classification

Chen Si (chensi3), Yuchen Cao (yuchenc5)

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```
library(caret)
```

```
##      ggplot2
```

```
##      lattice
```

```
library(kernlab)
```

```
##
##     'kernlab'
```

```
## The following object is masked from 'package:ggplot2':
##
##     alpha
```

```
library(ggplot2)
library(lattice)
library(tibble)
```

Read Data

```
fifa = read.csv("../dataset/players_20_edited.csv")
```

```
colnames(fifa)
```

```
##  [1] "short_name"                "long_name"
##  [3] "age"                       "height_cm"
##  [5] "weight_kg"                 "nationality"
##  [7] "club"                      "overall"
##  [9] "potential"                 "value_eur"
## [11] "wage_eur"                  "player_positions"
## [13] "preferred_foot"            "international_reputation"
## [15] "weak_foot"                 "pace"
## [17] "shooting"                  "passing"
## [19] "dribbling"                 "defending"
## [21] "physic"                    "attacking_crossing"
```

```
## [23] "attacking_finishing"         "attacking_heading_accuracy"
## [25] "attacking_short_passing"     "attacking_volleys"
## [27] "skill_dribbling"             "skill_curve"
## [29] "skill_fk_accuracy"           "skill_long_passing"
## [31] "skill_ball_control"          "movement_acceleration"
## [33] "movement_sprint_speed"       "movement_agility"
## [35] "movement_reactions"          "movement_balance"
## [37] "power_shot_power"            "power_jumping"
## [39] "power_stamina"               "power_strength"
## [41] "power_long_shots"            "mentality_aggression"
## [43] "mentality_interceptions"     "mentality_positioning"
## [45] "mentality_vision"            "mentality_penalties"
## [47] "mentality_composure"         "defending_marking"
## [49] "defending_standing_tackle"   "defending_sliding_tackle"
## [51] "ls"                          "st"
## [53] "rs"                          "lw"
## [55] "lf"                          "cf"
## [57] "rf"                          "rw"
## [59] "lam"                         "cam"
## [61] "ram"                         "lm"
## [63] "lcm"                         "cm"
## [65] "rcm"                         "rm"
## [67] "lwb"                         "ldm"
## [69] "cdm"                         "rdm"
## [71] "rwb"                         "lb"
## [73] "lcb"                         "cb"
## [75] "rcb"                         "rb"
## [77] "classification"
```

Create st_or_cb column

```
fifa$st_or_cb <- with(fifa, ifelse(st > cb, 'ST', 'CB'))
fifa$st_or_cb = as.factor(fifa$st_or_cb)
summary(fifa$st_or_cb)
```

```
##   CB   ST
## 8407 7835
```

Train-Test Split 8-2

```
set.seed(432)

N=dim(fifa)[1]
cat("There are ", N, "players in the dataset\n")
```

```
## There are  16242 players in the dataset
```

```r
all.idx=1:N

trn.idx = sample(all.idx, size=round(0.8*N))
tst.idx = all.idx[is.na(pmatch(all.idx,trn.idx))]

fifa.trn = fifa[trn.idx,]
fifa.tst = fifa[tst.idx,]
cat("Train Set Size:", dim(fifa.trn)[1], "\n")
```

```
## Train Set Size: 12994
```

```r
cat("Test Set Size:", dim(fifa.tst)[1], "\n")
```

```
## Test Set Size: 3248
```

Some Famous Players

```r
test.st.1 = 9 # Kylian Mbappé
test.st.2 = 35 # Heung-min Son
test.st.3 = 318 # Wout Weghorst

test.cb.1 = 24 # Gerard Piqué Bernabéu
test.cb.2 = 73 # Clément Lenglet
test.cb.3 = 185 # David Luiz

test.lb = 1132 # Kieran Tierney
test.rb = 2410 # Tomiyasu
test.lw = 6034 # Gabriel Martinelli
test.rw = 8971 # Bukayo Saka

test.confus.1 = 296 # Granit Xhaka
test.confus.2 = 28 # Toni Kroos
test.confus.3 = 34 # Casemiro
test.confus.4 = 221 # Thomas Partey
test.confus.5 = 64 # Frenkie de Jong
test.confus.6 = 67 # Niklas Süle
test.confus.7 = 68 # Sergej Milinković-Savić
test.confus.8 = 69 # Rodri

test.players = fifa[c(test.st.1,test.st.2,test.st.3,
                      test.cb.1,test.cb.2,test.cb.3,
                      test.lb,test.rb,test.lw,test.rw,
                      test.confus.1,test.confus.2,test.confus.3,test.confus.4,
                      test.confus.5,test.confus.6,test.confus.7,test.confus.8),]
test.players
```

```
##               short_name                      long_name age height_cm
## 9              K. Mbappé                 Kylian Mbappé  20       178
## 35                H. Son                       26       183
## 318          W. Weghorst                 Wout Weghorst  26       197
```

