

Stats Project

Miguel/Antonia

2022-12-19

Load packages and set working directory

```
library(glmnet)
```

```
## Loading required package: Matrix
```

```
## Loaded glmnet 4.1-4
```

```
library(gridExtra)
```

```
#source(file.path("../SIM_project/helper_functions/routines_seminar1.R"))
```

```
library("readxl")
```

```
library(lme4)
```

```
library(arm)
```

```
## Loading required package: MASS
```

```
##
```

```
## arm (Version 1.13-1, built: 2022-8-25)
```

```
## Working directory is /Users/Miguel/Desktop/SIM_project
```

```
library(tidyverse)
```

```
## -- Attaching packages ----- tidyverse 1.3.2 --
```

```
## v ggplot2 3.4.0      v purrr   0.3.4
```

```
## v tibble  3.1.8      v dplyr  1.0.10
```

```
## v tidyr   1.2.1      v stringr 1.4.1
```

```
## v readr   2.1.2      v forcats 0.5.2
```

```
## -- Conflicts ----- tidyverse_conflicts() --
```

```
## x dplyr::combine() masks gridExtra::combine()
```

```
## x tidyr::expand()  masks Matrix::expand()
```

```
## x dplyr::filter()  masks stats::filter()
```

```
## x dplyr::lag()     masks stats::lag()
```

```
## x tidyr::pack()    masks Matrix::pack()
```

```
## x dplyr::select()  masks MASS::select()
```

```
## x tidyr::unpack()  masks Matrix::unpack()
```

Set seed

```
set.seed(1234)
```

Load data

Remove some unnecessary columns

```
f22 <- f22 %>% dplyr::select(-c("player_face_url", "club_logo_url", "club_flag_url",  
                                "nation_logo_url", "nation_flag_url", "player_url",  
                                "real_face"))
```

```

f21 <- f21 %>% dplyr::select(-c("player_face_url", "club_logo_url", "club_flag_url",
                                "nation_logo_url", "nation_flag_url", "player_url",
                                "real_face"))

f20 <- f20 %>% dplyr::select(-c("player_face_url", "club_logo_url", "club_flag_url",
                                "nation_logo_url", "nation_flag_url", "player_url",
                                "real_face"))

f19 <- f19 %>% dplyr::select(-c("player_face_url", "club_logo_url", "club_flag_url",
                                "nation_logo_url", "nation_flag_url", "player_url",
                                "real_face"))

f18 <- f18 %>% dplyr::select(-c("player_face_url", "club_logo_url", "club_flag_url",
                                "nation_logo_url", "nation_flag_url", "player_url",
                                "real_face"))

f17 <- f17 %>% dplyr::select(-c("player_face_url", "club_logo_url", "club_flag_url",
                                "nation_logo_url", "nation_flag_url", "player_url",
                                "real_face"))

f16 <- f16 %>% dplyr::select(-c("player_face_url", "club_logo_url", "club_flag_url",
                                "nation_logo_url", "nation_flag_url", "player_url",
                                "real_face"))

f15 <- f15 %>% dplyr::select(-c("player_face_url", "club_logo_url", "club_flag_url",
                                "nation_logo_url", "nation_flag_url", "player_url",
                                "real_face"))

```

TIMELINE

Season Starts (Fall 2020)

Season Ends (Spring 2021)

Game (FIFA 2022) is made and players are rated (Summer 2021)

New Teams (Summer 2021) (These come from the 2022 edition of the game because they are from the 2021-2022 season.)

Predictions are Made for next season (Summer 2021)

New Season (2021 -> 2022)

So, we are going to use the FIFA 2022 ratings to predict the 2021-2022 season with the FIFA 2022 rosters.

The 2021-2022 points data goes with FIFA 2022, since that is what we are trying to predict.

Import REAL end of season info (total number of points, wins, losses, etc. for each team)

```
table22 <- read_excel("./data/LaLiga_results.xlsx", sheet = "2021-2022")
table21 <- read_excel("./data/LaLiga_results.xlsx", sheet = "2020-2021")
table20 <- read_excel("./data/LaLiga_results.xlsx", sheet = "2019-2020")
table19 <- read_excel("./data/LaLiga_results.xlsx", sheet = "2018-2019")
table18 <- read_excel("./data/LaLiga_results.xlsx", sheet = "2017-2018")
table17 <- read_excel("./data/LaLiga_results.xlsx", sheet = "2016-2017")
table16 <- read_excel("./data/LaLiga_results.xlsx", sheet = "2015-2016")
table15 <- read_excel("./data/LaLiga_results.xlsx", sheet = "2014-2015")
```

View data

f22

```
## # A tibble: 19,239 x 104
##   ...1 sofifa_id short~1 long_~2 playe~3 overall poten~4 value~5 wage_~6 age
##   <dbl>         <dbl> <chr>   <chr>   <chr>         <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
## 1      1      158023 L. Mes~ Lionel~ RW, ST~      93      93  7.8 e7  320000  34
## 2      2      188545 R. Lew~ Robert~ ST          92      92  1.20e8  270000  32
## 3      3      20801  Cristi~ Cristi~ ST, LW      91      91  4.5 e7  270000  36
## 4      4      190871 Neymar~ Neymar~ LW, CAM      91      91  1.29e8  270000  29
## 5      5      192985 K. De ~ Kevin ~ CM, CAM      91      91  1.25e8  350000  30
## 6      6      200389 J. Obl~ Jan Ob~ GK          91      93  1.12e8  130000  28
## 7      7      231747 K. Mba~ Kylian~ ST, LW      91      95  1.94e8  230000  22
## 8      8      167495 M. Neu~ Manuel~ GK          90      90  1.35e7   86000  35
```

```
## 9      9      192448 M. ter~ Marc-A- GK          90      92 9.9 e7 250000 29
## 10     10     202126 H. Kane Harry ~ ST          90      90 1.30e8 240000 27
## # ... with 19,229 more rows, 94 more variables: dob <date>, height_cm <dbl>,
## #   weight_kg <dbl>, club_team_id <dbl>, club_name <chr>, league_name <chr>,
## #   league_level <dbl>, club_position <chr>, club_jersey_number <dbl>,
## #   club_loaned_from <chr>, club_joined <date>,
## #   club_contract_valid_until <dbl>, nationality_id <dbl>,
## #   nationality_name <chr>, nation_team_id <dbl>, nation_position <chr>,
## #   nation_jersey_number <dbl>, preferred_foot <chr>, weak_foot <dbl>, ...
```

```
colnames(f22)
```

```
## [1] "...1" "sofifa_id"
## [3] "short_name" "long_name"
## [5] "player_positions" "overall"
## [7] "potential" "value_eur"
## [9] "wage_eur" "age"
## [11] "dob" "height_cm"
## [13] "weight_kg" "club_team_id"
## [15] "club_name" "league_name"
## [17] "league_level" "club_position"
## [19] "club_jersey_number" "club_loaned_from"
## [21] "club_joined" "club_contract_valid_until"
## [23] "nationality_id" "nationality_name"
## [25] "nation_team_id" "nation_position"
## [27] "nation_jersey_number" "preferred_foot"
## [29] "weak_foot" "skill_moves"
## [31] "international_reputation" "work_rate"
## [33] "body_type" "release_clause_eur"
## [35] "player_tags" "player_traits"
## [37] "pace" "shooting"
## [39] "passing" "dribbling"
## [41] "defending" "physic"
## [43] "attacking_crossing" "attacking_finishing"
## [45] "attacking_heading_accuracy" "attacking_short_passing"
## [47] "attacking_volleys" "skill_dribbling"
## [49] "skill_curve" "skill_fk_accuracy"
## [51] "skill_long_passing" "skill_ball_control"
## [53] "movement_acceleration" "movement_sprint_speed"
## [55] "movement_agility" "movement_reactions"
## [57] "movement_balance" "power_shot_power"
## [59] "power_jumping" "power_stamina"
## [61] "power_strength" "power_long_shots"
## [63] "mentality_aggression" "mentality_interceptions"
## [65] "mentality_positioning" "mentality_vision"
## [67] "mentality_penalties" "mentality_composure"
## [69] "defending_marking_awareness" "defending_standing_tackle"
## [71] "defending_sliding_tackle" "goalkeeping_diving"
## [73] "goalkeeping_handling" "goalkeeping_kicking"
## [75] "goalkeeping_positioning" "goalkeeping_reflexes"
## [77] "goalkeeping_speed" "ls"
## [79] "st" "rs"
## [81] "lw" "lf"
## [83] "cf" "rf"
## [85] "rw" "lam"
```

```
## [87] "cam"           "ram"
## [89] "lm"            "lcm"
## [91] "cm"            "rcm"
## [93] "rm"            "lwb"
## [95] "ldm"           "cdm"
## [97] "rdm"           "rwb"
## [99] "lb"            "lcb"
## [101] "cb"            "rcb"
## [103] "rb"            "gk"
```

Filter for only Spain Primera Division

```
f22_sp <- f22 %>% filter(league_name=='Spain Primera Division')
f21_sp <- f21 %>% filter(league_name=='Spain Primera Division')
f20_sp <- f20 %>% filter(league_name=='Spain Primera Division')
f19_sp <- f19 %>% filter(league_name=='Spain Primera Division')
f18_sp <- f18 %>% filter(league_name=='Spain Primera Division')
f17_sp <- f17 %>% filter(league_name=='Spain Primera Division')
f16_sp <- f16 %>% filter(league_name=='Spain Primera Division')
f15_sp <- f15 %>% filter(league_name=='Spain Primera Division')
```

Pick only the columns that we want.

```
cols_to_choose <- c("overall", "potential", "value_eur", "wage_eur", "age", #"dob",
  "height_cm", "weight_kg", "club_name", #"club_team_id",
  #"league_level",
  "preferred_foot", "weak_foot", "skill_moves", "international_reputation", #"work_ra
  "release_clause_eur", #"player_tags", #"player_traits",
  "pace",
  "club_position",
  "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_accelera
  "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_p
  "mentality_vision", "mentality_penalties", "mentality_composure", "defending_marking
  "defending_standing_tackle", "defending_sliding_tackle", "goalkeeping_diving", "goal
  "goalkeeping_kicking", "goalkeeping_positioning", "goalkeeping_reflexes", "goalkeep
  #"ls", "st", "rs", "lw",
  #"lf", "cf", "rf", "rw",
  #"lam", "cam", "ram", "lm",
  #"lcm", "cm", "rcm", "rm",
  #"lwb", "ldm", "cdm", "rdm",
  #"rwb", "lb", "lcb", "cb",
  #"rcb", "rb", "gk"
)
```

Make the column selection.

```
f22_sp <- f22_sp[cols_to_choose]
f21_sp <- f21_sp[cols_to_choose]
f20_sp <- f20_sp[cols_to_choose]
f19_sp <- f19_sp[cols_to_choose]
f18_sp <- f18_sp[cols_to_choose]
```

```
f17_sp <- f17_sp[cols_to_choose]
f16_sp <- f16_sp[cols_to_choose]
f15_sp <- f15_sp[cols_to_choose]
```

Make simplified position: GK/Defense/Midfield/Forward/Reserve

```
get_pos <- function(setx) {
  setx$pos <- c(rep("POS", nrow(setx)))
  defc <- setx$club_position %in% c("LCB", "LB", "RB", "RCB", "CB", "RWB", "LWB")
  midc <- setx$club_position %in% c("CDM", "LCM", "RCM", "RM", "CAM", "LW", "LM", "RW", "RDM", "LDM", "CM")
  forc <- setx$club_position %in% c("RS", "ST", "LS", "CF", "LF", "RF")
  subc <- setx$club_position %in% c("SUB", "RES")
  gkc <- setx$club_position %in% c("GK")
  setx$pos[defc] <- "defender"
  setx$pos[midc] <- "midfielder"
  setx$pos[forc] <- "forward"
  setx$pos[subc] <- "sub/res"
  setx$pos[gkc] <- "goalkeeper"
  return(setx)
}

f22_sp <- get_pos(f22_sp)
f21_sp <- get_pos(f21_sp)
f20_sp <- get_pos(f20_sp)
f19_sp <- get_pos(f19_sp)
f18_sp <- get_pos(f18_sp)
f17_sp <- get_pos(f17_sp)
f16_sp <- get_pos(f16_sp)
f15_sp <- get_pos(f15_sp)
```

