Horse Racing Analysis

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Introduction

This analysis devles into horse racing data, and attempting to identify ways to predict which horse will win, and the best way to make a profit from betting on horse racing in Australia.

The horse racing data was sourced from the Racing Australia website under the racing results tab. The Racing Australia website only stores data for the previous month of races, however it does include trial runs. The race data includes information such as the barrier, weight the horse is carrying, the trainer, the jockey, the date, the track, among many other attributes. The position of the horse at the end of the race, and the length the horse lost by (in lengths) are also included in the data, however lengths is an arbitrary unit of distance, so this was converted to metres by assuming a single horse length was 2.5 metres. The horse racing data initially looks like this:

Finish	No.	Horse	Trainer	Jockey	Margin	Barrier	Weight	Starting Price	race_character	race_info	info	odds	Date	Start	Track	Distance	Track_condition	Time
1	2	BOMBARDIER FRANKIE	Aaron Nicholls	Nick Hey-wood	9	59	$11		Of $24,000.1st $12,280, 2nd $4,440, 3rd $2,300, 4th $1,200, 5th $750, 6th $550, 7th $500, 8th $500, 9th $500, 10th $500, Equine Welfare Fund $240, Jockey Welfare Fund $240. Maiden, Set Weights, Apprentices can claim.BOBS Silver Bonus Available Up To $9625Track Name: Main Track Type: Turf Track Condition: Heavy 8 Time: 1:01.06 Last 600m: 0:37.11 Timing Method: Electronic INTERIM RESULTS	Race 1 - 12:55PM MER-IM-BULA RSL MAIDEN PLATE (1005 ME-TRES)								

Finish	No.	Horse	Trainer	Jockey	Margin	Barrier	Weight	Starting Price	Race Character	race_info	info	odds	Date	Start	Race	Track	Distance	Track Condition	Time
Times displayed in local time of Race Meeting	2022-05-01	2022-05-01	NSW	Coast	1	1	1005	T	Track Condition: Heavy 8	1:01.06									
2	9	STUDLY SUNRISE	Nicholas Rolfe	Travers	4	10	12	L	57	$20	Of $24,000.1st $12,280, 2nd $4,440, 3rd $2,300, 4th $1,200, 5th $750, 6th $550, 7th $500, 8th $500, 9th $500, 10th $500, Equine Welfare Fund $240, Jockey Welfare Fund $240. Maiden, Set Weights, Apprentices can claim.BOBS Silver Bonus Available Up To $9625Track Name: Main Track Type: Turf Track Condition: Heavy 8 Time: 1:01.06 Last 600m: 0:37.11 Timing Method: Electronic INTERIM RESULTS	Race 1 - 12:55PM MER-IM-BULA RSL MAIDEN PLATE (1005 ME-TRES)								
Times displayed in local time of Race Meeting	2022-05-01	2022-05-01	NSW	Coast	1	1	1005	T	Track Condition: Heavy 8	1:01.06									

Finish	No.	Horse	Trainer	Jockey	Margin	Barrier	Weight	Starting Price	character	race_info	info	odds	Date State_racecourse Race Day distance track_condition time
3	11	STEAMED HAMS	Natalie Jarvis	Kayla Nisbet	0.5L	12	55	$6.50	Of $24,000.1st $12,280, 2nd $4,440, 3rd $2,300, 4th $1,200, 5th $750, 6th $550, 7th $500, 8th $500, 9th $500, 10th $500, Equine Welfare Fund $240, Jockey Welfare Fund $240. Maiden, Set Weights, Apprentices can claim.BOBS Silver Bonus Available Up To $9625Track Name: Main Track Type: Turf Track Condition: Heavy 8 Time: 1:01.06 Last 600m: 0:37.11 Timing Method: Electronic INTERIM RESULTS	Race 1 - 12:55PM MERIMBULA RSL MAIDEN PLATE (1005 METRES)			
Times displayed in local time of Race Meeting	25 May 2022, NSW, Sapphire Coast		2022-05-01	NSW	Sapphire Coast	1st		1005	Track Condition: Heavy 8 T	1:01.06			
4	6	RAGING RIVER	Greg Backhouse	Ms Jess Del Frari (a2/51.5kg)	1.38L	10	57	$19	Of $24,000.1st $12,280, 2nd $4,440, 3rd $2,300, 4th $1,200, 5th $750, 6th $550, 7th $500, 8th $500, 9th $500, 10th $500, Equine Welfare Fund $240, Jockey Welfare Fund $240. Maiden, Set Weights, Apprentices can claim.BOBS Silver Bonus Available Up To $9625Track Name: Main Track Type: Turf Track Condition: Heavy 8 Time: 1:01.06 Last 600m: 0:37.11 Timing Method: Electronic INTERIM RESULTS	Race 1 - 12:55PM MERIMBULA RSL MAIDEN PLATE (1005 METRES)			

Finish	No.	Horse	Trainer	Jockey	Margin	Bar.	Weight	Starting Price	character	race_info	info	odds	Date	State_from	Racecourse	Race Day	distance	track_condition	time
Times displayed in local time of Race Meeting	2022	29 May 2022 Coast	2022-05-01	NSW	Sapphire Coast	Race 1st	1005		Track Condition: Heavy 8 T	1:01.06									
5	1	BLUE GROTTO	Jamie Quay Stewart	Steve Hough	3.68	8	59	$2.60F	OF $24,000.1st $12,280, 2nd $4,440, 3rd $2,300, 4th $1,200, 5th $750, 6th $550, 7th $500, 8th $500, 9th $500, 10th $500, Equine Welfare Fund $240, Jockey Welfare Fund $240. Maiden, Set Weights, Apprentices can claim.BOBS Silver Bonus Available Up To $9625Track Name: Main Track Type: Turf Track Condition: Heavy 8 Time: 1:01.06 Last 600m: 0:37.11 Timing Method: Electronic INTERIM RESULTS	Race 1 - 12:55PM MERIMBULA RSL MAIDEN PLATE (1005 METRES)									
Times displayed in local time of Race Meeting	2022	16 May 2022 Coast	2022-05-01	NSW	Sapphire Coast	Race 1st	1005		Track Condition: Heavy 8 T	1:01.06									

Finish	No.	Horse	Trainer	Jockey	Margin	Bar	Weight	Starting Price	character	race_info	info	odds	Date	State	Racecourse	Race	Day	distance	track_condition	time
6	7	RAIN EM OUT	Lynda Bundy	Ruby Haylock (a3/52.5kg)	3.69	5L	57	$21	Of $24,000.1st $12,280, 2nd $4,440, 3rd $2,300, 4th $1,200, 5th $750, 6th $550, 7th $500, 8th $500, 9th $500, 10th $500, Equine Welfare Fund $240, Jockey Welfare Fund $240. Maiden, Set Weights, Apprentices can claim.BOBS Silver Bonus Available Up To $9625Track Name: Main Track Type: Turf Track Condition: Heavy 8 Time: 1:01.06 Last 600m: 0:37.11 Timing Method: Electronic INTERIM RESULTS	Race 1 - 12:55PM MERIMBULA RSL MAIDEN PLATE (1005 METRES)										
Times displayed in local time of Race Meeting	2022 May 01, NSW, Sapphire Coast		2022-05-01	NSW	Sapphire Coast	1st		1005	Track Condition: Heavy 8 T	1:01.06										

After scraping the data, it was decided to convert each horses run into an approximate time estimation, by taking each race's winning time, and the using the trailing horses distance and estimating their final time by adding time allowing for each horse to cover their losing distance at the winners average speed throughout the race. These times look like this:

```r
# creating time function to approximate a finish time for all horses, not just winning horses
time_function <- function(dataset){
dataset$winning_time_sec<- as.numeric(gsub(":","",str_extract(dataset$winning_time,":\\d+.\\d+")))

dataset$winning_time_min <- as.numeric(str_extract(dataset$winning_time,"\\d+"))*60
dataset$winning_time_total <- dataset$winning_time_min+dataset$winning_time_sec
dataset$Margin <- gsub("L","",dataset$Margin)
## using the assumption that a horse length is roughly 2.5 metres
dataset$Margin_Metres <- as.numeric(dataset$Margin)*2.5
dataset$winner_MperSec <- dataset$distance/dataset$winning_time_total

dataset$time <- dataset$winning_time_total+
  ifelse(is.na(dataset$Margin_Metres/dataset$winner_MperSec),
         0,
         dataset$Margin_Metres/dataset$winner_MperSec)
return(dataset)
```

```
}

#calculating times for all races - hoping this helps improve accuracy
all_race_data <- time_function(all_race_data)

kable(head(all_race_data %>%
        select(Horse,
               Jockey,
               Trainer,
               distance,
               Margin,
               winning_time_total,
               time)))
```

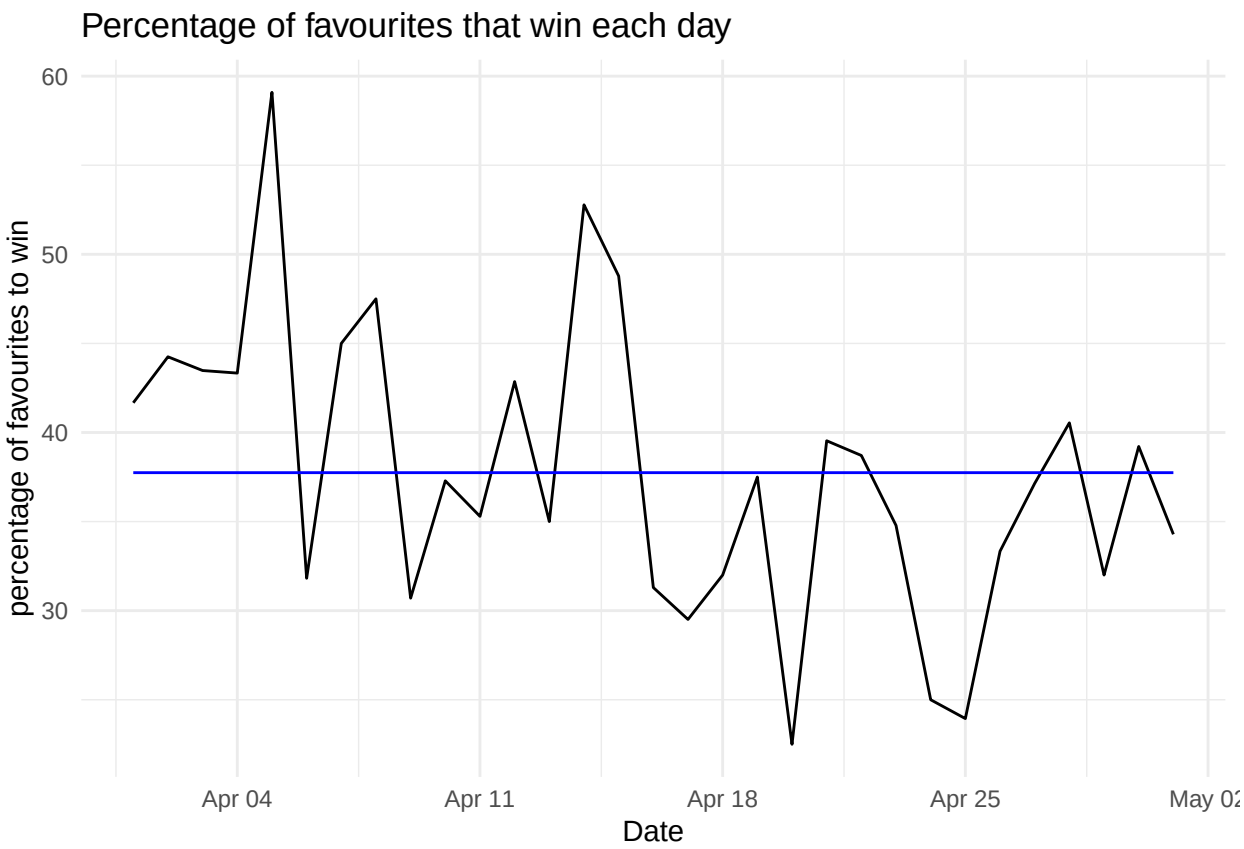
Horse	Jockey	Trainer	distance	Margin	winning_time_total	time
BON FRANKIE	Nick Heywood	Aaron Clarke	1005		61.06	61.06000
STUNNING SUNRISE	Michael Travers	Darryl Rolfe	1005	0.12	61.06	61.07823
STEAMED HAMS	Ms Kayla Nisbet	Natalie Jarvis	1005	0.5	61.06	61.13595
RAGING RIVER	Ms Jess Del Frari (a2/51.5kg)	Greg Backhouse	1005	1.38	61.06	61.26961
BLUE GROTTO	Quayde Krogh	Jamie Stewart	1005	3.6	61.06	61.60681
RAINED OUT	Ms Ruby Haylock (a3/52.5kg)	Lynda Bundy	1005	3.69	61.06	61.62048

Assessing Favouritism

In this section, a brief assessment of the favouritism is assessed. Specifically, how often the favourite (the horse with the lowet odds at the time of the race) wins.