```
## 24                Piqué             Gerard Piqué Bernabéu  32       194
## 73            C. Lenglet                   Clément Lenglet  24       186
## 185           David Luiz       David Luiz Moreira Marinho  32       189
## 1132          K. Tierney                   Kieran Tierney  22       178
## 2410         T. Tomiyasu                               20       188
## 6034  Gabriel Martinelli  Gabriel Teodoro Martinelli Silva  18       180
## 8971             B. Saka                      Bukayo Saka  17       178
## 296             G. Xhaka                     Granit Xhaka  26       185
## 28              T. Kroos                      Toni Kroos  29       183
## 34              Casemiro Carlos Henrique Venancio Casimiro  27       185
## 221            T. Partey                     Thomas Partey  26       185
## 64            F. de Jong                   Frenkie de Jong  22       180
## 67   S. Milinković-Savić          Sergej Milinković-Savić  24       191
## 68                Rodri        Rodrigo Hernández Cascante  23       191
## 69                 Saúl              Saúl Ñíguez Esclápez  24       184
##      weight_kg    nationality               club overall potential value_eur
## 9           73         France Paris Saint-Germain      89        95  93500000
## 35          78 Korea Republic   Tottenham Hotspur      87        88  60000000
## 318         84    Netherlands       VfL Wolfsburg      81        82  21000000
## 24          85          Spain        FC Barcelona      88        88  38000000
## 73          81         France        FC Barcelona      85        89  45000000
## 185         86         Brazil             Arsenal      83        83  16500000
## 1132        78       Scotland             Arsenal      76        86  11000000
## 2410        84          Japan             Bologna      73        84   6500000
## 6034        75         Brazil             Arsenal      68        83   1800000
## 8971        70        England             Arsenal      65        86   1200000
## 296         82    Switzerland             Arsenal      81        84  21500000
## 28          76        Germany         Real Madrid      88        88  57000000
## 34          84         Brazil         Real Madrid      87        89  53500000
## 221         77          Ghana     Atlético Madrid      82        85  27000000
## 64          74    Netherlands        FC Barcelona      85        91  52000000
## 67          76         Serbia               Lazio      85        90  50500000
## 68          82          Spain     Manchester City      85        90  47000000
## 69          77          Spain     Atlético Madrid      85        89  49500000
##      wage_eur player_positions preferred_foot international_reputation
## 9      155000           ST, RW          Right                         3
## 35     185000           CF, LM          Right                         3
## 318     62000               ST          Right                         1
## 24     285000               CB          Right                         4
## 73     175000               CB           Left                         2
## 185    105000               CB          Right                         4
## 1132    52000               LB           Left                         1
## 2410    16000          CB, CDM          Right                         1
## 6034    11000       LW, LM, ST          Right                         1
## 8971     2000           LM, RM           Left                         1
## 296     94000          CM, CDM           Left                         3
## 28     330000               CM          Right                         4
## 34     240000              CDM          Right                         3
## 221     68000      CM, CDM, RM          Right                         2
## 64     195000          CM, CDM          Right                         3
## 67      73000          CM, CAM          Right                         2
## 68     150000          CDM, CM          Right                         2
## 69      77000       CM, LM, RM           Left                         3
##      weak_foot pace shooting passing dribbling defending physic
```

```
## 9            4   96       84      78        90        39     75
## 35           5   88       86      80        87        42     68
## 318          3   63       80      59        69        39     83
## 24           3   56       61      72        68        88     80
## 73           4   75       45      68        65        86     80
## 185          3   61       65      74        70        82     77
## 1132         3   88       59      70        74        71     81
## 2410         5   66       28      57        63        72     76
## 6034         2   85       62      59        72        25     55
## 8971         4   83       60      58        67        37     59
## 296          3   51       67      81        71        69     78
## 28           5   45       80      90        81        70     69
## 34           3   62       72      75        72        85     89
## 221          3   73       72      77        77        79     84
## 64           3   79       64      84        87        76     76
## 67           4   67       79      80        83        77     84
## 68           4   67       68      77        77        82     80
## 69           4   70       78      79        81        78     78
##      attacking_crossing attacking_finishing attacking_heading_accuracy
## 9                    78                  89                         77
## 35                   81                  86                         65
## 318                  42                  84                         87
## 24                   57                  65                         85
## 73                   55                  39                         82
## 185                  68                  55                         81
## 1132                 74                  52                         59
## 2410                 47                  27                         70
## 6034                 59                  62                         59
## 8971                 61                  60                         45
## 296                  73                  53                         62
## 28                   88                  75                         58
## 34                   58                  64                         76
## 221                  66                  68                         68
## 64                   75                  64                         66
## 67                   64                  80                         86
## 68                   63                  64                         75
## 69                   69                  78                         83
##      attacking_short_passing attacking_volleys skill_dribbling skill_curve
## 9                         82                79              91          79
## 35                        83                81              88          85
## 318                       76                79              65          40
## 24                        83                57              63          58
## 73                        81                37              57          59
## 185                       77                63              66          70
## 1132                      72                27              75          72
## 2410                      68                22              60          43
## 6034                      64                61              73          62
## 8971                      60                55              66          60
## 296                       85                50              70          76
## 28                        91                82              80          86
## 34                        83                61              69          63
## 221                       84                53              79          68
## 64                        90                69              88          84
## 67                        85                74              86          78
```

```
## 68                       85               59              76          65
## 69                       85               76              81          72
##      skill_fk_accuracy skill_long_passing skill_ball_control
## 9                   63                 70                 90
## 35                  70                 70                 87
## 318                 37                 48                 78
## 24                  43                 81                 82
## 73                  31                 75                 76
## 185                 76                 82                 79
## 1132                56                 66                 73
## 2410                35                 65                 67
## 6034                49                 45                 73
## 8971                48                 44                 63
## 296                 77                 85                 80
## 28                  84                 92                 89
## 34                  74                 82                 78
## 221                 58                 80                 81
## 64                  64                 86                 89
## 67                  75                 85                 87
## 68                  54                 82                 82
## 69                  60                 83                 85
##      movement_acceleration movement_sprint_speed movement_agility
## 9                       96                    96               92
## 35                      86                    89               86
## 318                     57                    68               63
## 24                      48                    63               57
## 73                      77                    74               62
## 185                     58                    63               66
## 1132                    87                    89               76
## 2410                    67                    66               65
## 6034                    86                    84               76
## 8971                    86                    81               80
## 296                     50                    52               49
## 28                      50                    41               60
## 34                      58                    66               62
## 221                     70                    75               70
## 64                      80                    78               84
## 67                      66                    67               65
## 68                      68                    66               69
## 69                      71                    70               73
##      movement_reactions movement_balance power_shot_power power_jumping
## 9                    89                83               83            76
## 35                   89                76               88            63
## 318                  82                44               84            79
## 24                   85                36               62            75
## 73                   84                60               58            86
## 185                  77                56               81            78
## 1132                 72                77               79            80
## 2410                 62                58               37            69
## 6034                 51                69               65            47
## 8971                 56                78               64            56
## 296                  75                61               90            30
## 28                   87                71               87            30
## 34                   86                66               86            87
```