Preprocessing of data

```
# Replace NAs by 0
f22_sp[is.na(f22_sp)] <- 0
f21_sp[is.na(f21_sp)] <- 0
f20_sp[is.na(f20_sp)] <- 0
f19_sp[is.na(f19_sp)] <- 0
f18_sp[is.na(f18_sp)] <- 0
f17_sp[is.na(f17_sp)] <- 0
f16_sp[is.na(f16_sp)] <- 0
f15_sp[is.na(f15_sp)] <- 0

# Group dataframes by team.
f22_gp <- f22_sp %>% group_by(club_name) %>% summarise(across(where(is.numeric), mean))
f21_gp <- f21_sp %>% group_by(club_name) %>% summarise(across(where(is.numeric), mean))
f20_gp <- f20_sp %>% group_by(club_name) %>% summarise(across(where(is.numeric), mean))
f19_gp <- f19_sp %>% group_by(club_name) %>% summarise(across(where(is.numeric), mean))
f18_gp <- f18_sp %>% group_by(club_name) %>% summarise(across(where(is.numeric), mean))
f17_gp <- f17_sp %>% group_by(club_name) %>% summarise(across(where(is.numeric), mean))
f16_gp <- f16_sp %>% group_by(club_name) %>% summarise(across(where(is.numeric), mean))
f15_gp <- f15_sp %>% group_by(club_name) %>% summarise(across(where(is.numeric), mean))

# Join dataframes
f22_gp <- left_join(f22_gp, table22, by = c("club_name"="Equipo"))
f21_gp <- left_join(f21_gp, table21, by = c("club_name"="Equipo"))
f20_gp <- left_join(f20_gp, table20, by = c("club_name"="Equipo"))
f19_gp <- left_join(f19_gp, table19, by = c("club_name"="Equipo"))
```

```
f18_gp <- left_join(f18_gp, table18, by = c("club_name"="Equipo"))
f17_gp <- left_join(f17_gp, table17, by = c("club_name"="Equipo"))
f16_gp <- left_join(f16_gp, table16, by = c("club_name"="Equipo"))
f15_gp <- left_join(f15_gp, table15, by = c("club_name"="Equipo"))
## Check for NAs in dataframe.
# for(i in 1:length(cols_to_choose)){
#   print(sum(is.na(f22_gp[i])))
# }
```

Add a multiplier on points for second division teams going to first division.

```
# second_div_mult <- 0.5
```

Create new dataframe

```
new_df <- bind_rows(f21_gp, f20_gp, f19_gp, f18_gp, f17_gp, f16_gp, f15_gp)
```

Remove some columns

```
colnames(new_df)
```

```
## [1] "club_name"          "overall"
## [3] "potential"          "value_eur"
## [5] "wage_eur"           "age"
## [7] "height_cm"          "weight_kg"
## [9] "weak_foot"          "skill_moves"
## [11] "international_reputation" "release_clause_eur"
## [13] "pace"               "shooting"
## [15] "passing"            "dribbling"
## [17] "defending"          "physic"
## [19] "attacking_crossing" "attacking_finishing"
## [21] "attacking_heading_accuracy" "attacking_short_passing"
## [23] "attacking_volleys"  "skill_dribbling"
## [25] "skill_curve"        "skill_fk_accuracy"
## [27] "skill_long_passing" "skill_ball_control"
## [29] "movement_acceleration" "movement_sprint_speed"
## [31] "movement_agility"   "movement_reactions"
## [33] "movement_balance"   "power_shot_power"
## [35] "power_jumping"       "power_stamina"
## [37] "power_strength"      "power_long_shots"
## [39] "mentality_aggression" "mentality_interceptions"
## [41] "mentality_positioning" "mentality_vision"
## [43] "mentality_penalties" "mentality_composure"
## [45] "defending_marking_awareness" "defending_standing_tackle"
## [47] "defending_sliding_tackle" "goalkeeping_diving"
## [49] "goalkeeping_handling" "goalkeeping_kicking"
## [51] "goalkeeping_positioning" "goalkeeping_reflexes"
## [53] "goalkeeping_speed"    "Pos."
## [55] "Pts."                 "PJ"
## [57] "G"                    "E"
## [59] "P"                    "GF"
## [61] "GC"                   "Dif."
## [63] "Des"                  "Asc"
```

```
cols_to_drop <- c("Pos.", "PJ", "G", "E", "P", "GF", "GC", "Dif.", "Des", "Asc")
new_df <- new_df[, !colnames(new_df) %in% cols_to_drop]
f22_gp <- f22_gp[, !colnames(f22_gp) %in% cols_to_drop]
```

TRAIN

```
y <- new_df$Pts.  
x <- dplyr::select(new_df, -c("Pts.", "club_name") ) %>% as.matrix() %>% scale()
```

TEST ##### NEEDS TO BE SAME SCALE!!

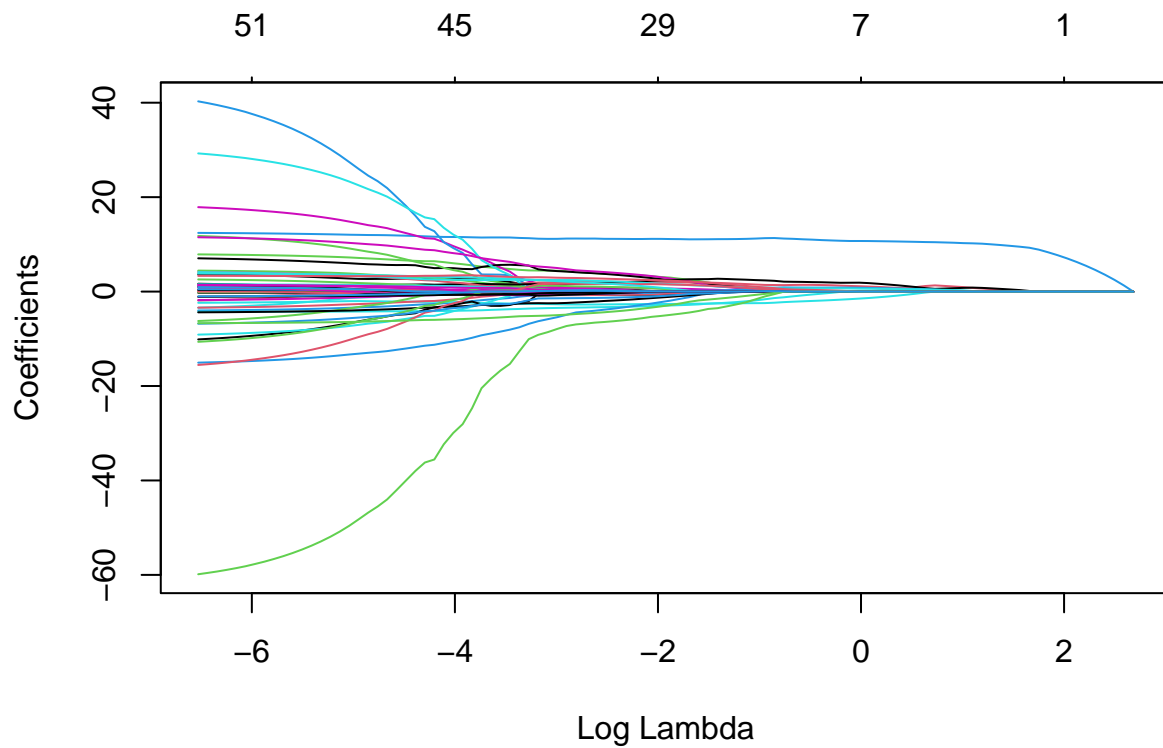
```
y_te <- f22_gp[c("club_name", "Pts.")]  
x_te <- dplyr::select(f22_gp, -c("Pts.", "club_name") ) %>% as.matrix() %>% scale()
```

LASSO MODEL

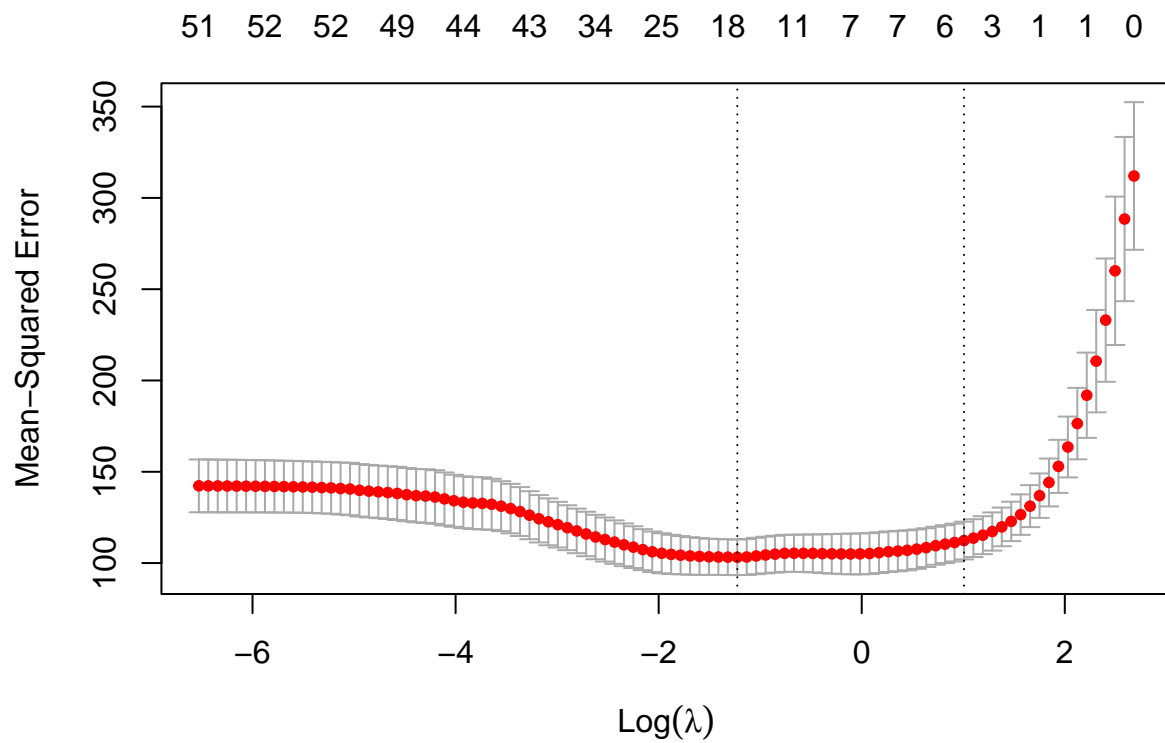
```
fit.lasso= cv.glmnet(x=x, y=y, family = "gaussian", nfolds = 5, alpha=1, type.measure = "mse")  
  
# model  
lasso.err <- assess.glmnet(fit.lasso, newx=x, newy=y, family='gaussian')  
lasso.err
```

```
## $mse  
## lambda.1se  
## 101.0203  
## attr("measure")  
## [1] "Mean-Squared Error"  
##  
## $mae  
## lambda.1se  
## 8.004357  
## attr("measure")  
## [1] "Mean Absolute Error"
```

```
plot(fit.lasso$glmnet.fit, xvar='lambda')
```

```
plot(fit.lasso)
```



```
# try model w min value of lambda
b.lasso= as.vector(coef(fit.lasso, s='lambda.min'))
betas = data.frame("word" = c("intercept", colnames(x)), "beta_hat"= round(b.lasso, 5))
betas %>% arrange(desc(abs(beta_hat)))
```

```

##                word beta_hat
## 1                intercept 52.17143
## 2 international_reputation 11.12791
## 3                dribbling -2.70233
## 4      movement_reactions  2.58930
## 5                  age -2.48630
## 6      release_clause_eur -2.22120
## 7 attacking_heading_accuracy 1.68062
## 8      goalkeeping_positioning 1.37290
## 9                value_eur  1.20551
## 10      attacking_finishing  1.15722
## 11      goalkeeping_reflexes -1.12758
## 12                power_stamina 0.97659
## 13 defending_marking_awareness 0.91311
## 14      movement_agility  0.76300
## 15      power_jumping  0.40762
## 16      height_cm  0.19937
## 17 defending_sliding_tackle -0.15589
## 18      mentality_composure -0.10865
## 19      weight_kg -0.01496
## 20      overall  0.00000
## 21      potential 0.00000
## 22      wage_eur  0.00000
## 23      weak_foot 0.00000
## 24      skill_moves 0.00000
## 25      pace 0.00000
## 26      shooting 0.00000
## 27      passing 0.00000
## 28      defending 0.00000
## 29      physic 0.00000
## 30      attacking_crossing 0.00000
## 31      attacking_short_passing 0.00000
## 32      attacking_volleys 0.00000
## 33      skill_dribbling 0.00000
## 34      skill_curve 0.00000
## 35      skill_fk_accuracy 0.00000
## 36      skill_long_passing 0.00000
## 37      skill_ball_control 0.00000
## 38      movement_acceleration 0.00000
## 39      movement_sprint_speed 0.00000
## 40      movement_balance 0.00000
## 41      power_shot_power 0.00000
## 42      power_strength 0.00000
## 43      power_long_shots 0.00000
## 44      mentality_aggression 0.00000
## 45      mentality_interceptions 0.00000
## 46      mentality_positioning 0.00000
## 47      mentality_vision 0.00000
## 48      mentality_penalties 0.00000
## 49      defending_standing_tackle 0.00000
## 50      goalkeeping_diving 0.00000
## 51      goalkeeping_handling 0.00000
## 52      goalkeeping_kicking 0.00000
## 53      goalkeeping_speed 0.00000