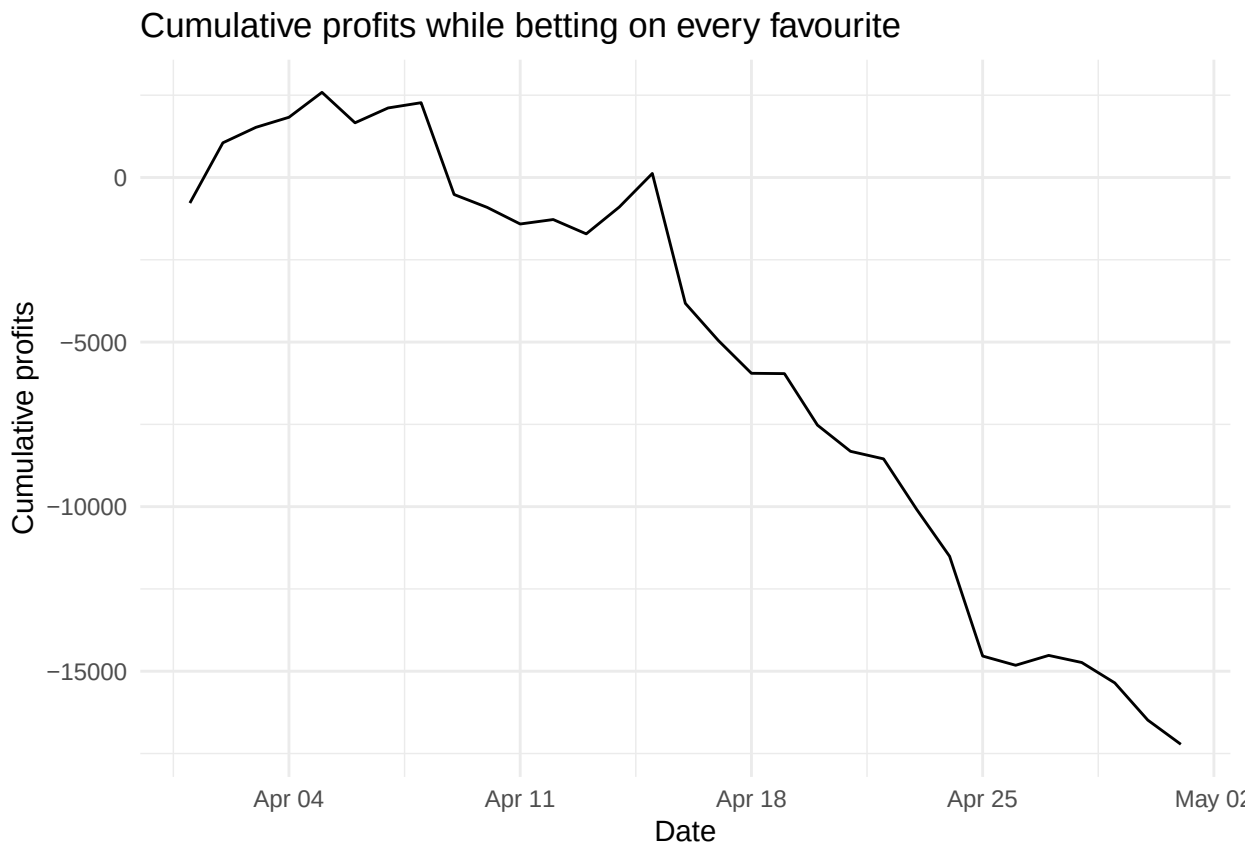
```
##cleaning the race data a little bit more before getting into some exploratory analysis
all_race_data_clean <- all_race_data %>%
  select(-winning_time,
         -winning_time_sec,
         -winning_time_min,
         -winning_time_total,
         -winner_MperSec) %>%
  mutate(RaceID = paste(info,",",Race),
         ID = paste(info,",",Race,"Finish-", Finish),
         Margin_Metres = ifelse(is.na(Margin_Metres)==T, 0, Margin_Metres),
         winner = ifelse(Finish==1,1,0),
         track_condition = gsub('.{2}$','',track_condition),
         Weight = ifelse(is.na(Weight),0,Weight),
         Race_time = str_extract(race_info,"\\d+:\\d+[AP]M"),
         Datetime = as.POSIXct(paste(Date_format, " ", Race_time), format = "%Y-%m-%d %I:%M%p")) %>%
  filter(time >0,
         is.na(Finish)!=T,
         track_condition!="character(") %>%
```

```
  arrange(Datetime,RaceID, Finish) %>%
  group_by(RaceID) %>%
  mutate(favourite = ifelse(odds == min(odds),1,0),
         fav_winner = ifelse(favourite ==1 & winner ==1,1,0)) %>%
  ungroup() %>%
  na.omit() %>%
  data.frame()


## Assessing how often the favourite wins
fav_win_odds <- all_race_data_clean %>%
  filter(!is.na(odds)) %>%
  group_by(Date_format) %>%
  summarise(num_fav_winners = sum(fav_winner, na.rm = T),
            races = length(unique(RaceID)),
            fav_win_odds = (num_fav_winners/races)*100)


##Plotting favourite winning rate per day over the previous month
ggplot(fav_win_odds) +
  geom_line(aes(x=Date_format, y = fav_win_odds))+
  geom_line(aes(x=Date_format, y = mean(fav_win_odds)), colour = "blue")+
  labs(title = "Percentage of favourites that win each day",
       x= "Date",
       y = "percentage of favourites to win")+
  theme_minimal()
```



After seeing that the favourite wins approximately 40% of the time, a quick trial of how betting $100 on every favourite would turn out financially was run, with the results being below.

```
## looking at how you end up if you bet $100 on every favourite
every_favourite <- all_race_data_clean %>%
  #only need the favourite for each race
  filter(favourite ==1) %>%
  arrange(Datetime,RaceID) %>%
  ungroup() %>%
  mutate(race_result = ifelse(winner ==1,(100*odds)-100,-100),
         cumulative_race_total = cumsum(race_result)) %>%
  group_by(Date_format) %>%
  slice(c(n()))

#plotting outcomes if a bet on every favourite is placed
ggplot(every_favourite) +
  geom_line(aes(x=Date_format,y=cumulative_race_total)) +
  labs(title = "Cumulative profits while betting on every favourite",
       x = "Date",
       y = "Cumulative profits") +
  theme_minimal()
```



Seeing the variability in cashflows, and that this run ends with losing money, it it not simply enough to rely on the odds of the bookmaker and the public. It is important that we try to predict a winner. To do this initially, a generalized linear model is used to model a winning horse, using important variables such as the barrier, weight, track condition, and distance. Variables such as Horse, Jockey and Trainer have been excluded initially as these variables may only appear once or not at all in the training set.

```
#splitting data by date to use last 2 days as test data, the rest as train data
train_horse_data <- all_race_data_clean[!all_race_data_clean$Datetime>'2022-04-28',]
test_horse_data <- all_race_data_clean[all_race_data_clean$Datetime>'2022-04-28',]

#creating basic glm to predict winning horse
glm_winner <- glm(data = train_horse_data, formula = winner ~ Bar. + Weight + track_condition + distanc

#summary of glm model shows barrier and weight are only significant variables
summary(glm_winner)
```

```
FALSE
FALSE Call:
FALSE glm(formula = winner ~ Bar. + Weight + track_condition + distance +
FALSE     odds, family = binomial, data = train_horse_data)
FALSE
FALSE Deviance Residuals:
FALSE     Min       1Q   Median       3Q      Max
FALSE -0.8477  -0.5967  -0.3618  -0.0717   4.9440
FALSE
FALSE Coefficients:
```

```
FALSE                                          Estimate Std. Error z value Pr(>|z|)
FALSE (Intercept)                             -6.586e-01  7.924e-01  -0.831    0.406
FALSE Bar.                                    -1.504e-02  1.024e-02  -1.469    0.142
FALSE Weight                                  -4.386e-03  1.142e-02  -0.384    0.701
FALSE track_conditionTrack Condition: Good 3   1.800e-01  3.848e-01   0.468    0.640
FALSE track_conditionTrack Condition: Good 4   2.190e-01  3.726e-01   0.588    0.557
FALSE track_conditionTrack Condition: Heavy 10 2.875e-01  3.881e-01   0.741    0.459
FALSE track_conditionTrack Condition: Heavy 8  1.748e-01  3.928e-01   0.445    0.656
FALSE track_conditionTrack Condition: Heavy 9  2.325e-01  3.906e-01   0.595    0.552
FALSE track_conditionTrack Condition: Soft 5   2.526e-01  3.772e-01   0.670    0.503
FALSE track_conditionTrack Condition: Soft 6   2.526e-01  3.910e-01   0.646    0.518
FALSE track_conditionTrack Condition: Soft 7   2.510e-01  3.827e-01   0.656    0.512
FALSE distance                                -1.033e-07  8.596e-05  -0.001    0.999
FALSE odds                                    -1.262e-01  5.930e-03 -21.284   <2e-16
FALSE
FALSE (Intercept)
FALSE Bar.
FALSE Weight
FALSE track_conditionTrack Condition: Good 3
FALSE track_conditionTrack Condition: Good 4
FALSE track_conditionTrack Condition: Heavy 10
FALSE track_conditionTrack Condition: Heavy 8
FALSE track_conditionTrack Condition: Heavy 9
FALSE track_conditionTrack Condition: Soft 5
FALSE track_conditionTrack Condition: Soft 6
FALSE track_conditionTrack Condition: Soft 7
FALSE distance
FALSE odds                                    ***
FALSE ---
FALSE Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
FALSE
FALSE (Dispersion parameter for binomial family taken to be 1)
FALSE
FALSE     Null deviance: 8508.6  on 12214  degrees of freedom
FALSE Residual deviance: 7349.5  on 12202  degrees of freedom
FALSE AIC: 7375.5
FALSE
FALSE Number of Fisher Scoring iterations: 8
```

```
#attempting to predict winner through glm
fitted.results <- predict(glm_winner,
                          newdata=test_horse_data,type='response')

#fitted.results <- ifelse(fitted.results > 0.5,1,0)
##oh no, glm dont predict any horses winning
cat(glue("The GLM's largest prediction for a horse winning is {round(max(fitted.results)*100,2)}%"))
```

```
FALSE The GLM's largest prediction for a horse winning is 30.22%
```