```
## 221                 81              50              83             83
## 64                  87              79              68             76
## 67                  80              59              83             85
## 68                  82              72              74             69
## 69                  82              69              82             78
##      power_stamina power_strength power_long_shots mentality_aggression
## 9               84             76               79                   62
## 35              87             62               90                   60
## 318             85             86               66                   76
## 24              70             87               51                   76
## 73              75             82               46                   80
## 185             65             79               73                   86
## 1132            89             76               66                   82
## 2410            68             81               24                   74
## 6034            66             55               59                   42
## 8971            65             55               59                   64
## 296             79             77               79                   92
## 28              74             73               86                   60
## 34              88             90               81                   89
## 221             91             81               80                   82
## 64              82             74               62                   72
## 67              85             88               80                   73
## 68              84             80               76                   76
## 69              87             77               81                   69
##      mentality_interceptions mentality_positioning mentality_vision
## 9                         38                    89              80
## 35                        39                    88              81
## 318                       34                    85              65
## 24                        89                    64              72
## 73                        87                    54              66
## 185                       84                    54              71
## 1132                      71                    64              70
## 2410                      69                    23              51
## 6034                      18                    62              61
## 8971                      40                    61              62
## 296                       71                    75              82
## 28                        76                    75              89
## 34                        86                    69              77
## 221                       79                    73              78
## 64                        81                    70              86
## 67                        78                    79              85
## 68                        84                    75              82
## 69                        79                    82              82
##      mentality_penalties mentality_composure defending_marking
## 9                     70                  84                34
## 35                    71                  87                48
## 318                   77                  80                37
## 24                    69                  87                89
## 73                    49                  82                90
## 185                   75                  77                79
## 1132                  36                  74                72
## 2410                  37                  59                72
## 6034                  60                  48                22
## 8971                  58                  70                39
```

```
## 296                    63                 74                66
## 28                     73                 88                72
## 34                     66                 84                84
## 221                    49                 75                79
## 64                     45                 90                75
## 67                     56                 82                75
## 68                     46                 85                82
## 69                     55                 83                77
##      defending_standing_tackle defending_sliding_tackle ls st rs lw lf cf rf rw
## 9                           34                        32 86 86 86 87 87 87 87 87
## 35                          34                        33 83 83 83 86 86 86 86 86
## 318                         32                        25 79 79 79 70 75 75 75 70
## 24                          88                        87 70 70 70 67 69 69 69 67
## 73                          83                        81 63 63 63 64 64 64 64 64
## 185                         83                        81 68 68 68 67 68 68 68 67
## 1132                        73                        74 67 67 67 71 70 70 70 71
## 2410                        75                        74 49 49 49 53 51 51 51 53
## 6034                        22                        24 64 64 64 67 66 66 66 67
## 8971                        34                        29 61 61 61 65 63 63 63 65
## 296                         72                        69 69 69 69 70 72 72 72 70
## 28                          70                        62 75 75 75 78 79 79 79 78
## 34                          87                        86 74 74 74 71 74 74 74 71
## 221                         83                        81 75 75 75 75 77 77 77 75
## 64                          75                        77 74 74 74 80 79 79 79 80
## 67                          77                        72 81 81 81 78 81 81 81 78
## 68                          84                        78 73 73 73 74 76 76 76 74
## 69                          78                        77 80 80 80 79 80 80 80 79
##      lam cam ram lm lcm cm rcm rm lwb ldm cdm rdm rwb lb lcb cb rcb rb
## 9     86  86  86 86  78 78  78 86  66  62  62  62  66 63  54 54  54 63
## 35    85  85  85 85  78 78  78 85  67  63  63  63  67 63  53 53  53 63
## 318   72  72  72 69  67 67  67 69  54  57  57  57  54 53  54 54  54 53
## 24    71  71  71 69  76 76  76 69  77  83  83  83  77 78  85 85  85 78
## 73    66  66  66 67  72 72  72 67  77  81  81  81  77 79  83 83  83 79
## 185   69  69  69 68  74 74  74 68  74  79  79  79  74 75  80 80  80 75
## 1132  70  70  70 73  71 71  71 73  75  73  73  73  75 75  72 72  72 75
## 2410  54  54  54 56  59 59  59 56  66  68  68  68  66 67  72 72  72 67
## 6034  65  65  65 66  57 57  57 66  49  43  43  43  49 46  37 37  37 46
## 8971  62  62  62 63  56 56  56 63  53  49  49  49  53 51  45 45  45 51
## 296   74  74  74 72  78 78  78 72  71  77  77  77  71 70  71 71  71 70
## 28    81  81  81 79  85 85  85 79  75  79  79  79  75 72  69 69  69 72
## 34    74  74  74 72  79 79  79 72  78  84  84  84  78 79  84 84  84 79
## 221   78  78  78 77  80 80  80 77  79  81  81  81  79 78  79 79  79 78
## 64    82  82  82 82  83 83  83 82  81  82  82  82  81 79  76 76  76 79
## 67    82  82  82 79  83 83  83 79  76  80  80  80  76 76  79 79  79 76
## 68    78  78  78 76  81 81  81 76  78  82  82  82  78 78  80 80  80 78
## 69    81  81  81 79  82 82  82 79  78  80  80  80  78 78  78 78  78 78
##                  classification st_or_cb
## 9                   ['Striker']       ST
## 35   ['Striker', 'Midfielder']       ST
## 318                 ['Striker']       ST
## 24                ['Defender']       CB
## 73                ['Defender']       CB
## 185               ['Defender']       CB
## 1132              ['Defender']       CB
```

```
## 2410 ['Defender', 'Midfielder']       CB
## 6034  ['Striker', 'Midfielder']       ST
## 8971              ['Midfielder']       ST
## 296               ['Midfielder']       CB
## 28                ['Midfielder']       ST
## 34                ['Midfielder']       CB
## 221               ['Midfielder']       CB
## 64                ['Midfielder']       CB
## 67                ['Midfielder']       ST
## 68                ['Midfielder']       CB
## 69                ['Midfielder']       ST
```

Simple SVM

Train