```

```
# not as good but just to try something else
b.lasso= as.vector(coef(fit.lasso, s=0.1))
betas = data.frame("word" = c("intercept", colnames(x)), "beta_hat"= round(b.lasso, 5))
betas %>% arrange(desc(abs(beta_hat)))
```

```
##           word beta_hat
## 1      intercept 52.17143
## 2 international_reputation 11.14742
## 3      dribbling -6.00486
## 4 goalkeeping_reflexes -3.96706
## 5      movement_agility 3.76728
## 6      value_eur 3.58226
## 7 attacking_finishing 3.35371
## 8 movement_acceleration -3.24349
## 9      release_clause_eur -3.19860
## 10           age -2.67837
## 11 goalkeeping_positioning 2.58537
## 12 attacking_heading_accuracy 2.06340
## 13      power_stamina 2.02147
## 14      movement_reactions 2.00314
## 15      mentality_composure -1.73331
## 16 defending_marking_awareness 1.59026
## 17      goalkeeping_diving 1.39596
## 18 defending_sliding_tackle -1.20415
## 19      mentality_interceptions 0.88205
## 20           height_cm 0.82295
## 21           weight_kg -0.66048
## 22      weak_foot -0.65300
## 23      overall 0.41500
## 24 attacking_volleys -0.34161
## 25 attacking_crossing 0.28115
## 26      power_strength -0.24273
## 27      power_long_shots -0.24154
## 28      skill_moves 0.22029
## 29      power_jumping 0.17507
## 30      goalkeeping_speed 0.10522
## 31      goalkeeping_kicking -0.00253
## 32      skill_fk_accuracy 0.00063
## 33      potential 0.00000
## 34      wage_eur 0.00000
## 35      pace 0.00000
## 36      shooting 0.00000
## 37      passing 0.00000
## 38      defending 0.00000
## 39      physic 0.00000
## 40 attacking_short_passing 0.00000
## 41      skill_dribbling 0.00000
## 42      skill_curve 0.00000
## 43      skill_long_passing 0.00000
## 44      skill_ball_control 0.00000
## 45      movement_sprint_speed 0.00000
## 46      movement_balance 0.00000
## 47      power_shot_power 0.00000
## 48      mentality_aggression 0.00000
```

```
## 49      mentality_positioning 0.00000
## 50      mentality_vision    0.00000
## 51      mentality_penalties 0.00000
## 52      defending_standing_tackle 0.00000
## 53      goalkeeping_handling 0.00000
```

```
# Test base model on 22 dataset
```

```
predictions <- predict(fit.lasso, newx = x_te)
y_te_sorted <- y_te
y_te_sorted$pred <- predictions
y_te_sorted <- y_te_sorted %>% arrange(desc(Pts.))
y_te_sorted
```

```
## # A tibble: 20 x 3
```

##	club_name	Pts.	pred["lambda.1se"]
##	<chr>	<dbl>	<dbl>
## 1	Real Madrid CF	86	80.1
## 2	FC Barcelona	73	74.9
## 3	Atlético de Madrid	71	73.8
## 4	Sevilla FC	70	60.3
## 5	Real Betis Balompié	65	57.5
## 6	Real Sociedad	62	52.8
## 7	Villarreal CF	59	55.6
## 8	Athletic Club de Bilbao	55	51.9
## 9	Valencia CF	48	50.6
## 10	CA Osasuna	47	41.4
## 11	RC Celta de Vigo	46	45.4
## 12	Elche CF	42	46.9
## 13	Rayo Vallecano	42	42.9
## 14	RCD Espanyol de Barcelona	42	44.6
## 15	Cádiz CF	39	41.7
## 16	Getafe CF	39	45.0
## 17	RCD Mallorca	39	41.2
## 18	Granada CF	38	44.9
## 19	Levante Unión Deportiva	35	49.2
## 20	Deportivo Alavés	31	42.5

```
# Test other model on 22 dataset
```

```
predictions <- predict(fit.lasso, newx = x_te)
y_te_sorted <- y_te
y_te_sorted$pred <- predictions
y_te_sorted <- y_te_sorted %>% arrange(desc(Pts.))
y_te_sorted
```

```
## # A tibble: 20 x 3
```

##	club_name	Pts.	pred["lambda.1se"]
##	<chr>	<dbl>	<dbl>
## 1	Real Madrid CF	86	80.1
## 2	FC Barcelona	73	74.9
## 3	Atlético de Madrid	71	73.8
## 4	Sevilla FC	70	60.3
## 5	Real Betis Balompié	65	57.5
## 6	Real Sociedad	62	52.8
## 7	Villarreal CF	59	55.6
## 8	Athletic Club de Bilbao	55	51.9
## 9	Valencia CF	48	50.6

## 10 CA Osasuna	47	41.4
## 11 RC Celta de Vigo	46	45.4
## 12 Elche CF	42	46.9
## 13 Rayo Vallecano	42	42.9
## 14 RCD Espanyol de Barcelona	42	44.6
## 15 Cádiz CF	39	41.7
## 16 Getafe CF	39	45.0
## 17 RCD Mallorca	39	41.2
## 18 Granada CF	38	44.9
## 19 Levante Unión Deportiva	35	49.2
## 20 Deportivo Alavés	31	42.5

```

# For dataset
# compute averages by player
# calculate month of birth for player
# modify goalkeeper stats to 0 for

# For model
# different values of lambda

```

HIERARCHICAL MODEL

```

fp22_hm <- left_join(fp22_sp, table22, by = c("club_name"="Equipo"))
fp21_hm <- left_join(fp21_sp, table21, by = c("club_name"="Equipo"))
fp20_hm <- left_join(fp20_sp, table20, by = c("club_name"="Equipo"))
fp19_hm <- left_join(fp19_sp, table19, by = c("club_name"="Equipo"))
fp18_hm <- left_join(fp18_sp, table18, by = c("club_name"="Equipo"))
fp17_hm <- left_join(fp17_sp, table17, by = c("club_name"="Equipo"))
fp16_hm <- left_join(fp16_sp, table16, by = c("club_name"="Equipo"))
fp15_hm <- left_join(fp15_sp, table15, by = c("club_name"="Equipo"))

cols_to_drop <- c( "Pos.", "PJ", "G", "E", "P", "GF", "GC", "Dif.", "Des", "Asc", "league_level")

y_te2 <- fp22_hm[c("Pts.", "club_name")]
hm_data <- bind_rows(fp21_hm, fp20_hm, fp19_hm, fp18_hm, fp17_hm, fp16_hm, fp15_hm)
hm_data <- hm_data[, !colnames(hm_data) %in% cols_to_drop]
fp22_hm <- fp22_hm[, !colnames(fp22_hm) %in% cols_to_drop]

# fp22_hm[] <- lapply(fp22_hm, function(x) if(is.numeric(x)){
#   scale(x, center=TRUE, scale=TRUE)
# } else x)

# Check for NAs in dataframe.
for(i in 1:length(colnames(fp22_hm))){
  print(sum(is.na(fp22_hm[i])))
}

```

[illegible]

```

## [1] 0
## [1] 0
## [1] 0
## [1] 0
## [1] 0

# fp22_hm$ran <- sample(-10:10, 633, rep = TRUE)
# fp22_hm$ranpts <- fp22_hm$Pts.+ fp22_hm$ran

# later add right/left foot as binary variable

hm_datasc <- hm_data %>%
  dplyr::select(-c(preferred_foot, club_name, Pts., club_position, pos)) %>%
  scale() %>%
  data.frame () %>%
  mutate_if(is.character, as.numeric)
hm_datasc <- cbind(hm_datasc, 'club_name'= hm_data$club_name,
                    'Pts.'=hm_data$Pts.,
                    'club_position'=hm_data$club_position,
                    'pos'=hm_data$pos)

fp22_hm_sc <- fp22_hm %>%
  dplyr::select(-c(preferred_foot, club_name, Pts., club_position, pos)) %>%
  scale() %>%
  data.frame () %>%
  mutate_if(is.character, as.numeric)
fp22_hm_sc <- cbind(fp22_hm_sc,
                    'club_name'= fp22_hm$club_name,
                    'Pts.'=fp22_hm$Pts.,
                    'club_position'=fp22_hm$club_position,
                    'pos'=fp22_hm$pos)

hm_datasc <- data.frame(hm_datasc)
fp22_hm_sc <- data.frame(fp22_hm_sc)

str(hm_datasc)

## 'data.frame':    4267 obs. of  56 variables:
## $ overall          : num  2.79 2.51 2.37 2.23 2.23 ...
## $ potential         : num  2.71 2.71 2.71 2 2 ...
## $ value_eur         : num  7.61 8.93 8.13 2.02 6.01 ...
## $ wage_eur          : num  9.25 1.57 3.95 4.66 5.54 ...
## $ age               : num  1.848 0.457 0.689 2.08 1.616 ...
## $ height_cm         : num  -1.744 1.193 1.03 0.541 0.704 ...
## $ weight_kg         : num  -0.394 2.017 1.696 1.213 1.053 ...
## $ weak_foot         : num  1.535 -0.107 1.535 -0.107 1.535 ...
## $ skill_moves       : num  1.656 -1.795 -1.795 0.506 1.656 ...
## $ international_reputation : num  4.94 2.22 2.22 3.58 3.58 ...
## $ release_clause_eur : num  5.88 6.84 6.3 1.81 4.51 ...
## $ pace              : num  0.997 -2.536 -2.536 0.415 0.54 ...
## $ shooting          : num  1.729 -2.284 -2.284 0.769 1.424 ...
## $ passing           : num  1.488 -2.554 -2.554 0.822 1.044 ...
## $ dribbling         : num  1.445 -2.585 -2.585 0.512 1.063 ...
## $ defending          : num  -0.482 -2.004 -2.004 1.522 -0.402 ...