As the GLM found no way to make any predictions where a horse would win, it was decided that we will try using a random forest to predict some winning horses via classification.

```
library(randomForest)
#random forest
rf_winner <- randomForest(data = train_horse_data,winner ~ Bar. + Weight + track_condition + distance +
# random forest model summary
rf_winner
```

```
FALSE
FALSE Call:
FALSE  randomForest(formula = winner ~ Bar. + Weight + track_condition +      distance + odds, data = t
FALSE                Type of random forest: regression
FALSE                      Number of trees: 500
FALSE No. of variables tried at each split: 1
FALSE
FALSE           Mean of squared residuals: 0.08823372
FALSE                     % Var explained: 10.48
```

```
#predicting horse races on the test set
predTrain <- predict(rf_winner, test_horse_data, type = "class")
#converting the prediction probability to a simply win or no win
predTrain <- ifelse(predTrain>=0.5,1,0)

#table of predicted vs actual
cat("Predicted against actual results")
```

```
FALSE Predicted against actual results
```

```
table(test_horse_data$winner,predTrain)
```

```
FALSE    predTrain
FALSE        0    1
FALSE   0 1828    4
FALSE   1  213   11
```

```
#randomforest model summary stats in sentence.
cat(glue("The Random forest does not predict a lot of horses to win (only {sum(predTrain==1)}), however
```

```
FALSE The Random forest does not predict a lot of horses to win (only 15), however its accuracy of 89.4
```

```
#testing to see if betting on these races can be profitable
test_horse_data_rf_bet <- test_horse_data %>%
  mutate(pred = predTrain) %>%
  filter(pred == 1) %>%
  #calculating required bet amount to profit $100 if the horse wins
  mutate(bet = 100/(odds-1),
         profit = ifelse(winner==1,(bet*odds)-bet,-bet),
         roll_total = cumsum(profit))


kable(test_horse_data_rf_bet %>%
        select(Horse,
```

```
            RaceID,
            Bar.,
            Weight,
            distance,
            track_condition,
            odds,
            winner,
            bet,
            profit,
            roll_total))
```

Horse	RaceID	Bar.	Weight	distance	track_condition	odds	winner	bet	profit	roll_total
AFRICAN DAISY	2022Apr28,NSW,Wyong , Race 1	6	56.5	1350	Track Condition: Heavy 10	1.24	1	416.66667	100.00000	100.00000
ZIPPING IRISH	2022Apr28,QLD,Mackay , Race 2	7	56.5	1200	Track Condition: Soft 7	1.45	0	222.22222	-222.22222	-22.22222
OUTBACK ACTION	2022Apr28,VIC,Mornington , Race 2	9	59.0	1200	Track Condition: Good 4	1.30	1	333.33333	100.00000	-22.22222
HILTON	2022Apr28,WA,Narrogin , Race 7	1	57.5	1100	Track Condition: Good 3	1.50	1	200.00000	100.00000	77.77778
COUNT DA BEANS	2022Apr29,NSW,Grafton , Race 2	3	57.0	1206	Track Condition: Heavy 8	1.50	1	200.00000	100.00000	177.77778
AUDETTE	2022Apr29,NSW,Muswellbrook , Race 4	5	57.5	1450	Track Condition: Soft 7	2.15	0	86.95652	-86.95652	90.82126
DAWN ISSUE	2022Apr30,QLD,Aquis Beaudesert , Race 4	2	56.5	1200	Track Condition: Soft 5	1.60	1	166.66667	100.00000	190.82126
PRUNDA	2022Apr30,QLD,Barcaldine , Race 3	4	57.5	1600	Track Condition: Soft 6	2.15	0	86.95652	-86.95652	103.86473
ECHO POINT	2022Apr30,QLD,Barcaldine , Race 4	3	61.0	1600	Track Condition: Soft 5	1.30	1	333.33333	100.00000	203.86473
ALMSGIVER (NZ)	2022Apr30,VIC,Horsham , Race 4	2	60.0	1800	Track Condition: Soft 6	2.80	1	55.55556	100.00000	303.86473
HOSTWIN TORON-ADO	2022Apr30,QLD,Aquis Beaudesert , Race 6	2	57.5	1200	Track Condition: Soft 5	1.60	1	166.66667	100.00000	403.86473
ENABLER	2022Apr30,QLD,Toowoomba , Race 4	7	57.5	1000	Track Condition: Soft 5	1.60	1	166.66667	100.00000	503.86473
LEGEND OF THE FALL	2022May01,VIC,bet365 Bairnsdale , Race 1	2	58.0	1200	Track Condition: Soft 6	1.22	1	454.54545	100.00000	603.86473

Horse	RaceID	Bar.	Weight	distance	track_condition	odds	winner	bet	profit	roll_total
BELLE ET RICHE	2022May01,VIC,Bendigo , Race 2	3	56.0	1400	Track Condition: Heavy 8	1.28	1	357.14286	100.00000	703.86473
GAME TO LOVE	2022May01,VIC,Bendigo , Race 4	9	57.5	1000	Track Condition: Heavy 8	1.70	0	142.85714	- 142.85714	561.00759

