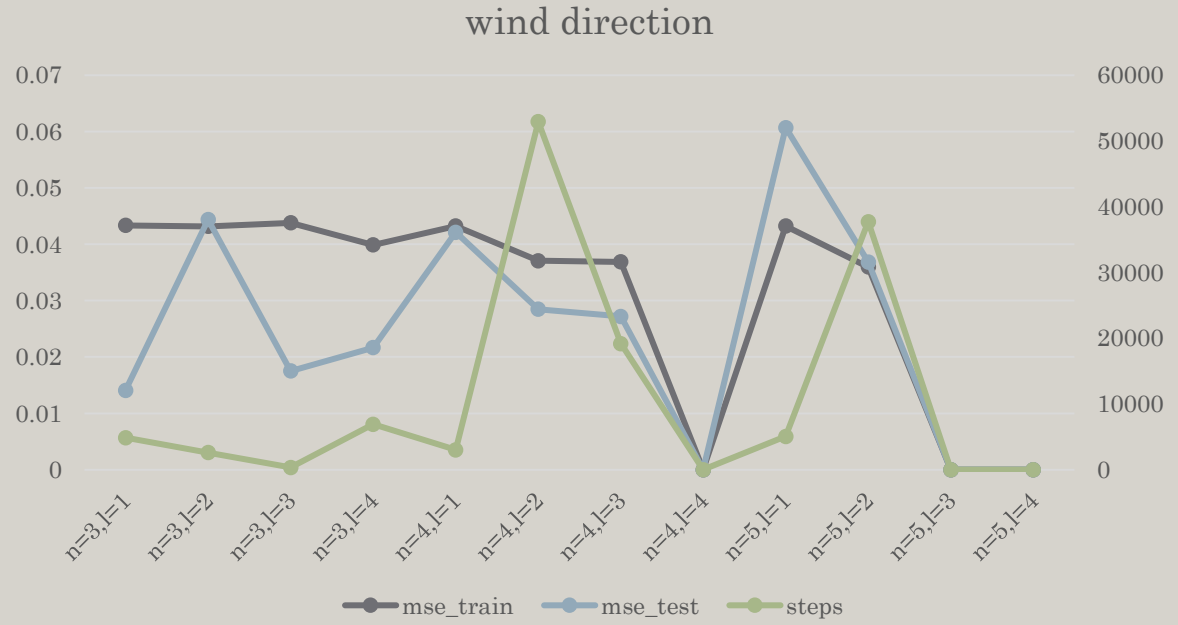
ANN:

wind speed

nodes – 5

layers – 1





Data Model -7

Regression:

Feature:

Wind direction : 10 m

Wind speed : 10 m

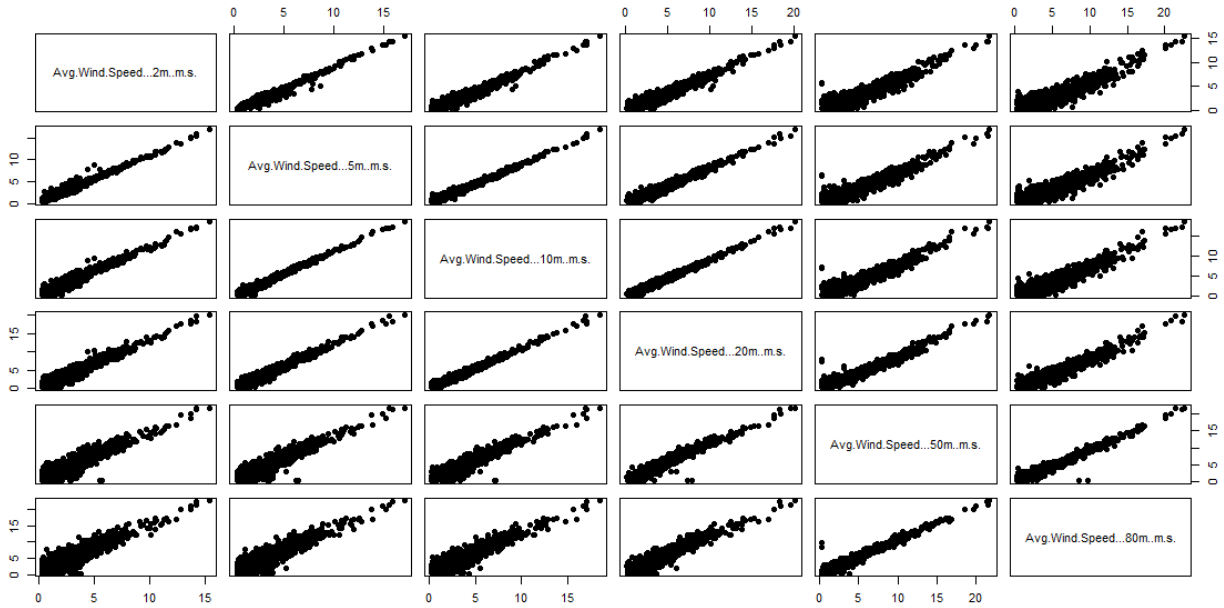
Labels:

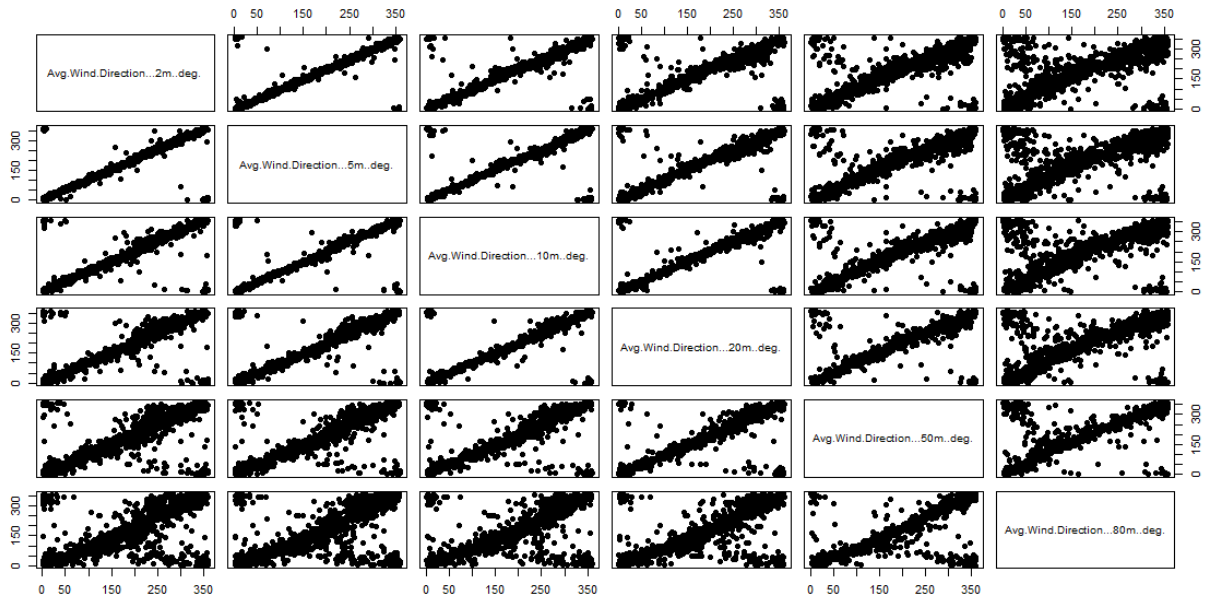
Wind direction : 2,5,20,50,80 m

Wind speed : 2,5,20,50,80 m

Data Model -7

Regression:

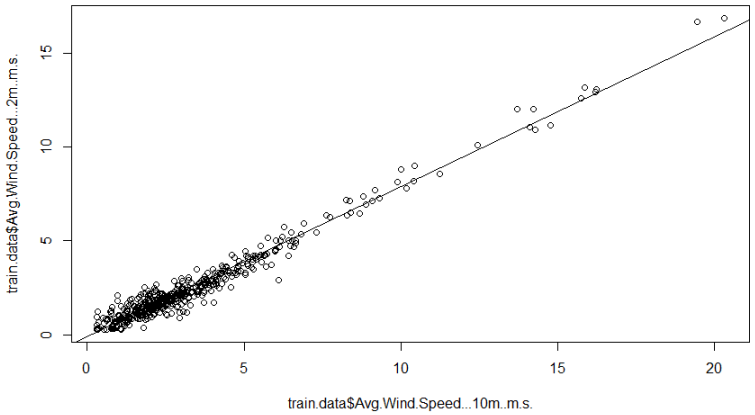


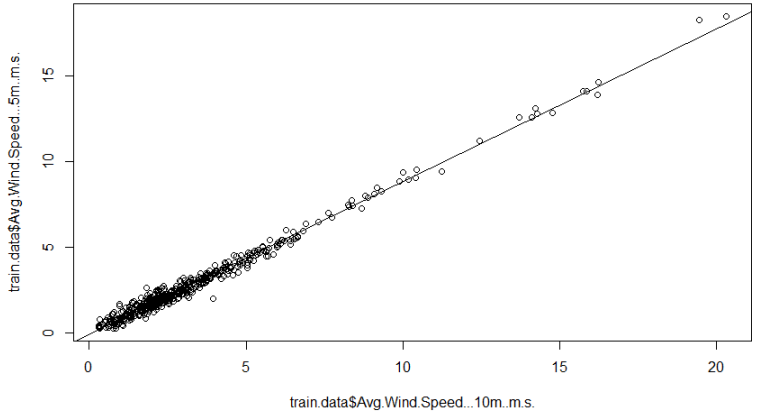


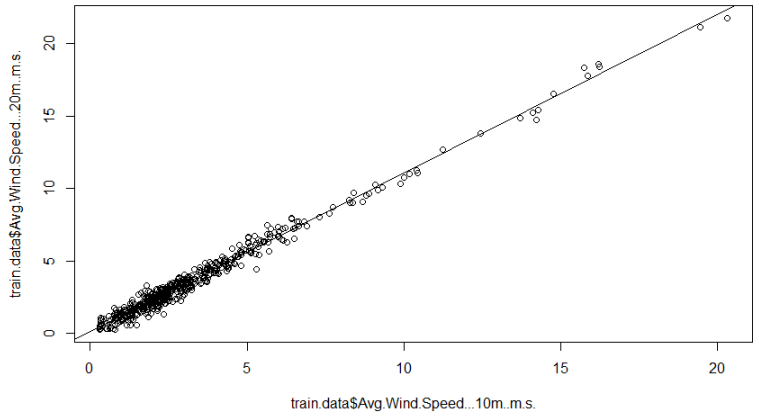
Data Model -7

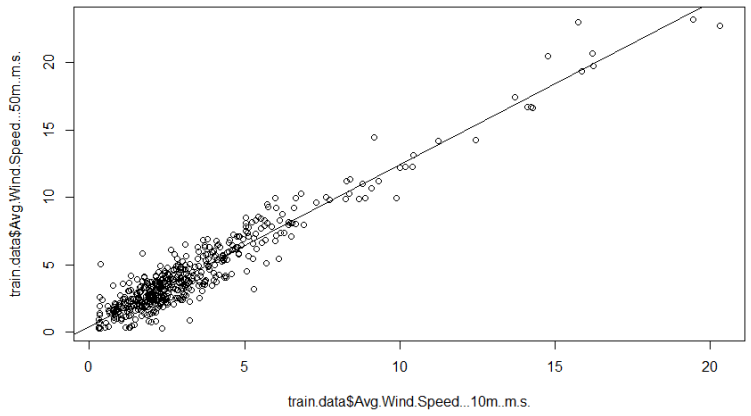
Regression:

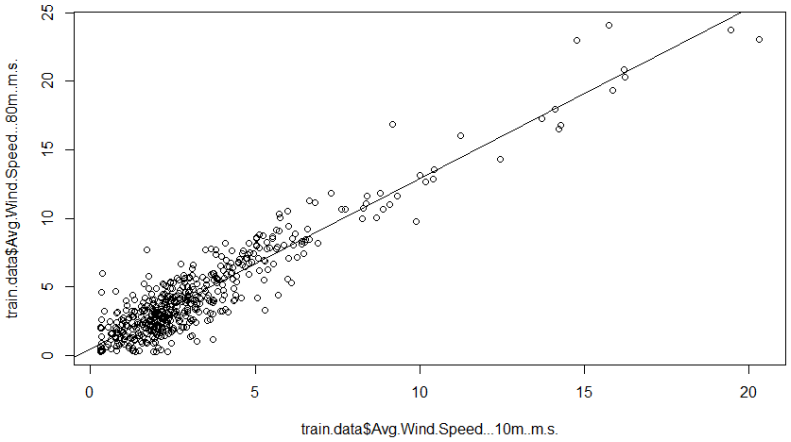
Wind Speed







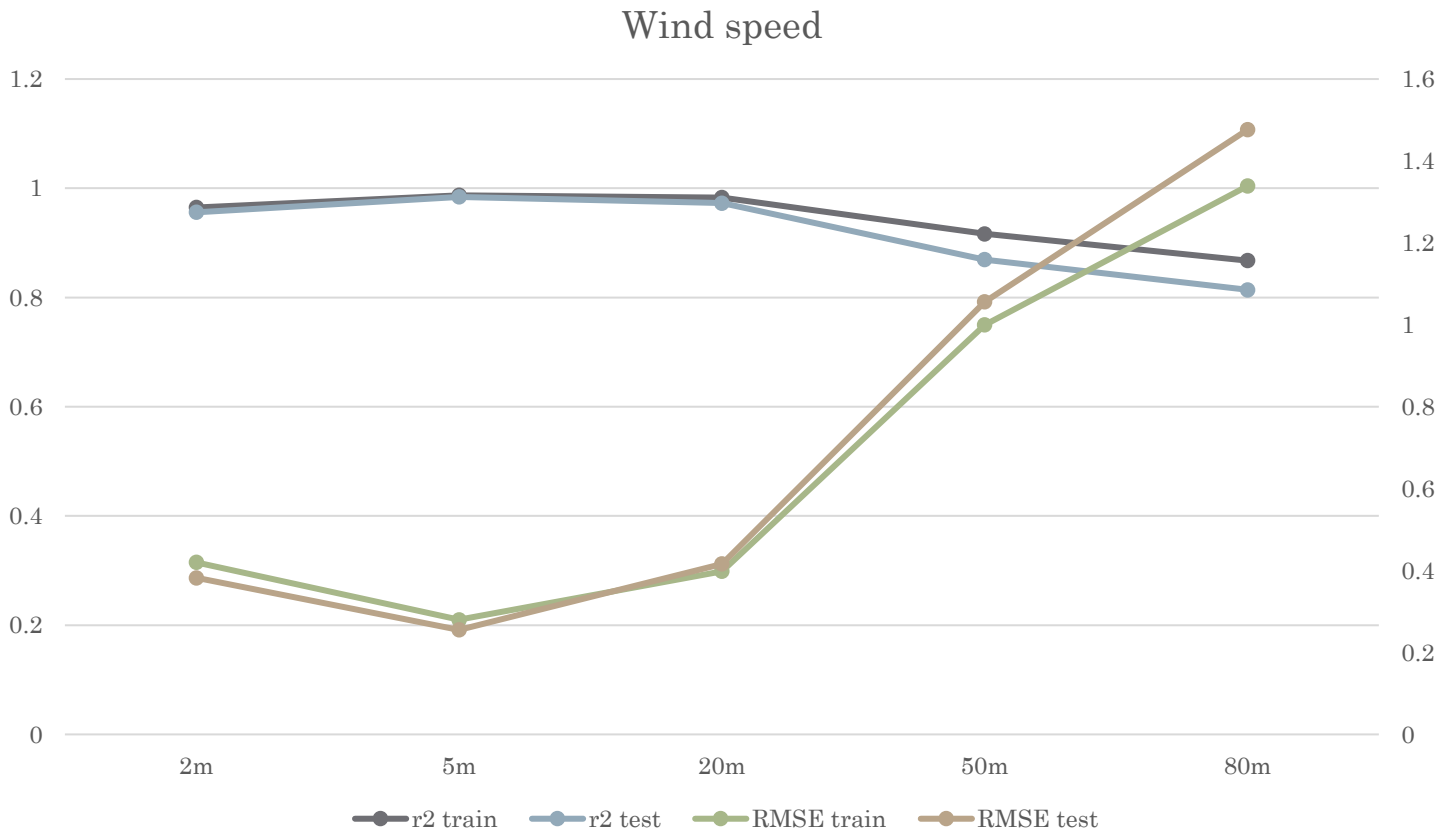


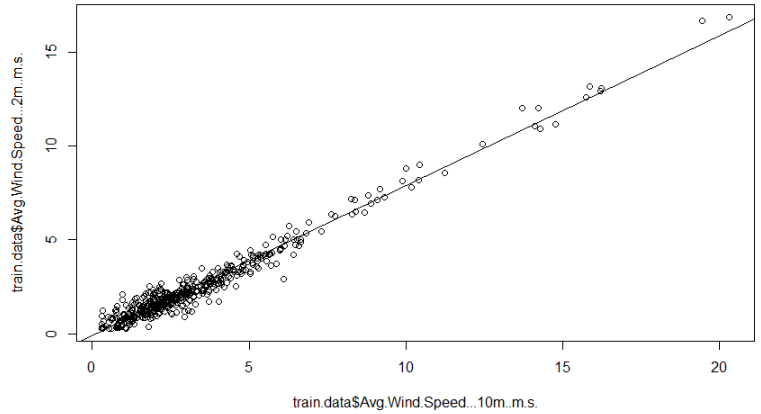


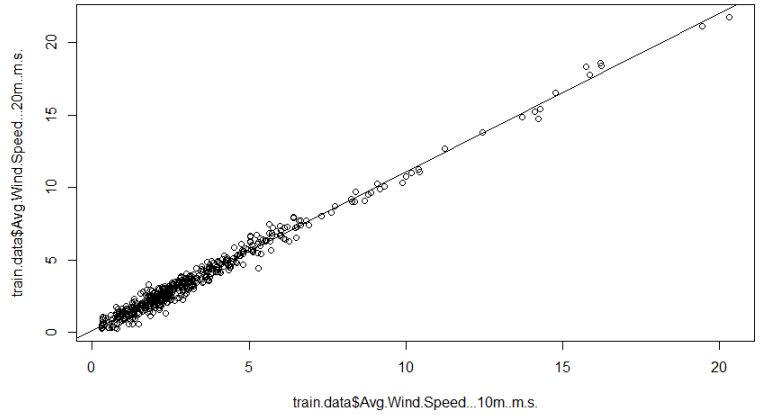
Data Model -7

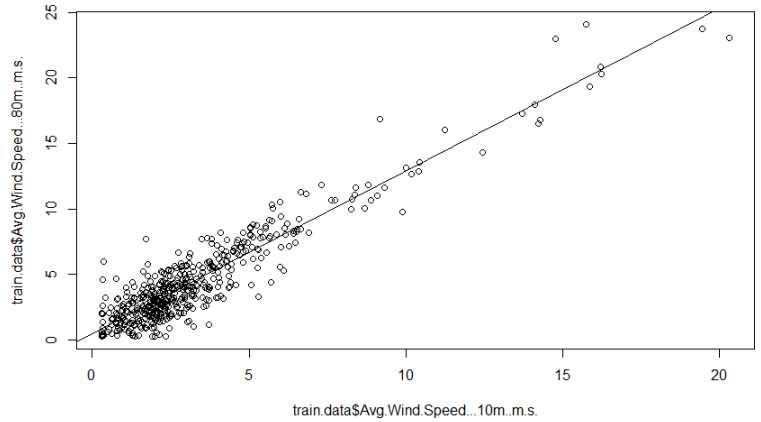
Regression:

Wind Speed









Data Model -7

Regression:

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# Wind direction
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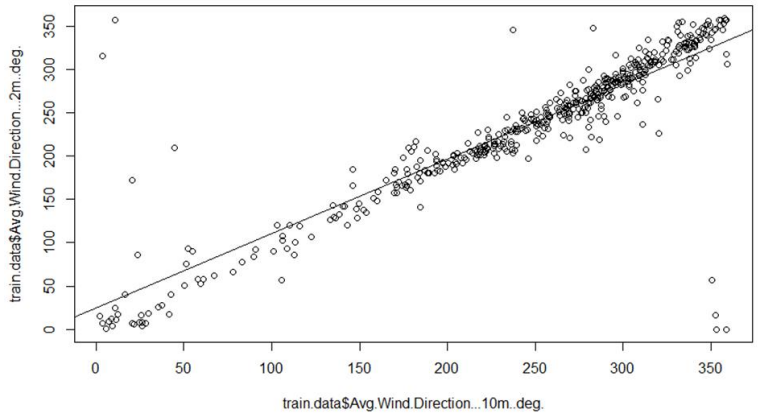
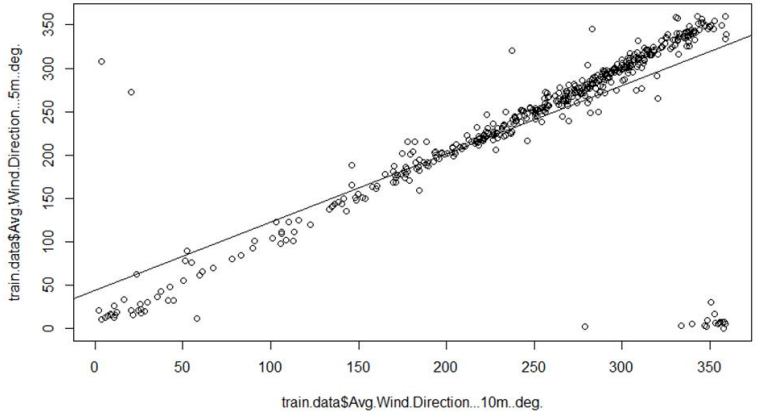
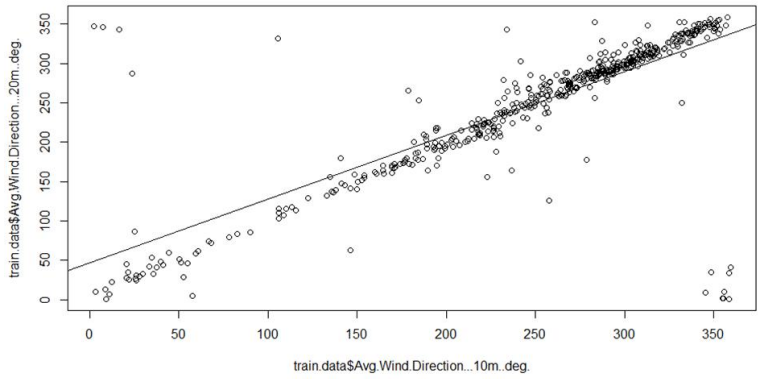
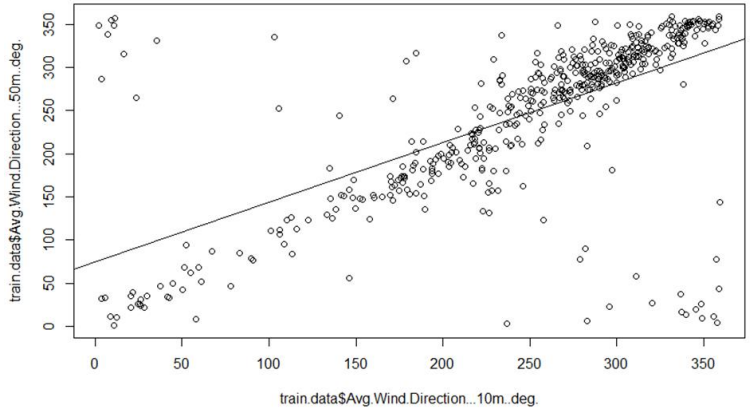
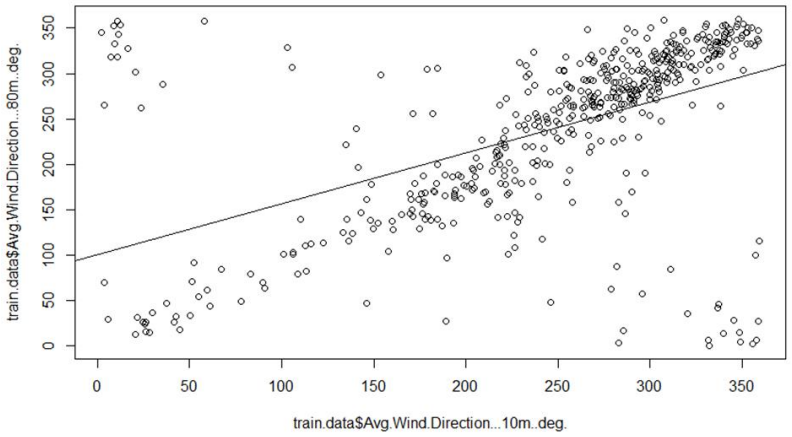