```

```
## $ physic : num 0.25 -2.562 -2.562 1.115 0.725 ...
## $ attacking_crossing : num 1.442 -2.207 -1.953 0.479 0.935 ...
## $ attacking_finishing : num 2.054 -1.935 -1.792 0.629 1.722 ...
## $ attacking_heading_accuracy : num 0.732 -2.202 -2.416 1.905 1.852 ...
## $ attacking_short_passing : num 1.555 -1.435 -0.314 0.994 1.243 ...
## $ attacking_volleys : num 2.11 -1.83 -1.78 1.11 2.01 ...
## $ skill_dribbling : num 1.727 -2.423 -1.979 0.196 1.283 ...
## $ skill_curve : num 1.863 -2.119 -1.87 0.917 1.266 ...
## $ skill_fk_accuracy : num 2.34 -1.87 -1.98 1.39 1.23 ...
## $ skill_long_passing : num 1.915 -1.185 0.213 1.429 0.821 ...
## $ skill_ball_control : num 1.615 -1.923 -1.923 0.918 1.294 ...
## $ movement_acceleration : num 1.786 -1.611 -1.964 0.442 0.795 ...
## $ movement_sprint_speed : num 1.005 -0.435 -1.155 0.285 0.429 ...
## $ movement_agility : num 1.8428 0.0908 -2.0993 0.8938 0.9668 ...
## $ movement_reactions : num 2.61 1.97 1.76 2.39 2.29 ...
## $ movement_balance : num 2.2005 -1.2084 -1.653 0.0515 0.2738 ...
## $ power_shot_power : num 1.407 -0.206 0.212 0.989 1.287 ...
## $ power_jumping : num 0.0799 0.9246 1.009 2.1916 1.009 ...
## $ power_stamina : num 0.476 -1.585 -1.984 1.075 0.875 ...
## $ power_strength : num 0.223 0.941 0.941 1.499 1.1 ...
## $ power_long_shots : num 1.956 -2.06 -2.158 0.487 1.221 ...
## $ mentality_aggression : num -0.854 -1.388 -0.907 1.602 0.16 ...
## $ mentality_interceptions : num -0.543 -1.453 -1.323 1.538 -0.586 ...
## $ mentality_positioning : num 1.753 -2.163 -2.163 0.798 1.61 ...
## $ mentality_vision : num 2.258 0.363 0.679 0.742 1.753 ...
## $ mentality_penalties : num 1.34 -2.49 -1.65 2.36 1.88 ...
## $ mentality_composure : num 1.633 0.721 0.786 1.372 1.437 ...
## $ defending_marking_awareness : num -0.776 -0.997 -1.085 1.569 -0.112 ...
## $ defending_standing_tackle : num -0.731 -1.686 -1.645 1.469 -1.188 ...
## $ defending_sliding_tackle : num -1.09 -1.34 -1.67 1.66 -1.34 ...
## $ goalkeeping_diving : num -0.184 5.97 6.041 -0.184 -0.184 ...
## $ goalkeeping_handling : num -0.184 6.507 5.998 -0.184 -0.184 ...
## $ goalkeeping_kicking : num -0.183 5.738 6.497 -0.183 -0.183 ...
## $ goalkeeping_positioning : num -0.184 6.31 6.166 -0.184 -0.184 ...
## $ goalkeeping_reflexes : num -0.184 6.094 6.094 -0.184 -0.184 ...
## $ goalkeeping_speed : num -0.212 5.155 4.432 -0.212 -0.212 ...
## $ club_name : chr "FC Barcelona" "Atlético de Madrid" "FC Barcelona" "Real Madrid"
## $ Pts. : num 79 86 79 84 84 84 84 84 79 ...
## $ club_position : chr "CAM" "GK" "GK" "LCB" ...
## $ pos : chr "midfielder" "goalkeeper" "goalkeeper" "defender" ...
```

```
ML_ex <- lmer(Pts. ~age + overall + international_reputation + (1|pos), data=hm_datasc, REML = FALSE)
pts_pred<-predict(ML_ex, newdata=fp22_hm_sc)
ML_ex
```

```
## Linear mixed model fit by maximum likelihood ['lmerMod']
## Formula: Pts. ~ age + overall + international_reputation + (1 | pos)
## Data: hm_datasc
## AIC BIC logLik deviance df.resid
## 34962.65 35000.80 -17475.33 34950.65 4261
## Random effects:
## Groups Name Std.Dev.
## pos (Intercept) 3.32
## Residual 14.51
## Number of obs: 4267, groups: pos, 5
```



```
## Fixed Effects:
##           (Intercept)                age                overall
##           49.094                -5.949                5.950
## international_reputation
##           7.736
```

```
d <- f22 %>% filter(league_name=='Spain Primera Division')
compare <- cbind(y_te2, pts_pred, d$short_name)
compare <- compare %>% mutate("diff" = Pts.-pts_pred)
sd = mean((compare$diff)^2)^0.5
sd
```

```
## [1] 12.16879
```

```
#[1] 12.16879 age + overall + international_reputation + (1/pos)
#[1] 7.522987 age + overall + international_reputation + (1/club_name)
#[1] 7.4702 age + overall + international_reputation + (1/club_name:pos)
```

```
compare
```

##	Pts.	club_name	pts_pred	d\$short_name	diff
## 1	71	Atlético de Madrid	100.33577	J. Oblak	-29.335771574
## 2	73	FC Barcelona	87.53256	M. ter Stegen	-14.532563274
## 3	86	Real Madrid CF	77.68996	K. Benzema	8.310041189
## 4	86	Real Madrid CF	86.65239	T. Courtois	-0.652385754
## 5	86	Real Madrid CF	73.04121	Casemiro	12.958787060
## 6	71	Atlético de Madrid	86.16471	L. Suárez	-15.164714131
## 7	86	Real Madrid CF	80.23192	T. Kroos	5.768080710
## 8	73	FC Barcelona	75.92960	S. Agüero	-2.929603771
## 9	86	Real Madrid CF	74.21555	L. Modrić	11.784454111
## 10	73	FC Barcelona	77.70110	F. de Jong	-4.701102750
## 11	73	FC Barcelona	69.76755	Jordi Alba	3.232454412
## 12	73	FC Barcelona	77.18752	Sergio Busquets	-4.187515280
## 13	59	Villarreal CF	55.90955	Parejo	3.090448341
## 14	59	Villarreal CF	58.90766	Gerard Moreno	0.092341489
## 15	71	Atlético de Madrid	74.25283	Marcos Llorente	-3.252827290
## 16	70	Sevilla FC	64.38431	A. Gómez	5.615693020
## 17	62	Real Sociedad	72.45519	David Silva	-10.455190850
## 18	86	Real Madrid CF	78.87544	E. Hazard	7.124564300
## 19	71	Atlético de Madrid	69.52050	Koke	1.479497140
## 20	71	Atlético de Madrid	78.02140	A. Griezmann	-7.021395641
## 21	73	FC Barcelona	72.08860	M. Depay	0.911399200
## 22	86	Real Madrid CF	72.73951	Carvajal	13.260485021
## 23	62	Real Sociedad	65.30177	Oyarzabal	-3.301765900
## 24	70	Sevilla FC	53.51606	Jesús Navas	16.483938172
## 25	73	FC Barcelona	76.07807	Piqué	-3.078074418
## 26	70	Sevilla FC	52.86515	Fernando	17.134852350
## 27	71	Atlético de Madrid	65.05261	K. Trippier	5.947392258
## 28	46	RC Celta de Vigo	52.01111	Iago Aspas	-6.011107591
## 29	86	Real Madrid CF	82.49832	D. Alaba	3.501680731
## 30	71	Atlético de Madrid	59.93631	S. Savić	11.063693322
## 31	71	Atlético de Madrid	73.12349	Felipe	-2.123491612
## 32	71	Atlético de Madrid	71.20842	Y. Carrasco	-0.208423280
## 33	71	Atlético de Madrid	65.07250	J. Giménez	5.927497441
## 34	65	Real Betis Balompié	71.20842	N. Fekir	-6.208423280
## 35	70	Sevilla FC	61.22036	M. Acuña	8.779644352

## 36	59	Villarreal CF	61.60433	Sergio Asenjo	-2.604332282
## 37	55	Athletic Club de Bilbao	58.40521	Muniain	-3.405214980
## 38	65	Real Betis Balompié	55.83712	Canales	9.162882960
## 39	70	Sevilla FC	60.97331	L. Ocampos	9.026687080
## 40	48	Valencia CF	74.83131	Gayà	-26.831306849
## 41	71	Atlético de Madrid	72.89634	T. Lemar	-1.896343701
## 42	71	Atlético de Madrid	69.30863	Á. Correa	1.691373897
## 43	86	Real Madrid CF	81.23166	Marco Asensio	4.768343117
## 44	62	Real Sociedad	51.61838	Merino	10.381619920
## 45	86	Real Madrid CF	58.66964	F. Mendy	27.330355707
## 46	73	FC Barcelona	74.18039	O. Dembélé	-1.180392671
## 47	86	Real Madrid CF	63.80584	F. Valverde	22.194159827
## 48	70	Sevilla FC	69.32852	J. Koundé	0.671479081
## 49	71	Atlético de Madrid	75.72887	João Félix	-4.728870953
## 50	59	Villarreal CF	62.39469	Raúl Albiol	-3.394688598
## 51	70	Sevilla FC	70.07909	I. Rakitić	-0.079087602
## 52	86	Real Madrid CF	74.95085	G. Bale	11.049145829
## 53	55	Athletic Club de Bilbao	62.00820	Yuri Berchiche	-7.008203732
## 54	73	FC Barcelona	85.85427	Coutinho	-12.854265293
## 55	73	FC Barcelona	62.00820	Neto	10.991796268
## 56	86	Real Madrid CF	75.21528	Isco	10.784716517
## 57	35	Levante Unión Deportiva	46.88606	Campaña	-11.886055650
## 58	48	Valencia CF	58.17595	Gabriel Paulista	-10.175951639
## 59	70	Sevilla FC	58.80909	Suso	11.190913570
## 60	62	Real Sociedad	53.93732	Portu	8.062680138
## 61	70	Sevilla FC	47.29015	Y. Bounou	22.709851286
## 62	71	Atlético de Madrid	56.50542	R. De Paul	14.494582197
## 63	70	Sevilla FC	60.74405	Diego Carlos	9.255950421
## 64	73	FC Barcelona	68.42845	C. Lenglet	4.571551417
## 65	71	Atlético de Madrid	52.67317	Mario Hermoso	18.326834291
## 66	55	Athletic Club de Bilbao	76.27241	Unai Simón	-21.272406155
## 67	62	Real Sociedad	65.65934	A. Isak	-3.659340192
## 68	70	Sevilla FC	61.80719	Y. En-Nesyri	8.192806718
## 69	86	Real Madrid CF	67.16429	Éder Militão	18.835705571
## 70	59	Villarreal CF	70.99655	Pau Torres	-11.996546523
## 71	65	Real Betis Balompié	42.52032	Joaquín	22.479678731
## 72	71	Atlético de Madrid	71.76701	H. Herrera	-0.767008023
## 73	70	Sevilla FC	63.69612	T. Delaney	6.303875847
## 74	35	Levante Unión Deportiva	46.40997	Aitor	-11.409971194
## 75	73	FC Barcelona	74.33511	Sergi Roberto	-1.335105963
## 76	48	Valencia CF	70.48296	J. Cillessen	-22.482959053
## 77	59	Villarreal CF	57.07487	Paco Alcácer	1.925131148
## 78	86	Real Madrid CF	56.01173	Nacho Fernández	29.988274851
## 79	55	Athletic Club de Bilbao	57.29577	Iñigo Martínez	-2.295774119
## 80	62	Real Sociedad	48.57398	A. Januzaj	13.426023930
## 81	86	Real Madrid CF	62.41208	Lucas Vázquez	23.587924817
## 82	65	Real Betis Balompié	50.26212	Rui Silva	14.737881896
## 83	38	Granada CF	46.00588	D. Machís	-8.005878130
## 84	55	Athletic Club de Bilbao	57.07487	Iñaki Williams	-2.074868852
## 85	35	Levante Unión Deportiva	49.37058	Morales	-14.370575031
## 86	39	Getafe CF	47.94084	D. Djené	-8.940841279
## 87	39	Getafe CF	48.97807	David Soria	-9.978069134
## 88	48	Valencia CF	60.92702	Gonçalo Guedes	-12.927015762
## 89	62	Real Sociedad	51.54617	Álex Remiro	10.453832926