```
train_control <- trainControl(method="cv", number=10)

formula = st_or_cb ~ age + height_cm + weight_kg +
                    shooting + shooting + passing + dribbling +
                    defending + physic + attacking_crossing +
                    attacking_finishing + attacking_heading_accuracy +
                    attacking_short_passing + attacking_volleys +
                    skill_dribbling + skill_curve + skill_fk_accuracy +
                    skill_long_passing + skill_ball_control +
                    movement_acceleration + movement_sprint_speed +
                    movement_agility + movement_reactions +
                    movement_balance + power_shot_power +
                    power_jumping + power_stamina + power_strength +
                    power_long_shots + mentality_aggression +
                    mentality_interceptions + mentality_positioning +
                    mentality_vision + mentality_penalties +
                    mentality_composure + defending_marking +
                    defending_standing_tackle + defending_sliding_tackle

simple.svm <- train(formula,
              data = fifa.trn, method = "svmLinear",
              trControl = train_control,
              preProcess = c("center","scale"))

simple.svm
```

```
## Support Vector Machines with Linear Kernel
##
## 12994 samples
##    37 predictor
##     2 classes: 'CB', 'ST'
##
## Pre-processing: centered (37), scaled (37)
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 11695, 11694, 11695, 11695, 11694, 11695, ...
```

```
## Resampling results:
##
##   Accuracy   Kappa
##   0.9937662  0.9875169
##
## Tuning parameter 'C' was held constant at a value of 1
```

Test - Test Set

```
predict.res = predict(simple.svm, newdata=fifa.tst)

show.predict = data.frame(name=fifa.tst$short_name,
                          score_st = fifa.tst$st,
                          score_cb = fifa.tst$cb,
                          real_class = fifa.tst$st_or_cb,
                          pred_class = predict.res)
head(show.predict)
```

```
##          name score_st score_cb real_class pred_class
## 1   L. Modrić       77       72         ST         ST
## 2   L. Suárez       86       63         ST         ST
## 3  M. Hummels       68       84         CB         CB
## 4  Marquinhos       63       83         CB         CB
## 5 A. Di María       78       57         ST         ST
## 6      Parejo       74       69         ST         ST
```

```
confusionMatrix(predict.res, fifa.tst$st_or_cb)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   CB   ST
##         CB 1675   12
##         ST   12 1549
##
##                Accuracy : 0.9926
##                  95% CI : (0.989, 0.9953)
##     No Information Rate : 0.5194
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9852
##
##  Mcnemar's Test P-Value : 1
##
##             Sensitivity : 0.9929
##             Specificity : 0.9923
##          Pos Pred Value : 0.9929
##          Neg Pred Value : 0.9923
##              Prevalence : 0.5194
##          Detection Rate : 0.5157
##    Detection Prevalence : 0.5194
```

```
##       Balanced Accuracy : 0.9926
##
##        'Positive' Class : CB
##
```

Test - Famous Players

```
predict.res = predict(simple.svm, newdata=test.players)
show.predict = data.frame(name=test.players$short_name,
                          score_st = test.players$st,
                          score_cb = test.players$cb,
                          real_class = test.players$st_or_cb,
                          pred_class = predict.res)
show.predict
```

```
##                   name score_st score_cb real_class pred_class
## 1            K. Mbappé       86       54         ST         ST
## 2               H. Son       83       53         ST         ST
## 3          W. Weghorst       79       54         ST         ST
## 4                Piqué       70       85         CB         CB
## 5           C. Lenglet       63       83         CB         CB
## 6           David Luiz       68       80         CB         CB
## 7           K. Tierney       67       72         CB         CB
## 8          T. Tomiyasu       49       72         CB         CB
## 9   Gabriel Martinelli       64       37         ST         ST
## 10             B. Saka       61       45         ST         ST
## 11            G. Xhaka       69       71         CB         CB
## 12            T. Kroos       75       69         ST         ST
## 13            Casemiro       74       84         CB         CB
## 14           T. Partey       75       79         CB         CB
## 15          F. de Jong       74       76         CB         CB
## 16 S. Milinković-Savić       81       79         ST         ST
## 17               Rodri       73       80         CB         CB
## 18                Saúl       80       78         ST         ST
```

```
confusionMatrix(predict.res, test.players$st_or_cb)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction CB ST
##         CB 10  0
##         ST  0  8
##
##                Accuracy : 1
##                  95% CI : (0.8147, 1)
##     No Information Rate : 0.5556
##     P-Value [Acc > NIR] : 2.542e-05
##
##                   Kappa : 1
##
```