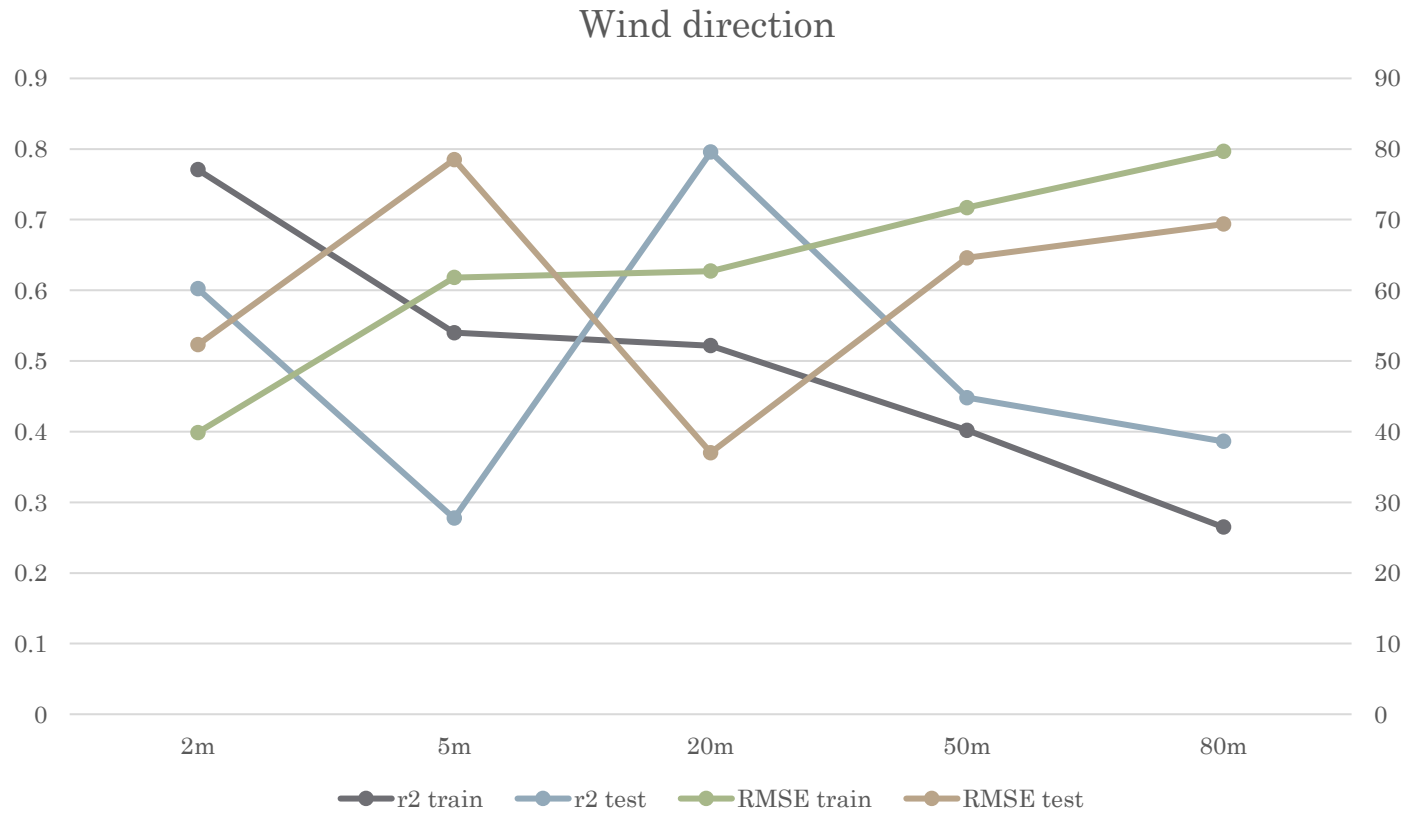


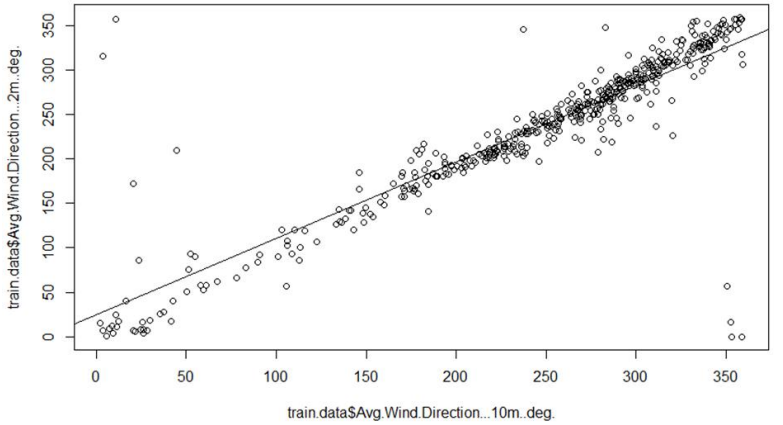


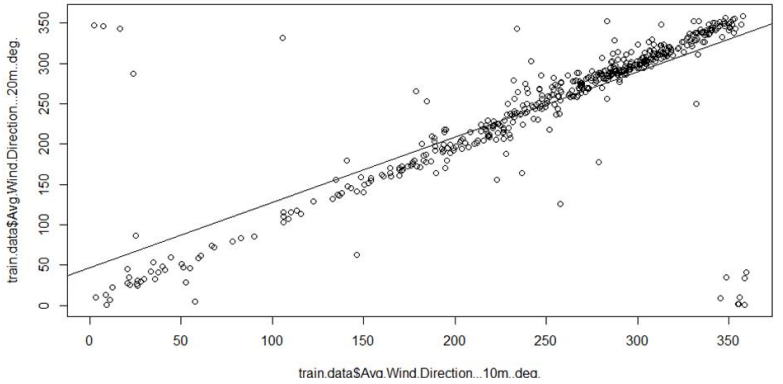
Data Model -7

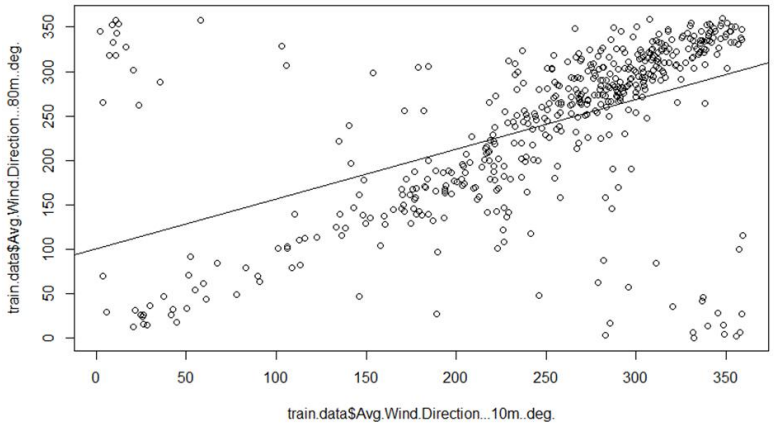
Regression:

Wind direction









Data Model -7

Regression:

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# Wind direction
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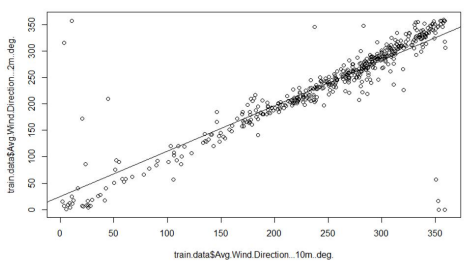
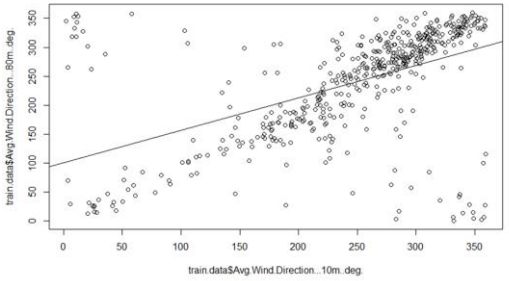
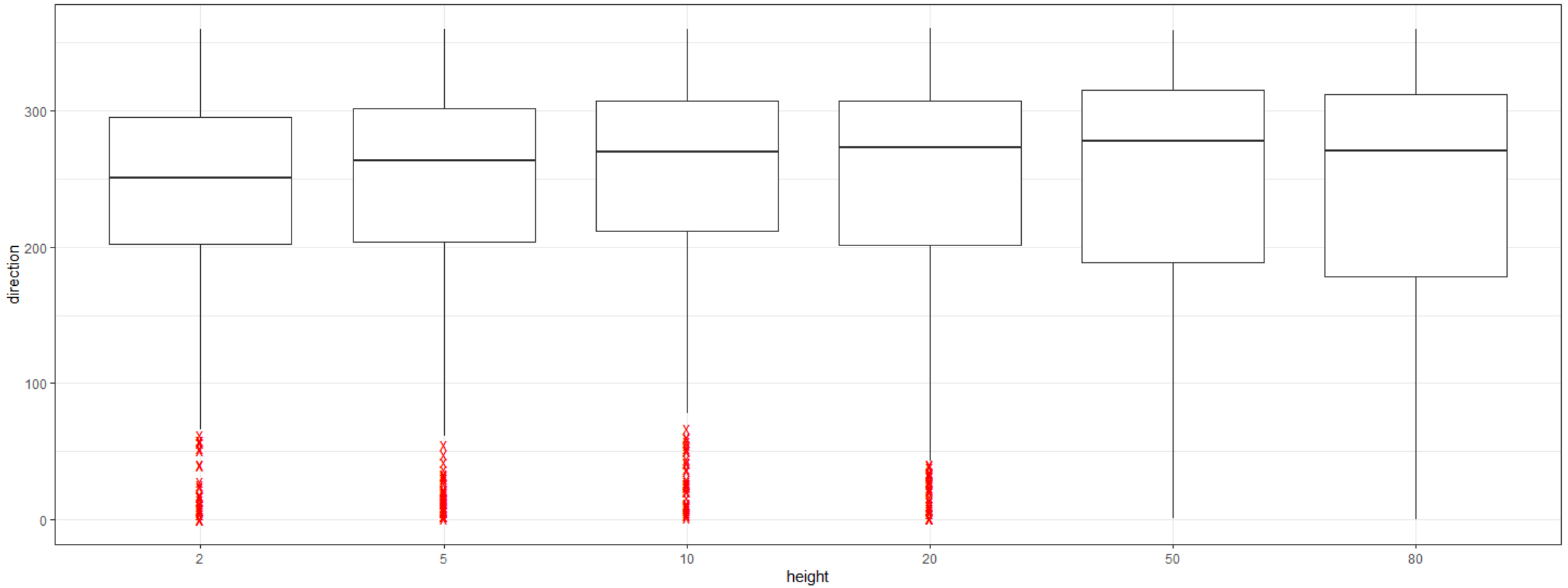