## 90	55	Athletic Club de Bilbao	62.43197	Yeray	-7.431969999
## 91	48	Valencia CF	61.78106	Carlos Soler	-13.781055821
## 92	71	Atlético de Madrid	60.76144	Renan Lodi	10.238563837
## 93	73	FC Barcelona	69.48535	Pedri	3.514650358
## 94	55	Athletic Club de Bilbao	47.20635	Raúl García	7.793651459
## 95	48	Valencia CF	50.62849	D. Wass	-2.628486540
## 96	86	Real Madrid CF	78.95771	Marcelo	7.042285627
## 97	62	Real Sociedad	49.99535	Nacho Monreal	12.004648252
## 98	59	Villarreal CF	61.53190	F. Coquelin	-2.531897663
## 99	65	Real Betis Balompié	67.05458	Bartra	-2.054578409
## 100	59	Villarreal CF	47.06066	A. Mandi	11.939336241
## 101	71	Atlético de Madrid	62.81595	Š. Vrsaljko	8.184053367
## 102	73	FC Barcelona	76.02303	S. Umtiti	-3.023026383
## 103	35	Levante Unión Deportiva	52.34254	Roger	-17.342544422
## 104	31	Deportivo Alavés	46.81384	Pacheco	-15.813842644
## 105	59	Villarreal CF	68.09181	G. Rulli	-9.091806265
## 106	55	Athletic Club de Bilbao	57.69965	Capa	-2.699645569
## 107	42	RCD Espanyol de Barcelona	43.84165	Embarba	-1.841651640
## 108	65	Real Betis Balompié	44.27166	Borja Iglesias	20.728339448
## 109	70	Sevilla FC	47.69380	Joan Jordán	22.306201449
## 110	55	Athletic Club de Bilbao	48.97785	Álex Berenguer	6.022152479
## 111	70	Sevilla FC	52.17696	M. Dmitrović	17.823035177
## 112	86	Real Madrid CF	74.37239	Vinícius Jr.	11.627612636
## 113	48	Valencia CF	49.40786	M. Gómez	-1.407856432
## 114	55	Athletic Club de Bilbao	58.59721	Unai Núñez	-3.597209673
## 115	38	Granada CF	46.16059	Montoro	-8.160591422
## 116	59	Villarreal CF	56.79957	Iborra	2.200426767
## 117	73	FC Barcelona	60.65172	L. de Jong	12.348279857
## 118	62	Real Sociedad	59.36767	Illarramendi	2.632328827
## 119	59	Villarreal CF	55.53542	Mario Gaspar	3.464580921
## 120	70	Sevilla FC	61.93577	N. Gudelj	8.064230887
## 121	38	Granada CF	39.76024	Germán	-1.760241388
## 122	42	Elche CF	48.89427	Lucas Pérez	-6.894268962
## 123	65	Real Betis Balompié	61.93577	Cristian Tello	3.064230887
## 124	71	Atlético de Madrid	60.65172	B. Lecomte	10.348279857
## 125	71	Atlético de Madrid	54.88450	G. Kondogbia	16.115495099
## 126	42	RCD Espanyol de Barcelona	53.86489	Sergi Darder	-11.864885243
## 127	42	Elche CF	51.29679	Edgar Badia	-9.296787303
## 128	38	Granada CF	56.81947	S. Arias	-18.819468049
## 129	59	Villarreal CF	53.60046	Manu Trigueros	5.399544069
## 130	42	RCD Espanyol de Barcelona	45.95958	De Tomás	-3.959580972
## 131	47	CA Osasuna	45.52957	Rubén García	1.470427939
## 132	59	Villarreal CF	51.29679	Rubén Peña	7.703212697
## 133	70	Sevilla FC	67.07196	Munir	2.928035007
## 134	46	RC Celta de Vigo	48.09767	R. Tapia	-2.097670001
## 135	39	Getafe CF	47.44464	Mata	-8.444640392
## 136	62	Real Sociedad	48.74858	Aritz Elustondo	13.251415821
## 137	47	CA Osasuna	53.86489	E. Ávila	-6.864885243
## 138	86	Real Madrid CF	59.00108	L. Jović	26.998918877
## 139	39	Getafe CF	48.09767	M. Arambarri	-9.097670001
## 140	62	Real Sociedad	57.71703	Zubeldia	4.282967847
## 141	35	Levante Unión Deportiva	58.73665	E. Bardhi	-23.736651811
## 142	59	Villarreal CF	59.00108	P. Estupiñán	-0.001081123
## 143	39	Getafe CF	46.81362	N. Maksimović	-7.813621031

## 144	71	Atlético de Madrid	70.92411	Matheus Cunha	0.075888096
## 145	86	Real Madrid CF	62.85323	Rodrygo	23.146771966
## 146	39	Cádiz CF	54.80093	Negredo	-15.800926342
## 147	42	Rayo Vallecano	54.80093	Falcao	-12.800926342
## 148	70	Sevilla FC	61.05559	E. Lamela	8.944408407
## 149	65	Real Betis Balompié	56.93902	A. Guardado	8.060984629
## 150	65	Real Betis Balompié	60.13813	C. Bravo	4.861867328
## 151	39	RCD Mallorca	34.80701	Ángel	4.192988309
## 152	59	Villarreal CF	57.20344	E. Capoue	1.796555317
## 153	47	CA Osasuna	61.05559	A. Budimir	-14.055591593
## 154	42	Elche CF	67.84243	J. Pastore	-25.842426493
## 155	47	CA Osasuna	38.65916	Kike García	8.340841398
## 156	38	Granada CF	42.73221	Escudero	-4.732210779
## 157	39	RCD Mallorca	45.28041	Jaume Costa	-6.280413902
## 158	65	Real Betis Balompié	52.08714	Víctor Ruiz	12.912856381
## 159	31	Deportivo Alavés	42.73221	Laguardia	-11.732210779
## 160	39	Getafe CF	50.15218	Vitolo	-11.152180471
## 161	65	Real Betis Balompié	70.43042	Héctor Bellerín	-5.430419250
## 162	39	Getafe CF	40.16411	D. Suárez	-1.164112839
## 163	46	RC Celta de Vigo	55.28838	Denis Suárez	-9.288376351
## 164	59	Villarreal CF	44.64939	Moi Gómez	14.350605459
## 165	47	CA Osasuna	46.56446	Roberto Torres	0.435537127
## 166	65	Real Betis Balompié	61.05559	William Carvalho	3.944408407
## 167	38	Granada CF	50.41661	Puertas	-12.416609783
## 168	55	Athletic Club de Bilbao	39.51320	Dani García	15.486801340
## 169	65	Real Betis Balompié	46.58436	Álex Moreno	18.415642311
## 170	47	CA Osasuna	46.33754	Sergio Herrera	0.662463425
## 171	47	CA Osasuna	47.86841	David García	-0.868406659
## 172	65	Real Betis Balompié	45.93344	G. Rodríguez	19.066556489
## 173	70	Sevilla FC	56.83685	G. Montiel	13.163145367
## 174	62	Real Sociedad	51.72055	R. Le Normand	10.279446430
## 175	42	RCD Espanyol de Barcelona	49.78559	Y. Herrera	-7.785590421
## 176	38	Granada CF	49.15246	Domingos Duarte	-11.152455629
## 177	38	Granada CF	45.93344	Luis Milla	-7.933443511
## 178	35	Levante Unión Deportiva	48.50154	De Frutos	-13.501541451
## 179	48	Valencia CF	49.78559	U. Račić	-1.785590421
## 180	42	RCD Espanyol de Barcelona	49.78559	Puado	-7.785590421
## 181	38	Granada CF	55.55281	Carlos Neva	-17.552805663
## 182	86	Real Madrid CF	85.81911	E. Camavinga	0.180887925
## 183	42	RCD Espanyol de Barcelona	52.61078	Diego López	-10.610784004
## 184	35	Levante Unión Deportiva	61.82605	Soldado	-26.826053093
## 185	38	Granada CF	36.69594	Jorge Molina	1.304057438
## 186	31	Deportivo Alavés	37.77898	Joselu	-6.778981082
## 187	38	Granada CF	44.40024	Víctor Díaz	-6.400236383
## 188	42	Elche CF	56.32327	P. Piatti	-14.323267163
## 189	38	Granada CF	48.25238	Rochina	-10.252383293
## 190	47	CA Osasuna	45.68429	Aridane	1.315714647
## 191	47	CA Osasuna	41.85203	Cote	5.147966741
## 192	55	Athletic Club de Bilbao	56.32327	De Marcos	-1.323267163
## 193	47	CA Osasuna	33.49683	Oier	13.503174740
## 194	42	RCD Espanyol de Barcelona	43.13608	L. Cabrera	-1.136082229
## 195	73	FC Barcelona	58.89137	M. Braithwaite	14.108634897
## 196	65	Real Betis Balompié	48.25238	G. Pezzella	16.747616707
## 197	46	RC Celta de Vigo	53.77506	Hugo Mallo	-7.775064039

## 198	65	Real Betis Balompié	60.17541	Willian José	4.824585927
## 199	31	Deportivo Alavés	53.77506	F. Lejeune	-22.775064039
## 200	62	Real Sociedad	49.53643	M. Ryan	12.463567737
## 201	46	RC Celta de Vigo	55.05911	J. Murillo	-9.059113009
## 202	42	RCD Espanyol de Barcelona	38.63302	David López	3.366978860
## 203	42	RCD Espanyol de Barcelona	52.49102	Aleix Vidal	-10.491015069
## 204	48	Valencia CF	45.70418	D. Foulquier	2.295819831
## 205	35	Levante Unión Deportiva	44.42013	Clerc	-9.420131199
## 206	38	Granada CF	55.20480	C. Bacca	-17.204797792
## 207	70	Sevilla FC	64.02756	Óliver Torres	5.972439016
## 208	46	RC Celta de Vigo	45.48327	Santi Mina	0.516725098
## 209	42	Elche CF	38.63302	I. Marcone	3.366978860
## 210	39	Cádiz CF	45.45736	J. Ledesma	-6.457359055
## 211	62	Real Sociedad	49.53643	Zaldúa	12.463567737
## 212	42	Rayo Vallecano	46.33731	Unai López	-4.337314961
## 213	86	Real Madrid CF	66.59566	Dani Ceballos	19.404341076
## 214	31	Deportivo Alavés	49.55633	Rubén Duarte	-18.556327080
## 215	35	Levante Unión Deportiva	43.76922	Melero	-8.769217021
## 216	59	Villarreal CF	49.55633	Pedraza	9.443672920
## 217	70	Sevilla FC	55.95668	Rafa Mir	14.043322886
## 218	39	Cádiz CF	39.91707	Salvi Sánchez	-0.917070111
## 219	62	Real Sociedad	50.84038	Gorosabel	11.159623950
## 220	73	FC Barcelona	66.61555	Eric García	6.384446260
## 221	38	Granada CF	48.90541	L. Suárez	-10.905412901
## 222	59	Villarreal CF	58.52478	S. Chukwueze	0.475224946
## 223	59	Villarreal CF	55.95668	B. Dia	3.043322886
## 224	73	FC Barcelona	58.52478	R. Araujo	14.475224946
## 225	46	RC Celta de Vigo	43.53995	N. Araújo	2.460046321
## 226	38	Granada CF	57.74676	M. Gonalons	-19.746758271
## 227	65	Real Betis Balompié	46.08816	Joel Robles	18.911843197
## 228	31	Deportivo Alavés	35.18475	Tomás Pina	-4.184745680
## 229	46	RC Celta de Vigo	44.53968	Nolito	1.460321479
## 230	42	RCD Espanyol de Barcelona	43.53995	Sergi Gómez	-1.539953679
## 231	46	RC Celta de Vigo	51.22435	O. Yokuşlu	-5.224352683
## 232	59	Villarreal CF	52.24397	Alberto Moreno	6.756027659
## 233	48	Valencia CF	49.67587	D. Cheryshev	-1.675874401
## 234	70	Sevilla FC	61.86333	L. Augustinsson	8.136665506
## 235	35	Levante Unión Deportiva	51.22435	Rúben Vezo	-16.224352683
## 236	65	Real Betis Balompié	60.57929	Y. Sabaly	4.420714476
## 237	62	Real Sociedad	53.79245	A. Sørloth	8.207549376
## 238	35	Levante Unión Deportiva	53.79245	M. Malsa	-18.792450624
## 239	70	Sevilla FC	53.79245	O. Idrissi	16.207549376
## 240	42	Rayo Vallecano	44.17309	Isi	-2.173088471
## 241	39	RCD Mallorca	55.07650	A. Ndiaye	-16.076499594
## 242	46	RC Celta de Vigo	46.74119	Brais Méndez	-0.741186411
## 243	47	CA Osasuna	40.32094	D. Brašanac	6.679058439
## 244	59	Villarreal CF	55.07650	A. Danjuma	3.923500406
## 245	42	RCD Espanyol de Barcelona	56.36055	Melendo	-14.360548564
## 246	42	RCD Espanyol de Barcelona	56.36055	K. Bare	-14.360548564
## 247	62	Real Sociedad	56.36055	Ander Guevara	5.639451436
## 248	39	Getafe CF	51.24425	M. Olivera	-12.244247500
## 249	65	Real Betis Balompié	58.92865	Miranda	6.071353496
## 250	42	RCD Espanyol de Barcelona	51.22435	Loren	-9.224352683
## 251	73	FC Barcelona	58.92865	Riqui Puig	14.071353496