Whilst we can see this random forest does predict accurately, we were hoping for better in the prediction department. Maybe if we use some machine learning we can get some better predictions. Lets have a look at how a neural network goes with predicting winning horses.

```
#train_params <- trainControl(method = "repeatedcv", number = 3, repeats=2)
nn_train_df <- train_horse_data %>%
                      select(Bar.,Weight, track_condition, distance, odds)

nnet_model <- train(nn_train_df,
                    train_horse_data$winner,
                    method = "nnet",
                    #trControl= train_params,
                    na.action = na.omit
)
```

```
FALSE # weights:  15
FALSE initial  value 2506.961654
FALSE final  value 1443.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 2222.668536
FALSE final  value 1443.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 4537.070634
FALSE final  value 1443.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 1737.765423
FALSE iter  10 value 1291.085989
FALSE iter  20 value 1273.001153
FALSE iter  30 value 1167.234014
FALSE iter  40 value 1103.646522
FALSE iter  50 value 1100.802291
FALSE iter  60 value 1096.784283
FALSE iter  70 value 1095.663733
FALSE final  value 1095.644124
FALSE converged
FALSE # weights:  43
FALSE initial  value 4932.183399
FALSE iter  10 value 1324.193920
FALSE iter  20 value 1270.626630
FALSE iter  30 value 1189.806445
FALSE iter  40 value 1120.790317
```

```
FALSE iter  50 value 1110.097888
FALSE iter  60 value 1109.043488
FALSE iter  70 value 1101.200587
FALSE iter  80 value 1096.099277
FALSE iter  90 value 1095.318088
FALSE iter  90 value 1095.318084
FALSE final  value 1095.318084
FALSE converged
FALSE # weights:  71
FALSE initial  value 3966.099461
FALSE iter  10 value 1342.815145
FALSE iter  20 value 1273.435250
FALSE iter  30 value 1245.095169
FALSE iter  40 value 1209.964299
FALSE iter  50 value 1169.882078
FALSE iter  60 value 1101.200597
FALSE iter  70 value 1084.487417
FALSE iter  80 value 1083.338089
FALSE iter  80 value 1083.338083
FALSE iter  90 value 1083.228073
FALSE iter 100 value 1082.028817
FALSE final  value 1082.028817
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 4634.942917
FALSE iter  10 value 1481.062542
FALSE iter  20 value 1443.438831
FALSE iter  30 value 1443.016538
FALSE iter  40 value 1443.016229
FALSE iter  50 value 1443.015903
FALSE iter  60 value 1443.015558
FALSE iter  70 value 1443.013609
FALSE iter  80 value 1443.012825
FALSE iter  90 value 1443.011875
FALSE iter 100 value 1443.010691
FALSE final  value 1443.010691
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 2151.870979
FALSE iter  10 value 1444.709716
FALSE iter  20 value 1443.003395
FALSE iter  30 value 1442.950067
FALSE iter  40 value 1441.797259
FALSE iter  50 value 1272.574073
FALSE iter  60 value 1272.534743
FALSE iter  70 value 1257.837841
FALSE iter  80 value 1146.336552
FALSE iter  90 value 1137.925907
FALSE iter 100 value 1118.143176
FALSE final  value 1118.143176
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 2768.545843
FALSE iter  10 value 1447.004262
```

```
FALSE iter  20 value 1443.124849
FALSE iter  30 value 1443.123586
FALSE iter  40 value 1443.122146
FALSE iter  50 value 1443.120453
FALSE iter  60 value 1443.118374
FALSE iter  70 value 1443.115664
FALSE iter  80 value 1443.111817
FALSE iter  90 value 1443.105574
FALSE iter 100 value 1443.092699
FALSE final  value 1443.092699
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 3275.871912
FALSE final  value 1366.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 1846.600704
FALSE final  value 1366.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 1653.155470
FALSE final  value 1366.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 3580.156559
FALSE iter  10 value 1275.020787
FALSE iter  20 value 1213.485185
FALSE iter  30 value 1211.865666
FALSE iter  40 value 1143.929164
FALSE iter  50 value 1083.147096
FALSE iter  60 value 1066.790025
FALSE iter  70 value 1065.976045
FALSE iter  80 value 1065.481156
FALSE final  value 1065.479921
FALSE converged
FALSE # weights:  43
FALSE initial  value 1942.129984
FALSE iter  10 value 1222.429429
FALSE iter  20 value 1125.593486
FALSE iter  30 value 1093.433039
FALSE iter  40 value 1073.148839
FALSE iter  50 value 1068.545328
FALSE iter  60 value 1067.510109
FALSE iter  70 value 1065.924434
FALSE iter  80 value 1056.637426
FALSE iter  90 value 1056.210811
FALSE iter 100 value 1055.309675
FALSE final  value 1055.309675
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1585.188170
FALSE iter  10 value 1216.292973
FALSE iter  20 value 1189.947420
FALSE iter  30 value 1129.695802
```

```
FALSE iter  40 value 1085.833386
FALSE iter  50 value 1071.574173
FALSE iter  60 value 1067.396443
FALSE iter  70 value 1063.599468
FALSE iter  80 value 1060.437386
FALSE iter  90 value 1060.172121
FALSE iter 100 value 1059.747935
FALSE final  value 1059.747935
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2049.342907
FALSE iter  10 value 1375.839718
FALSE iter  20 value 1366.113444
FALSE iter  30 value 1366.016049
FALSE iter  40 value 1366.014177
FALSE iter  50 value 1366.013494
FALSE iter  60 value 1366.012684
FALSE iter  70 value 1366.011699
FALSE iter  80 value 1366.010464
FALSE iter  90 value 1366.008850
FALSE iter 100 value 1366.006621
FALSE final  value 1366.006621
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 2287.047151
FALSE iter  10 value 1367.087480
FALSE iter  20 value 1366.029000
FALSE iter  30 value 1366.023295
FALSE iter  40 value 1366.008219
FALSE iter  50 value 1365.845833
FALSE iter  60 value 1213.274624
FALSE iter  70 value 1213.243525
FALSE iter  80 value 1213.240782
FALSE final  value 1213.240753
FALSE converged
FALSE # weights:  71
FALSE initial  value 1242.828862
FALSE iter  10 value 1213.231740
FALSE final  value 1213.230342
FALSE converged
FALSE # weights:  15
FALSE initial  value 2214.498668
FALSE final  value 1348.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 4141.060493
FALSE final  value 1348.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 4954.122648
FALSE final  value 1348.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 4204.344665
```

```
FALSE iter  10 value 1199.824991
FALSE final  value 1199.675202
FALSE converged
FALSE # weights:  43
FALSE initial  value 2727.455136
FALSE iter  10 value 1248.295592
FALSE iter  20 value 1199.546935
FALSE iter  30 value 1199.458689
FALSE iter  40 value 1195.340513
FALSE iter  50 value 1177.819031
FALSE iter  60 value 1131.116979
FALSE iter  70 value 1078.719293
FALSE iter  80 value 1063.022812
FALSE iter  90 value 1048.405115
FALSE iter 100 value 1039.679425
FALSE final  value 1039.679425
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 4184.437055
FALSE iter  10 value 1202.674509
FALSE iter  20 value 1199.365099
FALSE iter  30 value 1199.166259
FALSE iter  40 value 1195.929121
FALSE iter  50 value 1083.458540
FALSE iter  60 value 1061.905778
FALSE iter  70 value 1050.558960
FALSE iter  80 value 1046.020142
FALSE iter  90 value 1044.333031
FALSE iter 100 value 1043.236137
FALSE final  value 1043.236137
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 3846.689663
FALSE iter  10 value 1199.244739
FALSE final  value 1199.244722
FALSE converged
FALSE # weights:  43
FALSE initial  value 3660.483084
FALSE iter  10 value 1350.581172
FALSE iter  20 value 1348.051868
FALSE iter  30 value 1348.049608
FALSE iter  40 value 1348.046006
FALSE iter  50 value 1348.038962
FALSE iter  60 value 1348.017196
FALSE iter  70 value 1345.340251
FALSE iter  80 value 1199.291405
FALSE final  value 1199.240114
FALSE converged
FALSE # weights:  71
FALSE initial  value 3471.378414
FALSE iter  10 value 1199.291755
FALSE iter  20 value 1197.291758
FALSE iter  30 value 1148.536998
FALSE iter  40 value 1061.340831
```

```
FALSE iter  50 value 1054.711322
FALSE iter  60 value 1047.616993
FALSE iter  70 value 1042.894813
FALSE iter  80 value 1041.188556
FALSE iter  90 value 1040.306464
FALSE iter 100 value 1039.842348
FALSE final  value 1039.842348
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 3197.638989
FALSE final  value 1317.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 4516.191936
FALSE final  value 1317.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 2526.317638
FALSE final  value 1317.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 3420.275424
FALSE iter  10 value 1224.406559
FALSE iter  20 value 1142.508776
FALSE iter  30 value 1086.953844
FALSE iter  40 value 1058.701230
FALSE iter  50 value 1041.311782
FALSE iter  60 value 1037.726785
FALSE iter  70 value 1036.919006
FALSE iter  80 value 1036.728402
FALSE iter  80 value 1036.728401
FALSE iter  80 value 1036.728401
FALSE final  value 1036.728401
FALSE converged
FALSE # weights:  43
FALSE initial  value 4347.393614
FALSE iter  10 value 1225.525872
FALSE iter  20 value 1152.362233
FALSE iter  30 value 1088.837119
FALSE iter  40 value 1051.483457
FALSE iter  50 value 1039.890452
FALSE iter  60 value 1032.587558
FALSE iter  70 value 1029.907657
FALSE iter  80 value 1027.980700
FALSE iter  90 value 1027.597289
FALSE iter 100 value 1027.385309
FALSE final  value 1027.385309
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1740.010625
FALSE iter  10 value 1247.959390
FALSE iter  20 value 1174.637372
FALSE iter  30 value 1159.484648
FALSE iter  40 value 1067.361568
```

```
FALSE iter  50 value 1050.268954
FALSE iter  60 value 1043.897527
FALSE iter  70 value 1038.277933
FALSE iter  80 value 1035.849957
FALSE iter  90 value 1032.381296
FALSE iter 100 value 1032.144537
FALSE final  value 1032.144537
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 3928.462552
FALSE iter  10 value 1319.799547
FALSE iter  20 value 1317.031723
FALSE iter  30 value 1317.031336
FALSE iter  40 value 1317.030931
FALSE iter  50 value 1317.030504
FALSE iter  60 value 1317.030053
FALSE iter  70 value 1317.029575
FALSE iter  80 value 1317.029066
FALSE iter  90 value 1317.028519
FALSE iter 100 value 1317.027931
FALSE final  value 1317.027931
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 2169.703440
FALSE final  value 1175.014481
FALSE converged
FALSE # weights:  71
FALSE initial  value 1998.458207
FALSE iter  10 value 1318.931109
FALSE iter  20 value 1317.096035
FALSE iter  30 value 1317.094268
FALSE iter  40 value 1317.092009
FALSE iter  50 value 1317.088910
FALSE iter  60 value 1317.084186
FALSE iter  70 value 1317.075608
FALSE iter  80 value 1317.053435
FALSE iter  90 value 1316.833620
FALSE iter 100 value 1175.093890
FALSE final  value 1175.093890
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2149.913866
FALSE final  value 1337.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 2509.177073
FALSE final  value 1337.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 2981.081847
FALSE iter  10 value 1336.987172
FALSE iter  20 value 1336.974553
FALSE iter  30 value 1336.722565
FALSE final  value 1190.657880
```

```
FALSE converged
FALSE # weights:  15
FALSE initial  value 3666.458571
FALSE iter  10 value 1397.047007
FALSE iter  20 value 1191.339457
FALSE iter  30 value 1189.440414
FALSE iter  40 value 1160.676548
FALSE iter  50 value 1100.229550
FALSE iter  60 value 1058.211841
FALSE iter  70 value 1044.172663
FALSE iter  80 value 1037.848363
FALSE iter  90 value 1034.999746
FALSE iter 100 value 1034.470892
FALSE final  value 1034.470892
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 4663.524427
FALSE iter  10 value 1259.984541
FALSE iter  20 value 1190.567664
FALSE iter  30 value 1093.200146
FALSE iter  40 value 1065.398020
FALSE iter  50 value 1048.353999
FALSE iter  60 value 1036.439923
FALSE iter  70 value 1029.299817
FALSE iter  80 value 1025.925868
FALSE iter  90 value 1024.828089
FALSE iter 100 value 1024.264744
FALSE final  value 1024.264744
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 9105.106322
FALSE iter  10 value 1288.363566
FALSE iter  20 value 1185.676183
FALSE iter  30 value 1175.534574
FALSE iter  40 value 1096.459451
FALSE iter  50 value 1070.312986
FALSE iter  60 value 1064.891797
FALSE iter  70 value 1047.952856
FALSE iter  80 value 1038.676750
FALSE iter  90 value 1035.358257
FALSE iter 100 value 1034.135387
FALSE final  value 1034.135387
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2932.038255
FALSE iter  10 value 1360.347914
FALSE iter  20 value 1337.269183
FALSE iter  30 value 1337.015036
FALSE iter  40 value 1337.014651
FALSE iter  50 value 1337.014238
FALSE iter  60 value 1337.007196
FALSE iter  70 value 1337.004415
FALSE iter  80 value 1336.999984
FALSE iter  90 value 1336.991625
```

```