```
##  Mcnemar's Test P-Value : NA
##
##             Sensitivity : 1.0000
##             Specificity : 1.0000
##          Pos Pred Value : 1.0000
##          Neg Pred Value : 1.0000
##              Prevalence : 0.5556
##          Detection Rate : 0.5556
##    Detection Prevalence : 0.5556
##       Balanced Accuracy : 1.0000
##
##        'Positive' Class : CB
##
```

Tuned Linear SVM

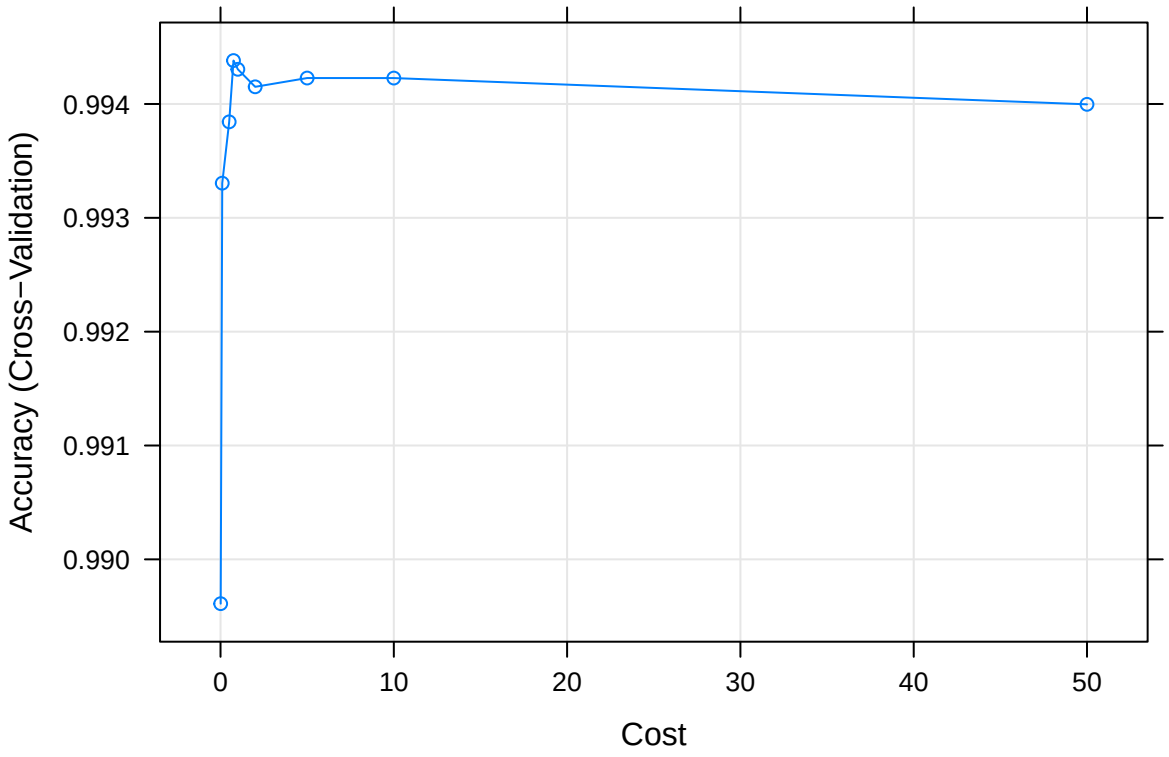
Train

```
train_control <- trainControl(method="cv", number=10)

formula = st_or_cb ~ age + height_cm + weight_kg +
                    shooting + shooting + passing + dribbling +
                    defending + physic + attacking_crossing +
                    attacking_finishing + attacking_heading_accuracy +
                    attacking_short_passing + attacking_volleys +
                    skill_dribbling + skill_curve + skill_fk_accuracy +
                    skill_long_passing + skill_ball_control +
                    movement_acceleration + movement_sprint_speed +
                    movement_agility + movement_reactions +
                    movement_balance + power_shot_power +
                    power_jumping + power_stamina + power_strength +
                    power_long_shots + mentality_aggression +
                    mentality_interceptions + mentality_positioning +
                    mentality_vision + mentality_penalties +
                    mentality_composure + defending_marking +
                    defending_standing_tackle + defending_sliding_tackle

linear.svm <- train(formula,
              data = fifa.trn, method = "svmLinear",
              trControl = train_control,
              preProcess = c("center","scale"),
              tuneGrid = expand.grid(C = c(0.01,0.1,0.5,0.75,1,2,5,10,50)))

linear.svm
```

```
## Support Vector Machines with Linear Kernel
##
## 12994 samples
##    37 predictor
##     2 classes: 'CB', 'ST'
##
```

```
## Pre-processing: centered (37), scaled (37)
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 11695, 11695, 11694, 11695, 11695, 11695, ...
## Resampling results across tuning parameters:
##
##   C      Accuracy   Kappa
##    0.01  0.9896106  0.9791873
##    0.10  0.9933047  0.9865921
##    0.50  0.9938431  0.9876709
##    0.75  0.9943818  0.9887495
##    1.00  0.9943048  0.9885954
##    2.00  0.9941509  0.9882876
##    5.00  0.9942280  0.9884425
##   10.00  0.9942278  0.9884422
##   50.00  0.9939970  0.9879801
##
## Accuracy was used to select the optimal model using the largest value.
## The final value used for the model was C = 0.75.
```

```
plot(linear.svm)
```




```
linear.best.C = linear.svm$bestTune$C

linear.best.res<-as_tibble(linear.svm$results[which.max(linear.svm$results[,2]),])
linear.best.res
```

```
## # A tibble: 1 x 5
##       C Accuracy Kappa AccuracySD KappaSD
##   <dbl>    <dbl> <dbl>      <dbl>   <dbl>
## 1  0.75    0.994 0.989    0.00158 0.00317
```

```
best.linear.svm = linear.svm$finalModel
best.linear.svm
```

```
## Support Vector Machine object of class "ksvm"
##
## SV type: C-svc  (classification)
##  parameter : cost C = 0.75
##
## Linear (vanilla) kernel function.
##
## Number of Support Vectors : 315
##
## Objective Function Value : -180.9209
## Training error : 0.004618
```

Test - Test Set

```
predict.res = predict(linear.svm, newdata=fifa.tst)

show.predict = data.frame(name=fifa.tst$short_name,
                          score_st = fifa.tst$st,
                          score_cb = fifa.tst$cb,
                          real_class = fifa.tst$st_or_cb,
                          pred_class = predict.res)
head(show.predict)
```

```
##          name score_st score_cb real_class pred_class
## 1   L. Modrić       77       72         ST         ST
## 2   L. Suárez       86       63         ST         ST
## 3  M. Hummels       68       84         CB         CB
## 4  Marquinhos       63       83         CB         CB
## 5 A. Di María       78       57         ST         ST
## 6      Parejo       74       69         ST         ST
```

```
confusionMatrix(predict.res, fifa.tst$st_or_cb)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   CB   ST
##         CB 1676   13
##         ST   11 1548
##
##                Accuracy : 0.9926
##                  95% CI : (0.989, 0.9953)
```