##	252	38	Granada CF	57.64460	Luís Maximiano	-19.644597534
##	253	73	FC Barcelona	55.09639	S. Dest	17.903605590
##	254	73	FC Barcelona	73.41978	Ansu Fati	-0.419775225
##	255	55	Athletic Club de Bilbao	49.06013	Vesga	5.939873807
##	256	39	RCD Mallorca	39.80735	Salva Sevilla	-0.807354090
##	257	42	Rayo Vallecano	34.30457	Ó. Trejo	7.695431839
##	258	55	Athletic Club de Bilbao	37.52358	Balenziaga	17.476419721
##	259	39	RCD Mallorca	46.49203	L. Júnior	-7.492028253
##	260	39	Getafe CF	53.27886	A. Nyom	-14.278863153
##	261	65	Real Betis Balompié	57.13101	Montoya	7.868989937
##	262	65	Real Betis Balompié	49.06013	Juanmi	15.939873807
##	263	39	RCD Mallorca	34.30457	Dani Rodríguez	4.695431839
##	264	39	Cádiz CF	40.72481	Álex Fernández	-1.724813011
##	265	48	Valencia CF	49.06013	C. Piccini	-1.060126193
##	266	46	RC Celta de Vigo	35.99271	M. Dituto	10.007289806
##	267	42	Rayo Vallecano	45.22787	Kévin Rodrigues	-3.227874100
##	268	46	RC Celta de Vigo	52.91227	Rubén Blanco	-6.912273104
##	269	42	Rayo Vallecano	44.98105	S. Dimitrievski	-2.981052985
##	270	70	Sevilla FC	59.69911	I. Amadou	10.300891996
##	271	31	Deportivo Alavés	40.72481	Pere Pons	-9.724813011
##	272	35	Levante Unión Deportiva	43.92393	Postigo	-8.923930313
##	273	42	Elche CF	55.84696	D. Benedetto	-13.846961093
##	274	42	Rayo Vallecano	40.72481	Álvaro García	1.275186989
##	275	39	RCD Mallorca	47.77608	R. Battaglia	-8.776077223
##	276	48	Valencia CF	46.49203	Jaume	1.507971747
##	277	62	Real Sociedad	52.91227	Carlos Fernández	9.087726896
##	278	35	Levante Unión Deportiva	47.77608	N. Vukčević	-12.776077223
##	279	39	RCD Mallorca	50.36407	Pablo Maffeo	-11.364069980
##	280	42	RCD Espanyol de Barcelona	47.77608	Wu Lei	-5.776077223
##	281	86	Real Madrid CF	50.34418	Mariano	35.655824836
##	282	46	RC Celta de Vigo	60.98316	F. Cervi	-14.983156974
##	283	39	Getafe CF	45.00697	E. Ünal	-6.006968833
##	284	35	Levante Unión Deportiva	49.06013	N. Radoja	-14.060126193
##	285	86	Real Madrid CF	54.19632	Vallejo	31.803677926
##	286	39	Cádiz CF	45.22787	Fali	-6.227874100
##	287	39	Cádiz CF	51.62822	Iván Alejo	-12.628224134
##	288	46	RC Celta de Vigo	46.51192	Javi Galán	-0.511923070
##	289	38	Granada CF	52.91227	L. Abram	-14.912273104
##	290	38	Granada CF	55.48037	Y. Eteki	-17.480371044
##	291	46	RC Celta de Vigo	56.76442	Fran Beltrán	-10.764420014
##	292	59	Villarreal CF	55.48037	J. Foyth	3.519628956
##	293	39	RCD Mallorca	50.99720	T. Kubo	-11.997204772
##	294	47	CA Osasuna	46.51192	Nacho Vidal	0.488076930
##	295	70	Sevilla FC	55.48037	Óscar	14.519628956
##	296	39	Getafe CF	58.04847	J. Macías	-19.048468984
##	297	42	RCD Espanyol de Barcelona	52.91227	Calero	-10.912273104
##	298	48	Valencia CF	54.19632	Manu Vallejo	-6.196322074
##	299	31	Deportivo Alavés	52.91227	Martín	-21.912273104
##	300	42	RCD Espanyol de Barcelona	50.36407	Adrià Pedrosa	-8.364069980
##	301	55	Athletic Club de Bilbao	50.99720	Unai Vencedor	4.002795228
##	302	47	CA Osasuna	47.14506	Moncayola	-0.145057862
##	303	48	Valencia CF	54.19632	Marcos André	-6.196322074
##	304	73	FC Barcelona	56.76442	Mingueza	16.235579986
##	305	48	Valencia CF	53.96940	G. Mamardashvili	-5.969395776

## 306	42	RCD Espanyol de Barcelona	44.32780	Oier	-2.327801763
## 307	42	RCD Espanyol de Barcelona	44.32780	Fran Mérida	-2.327801763
## 308	39	Cádiz CF	44.32780	Juan Cala	-5.327801763
## 309	42	Elche CF	35.99249	Fidel	6.007511419
## 310	39	Cádiz CF	45.61185	Alberto Perea	-6.611850733
## 311	47	CA Osasuna	41.75970	Iñigo Pérez	5.240296177
## 312	31	Deportivo Alavés	39.21150	Ximo Navarro	-8.211500699
## 313	42	Rayo Vallecano	41.77960	I. Balliu	0.220401360
## 314	70	Sevilla FC	50.74805	K. Rekik	19.251953386
## 315	39	Cádiz CF	39.84464	A. Lozano	-0.844635491
## 316	47	CA Osasuna	50.74805	Lucas Torró	-3.748046614
## 317	42	Elche CF	58.81893	Omar Mascarell	-16.818930484
## 318	39	Cádiz CF	46.89590	Rubén Sobrino	-7.895899703
## 319	35	Levante Unión Deportiva	57.53488	Hernâni	-22.534881514
## 320	42	Elche CF	39.84464	J. Mojica	2.155364509
## 321	39	Getafe CF	49.46400	J. Silva	-10.463997644
## 322	39	RCD Mallorca	46.91579	M. Valjent	-7.915794520
## 323	48	Valencia CF	60.10298	Hélder Costa	-12.102979454
## 324	42	Elche CF	42.84274	L. Boyé	-0.842742343
## 325	55	Athletic Club de Bilbao	48.17995	Lekue	6.820051326
## 326	42	Rayo Vallecano	50.74805	Merquelanz	-8.748046614
## 327	42	Elche CF	48.17995	Pere Milla	-6.179948674
## 328	39	Getafe CF	54.33576	J. Jankto	-15.335764212
## 329	35	Levante Unión Deportiva	43.04375	Jorge Miramón	-8.043752793
## 330	46	RC Celta de Vigo	52.03210	J. Aidoo	-6.032095584
## 331	70	Sevilla FC	53.31614	J. Gnagnon	16.683855446
## 332	47	CA Osasuna	54.60019	Ontiveros	-7.600193524
## 333	42	RCD Espanyol de Barcelona	45.41084	L. Dimata	-3.410840283
## 334	39	Getafe CF	54.60019	Aleñá	-15.600193524
## 335	39	Getafe CF	57.16829	Florentino	-18.168291464
## 336	65	Real Betis Balompié	57.16829	D. Lainez	7.831708536
## 337	48	Valencia CF	48.19984	O. Alderete	-0.199843490
## 338	65	Real Betis Balompié	52.03210	Aitor Ruibal	12.967904416
## 339	39	RCD Mallorca	58.45234	Kangin Lee	-19.452340434
## 340	86	Real Madrid CF	55.88424	A. Lunin	30.115757506
## 341	62	Real Sociedad	59.73639	Barrenetxea	2.263610595
## 342	62	Real Sociedad	54.60019	Aihen Muñoz	7.399806476
## 343	39	Cádiz CF	41.77960	A. Espino	-2.779598640
## 344	48	Valencia CF	55.88424	Thierry Correia	-7.884242494
## 345	62	Real Sociedad	47.54893	Zubimendi	14.451070688
## 346	42	RCD Espanyol de Barcelona	58.45234	Nico Melamed	-16.452340434
## 347	42	Rayo Vallecano	44.73167	Bebé	-2.731673214
## 348	42	Elche CF	39.59548	Barragán	2.404522667
## 349	39	RCD Mallorca	31.66426	Manolo Reina	7.335742786
## 350	42	Elche CF	44.87134	Kiko Casilla	-2.871336965
## 351	42	RCD Espanyol de Barcelona	42.16358	Dídac Vilà	-0.163575273
## 352	35	Levante Unión Deportiva	67.29369	S. Mustafi	-32.293685804
## 353	55	Athletic Club de Bilbao	53.72002	Villalibre	1.279983996
## 354	31	Deportivo Alavés	56.65470	J. Guidetti	-25.654703994
## 355	39	Getafe CF	43.44762	Timor	-4.447624243
## 356	39	Cádiz CF	38.96446	J. Jønsson	0.035542029
## 357	39	RCD Mallorca	40.24851	Ruiz de Galarreta	-1.248506941
## 358	47	CA Osasuna	47.29977	Juan Cruz	-0.299771154
## 359	39	Getafe CF	38.33132	S. Mitrović	0.668676820

## 360	46	RC Celta de Vigo	46.01572	A. Solari	-0.015722184
## 361	42	Elche CF	52.82245	E. Roco	-10.822451900
## 362	35	Levante Unión Deportiva	37.04727	Ó. Duarte	-2.047274209
## 363	35	Levante Unión Deportiva	44.75157	Róber	-9.751568030
## 364	42	Rayo Vallecano	51.15192	I. Arboleda	-9.151918064
## 365	48	Valencia CF	49.86787	Jason	-1.867869094
## 366	39	Cádiz CF	42.18347	Akapo	-3.183470090
## 367	42	Rayo Vallecano	51.15192	Pozo	-9.151918064
## 368	42	Elche CF	38.96446	H. Palacios	3.035542029
## 369	31	Deportivo Alavés	35.11231	Edgar Méndez	-4.112311061
## 370	39	Cádiz CF	47.29977	Iza Carcelén	-8.299771154
## 371	62	Real Sociedad	47.29977	Diego Rico	14.700228846
## 372	31	Deportivo Alavés	45.38470	Manu García	-14.384702822
## 373	31	Deportivo Alavés	40.24851	Luis Rioja	-9.248506941
## 374	39	Cádiz CF	57.93875	F. Andone	-18.938752964
## 375	47	CA Osasuna	44.10065	Kike Barja	2.899346148
## 376	42	Elche CF	44.10065	Raúl Guti	-2.100653852
## 377	39	RCD Mallorca	46.01572	Raíllo	-7.015722184
## 378	42	Elche CF	43.44762	Josan	-1.447624243
## 379	48	Valencia CF	52.43597	M. Diakhaby	-4.435967034
## 380	48	Valencia CF	53.72002	Toni Lato	-5.720016004
## 381	39	RCD Mallorca	51.15192	Aleix Febas	-12.151918064
## 382	42	Rayo Vallecano	44.10065	Santi Comesaña	-2.100653852
## 383	39	Getafe CF	49.86787	E. Cabaco	-10.867869094
## 384	62	Real Sociedad	49.86787	Guridi	12.132130906
## 385	59	Villarreal CF	51.15192	Dani Raba	7.848081936
## 386	42	RCD Espanyol de Barcelona	55.00406	Manu Morlanes	-13.004064974
## 387	35	Levante Unión Deportiva	55.00406	Dani Gómez	-20.004064974
## 388	42	Rayo Vallecano	44.75157	Catena	-2.751568030
## 389	55	Athletic Club de Bilbao	56.28811	Sancet	-1.288113945
## 390	39	RCD Mallorca	51.15192	I. Baba	-12.151918064
## 391	48	Valencia CF	56.28811	Hugo Guillamón	-8.288113945
## 392	42	Rayo Vallecano	53.72002	R. Nteka	-11.720016004
## 393	35	Levante Unión Deportiva	43.46752	Son	-8.467519060
## 394	47	CA Osasuna	57.57216	Manu Sánchez	-10.572162915
## 395	39	RCD Mallorca	57.57216	Fer Niño	-18.572162915
## 396	55	Athletic Club de Bilbao	55.00406	Jon Morcillo	-0.004064974
## 397	59	Villarreal CF	60.14026	Jeremy Pino	-1.140260855
## 398	42	Rayo Vallecano	49.35428	Mario Suárez	-7.354281623
## 399	35	Levante Unión Deportiva	49.35428	Coke	-14.354281623
## 400	47	CA Osasuna	46.41959	Ramalho	0.580406366
## 401	42	RCD Espanyol de Barcelona	48.98769	Vadillo	-6.987691574
## 402	42	Elche CF	38.73519	Bigas	3.264805370
## 403	38	Granada CF	42.56745	Quini	-4.567446724
## 404	39	Cádiz CF	31.66404	José Mari	7.335964399
## 405	31	Deportivo Alavés	50.27174	M. Miazga	-19.271740544
## 406	47	CA Osasuna	41.30329	Unai García	5.696707430
## 407	39	Getafe CF	51.72137	Sandro	-12.721369113
## 408	65	Real Betis Balompié	47.70364	Camarasa	17.296357396
## 409	39	Cádiz CF	43.85150	Marcos Mauro	-4.851495694
## 410	31	Deportivo Alavés	51.55579	Sivera	-20.555789514
## 411	31	Deportivo Alavés	47.70364	M. Sylla	-16.703642604
## 412	46	RC Celta de Vigo	46.41959	Kevin	-0.419593634
## 413	42	Rayo Vallecano	43.85150	Sergi Guardiola	-1.851495694