FALSE iter 100 value 1336.969257
FALSE final  value 1336.969257
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 2034.251031
FALSE iter  10 value 1338.199564
FALSE iter  20 value 1337.040309
FALSE iter  30 value 1337.020507
FALSE iter  40 value 1336.869900
FALSE iter  50 value 1190.713588
FALSE iter  60 value 1190.670393
FALSE iter  70 value 1190.658128
FALSE iter  80 value 1102.297297
FALSE iter  90 value 1086.765049
FALSE iter 100 value 1083.278803
FALSE final  value 1083.278803
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 2096.742401
FALSE iter  10 value 1338.319272
FALSE iter  20 value 1337.017454
FALSE iter  30 value 1336.985365
FALSE iter  40 value 1191.061458
FALSE iter  50 value 1190.670533
FALSE iter  60 value 1152.071227
FALSE iter  70 value 1147.825845
FALSE iter  80 value 1147.194446
FALSE iter  90 value 1133.266958
FALSE iter 100 value 1090.070524
FALSE final  value 1090.070524
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 3286.231932
FALSE final  value 1315.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 3939.076960
FALSE final  value 1315.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 2992.789554
FALSE final  value 1315.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 3608.446104
FALSE iter  10 value 1307.330663
FALSE iter  20 value 1173.908077
FALSE iter  30 value 1165.006319
FALSE iter  40 value 1053.490584
FALSE iter  50 value 1038.637332
FALSE iter  60 value 1037.443597
FALSE iter  70 value 1036.827129
FALSE final  value 1036.790035
FALSE converged
```

```
FALSE # weights:  43
FALSE initial  value 1695.280923
FALSE iter  10 value 1175.346765
FALSE iter  20 value 1168.985603
FALSE iter  30 value 1157.285175
FALSE iter  40 value 1076.122635
FALSE iter  50 value 1044.870879
FALSE iter  60 value 1040.702396
FALSE iter  70 value 1037.764781
FALSE iter  80 value 1035.407420
FALSE iter  90 value 1031.575666
FALSE iter 100 value 1025.053061
FALSE final  value 1025.053061
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1239.534584
FALSE iter  10 value 1167.952245
FALSE iter  20 value 1127.432052
FALSE iter  30 value 1096.101994
FALSE iter  40 value 1059.063466
FALSE iter  50 value 1048.463274
FALSE iter  60 value 1039.650373
FALSE iter  70 value 1038.055299
FALSE iter  80 value 1037.201622
FALSE iter  90 value 1035.439727
FALSE iter 100 value 1029.728170
FALSE final  value 1029.728170
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2837.263689
FALSE iter  10 value 1337.242322
FALSE iter  20 value 1315.256437
FALSE iter  30 value 1315.012897
FALSE iter  40 value 1315.012341
FALSE iter  50 value 1315.011729
FALSE iter  60 value 1315.011050
FALSE iter  70 value 1315.010289
FALSE iter  80 value 1314.647132
FALSE final  value 1173.441977
FALSE converged
FALSE # weights:  43
FALSE initial  value 1462.854228
FALSE iter  10 value 1315.195975
FALSE iter  20 value 1315.053648
FALSE iter  30 value 1315.052473
FALSE iter  40 value 1315.050948
FALSE iter  50 value 1315.048816
FALSE iter  60 value 1315.045488
FALSE iter  70 value 1315.039218
FALSE iter  80 value 1315.021674
FALSE iter  90 value 1314.688483
FALSE iter 100 value 1173.484265
FALSE final  value 1173.484265
FALSE stopped after 100 iterations
```

```
FALSE # weights:  71
FALSE initial  value 1297.192967
FALSE final  value 1173.435589
FALSE converged
FALSE # weights:  15
FALSE initial  value 2760.990694
FALSE final  value 1340.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 4230.555151
FALSE final  value 1340.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 5683.939040
FALSE final  value 1340.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 1970.591362
FALSE iter  10 value 1289.414375
FALSE iter  20 value 1194.470011
FALSE iter  30 value 1193.233912
FALSE iter  40 value 1189.227830
FALSE iter  50 value 1175.976450
FALSE iter  60 value 1103.300570
FALSE iter  70 value 1080.512462
FALSE iter  80 value 1053.357994
FALSE iter  90 value 1029.862470
FALSE iter 100 value 1025.574988
FALSE final  value 1025.574988
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 1453.091732
FALSE iter  10 value 1210.164142
FALSE iter  20 value 1195.083618
FALSE iter  30 value 1193.303978
FALSE iter  40 value 1175.199235
FALSE iter  50 value 1119.429268
FALSE iter  60 value 1058.639028
FALSE iter  70 value 1037.279665
FALSE iter  80 value 1027.186413
FALSE iter  90 value 1024.901686
FALSE iter 100 value 1023.882206
FALSE final  value 1023.882206
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 3791.594844
FALSE iter  10 value 1323.029668
FALSE iter  20 value 1193.232173
FALSE iter  30 value 1144.102880
FALSE iter  40 value 1045.116687
FALSE iter  50 value 1027.396726
FALSE iter  60 value 1023.656335
FALSE iter  70 value 1023.003748
FALSE iter  80 value 1021.484512
```

```
FALSE iter  90 value 1015.843054
FALSE iter 100 value 1013.825796
FALSE final  value 1013.825796
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 5117.626912
FALSE iter  10 value 1340.830242
FALSE iter  20 value 1340.083301
FALSE iter  30 value 1334.518186
FALSE iter  40 value 1331.551290
FALSE iter  50 value 1212.772779
FALSE iter  60 value 1182.419152
FALSE iter  70 value 1137.719508
FALSE iter  80 value 1051.091072
FALSE iter  90 value 1049.350358
FALSE iter 100 value 1049.349414
FALSE final  value 1049.349414
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 1473.886004
FALSE final  value 1193.008966
FALSE converged
FALSE # weights:  71
FALSE initial  value 2302.665966
FALSE final  value 1193.019405
FALSE converged
FALSE # weights:  15
FALSE initial  value 1851.090760
FALSE final  value 1353.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 3795.332701
FALSE final  value 1353.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 2728.150825
FALSE final  value 1353.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 3863.229697
FALSE iter  10 value 1247.717051
FALSE iter  20 value 1203.565979
FALSE iter  30 value 1173.180953
FALSE iter  40 value 1148.361211
FALSE iter  50 value 1097.870796
FALSE iter  60 value 1079.057859
FALSE iter  70 value 1058.366871
FALSE iter  80 value 1055.366548
FALSE iter  90 value 1054.647075
FALSE final  value 1054.593272
FALSE converged
FALSE # weights:  43
FALSE initial  value 3671.948810
FALSE iter  10 value 1260.509022
```

```
FALSE iter  20 value 1203.568272
FALSE iter  30 value 1203.461664
FALSE iter  40 value 1198.926272
FALSE iter  50 value 1132.945054
FALSE iter  60 value 1094.368476
FALSE iter  70 value 1064.365141
FALSE iter  80 value 1054.223434
FALSE iter  90 value 1047.335292
FALSE iter 100 value 1046.925497
FALSE final  value 1046.925497
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 4721.236635
FALSE iter  10 value 1226.377792
FALSE iter  20 value 1179.530934
FALSE iter  30 value 1098.722208
FALSE iter  40 value 1078.474586
FALSE iter  50 value 1070.994849
FALSE iter  60 value 1052.663629
FALSE iter  70 value 1044.030874
FALSE iter  80 value 1040.906683
FALSE iter  90 value 1039.732110
FALSE iter 100 value 1038.722395
FALSE final  value 1038.722395
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 1967.015035
FALSE iter  10 value 1353.703979
FALSE iter  20 value 1203.142408
FALSE final  value 1203.140508
FALSE converged
FALSE # weights:  43
FALSE initial  value 1550.431044
FALSE iter  10 value 1353.590760
FALSE iter  20 value 1353.006152
FALSE iter  30 value 1349.735544
FALSE iter  40 value 1203.166523
FALSE iter  50 value 1203.135358
FALSE iter  60 value 1194.694818
FALSE iter  70 value 1175.250685
FALSE iter  80 value 1172.575386
FALSE iter  90 value 1167.269004
FALSE iter 100 value 1139.326584
FALSE final  value 1139.326584
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1985.096677
FALSE final  value 1203.153280
FALSE converged
FALSE # weights:  15
FALSE initial  value 3841.804413
FALSE final  value 1388.000000
FALSE converged
FALSE # weights:  43
```

```
FALSE initial  value 2384.643032
FALSE final  value 1388.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 1266.210474
FALSE final  value 1230.280475
FALSE converged
FALSE # weights:  15
FALSE initial  value 5653.539379
FALSE iter  10 value 1312.099169
FALSE iter  20 value 1230.703761
FALSE iter  30 value 1222.232802
FALSE iter  40 value 1180.723886
FALSE iter  50 value 1135.303393
FALSE iter  60 value 1111.240925
FALSE iter  70 value 1083.648963
FALSE iter  80 value 1075.279441
FALSE iter  90 value 1072.917583
FALSE iter 100 value 1072.258371
FALSE final  value 1072.258371
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 1947.859832
FALSE iter  10 value 1240.845559
FALSE iter  20 value 1230.486316
FALSE iter  30 value 1228.931374
FALSE iter  40 value 1179.024445
FALSE iter  50 value 1103.593862
FALSE iter  60 value 1075.668617
FALSE iter  70 value 1067.361054
FALSE iter  80 value 1059.229505
FALSE iter  90 value 1055.028858
FALSE iter 100 value 1052.307820
FALSE final  value 1052.307820
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 2665.134848
FALSE iter  10 value 1304.638591
FALSE iter  20 value 1229.354581
FALSE iter  30 value 1223.846916
FALSE iter  40 value 1186.767250
FALSE iter  50 value 1103.307669
FALSE iter  60 value 1082.101233
FALSE iter  70 value 1070.950561
FALSE iter  80 value 1069.737454
FALSE iter  90 value 1069.606723
FALSE iter 100 value 1068.068954
FALSE final  value 1068.068954
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2371.293967
FALSE iter  10 value 1389.166446
FALSE iter  20 value 1388.032919
FALSE iter  30 value 1388.032564
```

```
FALSE iter  40 value 1388.032196
FALSE iter  50 value 1388.031811
FALSE iter  60 value 1388.031408
FALSE iter  70 value 1388.030985
FALSE iter  80 value 1388.030538
FALSE iter  90 value 1388.030065
FALSE iter 100 value 1388.029561
FALSE final  value 1388.029561
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 4713.719060
FALSE iter  10 value 1388.066234
FALSE iter  20 value 1388.062170
FALSE iter  30 value 1388.055167
FALSE iter  40 value 1388.039190
FALSE iter  50 value 1387.957919
FALSE iter  60 value 1230.550726
FALSE iter  70 value 1224.613064
FALSE iter  80 value 1130.898486
FALSE iter  90 value 1126.508692
FALSE iter 100 value 1125.079022
FALSE final  value 1125.079022
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 4798.959665
FALSE iter  10 value 1390.193154
FALSE iter  20 value 1231.145967
FALSE iter  30 value 1212.602442
FALSE iter  40 value 1145.920364
FALSE iter  50 value 1143.721583
FALSE iter  60 value 1127.542837
FALSE iter  70 value 1126.116625
FALSE iter  80 value 1125.092263
FALSE iter  90 value 1124.315289
FALSE iter 100 value 1123.093740
FALSE final  value 1123.093740
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 4646.236968
FALSE final  value 1367.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 3181.328297
FALSE final  value 1367.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 1439.554401
FALSE final  value 1367.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 2220.655036
FALSE iter  10 value 1221.569087
FALSE iter  20 value 1214.311795
FALSE iter  30 value 1084.992121
```

```
FALSE iter  40 value 1072.362244
FALSE iter  50 value 1063.863864
FALSE iter  60 value 1062.058601
FALSE iter  70 value 1060.966821
FALSE final  value 1060.927008
FALSE converged
FALSE # weights:  43
FALSE initial  value 3309.651311
FALSE iter  10 value 1424.044489
FALSE iter  20 value 1214.325063
FALSE iter  30 value 1166.207515
FALSE iter  40 value 1143.593962
FALSE iter  50 value 1101.428200
FALSE iter  60 value 1055.459570
FALSE iter  70 value 1047.052340
FALSE iter  80 value 1046.569225
FALSE iter  90 value 1046.215203
FALSE iter 100 value 1045.627603
FALSE final  value 1045.627603
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 3495.895705
FALSE iter  10 value 1388.804806
FALSE iter  20 value 1196.000493
FALSE iter  30 value 1114.415879
FALSE iter  40 value 1087.926598
FALSE iter  50 value 1065.527329
FALSE iter  60 value 1061.840546
FALSE iter  70 value 1053.987337
FALSE iter  80 value 1050.932437
FALSE iter  90 value 1047.100073
FALSE iter 100 value 1046.184826
FALSE final  value 1046.184826
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 1957.012370
FALSE iter  10 value 1367.680120
FALSE iter  20 value 1214.030253
FALSE final  value 1214.025271
FALSE converged
FALSE # weights:  43
FALSE initial  value 3890.453740
FALSE iter  10 value 1371.105591
FALSE iter  20 value 1365.346503
FALSE iter  30 value 1214.050956
FALSE iter  40 value 1214.019044
FALSE iter  50 value 1214.017085
FALSE iter  50 value 1214.017084
FALSE iter  50 value 1214.017084
FALSE final  value 1214.017084
FALSE converged
FALSE # weights:  71
FALSE initial  value 4155.882815
FALSE iter  10 value 1405.319783