```
##     No Information Rate : 0.5194
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9852
##
##  Mcnemar's Test P-Value : 0.8383
##
##             Sensitivity : 0.9935
##             Specificity : 0.9917
##          Pos Pred Value : 0.9923
##          Neg Pred Value : 0.9929
##              Prevalence : 0.5194
##          Detection Rate : 0.5160
##    Detection Prevalence : 0.5200
##       Balanced Accuracy : 0.9926
##
##        'Positive' Class : CB
##
```

Test - Famous Player

```
predict.res = predict(linear.svm, newdata=test.players)

show.predict = data.frame(name=test.players$short_name,
                          score_st = test.players$st,
                          score_cb = test.players$cb,
                          real_class = test.players$st_or_cb,
                          pred_class = predict.res)
show.predict
```

```
##                   name score_st score_cb real_class pred_class
## 1            K. Mbappé       86       54         ST         ST
## 2               H. Son       83       53         ST         ST
## 3          W. Weghorst       79       54         ST         ST
## 4                Piqué       70       85         CB         CB
## 5           C. Lenglet       63       83         CB         CB
## 6           David Luiz       68       80         CB         CB
## 7           K. Tierney       67       72         CB         CB
## 8          T. Tomiyasu       49       72         CB         CB
## 9   Gabriel Martinelli       64       37         ST         ST
## 10             B. Saka       61       45         ST         ST
## 11            G. Xhaka       69       71         CB         CB
## 12            T. Kroos       75       69         ST         ST
## 13            Casemiro       74       84         CB         CB
## 14           T. Partey       75       79         CB         CB
## 15          F. de Jong       74       76         CB         CB
## 16 S. Milinković-Savić       81       79         ST         ST
## 17               Rodri       73       80         CB         CB
## 18                Saúl       80       78         ST         ST
```

```
confusionMatrix(predict.res, test.players$st_or_cb)
```

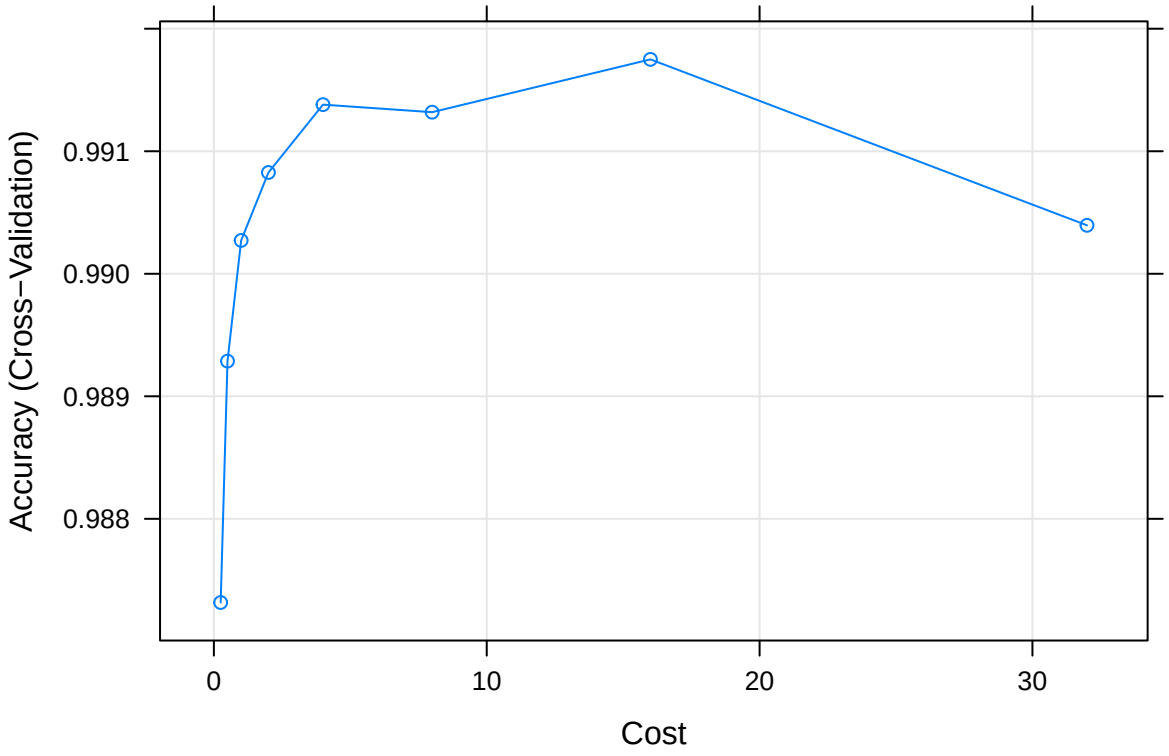
```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction CB ST
##         CB 10  0
##         ST  0  8
##
##                Accuracy : 1
##                  95% CI : (0.8147, 1)
##     No Information Rate : 0.5556
##     P-Value [Acc > NIR] : 2.542e-05
##
##                   Kappa : 1
##
##  Mcnemar's Test P-Value : NA
##
##             Sensitivity : 1.0000
##             Specificity : 1.0000
##          Pos Pred Value : 1.0000
##          Neg Pred Value : 1.0000
##              Prevalence : 0.5556
##          Detection Rate : 0.5556
##    Detection Prevalence : 0.5556
##       Balanced Accuracy : 1.0000
##
##        'Positive' Class : CB
##
```

Radial SVM

###Train

```
train_control <- trainControl(method="cv", number=10)

radial.svm <- train(formula,
              data = fifa, method = "svmRadial",
              trControl = train_control,
              preProcess = c("center","scale"),
              tuneLength = 8)
```

```
plot(radial.svm)
```




```
radial.best.C = radial.svm$bestTune$C

radial.best.res<-as_tibble(radial.svm$results[which.max(radial.svm$results[,2]),])
radial.best.res
```

```
## # A tibble: 1 x 6
##    sigma     C Accuracy Kappa AccuracySD KappaSD
##    <dbl> <dbl>    <dbl> <dbl>      <dbl>   <dbl>
## 1 0.0221    32    0.990 0.981    0.00184 0.00369
```