## 414	39	RCD Mallorca	51.55579	Joan Sastre	-12.555789514
## 415	39	Cádiz CF	42.56745	Garrido	-3.567446724
## 416	35	Levante Unión Deportiva	51.55579	Dani Cárdenas	-16.555789514
## 417	42	Elche CF	51.55579	Tete Morente	-9.555789514
## 418	42	RCD Espanyol de Barcelona	52.83984	Óscar Gil	-10.839838484
## 419	42	Rayo Vallecano	55.40794	Fran García	-13.407936425
## 420	65	Real Betis Balompié	51.55579	Edgar	13.444210486
## 421	39	RCD Mallorca	51.55579	Antonio Sánchez	-12.555789514
## 422	55	Athletic Club de Bilbao	54.12389	Zarraga	0.876112545
## 423	39	RCD Mallorca	51.55579	D. Greif	-12.555789514
## 424	39	RCD Mallorca	45.53942	Abdón Prats	-6.539416114
## 425	39	Cádiz CF	40.42312	V. Haroyan	-1.423115050
## 426	42	Elche CF	42.97132	G. Carrillo	-0.971318174
## 427	47	CA Osasuna	45.53942	Rober Ibáñez	1.460583886
## 428	31	Deportivo Alavés	48.10751	Saúl	-17.107514054
## 429	39	Getafe CF	44.25537	Chema Rodríguez	-5.255367144
## 430	35	Levante Unión Deportiva	53.24371	Pepelu	-18.243709935
## 431	42	RCD Espanyol de Barcelona	49.39156	Miguelón	-7.391563024
## 432	71	Atlético de Madrid	51.95966	I. Šaponjić	19.040339035
## 433	39	Cádiz CF	53.24371	T. Alarcón	-14.243709935
## 434	39	Getafe CF	54.52776	Jorge Cuenca	-15.527758905
## 435	39	RCD Mallorca	44.90840	Jordi Mboula	-5.908396752
## 436	42	Rayo Vallecano	49.39156	N. Maraš	-7.391563024
## 437	38	Granada CF	53.24371	Alberto Soro	-15.243709935
## 438	42	Rayo Vallecano	48.10751	Óscar Valentín	-6.107514054
## 439	42	Elche CF	35.28692	Gonzalo Verdú	6.713080830
## 440	31	Deportivo Alavés	50.67561	M. Loum	-19.675611994
## 441	39	RCD Mallorca	42.99121	F. Russo	-3.991212990
## 442	55	Athletic Club de Bilbao	54.52776	Vivian	0.472241095
## 443	48	Valencia CF	58.37991	Y. Musah	-10.379905815
## 444	86	Real Madrid CF	55.81181	Blanco	30.188192125
## 445	39	Cádiz CF	54.52776	M. Osmajić	-15.527758905
## 446	46	RC Celta de Vigo	40.80709	Thiago Galhardo	5.192908316
## 447	38	Granada CF	44.65924	R. Azeez	-6.659238594
## 448	42	Elche CF	47.22734	Gumbau	-5.227336534
## 449	42	Elche CF	48.51139	A. Werner	-6.511385504
## 450	39	Getafe CF	45.94329	Rubén Yáñez	-6.943287564
## 451	38	Granada CF	43.14826	Aarón	-5.148263326
## 452	42	Elche CF	47.22734	Diego González	-5.227336534
## 453	39	RCD Mallorca	40.82699	Brian Oliván	-1.826986500
## 454	39	RCD Mallorca	43.37519	A. Sedlar	-4.375189624
## 455	39	Cádiz CF	47.22734	Álvaro Jiménez	-8.227336534
## 456	73	FC Barcelona	52.36353	M. Wagué	20.636467585
## 457	42	Rayo Vallecano	51.07948	L. Zidane	-9.079483445
## 458	31	Deportivo Alavés	51.07948	Toni Moya	-20.079483445
## 459	38	Granada CF	45.31227	Monchu	-7.312268203
## 460	48	Valencia CF	52.36353	Álex Blanco	-4.363532415
## 461	31	Deportivo Alavés	52.36353	Iván Martín	-21.363532415
## 462	65	Real Betis Balompié	51.07948	P. Akoukou	13.920516555
## 463	39	Cádiz CF	51.07948	S. Arzamendia	-12.079483445
## 464	42	Rayo Vallecano	45.94329	P. Ciss	-3.943287564
## 465	73	FC Barcelona	57.49973	Y. Demir	15.500271705
## 466	35	Levante Unión Deportiva	49.79543	Franquesa	-14.795434475
## 467	31	Deportivo Alavés	56.21568	F. Pellistri	-25.215679325

## 468	47	CA Osasuna	53.64758	Javi Martínez	-6.647581385
## 469	65	Real Betis Balompié	53.64758	Rodri	11.352418615
## 470	35	Levante Unión Deportiva	53.64758	Cantero	-18.647581385
## 471	42	Rayo Vallecano	36.09466	E. Saveljich	5.905337930
## 472	47	CA Osasuna	48.91526	Juan Pérez	-1.915256955
## 473	42	Elche CF	47.63121	Josema	-5.631207985
## 474	55	Athletic Club de Bilbao	51.48335	Nolaskoain	3.516645105
## 475	48	Valencia CF	52.76740	Hugo Duro	-4.767403865
## 476	65	Real Betis Balompié	54.05145	Rober	10.948547165
## 477	42	Rayo Vallecano	52.76740	Andrés Martín	-10.767403865
## 478	73	FC Barcelona	51.48335	Iñaki Peña	21.516645105
## 479	47	CA Osasuna	48.91526	Jaume Grau	-1.915256955
## 480	46	RC Celta de Vigo	52.76740	Miguel Baeza	-6.767403865
## 481	42	RCD Espanyol de Barcelona	54.05145	Jofre Carreras	-12.051452835
## 482	39	RCD Mallorca	54.05145	M. Hoppe	-15.051452835
## 483	39	Getafe CF	51.48335	Juan Iglesias	-12.483354895
## 484	42	Rayo Vallecano	40.33079	Y. Qasmi	1.669214386
## 485	59	Villarreal CF	44.18293	Pablo Iñiguez	14.817067475
## 486	39	Cádiz CF	44.18293	David Gil	-5.182932525
## 487	73	FC Barcelona	49.31913	Matheus Pereira	23.680871595
## 488	73	FC Barcelona	50.60318	H. Abe	22.396822625
## 489	65	Real Betis Balompié	48.03508	Y. Fekir	16.964920565
## 490	31	Deportivo Alavés	51.88723	Miguel	-20.887226345
## 491	73	FC Barcelona	54.45532	Nico González	18.544675715
## 492	47	CA Osasuna	50.60318	Barbero	-3.603177375
## 493	46	RC Celta de Vigo	51.88723	José Fontán	-5.887226345
## 494	31	Deportivo Alavés	48.43895	Tachi	-17.438950885
## 495	47	CA Osasuna	51.00705	Areso	-4.007048825
## 496	48	Valencia CF	48.43895	Cristian Rivero	-0.438950885
## 497	73	FC Barcelona	49.72300	Álex Collado	23.277000145
## 498	38	Granada CF	43.30276	N. Lozano	-5.302755005
## 499	46	RC Celta de Vigo	53.57515	Iker Losada	-7.575146766
## 500	62	Real Sociedad	53.57515	Robert Navarro	8.424853234
## 501	65	Real Betis Balompié	52.29110	Raúl García	12.708902205
## 502	35	Levante Unión Deportiva	52.29110	Jorge Padilla	-17.291097795
## 503	55	Athletic Club de Bilbao	54.85920	Nico Williams	0.140804264
## 504	86	Real Madrid CF	51.00705	Marvin	34.992951175
## 505	73	FC Barcelona	52.29110	Arnau Tenas	20.708902205
## 506	39	Cádiz CF	51.00705	Víctor Chust	-12.007048825
## 507	42	RCD Espanyol de Barcelona	52.29110	Joan García	-10.291097795
## 508	55	Athletic Club de Bilbao	47.15490	Álex Petxa	7.845098085
## 509	39	Cádiz CF	49.72300	Chapela	-10.722999855
## 510	55	Athletic Club de Bilbao	46.27472	Ezkieta	8.725275605
## 511	39	Cádiz CF	47.55877	D. Gudelj	-8.558773365
## 512	46	RC Celta de Vigo	47.55877	Álex Martín	-1.558773365
## 513	65	Real Betis Balompié	50.12687	José Lara	14.873128695
## 514	65	Real Betis Balompié	50.12687	Kike Hermoso	14.873128695
## 515	42	RCD Espanyol de Barcelona	50.12687	Álvaro García	-8.126871305
## 516	35	Levante Unión Deportiva	47.55877	Pablo Martínez	-12.558773365
## 517	48	Valencia CF	52.69497	K. Koindredi	-4.694969246
## 518	73	FC Barcelona	53.97902	K. Ruiz-Atil	19.020981784
## 519	39	Cádiz CF	48.84282	Martín Calderón	-9.842822335
## 520	46	RC Celta de Vigo	51.41092	Lautaro	-5.410920276
## 521	48	Valencia CF	53.97902	Jesús Vázquez	-5.979018216