```

```
FALSE iter  20 value 1367.441797
FALSE iter  30 value 1367.013077
FALSE iter  40 value 1367.007673
FALSE iter  50 value 1366.995568
FALSE iter  60 value 1366.378036
FALSE iter  70 value 1213.325181
FALSE iter  80 value 1195.339982
FALSE iter  90 value 1087.287015
FALSE iter 100 value 1063.764596
FALSE final  value 1063.764596
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2620.934931
FALSE final  value 1335.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 1273.904209
FALSE final  value 1189.095375
FALSE converged
FALSE # weights:  71
FALSE initial  value 5040.997279
FALSE final  value 1335.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 2564.452230
FALSE iter  10 value 1199.317495
FALSE iter  20 value 1183.846795
FALSE iter  30 value 1171.999206
FALSE iter  40 value 1093.879729
FALSE iter  50 value 1081.224673
FALSE iter  60 value 1057.030760
FALSE iter  70 value 1051.461109
FALSE iter  80 value 1049.744140
FALSE iter  90 value 1049.647941
FALSE final  value 1049.643237
FALSE converged
FALSE # weights:  43
FALSE initial  value 3204.602824
FALSE iter  10 value 1239.146326
FALSE iter  20 value 1187.798442
FALSE iter  30 value 1180.780805
FALSE iter  40 value 1108.683895
FALSE iter  50 value 1094.465398
FALSE iter  60 value 1058.510885
FALSE iter  70 value 1043.429603
FALSE iter  80 value 1034.867831
FALSE iter  90 value 1034.083644
FALSE iter 100 value 1033.898607
FALSE final  value 1033.898607
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 4971.095874
FALSE iter  10 value 1362.063143
FALSE iter  20 value 1182.186181
```

```
FALSE iter  30 value 1161.403708
FALSE iter  40 value 1117.372206
FALSE iter  50 value 1052.568583
FALSE iter  60 value 1046.864507
FALSE iter  70 value 1037.712655
FALSE iter  80 value 1029.783911
FALSE iter  90 value 1026.703087
FALSE iter 100 value 1025.029579
FALSE final  value 1025.029579
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2635.872652
FALSE final  value 1189.099981
FALSE converged
FALSE # weights:  43
FALSE initial  value 5919.668884
FALSE iter  10 value 1339.710533
FALSE iter  20 value 1335.057234
FALSE iter  30 value 1335.053719
FALSE iter  40 value 1335.047931
FALSE iter  50 value 1335.035999
FALSE iter  60 value 1334.993915
FALSE iter  70 value 1193.007722
FALSE iter  80 value 1189.137197
FALSE iter  90 value 1154.191381
FALSE iter 100 value 1128.679926
FALSE final  value 1128.679926
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 4105.488284
FALSE iter  10 value 1189.112045
FALSE final  value 1189.112007
FALSE converged
FALSE # weights:  15
FALSE initial  value 2741.377491
FALSE final  value 1444.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 3560.560181
FALSE final  value 1444.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 1623.724452
FALSE final  value 1444.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 2178.803667
FALSE iter  10 value 1298.145203
FALSE iter  20 value 1273.501867
FALSE iter  30 value 1272.278584
FALSE iter  40 value 1215.053659
FALSE iter  50 value 1131.563116
FALSE iter  60 value 1100.910218
FALSE iter  70 value 1096.727591
```

```
FALSE iter  80 value 1093.971069
FALSE final  value 1093.717047
FALSE converged
FALSE # weights:  43
FALSE initial  value 3489.593934
FALSE iter  10 value 1359.627220
FALSE iter  20 value 1274.008630
FALSE iter  30 value 1273.438291
FALSE iter  40 value 1271.221267
FALSE iter  50 value 1195.696688
FALSE iter  60 value 1100.949014
FALSE iter  70 value 1094.983724
FALSE iter  80 value 1094.483196
FALSE iter  90 value 1093.432701
FALSE iter 100 value 1093.398155
FALSE final  value 1093.398155
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 3923.950807
FALSE iter  10 value 1374.415680
FALSE iter  20 value 1273.439268
FALSE iter  30 value 1273.366516
FALSE iter  40 value 1181.932526
FALSE iter  50 value 1155.479898
FALSE iter  60 value 1132.076804
FALSE iter  70 value 1120.668750
FALSE iter  80 value 1108.590860
FALSE iter  90 value 1095.985003
FALSE iter 100 value 1080.877822
FALSE final  value 1080.877822
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2670.948290
FALSE iter  10 value 1445.483149
FALSE iter  20 value 1444.007657
FALSE iter  30 value 1443.999918
FALSE iter  40 value 1443.986049
FALSE iter  50 value 1443.953106
FALSE iter  60 value 1443.770751
FALSE iter  70 value 1273.744061
FALSE final  value 1273.313242
FALSE converged
FALSE # weights:  43
FALSE initial  value 4369.942039
FALSE iter  10 value 1448.422071
FALSE iter  20 value 1442.633842
FALSE iter  30 value 1273.326739
FALSE iter  40 value 1270.050503
FALSE iter  50 value 1178.820224
FALSE iter  60 value 1092.261020
FALSE iter  70 value 1076.936338
FALSE iter  80 value 1076.198116
FALSE iter  90 value 1072.611965
FALSE iter 100 value 1069.511054
```

```
FALSE final  value 1069.511054
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 2956.695833
FALSE iter  10 value 1273.481417
FALSE final  value 1273.314089
FALSE converged
FALSE # weights:  15
FALSE initial  value 4412.776905
FALSE final  value 1363.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 2013.155137
FALSE final  value 1363.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 3280.391366
FALSE final  value 1363.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 2998.011653
FALSE iter  10 value 1218.682107
FALSE iter  20 value 1189.466424
FALSE iter  30 value 1111.506533
FALSE iter  40 value 1090.885440
FALSE iter  50 value 1070.302159
FALSE iter  60 value 1064.506599
FALSE iter  70 value 1062.579728
FALSE final  value 1062.098848
FALSE converged
FALSE # weights:  43
FALSE initial  value 5879.289700
FALSE iter  10 value 1269.967249
FALSE iter  20 value 1208.345906
FALSE iter  30 value 1202.046520
FALSE iter  40 value 1149.830748
FALSE iter  50 value 1090.442205
FALSE iter  60 value 1073.681389
FALSE iter  70 value 1071.883836
FALSE iter  80 value 1071.124457
FALSE iter  90 value 1062.165800
FALSE iter 100 value 1056.098260
FALSE final  value 1056.098260
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 3589.808513
FALSE iter  10 value 1279.128298
FALSE iter  20 value 1211.223806
FALSE iter  30 value 1211.020685
FALSE iter  40 value 1208.490494
FALSE iter  50 value 1173.556469
FALSE iter  60 value 1094.437313
FALSE iter  70 value 1087.790665
FALSE iter  80 value 1081.874336
```

```
FALSE iter  90 value 1059.655302
FALSE iter 100 value 1050.156429
FALSE final  value 1050.156429
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 1668.169071
FALSE iter  10 value 1363.358918
FALSE iter  20 value 1363.039797
FALSE iter  30 value 1363.039417
FALSE iter  40 value 1363.039023
FALSE iter  50 value 1363.038614
FALSE iter  60 value 1363.038186
FALSE iter  70 value 1363.037739
FALSE iter  80 value 1363.037269
FALSE iter  90 value 1363.036772
FALSE iter 100 value 1363.036246
FALSE final  value 1363.036246
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 1410.487750
FALSE final  value 1210.922466
FALSE converged
FALSE # weights:  71
FALSE initial  value 1362.796315
FALSE final  value 1210.915127
FALSE converged
FALSE # weights:  15
FALSE initial  value 4202.928650
FALSE final  value 1333.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 3973.966993
FALSE final  value 1333.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 1759.751201
FALSE final  value 1333.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 3574.397648
FALSE iter  10 value 1254.913863
FALSE iter  20 value 1187.976758
FALSE iter  30 value 1177.634835
FALSE iter  40 value 1168.448214
FALSE iter  50 value 1080.419441
FALSE iter  60 value 1054.676696
FALSE iter  70 value 1044.838815
FALSE iter  80 value 1043.337002
FALSE iter  90 value 1043.007657
FALSE final  value 1042.985577
FALSE converged
FALSE # weights:  43
FALSE initial  value 2794.469439
FALSE iter  10 value 1243.123473
```

```
FALSE iter  20 value 1182.580003
FALSE iter  30 value 1068.045121
FALSE iter  40 value 1049.590952
FALSE iter  50 value 1047.383653
FALSE iter  60 value 1042.568727
FALSE iter  70 value 1039.799527
FALSE iter  80 value 1037.274734
FALSE iter  90 value 1036.361139
FALSE iter 100 value 1036.033065
FALSE final  value 1036.033065
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 3030.229936
FALSE iter  10 value 1205.690218
FALSE iter  20 value 1187.656912
FALSE iter  30 value 1176.424002
FALSE iter  40 value 1170.723219
FALSE iter  50 value 1170.028116
FALSE iter  60 value 1088.919089
FALSE iter  70 value 1061.891085
FALSE iter  80 value 1051.569937
FALSE iter  90 value 1044.204527
FALSE iter 100 value 1037.185294
FALSE final  value 1037.185294
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2278.793735
FALSE iter  10 value 1334.100257
FALSE iter  20 value 1333.020093
FALSE iter  30 value 1333.016837
FALSE iter  40 value 1333.012324
FALSE iter  50 value 1333.005541
FALSE iter  60 value 1332.993978
FALSE iter  70 value 1332.969191
FALSE iter  80 value 1332.875096
FALSE iter  90 value 1219.860749
FALSE final  value 1187.551607
FALSE converged
FALSE # weights:  43
FALSE initial  value 2615.592341
FALSE iter  10 value 1187.543835
FALSE final  value 1187.543770
FALSE converged
FALSE # weights:  71
FALSE initial  value 1242.338694
FALSE final  value 1187.533288
FALSE converged
FALSE # weights:  15
FALSE initial  value 3031.735416
FALSE final  value 1383.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 3627.733976
FALSE final  value 1383.000000
```

```
FALSE converged
FALSE # weights:  71
FALSE initial  value 1477.318011
FALSE final  value 1383.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 3290.561878
FALSE iter  10 value 1235.471561
FALSE iter  20 value 1225.737551
FALSE iter  30 value 1132.262583
FALSE iter  40 value 1110.278799
FALSE iter  50 value 1093.900521
FALSE iter  60 value 1084.785553
FALSE iter  70 value 1081.198536
FALSE final  value 1080.907167
FALSE converged
FALSE # weights:  43
FALSE initial  value 4328.929358
FALSE iter  10 value 1392.043699
FALSE iter  20 value 1227.082584
FALSE iter  30 value 1217.646512
FALSE iter  40 value 1166.977468
FALSE iter  50 value 1131.575301
FALSE iter  60 value 1101.123133
FALSE iter  70 value 1088.273045
FALSE iter  80 value 1082.699282
FALSE iter  90 value 1080.762634
FALSE iter 100 value 1080.723693
FALSE final  value 1080.723693
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1236.075158
FALSE iter  10 value 1226.521887
FALSE iter  20 value 1226.075155
FALSE iter  30 value 1163.658027
FALSE iter  40 value 1115.700572
FALSE iter  50 value 1090.246530
FALSE iter  60 value 1079.641064
FALSE iter  70 value 1076.210288
FALSE iter  80 value 1070.449379
FALSE iter  90 value 1069.821829
FALSE iter 100 value 1069.478383
FALSE final  value 1069.478383
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2538.573039
FALSE iter  10 value 1384.374515
FALSE iter  20 value 1383.039631
FALSE iter  30 value 1383.039305
FALSE iter  40 value 1383.038969
FALSE iter  50 value 1383.038624
FALSE iter  60 value 1383.038267
FALSE iter  70 value 1383.037899
FALSE iter  80 value 1383.037516
```

```
FALSE iter  90 value 1383.037118
FALSE iter 100 value 1383.036703
FALSE final  value 1383.036703
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 2801.687610
FALSE iter  10 value 1226.425950
FALSE iter  10 value 1226.425946
FALSE iter  10 value 1226.425946
FALSE final  value 1226.425946
FALSE converged
FALSE # weights:  71
FALSE initial  value 3101.633015
FALSE iter  10 value 1385.032531
FALSE iter  20 value 1383.014232
FALSE iter  30 value 1233.900952
FALSE iter  40 value 1226.461217
FALSE iter  50 value 1226.414830
FALSE iter  50 value 1226.414829
FALSE iter  50 value 1226.414829
FALSE final  value 1226.414829
FALSE converged
FALSE # weights:  15
FALSE initial  value 3637.532798
FALSE final  value 1363.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 2049.015713
FALSE final  value 1363.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 1459.149665
FALSE final  value 1363.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 2729.544953
FALSE iter  10 value 1211.309509
FALSE iter  20 value 1211.128021
FALSE iter  30 value 1208.535752
FALSE iter  40 value 1131.616263
FALSE iter  50 value 1053.762666
FALSE iter  60 value 1049.689804
FALSE iter  70 value 1047.873307
FALSE iter  80 value 1047.020721
FALSE final  value 1047.020707
FALSE converged
FALSE # weights:  43
FALSE initial  value 3409.036666
FALSE iter  10 value 1350.795320
FALSE iter  20 value 1211.097855
FALSE iter  30 value 1209.239973
FALSE iter  40 value 1182.283615
FALSE iter  50 value 1070.037914
FALSE iter  60 value 1048.522277
```

```
FALSE iter  70 value 1047.349485
FALSE iter  80 value 1045.245932
FALSE iter  90 value 1039.960792