```
best.radial.svm = radial.svm$finalModel
best.radial.svm
```

```
## Support Vector Machine object of class "ksvm"
##
## SV type: C-svc  (classification)
##  parameter : cost C = 16
##
## Gaussian Radial Basis kernel function.
##  Hyperparameter : sigma =  0.0220763860824735
##
## Number of Support Vectors : 575
##
## Objective Function Value : -3759.679
## Training error : 0.001231
```

Test - Test Set

```
predict.res = predict(radial.svm, newdata=fifa.tst)

show.predict = data.frame(name=fifa.tst$short_name,
                          score_st = fifa.tst$st,
                          score_cb = fifa.tst$cb,
                          real_class = fifa.tst$st_or_cb,
                          pred_class = predict.res)
head(show.predict)
```

```
##          name score_st score_cb real_class pred_class
## 1   L. Modrić       77       72         ST         ST
## 2   L. Suárez       86       63         ST         ST
## 3  M. Hummels       68       84         CB         CB
## 4  Marquinhos       63       83         CB         CB
## 5 A. Di María       78       57         ST         ST
## 6      Parejo       74       69         ST         ST
```

```
confusionMatrix(predict.res, fifa.tst$st_or_cb)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   CB   ST
##         CB 1686    1
##         ST    1 1560
##
##                Accuracy : 0.9994
##                  95% CI : (0.9978, 0.9999)
##     No Information Rate : 0.5194
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9988
##
##  Mcnemar's Test P-Value : 1
##
##             Sensitivity : 0.9994
##             Specificity : 0.9994
##          Pos Pred Value : 0.9994
##          Neg Pred Value : 0.9994
##              Prevalence : 0.5194
##          Detection Rate : 0.5191
##    Detection Prevalence : 0.5194
##       Balanced Accuracy : 0.9994
##
##        'Positive' Class : CB
##
```

Test - Famous Player

```
predict.res = predict(radial.svm, newdata=test.players)

show.predict = data.frame(name=test.players$short_name,
                          score_st = test.players$st,
                          score_cb = test.players$cb,
                          real_class = test.players$st_or_cb,
                          pred_class = predict.res)
show.predict
```

```
##                   name score_st score_cb real_class pred_class
## 1            K. Mbappé       86       54         ST         ST
## 2               H. Son       83       53         ST         ST
## 3          W. Weghorst       79       54         ST         ST
## 4                Piqué       70       85         CB         CB
## 5           C. Lenglet       63       83         CB         CB
## 6           David Luiz       68       80         CB         CB
## 7           K. Tierney       67       72         CB         CB
## 8          T. Tomiyasu       49       72         CB         CB
## 9   Gabriel Martinelli       64       37         ST         ST
## 10             B. Saka       61       45         ST         ST
## 11            G. Xhaka       69       71         CB         CB
## 12            T. Kroos       75       69         ST         ST
## 13            Casemiro       74       84         CB         CB
## 14           T. Partey       75       79         CB         CB
## 15          F. de Jong       74       76         CB         CB
## 16 S. Milinković-Savić       81       79         ST         ST
## 17               Rodri       73       80         CB         CB
## 18                Saúl       80       78         ST         ST
```

```
confusionMatrix(predict.res, test.players$st_or_cb)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction CB ST
##         CB 10  0
##         ST  0  8
##
##                Accuracy : 1
##                  95% CI : (0.8147, 1)
##     No Information Rate : 0.5556
##     P-Value [Acc > NIR] : 2.542e-05
##
##                   Kappa : 1
##
##  Mcnemar's Test P-Value : NA
##
##             Sensitivity : 1.0000
##             Specificity : 1.0000
##          Pos Pred Value : 1.0000
```

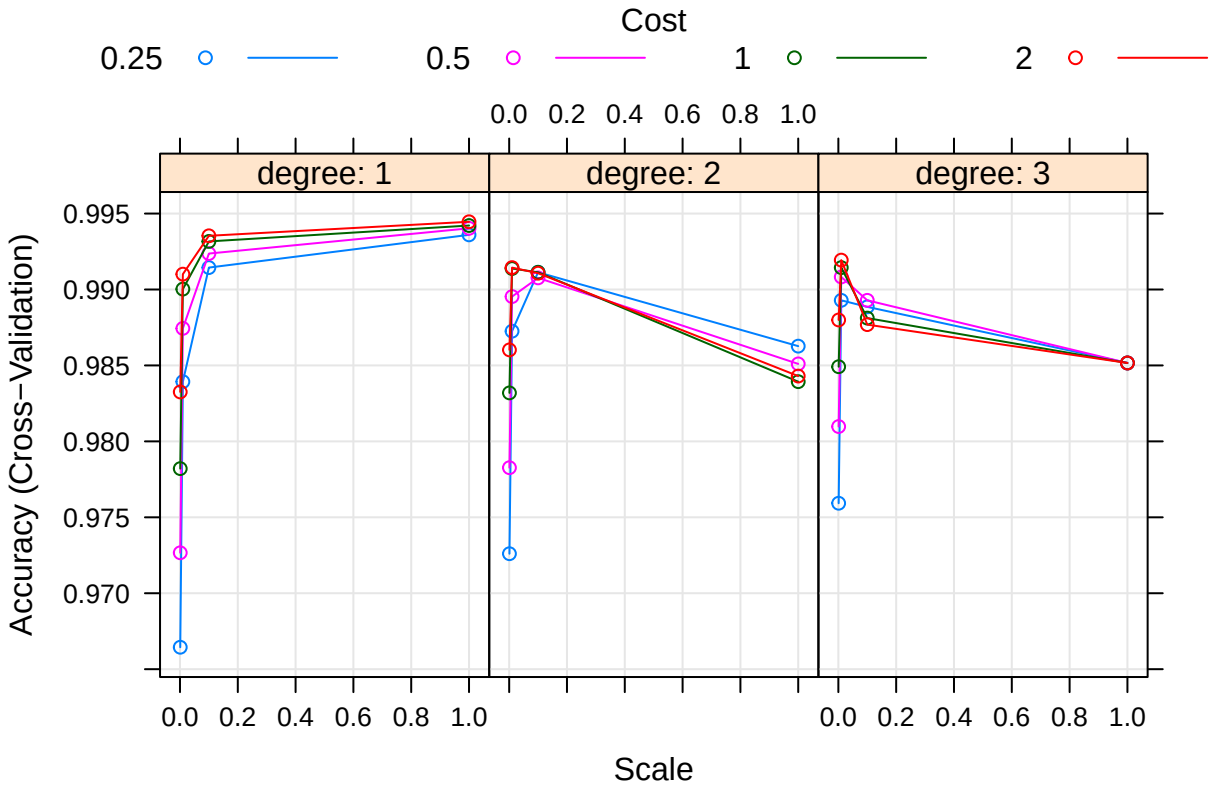
```
##          Neg Pred Value : 1.0000
##              Prevalence : 0.5556
##          Detection Rate : 0.5556
##    Detection Prevalence : 0.5556
##       Balanced Accuracy : 1.0000
##
##        'Positive' Class : CB
##
```

Polynomial SVM

Train