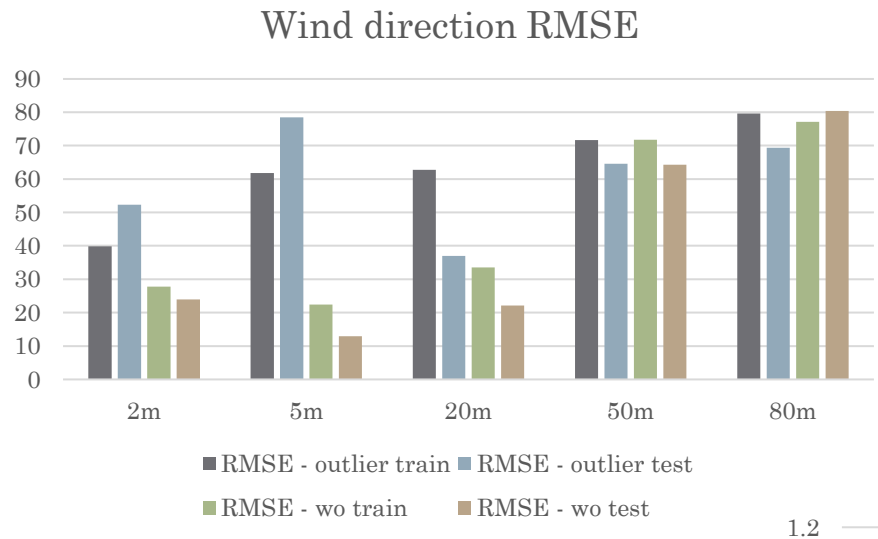


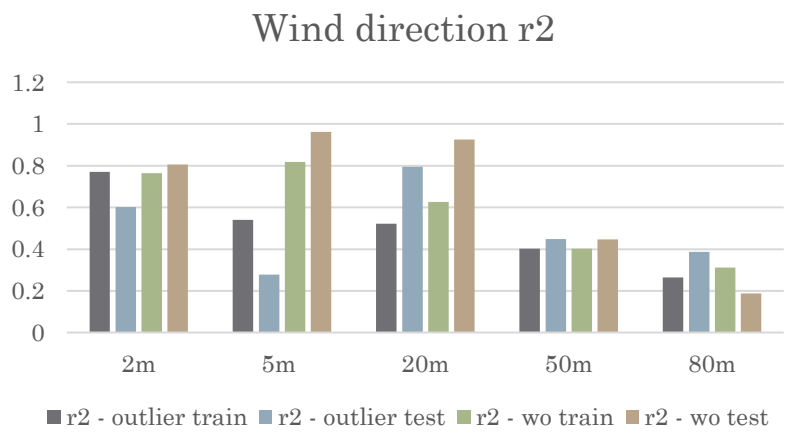


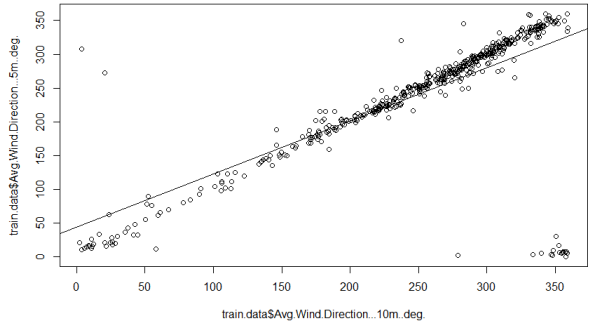
Data Model -7

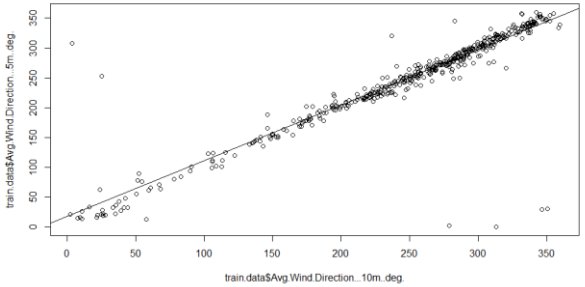
Regression:

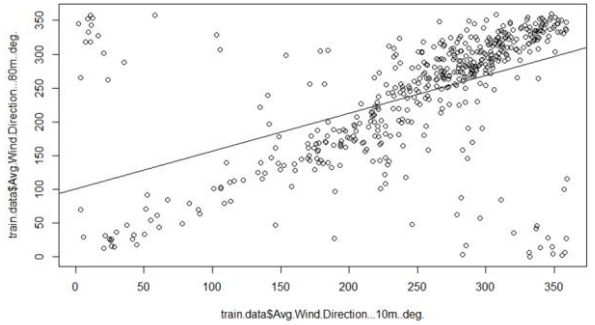
Wind direction

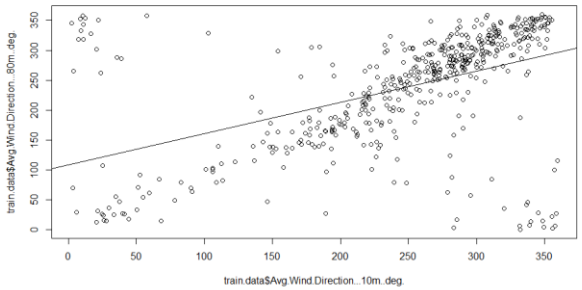




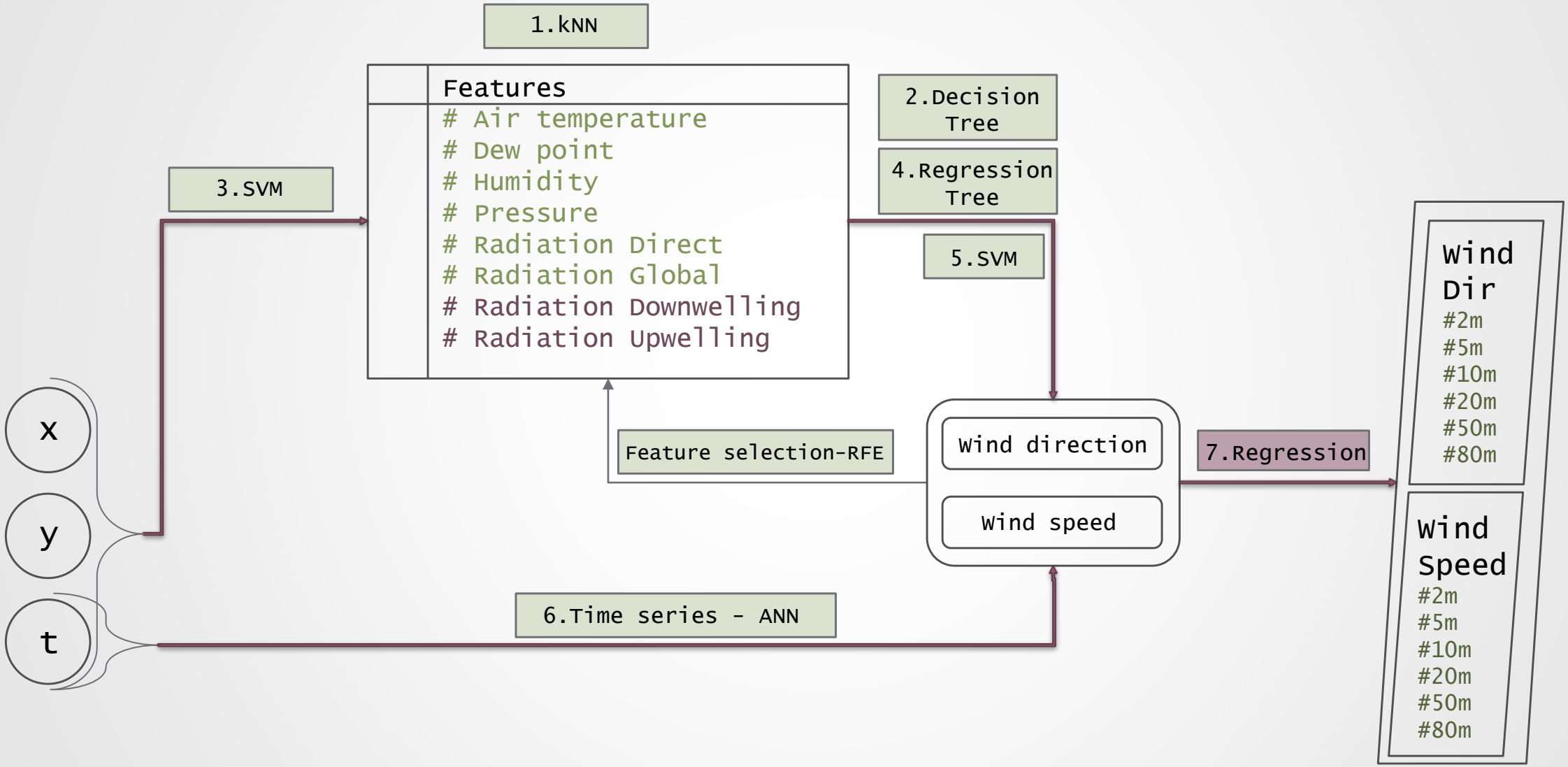








Future scope



VALIDATION

References

[1] https://www.dwd.de/DE/leistungen/seegangskarten/seegangskarten.html;jsessionid=E773DF7E0CCC13282587578E6734853A.live11041?nn=392762

[2] Bauen im Bestand: Skript; TU Berlin; Institut für Bauingenieurwesen

[3] DIN 1055-4:2005-03 Windlasten

Thank You

Questions? Comments?