FALSE iter 100 value 1036.883299
FALSE final  value 1036.883299
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 4612.593560
FALSE iter  10 value 1275.373162
FALSE iter  20 value 1210.407105
FALSE iter  30 value 1209.030336
FALSE iter  40 value 1203.229707
FALSE iter  50 value 1069.033148
FALSE iter  60 value 1046.052000
FALSE iter  70 value 1043.988426
FALSE iter  80 value 1041.712268
FALSE iter  90 value 1040.903186
FALSE iter 100 value 1040.543895
FALSE final  value 1040.543895
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2565.569538
FALSE iter  10 value 1380.746692
FALSE iter  20 value 1363.204605
FALSE iter  30 value 1363.020894
FALSE iter  40 value 1363.020735
FALSE iter  50 value 1363.020573
FALSE iter  60 value 1363.020408
FALSE iter  70 value 1363.020239
FALSE iter  80 value 1363.020068
FALSE iter  90 value 1363.019893
FALSE iter 100 value 1363.019713
FALSE final  value 1363.019713
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 2721.751699
FALSE iter  10 value 1364.617350
FALSE iter  20 value 1363.054658
FALSE iter  30 value 1363.054182
FALSE iter  40 value 1363.053670
FALSE iter  50 value 1363.053110
FALSE iter  60 value 1363.052491
FALSE iter  70 value 1363.051791
FALSE iter  80 value 1363.050981
FALSE iter  90 value 1363.050014
FALSE iter 100 value 1363.048812
FALSE final  value 1363.048812
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 4092.204908
FALSE final  value 1210.930284
FALSE converged
FALSE # weights:  15
FALSE initial  value 3702.354560
```

```
FALSE final  value 1362.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 1953.738685
FALSE final  value 1362.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 1382.553044
FALSE final  value 1362.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 2884.976021
FALSE iter  10 value 1265.189177
FALSE final  value 1210.564495
FALSE converged
FALSE # weights:  43
FALSE initial  value 5283.416047
FALSE iter  10 value 1262.481124
FALSE iter  20 value 1209.783741
FALSE iter  30 value 1173.836970
FALSE iter  40 value 1121.516699
FALSE iter  50 value 1089.172771
FALSE iter  60 value 1066.329196
FALSE iter  70 value 1063.231395
FALSE iter  80 value 1058.775059
FALSE iter  90 value 1057.639575
FALSE iter 100 value 1057.384942
FALSE final  value 1057.384942
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1611.363058
FALSE iter  10 value 1219.339100
FALSE iter  20 value 1208.354979
FALSE iter  30 value 1115.674828
FALSE iter  40 value 1104.120988
FALSE iter  50 value 1089.227435
FALSE iter  60 value 1067.985318
FALSE iter  70 value 1059.125644
FALSE iter  80 value 1057.395809
FALSE iter  90 value 1054.807086
FALSE iter 100 value 1053.292807
FALSE final  value 1053.292807
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 2863.957186
FALSE iter  10 value 1363.773891
FALSE iter  20 value 1362.030887
FALSE iter  30 value 1362.030375
FALSE iter  40 value 1362.029827
FALSE iter  50 value 1362.029236
FALSE iter  60 value 1362.028596
FALSE iter  70 value 1362.027897
FALSE iter  80 value 1362.027127
FALSE iter  90 value 1362.026270
```

```
FALSE iter 100 value 1362.025305
FALSE final  value 1362.025305
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 1712.118703
FALSE iter  10 value 1362.611993
FALSE iter  20 value 1362.042803
FALSE iter  30 value 1362.040461
FALSE iter  40 value 1362.037037
FALSE iter  50 value 1362.031371
FALSE iter  60 value 1362.019680
FALSE iter  70 value 1361.978908
FALSE iter  80 value 1329.078800
FALSE iter  90 value 1210.172960
FALSE iter 100 value 1210.134838
FALSE final  value 1210.134838
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1433.995187
FALSE iter  10 value 1210.150395
FALSE iter  10 value 1210.150384
FALSE iter  10 value 1210.150384
FALSE final  value 1210.150384
FALSE converged
FALSE # weights:  15
FALSE initial  value 3616.977533
FALSE final  value 1336.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 2153.934832
FALSE final  value 1336.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 1592.538211
FALSE final  value 1336.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 1707.326338
FALSE iter  10 value 1210.211936
FALSE final  value 1190.316145
FALSE converged
FALSE # weights:  43
FALSE initial  value 6098.173659
FALSE iter  10 value 1566.554978
FALSE iter  20 value 1330.863694
FALSE iter  30 value 1190.083629
FALSE iter  40 value 1181.368847
FALSE iter  50 value 1088.135333
FALSE iter  60 value 1083.981175
FALSE iter  70 value 1062.020197
FALSE iter  80 value 1047.678260
FALSE iter  90 value 1039.419002
FALSE iter 100 value 1038.928394
FALSE final  value 1038.928394
```

```
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1493.167464
FALSE iter  10 value 1187.394153
FALSE iter  20 value 1163.360902
FALSE iter  30 value 1087.878275
FALSE iter  40 value 1076.572966
FALSE iter  50 value 1075.621957
FALSE iter  60 value 1060.439799
FALSE iter  70 value 1041.377536
FALSE iter  80 value 1029.574360
FALSE iter  90 value 1023.735159
FALSE iter 100 value 1023.046568
FALSE final  value 1023.046568
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 3535.602406
FALSE iter  10 value 1366.919232
FALSE iter  20 value 1336.356474
FALSE iter  30 value 1323.700048
FALSE final  value 1189.880641
FALSE converged
FALSE # weights:  43
FALSE initial  value 2100.331071
FALSE final  value 1189.886095
FALSE converged
FALSE # weights:  71
FALSE initial  value 1634.292202
FALSE iter  10 value 1149.041387
FALSE iter  20 value 1078.382419
FALSE iter  30 value 1056.311161
FALSE iter  40 value 1041.737809
FALSE iter  50 value 1036.266089
FALSE iter  60 value 1033.136573
FALSE iter  70 value 1031.516111
FALSE iter  80 value 1030.665933
FALSE iter  90 value 1030.234279
FALSE iter 100 value 1030.029112
FALSE final  value 1030.029112
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 4158.147305
FALSE final  value 1316.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 4979.141820
FALSE final  value 1316.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 2653.572339
FALSE final  value 1316.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 2872.092764
```

```
FALSE iter  10 value 1369.659262
FALSE iter  20 value 1174.445167
FALSE iter  30 value 1167.313049
FALSE iter  40 value 1105.212444
FALSE iter  50 value 1055.569157
FALSE iter  60 value 1050.743189
FALSE iter  70 value 1049.147260
FALSE final  value 1048.928866
FALSE converged
FALSE # weights:  43
FALSE initial  value 6307.870093
FALSE iter  10 value 1219.957717
FALSE iter  20 value 1174.427381
FALSE iter  30 value 1168.905374
FALSE iter  40 value 1130.843782
FALSE iter  50 value 1072.915422
FALSE iter  60 value 1059.535203
FALSE iter  70 value 1051.280620
FALSE iter  80 value 1049.928383
FALSE iter  90 value 1049.337560
FALSE iter 100 value 1049.297484
FALSE final  value 1049.297484
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1944.875770
FALSE iter  10 value 1175.066460
FALSE iter  20 value 1172.340547
FALSE iter  30 value 1135.168528
FALSE iter  40 value 1099.853246
FALSE iter  50 value 1091.869183
FALSE iter  60 value 1067.431113
FALSE iter  70 value 1052.415444
FALSE iter  80 value 1051.645257
FALSE iter  90 value 1049.664307
FALSE iter 100 value 1045.147232
FALSE final  value 1045.147232
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 1745.917842
FALSE iter  10 value 1316.475963
FALSE iter  20 value 1316.030167
FALSE iter  30 value 1316.029442
FALSE iter  40 value 1316.028641
FALSE iter  50 value 1316.027749
FALSE iter  60 value 1316.026741
FALSE iter  70 value 1316.025587
FALSE iter  80 value 1316.024244
FALSE iter  90 value 1316.022649
FALSE iter 100 value 1316.020707
FALSE final  value 1316.020707
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 7622.995420
FALSE iter  10 value 1301.901052
```

```
FALSE iter  20 value 1226.561214
FALSE iter  30 value 1182.398414
FALSE iter  40 value 1110.972393
FALSE iter  50 value 1092.182679
FALSE iter  60 value 1044.474121
FALSE iter  70 value 1035.409310
FALSE iter  80 value 1034.399677
FALSE iter  90 value 1034.089215
FALSE iter 100 value 1033.609891
FALSE final  value 1033.609891
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 6132.060838
FALSE iter  10 value 1322.168155
FALSE iter  20 value 1313.661037
FALSE iter  30 value 1174.269796
FALSE iter  40 value 1174.226011
FALSE iter  50 value 1169.806664
FALSE iter  60 value 1149.085179
FALSE iter  70 value 1100.875054
FALSE iter  80 value 1074.572916
FALSE iter  90 value 1064.590989
FALSE iter 100 value 1055.086964
FALSE final  value 1055.086964
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 4205.633156
FALSE final  value 1315.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 2030.045112
FALSE final  value 1315.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 5559.269570
FALSE final  value 1315.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 4538.181981
FALSE iter  10 value 1173.946342
FALSE iter  20 value 1172.951139
FALSE iter  30 value 1144.381870
FALSE iter  40 value 1080.996496
FALSE iter  50 value 1070.501326
FALSE iter  60 value 1056.071230
FALSE iter  70 value 1040.360837
FALSE iter  80 value 1036.593535
FALSE iter  90 value 1035.736810
FALSE iter 100 value 1035.657479
FALSE final  value 1035.657479
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 4830.492210
FALSE iter  10 value 1313.652817
```

```
FALSE iter  20 value 1172.730160
FALSE iter  30 value 1072.760650
FALSE iter  40 value 1039.524571
FALSE iter  50 value 1033.385628
FALSE iter  60 value 1027.236288
FALSE iter  70 value 1025.816768
FALSE iter  80 value 1025.106845
FALSE iter  90 value 1024.979516
FALSE final  value 1024.971051
FALSE converged
FALSE # weights:  71
FALSE initial  value 4335.868374
FALSE iter  10 value 1326.205590
FALSE iter  20 value 1171.813255
FALSE iter  30 value 1153.759659
FALSE iter  40 value 1080.269300
FALSE iter  50 value 1052.915839
FALSE iter  60 value 1041.861789
FALSE iter  70 value 1037.367837
FALSE iter  80 value 1035.968807
FALSE iter  90 value 1035.490231
FALSE iter 100 value 1033.339187
FALSE final  value 1033.339187
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 3726.362929
FALSE iter  10 value 1348.124875
FALSE iter  20 value 1315.381904
FALSE iter  30 value 1315.010372
FALSE iter  40 value 1173.441604
FALSE final  value 1173.441568
FALSE converged
FALSE # weights:  43
FALSE initial  value 2234.326753
FALSE final  value 1173.443015
FALSE converged
FALSE # weights:  71
FALSE initial  value 3326.577863
FALSE iter  10 value 1185.552501
FALSE iter  20 value 1179.653515
FALSE iter  30 value 1173.512854
FALSE iter  40 value 1173.136240
FALSE iter  50 value 1149.969773
FALSE iter  60 value 1081.193689
FALSE iter  70 value 1031.685099
FALSE iter  80 value 1031.478258
FALSE iter  90 value 1031.155217
FALSE iter 100 value 1030.413975
FALSE final  value 1030.413975
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 3261.653401
FALSE final  value 1333.000000
FALSE converged
```

```
FALSE # weights:  43
FALSE initial  value 1586.359498
FALSE final  value 1333.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 1188.691842
FALSE final  value 1187.532214
FALSE converged
FALSE # weights:  15
FALSE initial  value 3041.836749
FALSE iter  10 value 1196.554153
FALSE iter  20 value 1185.875303
FALSE iter  30 value 1138.880746
FALSE iter  40 value 1060.637059
FALSE iter  50 value 1036.014148
FALSE iter  60 value 1035.422605
FALSE iter  70 value 1035.234811
FALSE iter  70 value 1035.234808
FALSE iter  70 value 1035.234808
FALSE final  value 1035.234808
FALSE converged
FALSE # weights:  43
FALSE initial  value 1736.045237
FALSE iter  10 value 1193.262936
FALSE iter  20 value 1187.926541
FALSE iter  30 value 1186.405455
FALSE iter  40 value 1181.970842
FALSE iter  50 value 1155.880209
FALSE iter  60 value 1152.372622
FALSE iter  70 value 1082.371425
FALSE iter  80 value 1056.154928
FALSE iter  90 value 1040.465065
FALSE iter 100 value 1029.043890
FALSE final  value 1029.043890
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 5278.046420
FALSE iter  10 value 1213.685769
FALSE iter  20 value 1187.364313
FALSE iter  30 value 1110.026530
FALSE iter  40 value 1062.940723
FALSE iter  50 value 1038.662699
FALSE iter  60 value 1026.925842
FALSE iter  70 value 1025.474263
FALSE iter  80 value 1020.927882
FALSE iter  90 value 1020.769092
FALSE iter  90 value 1020.769092
FALSE iter  90 value 1020.769091
FALSE final  value 1020.769091
FALSE converged
FALSE # weights:  15
FALSE initial  value 1886.447150
FALSE iter  10 value 1340.743046
FALSE iter  20 value 1333.089271
```

```
FALSE iter  30 value 1332.997514
FALSE iter  40 value 1332.987648