```
poly.svm <- train(formula,
                  data = fifa, method = "svmPoly",
                  trControl = train_control,
                  preProcess = c("center","scale"),
                  tuneLength = 4)
```

```
plot(poly.svm)
```



```
poly.best.C = poly.svm$bestTune$C

poly.best.res<-as_tibble(poly.svm$results[which.max(poly.svm$results[,2]),])
poly.best.res
```

```
## # A tibble: 1 x 7
##   degree scale     C Accuracy Kappa AccuracySD KappaSD
##    <int> <dbl> <dbl>    <dbl> <dbl>      <dbl>   <dbl>
## 1      1     1  0.25    0.994 0.987    0.00172 0.00345
```

```
best.poly.svm = poly.svm$finalModel
best.poly.svm
```

```
## Support Vector Machine object of class "ksvm"
##
## SV type: C-svc  (classification)
##  parameter : cost C = 2
##
## Polynomial kernel function.
##  Hyperparameters : degree =  1  scale =  1  offset =  1
##
## Number of Support Vectors : 297
##
## Objective Function Value : -473.898
## Training error : 0.004987
```

Test - Test Set

```
predict.res = predict(poly.svm, newdata=fifa.tst)

show.predict = data.frame(name=fifa.tst$short_name,
                          score_st = fifa.tst$st,
                          score_cb = fifa.tst$cb,
                          real_class = fifa.tst$st_or_cb,
                          pred_class = predict.res)
head(show.predict)
```

```
##          name score_st score_cb real_class pred_class
## 1   L. Modrić       77       72         ST         ST
## 2   L. Suárez       86       63         ST         ST
## 3  M. Hummels       68       84         CB         CB
## 4  Marquinhos       63       83         CB         CB
## 5 A. Di María       78       57         ST         ST
## 6      Parejo       74       69         ST         ST
```

```
confusionMatrix(predict.res, fifa.tst$st_or_cb)
```

```
## Confusion Matrix and Statistics
##
```

```
##           Reference
## Prediction   CB   ST
##         CB 1677    6
##         ST   10 1555
##
##                Accuracy : 0.9951
##                  95% CI : (0.992, 0.9972)
##     No Information Rate : 0.5194
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9901
##
##  Mcnemar's Test P-Value : 0.4533
##
##             Sensitivity : 0.9941
##             Specificity : 0.9962
##          Pos Pred Value : 0.9964
##          Neg Pred Value : 0.9936
##              Prevalence : 0.5194
##          Detection Rate : 0.5163
##    Detection Prevalence : 0.5182
##       Balanced Accuracy : 0.9951
##
##        'Positive' Class : CB
##
```

Test - Famous Player

```
predict.res = predict(poly.svm, newdata=test.players)

show.predict = data.frame(name=test.players$short_name,
                          score_st = test.players$st,
                          score_cb = test.players$cb,
                          real_class = test.players$st_or_cb,
                          pred_class = predict.res)
show.predict
```

```
##                   name score_st score_cb real_class pred_class
## 1            K. Mbappé       86       54         ST         ST
## 2               H. Son       83       53         ST         ST
## 3          W. Weghorst       79       54         ST         ST
## 4                Piqué       70       85         CB         CB
## 5            C. Lenglet       63       83         CB         CB
## 6           David Luiz       68       80         CB         CB
## 7            K. Tierney       67       72         CB         CB
## 8          T. Tomiyasu       49       72         CB         CB
## 9   Gabriel Martinelli       64       37         ST         ST
## 10             B. Saka       61       45         ST         ST
## 11           G. Xhaka       69       71         CB         CB
## 12           T. Kroos       75       69         ST         ST
## 13           Casemiro       74       84         CB         CB
## 14          T. Partey       75       79         CB         CB
```

```
## 15          F. de Jong       74       76         CB         CB
## 16 S. Milinković-Savić       81       79         ST         ST
## 17               Rodri       73       80         CB         CB
## 18                Saúl       80       78         ST         ST
```

```
confusionMatrix(predict.res, test.players$st_or_cb)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction CB ST
##         CB 10  0
##         ST  0  8
##
##                Accuracy : 1
##                  95% CI : (0.8147, 1)
##     No Information Rate : 0.5556
##     P-Value [Acc > NIR] : 2.542e-05
##
##                   Kappa : 1
##
##  Mcnemar's Test P-Value : NA
##
##             Sensitivity : 1.0000
##             Specificity : 1.0000
##          Pos Pred Value : 1.0000
##          Neg Pred Value : 1.0000
##              Prevalence : 0.5556
##          Detection Rate : 0.5556
##    Detection Prevalence : 0.5556
##       Balanced Accuracy : 1.0000
##
##        'Positive' Class : CB
##
```