Fall 2018 OR/MA 504 HW #6 *Reiland*

Due November 12

1. Theme parks are big business. In the United States there are nearly 500 theme and amusement parks which generate over $10 billion a year in revenue. The theme park business is also growing in Europe and Asia. Rides are the main attraction at most parks, and at the center of this attention are the roller coasters. Engineers and designers compete to make them bigger and faster to increase park attendance. Roller coaster fans will wait in line for hours for a speedy, stomach-churning, head spinning 3-minute ride.

What makes a roller coast fast? In the Excel file ***Roller Coasters*** on our class webpage www.stat.ncsu.edu/people/reiland/courses/st504/ are data on 78 of the fastest roller coasters in the world. The file contains the values for each roller coaster on several variables that are defined below.

Type: the kind of track the roller coaster has; usually the same as the frame but not always;
Duration: duration of the ride in seconds;
Height: maximum height in feet above ground level;
Drop: greatest drop in feet;
Length: total length of the track in feet;
Inversion: whether riders are turned upside down during the ride;
Speed: top speed in miles per hour.

An amusement park owner wants to build a new roller coaster with the following variable values:

Type: Steel; *Duration*: 170; *Height*: 300; *Drop*: 306; *length* 6100; *Inversion*: No.

Note that the *Drop* will be greater than the *Height* since the roller coaster will go through an underground tunnel (see picture).

QUESTION: what is the predicted *Speed* of the new roller coaster?

Use a neural network to answer the above question. Use software of your choice. **JMP Pro** is free to students and can be downloaded from the NCSU website. Or go to the website http://www.justnn.com/ and click *Download JustNN* to download the free neural network software. View the 3 examples in Getting Started (it takes 8 to 10 minutes) to learn how to use the software. Then click File --> New, File --> Import to open the Excel file ***Roller Coasters*** in JustNN.

- Use *Type, Duration, Height, Drop, Length,* and *Inversion* as the input variables and *Speed* as the output variable.
- In the appropriate pop-up windows input the following parameters:
  Growth rate: change every 10 cycles or 5 seconds
  CONTROLS:
  learning rate 0.7, click the Optimize box for learning rate
  momentum 0.8, click the Optimize box for momentum
  Validation: select 10 examples from 78 Training samples
  Stop on 5000 cycles (don't forget to click the check box to the left of "Stop")

2. What factors affect whether a NFL field goal attempt is successful? (A field goal attempt is successful if the kicked ball travels between the uprights of the goal post; a successful field goal kick is worth 3 points). The distance that the football is kicked has an affect on the difficulty of the attempt, but other environmental variables also have an affect.

In the Excel file ***FIELD GOALS NFL AND ENVIRON VARS.xls*** on our class webpage
www.stat.ncsu.edu/people/reiland/courses/st504/
are data for all 2003 field goal attempts in the *National Football League* for 2 recent seasons. The variables included in the file are described below.

Distance: length in yards of the field goal
Weather: (text variable) Sun = sunny, Inside = in a dome stadium, Clouds = cloudy, Rain/Snow = raining or snowing
Temperature: (text variable) Nice = inside dome stadiuim or 40 degrees < temperature < 80 degrees, Cold = temperature $\leq$ 40 degrees, Hot = temperature $\geq$ 80 degrees
Wind15: (boolean variable) = 1 if wind speed > 15 mph, 0 if windspeed $\leq$ 15 mph
Grass: (boolean variable) = 1 if grass field, 0 if artificial turf
Pressure: (boolean variable) = Y if field goal attempted under pressure (see definition below), = N otherwise
Ice: (boolean variable) = 1 if kicker was "iced" (see definition below), = 0 otherwise (note that a 1 can occur only if Pressure = 1 so Ice is a nested effect)
Good: (boolean variable) = Y if field goal attempt is successful, = N if field goal attempt is not successful

*A field goal attempt is a **Pressure** kick if it takes place within the last 3 minutes of the 4th quarter or in overtime AND could create a tie or put the kicking team ahead.

* A kicker is considered **Iced** if the opponent calls a time-out before a **pressure** kick.

The field goal kicker for your favorite team is attempting to make a field goal with the following variable values:
Distance **57** yards, ***Weather*** **SnowRain**, ***Wind15*** **true**, ***Temperature*** **Cold**, ***Grass*** **true**, ***Pressure*** **Y**, ***Ice*** **true**

QUESTION: will the kick be successful? If the field goal attempt is predicted to be not successful, what is the approximate maximum distance for which the field goal attempt is predicted to be successful (with all other input variables unchanged)?

Use a neural network to answer the above question. **JMP Pro** is free to students and can be downloaded from the NCSU website. Or go to the website http://www.justnn.com/ and click *Download JustNN* to download the free neural network software. If you did not do so for question 1, view the 3 examples in Getting Started (it takes 8 to 10 minutes) to learn how to use the software. Then click File --> New, File --> Import to open the Excel file ***FIELD GOALS NFL AND ENVIRON VARS.xls*** in JustNN.

- Use *Distance, Weather, Temperature,, Wind15, Grass, Pressure*, and *Ice* as the input variables and *Good* as the output variable
- In the appropriate pop-up windows input the following parameters:
  Growth rate: change every 10 cycles or 5 seconds
  CONTROLS:
  learning rate 0.7, click the Optimize box for learning rate
  momentum 0.8, click the Optimize box for momentum
  Validation: select 10 examples from 2003 Training samples
  Stop on 5000 cycles (don't forget to click the check box to the left of "Stop")