FALSE iter  50 value 1332.957608
FALSE iter  60 value 1331.440822
FALSE final  value 1187.539758
FALSE converged
FALSE # weights:  43
FALSE initial  value 1488.918254
FALSE final  value 1187.542165
FALSE converged
FALSE # weights:  71
FALSE initial  value 1271.881365
FALSE final  value 1187.533481
FALSE converged
FALSE # weights:  15
FALSE initial  value 2063.577181
FALSE final  value 1377.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 5948.093008
FALSE final  value 1377.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 3868.353758
FALSE final  value 1377.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 3448.375082
FALSE iter  10 value 1221.987033
FALSE iter  20 value 1221.348323
FALSE iter  30 value 1213.941482
FALSE iter  40 value 1198.821225
FALSE iter  50 value 1186.349637
FALSE iter  60 value 1153.554593
FALSE iter  70 value 1081.782462
FALSE iter  80 value 1076.148766
FALSE iter  90 value 1073.805839
FALSE iter 100 value 1067.454277
FALSE final  value 1067.454277
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 3041.778646
FALSE iter  10 value 1253.437961
FALSE iter  20 value 1237.452243
FALSE iter  30 value 1234.773164
FALSE iter  40 value 1209.869140
FALSE iter  50 value 1108.471063
FALSE iter  60 value 1074.251645
FALSE iter  70 value 1069.103931
FALSE iter  80 value 1067.240475
FALSE iter  90 value 1066.759472
FALSE final  value 1066.746652
FALSE converged
FALSE # weights:  71
```

```
FALSE initial  value 2926.768134
FALSE iter  10 value 1243.333110
FALSE iter  20 value 1215.304125
FALSE iter  30 value 1120.379912
FALSE iter  40 value 1075.862760
FALSE iter  50 value 1072.203993
FALSE iter  60 value 1068.224985
FALSE iter  70 value 1066.736091
FALSE final  value 1066.729610
FALSE converged
FALSE # weights:  15
FALSE initial  value 4187.261047
FALSE iter  10 value 1221.927182
FALSE final  value 1221.775812
FALSE converged
FALSE # weights:  43
FALSE initial  value 5177.873967
FALSE iter  10 value 1375.649579
FALSE iter  20 value 1227.850773
FALSE iter  30 value 1177.615764
FALSE iter  40 value 1088.462794
FALSE iter  50 value 1074.444436
FALSE iter  60 value 1071.594417
FALSE iter  70 value 1066.516635
FALSE iter  80 value 1058.594190
FALSE iter  90 value 1053.484719
FALSE iter 100 value 1052.749763
FALSE final  value 1052.749763
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 5279.192483
FALSE iter  10 value 1377.082223
FALSE iter  20 value 1199.413680
FALSE iter  30 value 1100.920123
FALSE iter  40 value 1076.755478
FALSE iter  50 value 1060.659164
FALSE iter  60 value 1055.202681
FALSE iter  70 value 1047.241056
FALSE iter  80 value 1043.896408
FALSE iter  90 value 1041.583608
FALSE iter 100 value 1039.280763
FALSE final  value 1039.280763
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 3150.962893
FALSE final  value 1321.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 4719.705925
FALSE final  value 1321.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 6862.940794
FALSE final  value 1321.000000
```

```
FALSE converged
FALSE # weights:  15
FALSE initial  value 6304.233264
FALSE iter  10 value 1178.771917
FALSE final  value 1178.584298
FALSE converged
FALSE # weights:  43
FALSE initial  value 4918.271410
FALSE iter  10 value 1309.421876
FALSE iter  20 value 1155.658300
FALSE iter  30 value 1118.792786
FALSE iter  40 value 1057.802838
FALSE iter  50 value 1035.472692
FALSE iter  60 value 1028.545461
FALSE iter  70 value 1022.543516
FALSE iter  80 value 1021.443679
FALSE iter  90 value 1021.226377
FALSE iter 100 value 1021.192437
FALSE final  value 1021.192437
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 1462.682787
FALSE iter  10 value 1183.381259
FALSE iter  20 value 1093.507313
FALSE iter  30 value 1042.137123
FALSE iter  40 value 1029.398513
FALSE iter  50 value 1028.168602
FALSE iter  60 value 1026.165647
FALSE iter  70 value 1025.217847
FALSE iter  80 value 1024.895780
FALSE iter  90 value 1022.562801
FALSE iter 100 value 1022.048488
FALSE final  value 1022.048488
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 5782.185295
FALSE iter  10 value 1321.125232
FALSE iter  20 value 1179.862625
FALSE iter  30 value 1178.139761
FALSE final  value 1178.139723
FALSE converged
FALSE # weights:  43
FALSE initial  value 5192.489759
FALSE iter  10 value 1325.885642
FALSE iter  20 value 1321.051015
FALSE iter  30 value 1321.040615
FALSE iter  40 value 1321.008531
FALSE iter  50 value 1317.834106
FALSE iter  60 value 1178.200026
FALSE iter  70 value 1178.145210
FALSE iter  80 value 1178.139786
FALSE final  value 1178.139728
FALSE converged
FALSE # weights:  71
```

```
FALSE initial  value 2200.019593
FALSE iter  10 value 1322.945967
FALSE iter  20 value 1321.040232
FALSE iter  30 value 1321.039941
FALSE iter  40 value 1321.039634
FALSE iter  50 value 1321.039308
FALSE iter  60 value 1321.038955
FALSE iter  70 value 1321.038571
FALSE iter  80 value 1321.038143
FALSE iter  90 value 1321.037657
FALSE iter 100 value 1321.037090
FALSE final  value 1321.037090
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 4422.079790
FALSE final  value 1324.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 1508.056483
FALSE final  value 1324.000000
FALSE converged
FALSE # weights:  71
FALSE initial  value 4737.199687
FALSE final  value 1324.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 4097.673636
FALSE iter  10 value 1181.324581
FALSE iter  20 value 1180.313204
FALSE iter  30 value 1154.156116
FALSE iter  40 value 1135.308635
FALSE iter  50 value 1064.515378
FALSE iter  60 value 1053.789826
FALSE iter  70 value 1040.547903
FALSE iter  80 value 1038.684032
FALSE iter  90 value 1037.583234
FALSE final  value 1037.567156
FALSE converged
FALSE # weights:  43
FALSE initial  value 4087.168411
FALSE iter  10 value 1272.619721
FALSE iter  20 value 1180.637172
FALSE iter  30 value 1140.975353
FALSE iter  40 value 1118.149356
FALSE iter  50 value 1070.234534
FALSE iter  60 value 1044.118375
FALSE iter  70 value 1029.677449
FALSE iter  80 value 1029.062771
FALSE iter  90 value 1028.825638
FALSE iter 100 value 1028.349911
FALSE final  value 1028.349911
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 6236.150750
```

```
FALSE iter  10 value 1273.411583
FALSE iter  20 value 1179.372883
FALSE iter  30 value 1069.625306
FALSE iter  40 value 1053.205617
FALSE iter  50 value 1035.765667
FALSE iter  60 value 1027.920772
FALSE iter  70 value 1024.644429
FALSE iter  80 value 1024.249455
FALSE iter  90 value 1021.967168
FALSE iter 100 value 1019.932668
FALSE final  value 1019.932668
FALSE stopped after 100 iterations
FALSE # weights:  15
FALSE initial  value 1925.246998
FALSE iter  10 value 1324.675623
FALSE iter  20 value 1324.026359
FALSE iter  30 value 1324.025571
FALSE iter  40 value 1324.024692
FALSE iter  50 value 1324.023699
FALSE iter  60 value 1324.022560
FALSE iter  70 value 1324.021232
FALSE iter  80 value 1324.019653
FALSE iter  90 value 1324.017729
FALSE iter 100 value 1324.015311
FALSE final  value 1324.015311
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 2160.276142
FALSE iter  10 value 1324.966881
FALSE iter  20 value 1324.021210
FALSE iter  30 value 1323.847059
FALSE iter  40 value 1180.537216
FALSE iter  50 value 1180.487751
FALSE iter  60 value 1176.309605
FALSE iter  70 value 1150.365589
FALSE iter  80 value 1104.194573
FALSE iter  90 value 1093.256763
FALSE iter 100 value 1089.740283
FALSE final  value 1089.740283
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 2465.949086
FALSE iter  10 value 1326.284470
FALSE iter  20 value 1324.100907
FALSE iter  30 value 1324.043330
FALSE iter  40 value 1180.835703
FALSE iter  50 value 1180.544099
FALSE iter  60 value 1180.490432
FALSE iter  70 value 1168.234388
FALSE iter  80 value 1087.480654
FALSE iter  90 value 1045.256643
FALSE iter 100 value 1039.472427
FALSE final  value 1039.472427
FALSE stopped after 100 iterations
```

```
FALSE # weights:  15
FALSE initial  value 4003.210874
FALSE final  value 1376.000000
FALSE converged
FALSE # weights:  43
FALSE initial  value 1238.167627
FALSE final  value 1220.995825
FALSE converged
FALSE # weights:  71
FALSE initial  value 3806.795152
FALSE final  value 1376.000000
FALSE converged
FALSE # weights:  15
FALSE initial  value 3333.594326
FALSE iter  10 value 1361.981003
FALSE iter  20 value 1221.215143
FALSE iter  30 value 1220.765412
FALSE iter  40 value 1219.581982
FALSE iter  50 value 1208.204338
FALSE iter  60 value 1158.849158
FALSE iter  70 value 1097.376767
FALSE iter  80 value 1083.048427
FALSE iter  90 value 1074.498477
FALSE iter 100 value 1067.779613
FALSE final  value 1067.779613
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 3770.465493
FALSE iter  10 value 1314.767883
FALSE iter  20 value 1220.996068
FALSE iter  30 value 1215.947737
FALSE iter  40 value 1189.940999
FALSE iter  50 value 1094.755823
FALSE iter  60 value 1071.949560
FALSE iter  70 value 1062.654880
FALSE iter  80 value 1058.065675
FALSE iter  90 value 1057.422738
FALSE iter 100 value 1056.190803
FALSE final  value 1056.190803
FALSE stopped after 100 iterations
FALSE # weights:  71
FALSE initial  value 3800.400818
FALSE iter  10 value 1400.303287
FALSE iter  20 value 1222.138137
FALSE iter  30 value 1221.113694
FALSE iter  40 value 1209.233918
FALSE iter  50 value 1110.626458
FALSE iter  60 value 1094.646934
FALSE iter  70 value 1079.784460
FALSE iter  80 value 1063.504874
FALSE iter  90 value 1055.684368
FALSE iter 100 value 1053.318483
FALSE final  value 1053.318483
FALSE stopped after 100 iterations
```

```
FALSE # weights:  15
FALSE initial  value 3870.065107
FALSE iter  10 value 1378.709453
FALSE iter  20 value 1376.022742
FALSE iter  30 value 1376.020460
FALSE iter  40 value 1376.017514
FALSE iter  50 value 1376.013518
FALSE iter  60 value 1376.007698
FALSE iter  70 value 1375.998273
FALSE iter  80 value 1375.979963
FALSE iter  90 value 1375.927357
FALSE iter 100 value 1374.855859
FALSE final  value 1374.855859
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 3673.542895
FALSE iter  10 value 1407.955608
FALSE iter  20 value 1376.368423
FALSE iter  30 value 1376.007449
FALSE final  value 1221.006244
FALSE converged
FALSE # weights:  71
FALSE initial  value 2318.959816
FALSE iter  10 value 1378.249404
FALSE iter  20 value 1376.044615
FALSE iter  30 value 1376.044101
FALSE iter  40 value 1376.043517
FALSE iter  50 value 1376.042834
FALSE iter  60 value 1376.042008
FALSE iter  70 value 1376.040960
FALSE iter  80 value 1376.039540
FALSE iter  90 value 1376.037426
FALSE iter 100 value 1376.033753
FALSE final  value 1376.033753
FALSE stopped after 100 iterations
FALSE # weights:  43
FALSE initial  value 3885.617882
FALSE iter  10 value 1242.652053
FALSE iter  20 value 1196.078571
FALSE iter  30 value 1101.276347
FALSE iter  40 value 1066.080318
FALSE iter  50 value 1048.342789
FALSE iter  60 value 1044.629092
FALSE iter  70 value 1043.449572
FALSE iter  80 value 1043.187293
FALSE iter  90 value 1042.935613
FALSE iter 100 value 1042.857623
FALSE final  value 1042.857623
FALSE stopped after 100 iterations
```

```
#showing summary of neuralnet
nnet_model
```

```
FALSE Neural Network
```

```
FALSE
FALSE 12215 samples
FALSE     5 predictor
FALSE
FALSE No pre-processing
FALSE Resampling: Bootstrapped (25 reps)
FALSE Summary of sample sizes: 12215, 12215, 12215, 12215, 12215, 12215, ...
FALSE Resampling results across tuning parameters:
FALSE
FALSE   size  decay  RMSE       Rsquared      MAE
FALSE   1     0e+00  0.3333142           NaN  0.1111257
FALSE   1     1e-04  0.3228154  4.553452e-02  0.1549150
FALSE   1     1e-01  0.2976129  1.126685e-01  0.1779733
FALSE   3     0e+00  0.3317877  2.829365e-05  0.1180290
FALSE   3     1e-04  0.3096669  9.335032e-02  0.1873060
FALSE   3     1e-01  0.2937948  1.268487e-01  0.1734104
FALSE   5     0e+00  0.3310961           NaN  0.1215172
FALSE   5     1e-04  0.3098722  1.052443e-01  0.1789693
FALSE   5     1e-01  0.2940043  1.255816e-01  0.1723305
FALSE
FALSE RMSE was used to select the optimal model using the smallest value.
FALSE The final values used for the model were size = 3 and decay = 0.1.
```

```
#Predictions on the test set
nnet_predictions_test <-ifelse(predict(nnet_model, test_horse_data)>=0.5,1,0)

# Confusion matrix on test set
table(test_horse_data$winner, nnet_predictions_test)
```

```
FALSE    nnet_predictions_test
FALSE        0    1
FALSE   0 1815   17
FALSE   1  205   19
```

For the above, we can see that the neural net does predict more horses to win than the random forest, however its prediction of which horses will win is lower than the random forest.

When selecting a model to

```
winners <- 1
```

‘‘‘