## 522	86	Real Madrid CF	52.69497	Miguel	33.305030754
## 523	46	RC Celta de Vigo	51.41092	Carlos Domínguez	-5.410920276
## 524	73	FC Barcelona	55.26307	Álex Balde	17.736932814
## 525	55	Athletic Club de Bilbao	51.41092	Beñat Prados	3.589079724
## 526	48	Valencia CF	52.69497	A. Burlamaqui	-4.694969246
## 527	73	FC Barcelona	56.54712	Gavi	16.452883844
## 528	71	Atlético de Madrid	45.39455	Camus	25.605453125
## 529	70	Sevilla FC	45.39455	Javi Díaz	24.605453125
## 530	39	Getafe CF	45.39455	Darío Poveda	-6.394546875
## 531	42	Rayo Vallecano	47.96264	Mario Hernández	-5.962644816
## 532	65	Real Betis Balompié	49.24669	Juan Cruz	15.753306214
## 533	59	Villarreal CF	49.24669	Martín	9.753306214
## 534	42	Rayo Vallecano	47.96264	Sergio Moreno	-5.962644816
## 535	71	Atlético de Madrid	53.09884	G. Simeone	17.901159304
## 536	48	Valencia CF	50.53074	Pablo Gozálbez	-2.530742756
## 537	46	RC Celta de Vigo	50.53074	Javi Castro	-4.530742756
## 538	62	Real Sociedad	50.53074	Pacheco	11.469257244
## 539	31	Deportivo Alavés	51.81479	Javi López	-20.814791726
## 540	39	RCD Mallorca	49.24669	Leo Román	-10.246693786
## 541	39	Getafe CF	47.96264	Diego Conde	-8.962644816
## 542	46	RC Celta de Vigo	51.81479	Cedric Teguía	-5.814791726
## 543	47	CA Osasuna	50.53074	Iván Bravo	-3.530742756
## 544	86	Real Madrid CF	51.81479	Arribas	34.185208274
## 545	38	Granada CF	43.23032	João Costa	-5.230320385
## 546	46	RC Celta de Vigo	45.79842	Carbonell	0.201581674
## 547	59	Villarreal CF	44.51437	R. Guerra	14.485630645
## 548	59	Villarreal CF	47.08247	De La Fuente	11.917532704
## 549	71	Atlético de Madrid	45.79842	A. Solano	25.201581674
## 550	46	RC Celta de Vigo	47.08247	Javi Gómez	-1.082467296
## 551	59	Villarreal CF	44.51437	Migue	14.485630645
## 552	38	Granada CF	48.36652	Pepe Sánchez	-10.366516266
## 553	71	Atlético de Madrid	47.08247	Fran González	23.917532704
## 554	35	Levante Unión Deportiva	49.65057	Toni Herrero	-14.650565236
## 555	35	Levante Unión Deportiva	50.93461	Álex Blesa	-15.934614206
## 556	47	CA Osasuna	50.93461	Aimar Oroz	-3.934614206
## 557	38	Granada CF	49.65057	Isma Ruiz	-11.650565236
## 558	42	RCD Espanyol de Barcelona	50.93461	Gori	-8.934614206
## 559	71	Atlético de Madrid	52.21866	Javi Serrano	18.781336824
## 560	71	Atlético de Madrid	50.93461	Alberto Moreno	20.065385794
## 561	39	RCD Mallorca	48.36652	Pep Gayà	-9.366516266
## 562	47	CA Osasuna	50.93461	Diego Moreno	-3.934614206
## 563	39	Cádiz CF	50.93461	L. Spatz	-11.934614206
## 564	71	Atlético de Madrid	48.36652	Christian Gómez	22.633483734
## 565	46	RC Celta de Vigo	47.48634	J. Holsgrave	-1.486338746
## 566	55	Athletic Club de Bilbao	44.91824	Sillero	10.081759194
## 567	38	Granada CF	46.20229	K. Fobi	-8.202289776
## 568	59	Villarreal CF	46.20229	Sergio Lozano	12.797710224
## 569	42	RCD Espanyol de Barcelona	48.77039	Nabil Touaizi	-6.770387716
## 570	42	Elche CF	50.05444	Jony Álamo	-8.054436686
## 571	86	Real Madrid CF	51.33849	Luis Carbonell	34.661514344
## 572	59	Villarreal CF	50.05444	F. Jørgensen	8.945563314
## 573	59	Villarreal CF	48.77039	Lanchi	10.229612284
## 574	70	Sevilla FC	50.05444	Zarzana	19.945563314
## 575	55	Athletic Club de Bilbao	51.33849	Nico Serrano	3.661514344

## 576	38	Granada CF	50.05444	Ángel Jiménez	-12.054436686
## 577	39	RCD Mallorca	47.48634	I. Diabate	-8.486338746
## 578	42	RCD Espanyol de Barcelona	50.05444	Svensson	-8.054436686
## 579	42	Rayo Vallecano	48.77039	Iker Recio	-6.770387716
## 580	35	Levante Unión Deportiva	50.05444	E. Sevikyan	-15.054436686
## 581	42	RCD Espanyol de Barcelona	52.62253	O. El Hilali	-10.622534626
## 582	71	Atlético de Madrid	46.20229	Mini	24.797710224
## 583	55	Athletic Club de Bilbao	48.77039	Agirrezabala	6.229612284
## 584	39	RCD Mallorca	50.05444	Pablo Gálvez	-11.054436686
## 585	38	Granada CF	50.05444	Torrente	-12.054436686
## 586	39	RCD Mallorca	50.05444	Llabrés	-11.054436686
## 587	47	CA Osasuna	51.33849	Iker Benito	-4.338485656
## 588	86	Real Madrid CF	48.77039	Luis López	37.229612284
## 589	46	RC Celta de Vigo	45.32211	Alfon	0.677887744
## 590	35	Levante Unión Deportiva	44.03806	Relu	-9.038063286
## 591	39	Cádiz CF	44.03806	Carrasco	-5.038063286
## 592	39	Cádiz CF	44.03806	J. Flere	-5.038063286
## 593	59	Villarreal CF	47.89021	N. Iosifov	11.109789804
## 594	39	RCD Mallorca	49.17426	Pere Joan	-10.174259166
## 595	55	Athletic Club de Bilbao	46.60616	Aitor Paredes	8.393838774
## 596	70	Sevilla FC	47.89021	Alfonso Pastor	22.109789804
## 597	38	Granada CF	47.89021	Sergio Barcia	-9.890210196
## 598	42	Rayo Vallecano	47.89021	De Tomás	-5.890210196
## 599	71	Atlético de Madrid	46.60616	E. Sutherland	24.393838774
## 600	39	Cádiz CF	51.74236	Bastida	-12.742357106
## 601	31	Deportivo Alavés	50.45831	Alan Godoy	-19.458308136
## 602	38	Granada CF	44.03806	Álvaro Bravo	-6.038063286
## 603	71	Atlético de Madrid	51.74236	Alejandro Iturbe	19.257642894
## 604	47	CA Osasuna	47.89021	Pablo Valencia	-0.890210196
## 605	46	RC Celta de Vigo	39.30574	Campos	6.694261144
## 606	31	Deportivo Alavés	44.44193	A. Abqar	-13.441934736
## 607	42	Rayo Vallecano	47.01003	Manu Navarro	-5.010032676
## 608	39	RCD Mallorca	47.01003	V. De Baunbag	-8.010032676
## 609	42	Elche CF	44.44193	Nacho Ramón	-2.441934736
## 610	38	Granada CF	44.44193	Dani Plomer	-6.441934736
## 611	70	Sevilla FC	48.29408	Pablo Pérez	21.705918354
## 612	86	Real Madrid CF	50.86218	T. Nakai	35.137820413
## 613	42	Rayo Vallecano	45.72598	Arratia	-3.725983706
## 614	42	RCD Espanyol de Barcelona	48.29408	Recasens	-6.294081646
## 615	47	CA Osasuna	44.44193	Pablo Ibáñez	2.558065264
## 616	48	Valencia CF	48.29408	Diego López	-0.294081646
## 617	31	Deportivo Alavés	46.12986	Adrián	-15.129855156
## 618	86	Real Madrid CF	48.69795	Salazar	37.302046903
## 619	42	Elche CF	46.12986	John Donald	-4.129855156
## 620	35	Levante Unión Deportiva	44.84581	Pablo Picón	-9.845806186
## 621	46	RC Celta de Vigo	44.84581	Carlos Beitia	1.154193814
## 622	70	Sevilla FC	47.41390	Carmona	22.586095873
## 623	70	Sevilla FC	46.12986	Iván Romero	23.870144844
## 624	70	Sevilla FC	46.12986	Pedro Ortiz	23.870144844
## 625	48	Valencia CF	47.41390	Joseda	0.586095873
## 626	39	Getafe CF	42.68158	Algobia	-3.681579696
## 627	39	Getafe CF	46.53373	M. Niang	-7.533726607
## 628	39	Getafe CF	49.10182	John Patrick	-10.101824547
## 629	42	Elche CF	46.93760	Diego Bri	-4.937598057

```
## 630 48 Valencia CF 46.93760 W. Suzuki 1.062401943
## 631 39 Getafe CF 45.65355 Alex Rodríguez -6.653549087
## 632 39 Getafe CF 45.65355 A. Akurugu -6.653549087
## 633 42 Elche CF 41.32510 Lluís Andreu 0.674903893
```

Try to predict player value from other data.

```
hm_datasc["value_eur"] <- hm_data$value_eur
fp22_hm_sc["value_eur"] <- fp22_hm$value_eur

ML_ex_o <- lmer(value_eur ~ age + overall + international_reputation + wage_eur + (1|club_position), data=hm_datasc)
v_pred <- predict(ML_ex_o, newdata=fp22_hm_sc)
ML_ex_o
```

```
## Linear mixed model fit by maximum likelihood ['lmerMod']
## Formula: value_eur ~ age + overall + international_reputation + wage_eur +
## (1 | club_position)
## Data: hm_datasc
## AIC BIC logLik deviance df.resid
## 144970.8 145015.3 -72478.4 144956.8 4260
## Random effects:
## Groups Name Std.Dev.
## club_position (Intercept) 2170351
## Residual 5723308
## Number of obs: 4267, groups: club_position, 25
## Fixed Effects:
## (Intercept) age overall
## 9098946 -2669270 6017374
## international_reputation wage_eur
## 1688958 5869841

compare_o <- cbind(y_te2, v_pred, d[c("short_name", "overall", "value_eur")])
compare_o <- compare_o %>% mutate("diff" = round(value_eur-v_pred))
mean((compare_o$diff)^2)^0.5
```

```
## [1] 9026972
```

```
# 9026972
```

Try to predict player wage from data

```
hm_datasc["wage_eur"] <- hm_data$wage_eur
fp22_hm_sc["wage_eur"] <- fp22_hm$wage_eur

ML_ex_o <- lmer(wage_eur ~ age + overall + international_reputation + (1|club_name:pos), data=hm_datasc)
w_pred <- predict(ML_ex_o, newdata=fp22_hm_sc)
ML_ex_o
```

```
## Linear mixed model fit by maximum likelihood ['lmerMod']
## Formula:
## wage_eur ~ age + overall + international_reputation + (1 | club_name:pos)
## Data: hm_datasc
## AIC BIC logLik deviance df.resid
## 98687.05 98725.21 -49337.53 98675.05 4261
## Random effects:
## Groups Name Std.Dev.
## club_name:pos (Intercept) 37374
## Residual 23858
```

```
## Number of obs: 4267, groups: club_name:pos, 155
## Fixed Effects:
##               (Intercept)                age                overall
##               33890                -1963                17320
## international_reputation
##               15013

compare_w <- cbind(y_te2, v_pred, d[c("short_name", "overall", "wage_eur")])
compare_w <- compare_w %>% mutate("diff" = round(wage_eur-w_pred))
mean((compare_w$diff)^2)^0.5

## [1] 21600.1

# 24548.54 (1/pos) + (1/club_name)
# 24591.14 (1/club_name)
# 23680.58 (1/club_position) + (1/club_name)
# 21600.1(1/club_name:pos)
# 21468.42 (1/club_name) + (1/club_name:pos)

mean(hm_data$wage_eur)

## [1] 35958.75
```

— BAYESIAN REGRESSION MODEL —

```
# Using scaled_new_df dataframe for Bayesian regression model
scaled_new_df <- bind_cols(x, y)

## New names:
## * ``->`...53`
names(scaled_new_df)[names(scaled_new_df) == '`...53`] <- 'Pts.'
```

Fitting the model

```
library(rstanarm)
```

```
## Loading required package: Rcpp
## This is rstanarm version 2.21.3
## - See https://mc-stan.org/rstanarm/articles/priors for changes to default priors!
## - Default priors may change, so it's safest to specify priors, even if equivalent to the defaults.
## - For execution on a local, multicore CPU with excess RAM we recommend calling
##   options(mc.cores = parallel::detectCores())
##
## Attaching package: 'rstanarm'
```

```

## The following objects are masked from 'package:arm':
##
##   invlogit, logit
# Fit the model:
bayes_reg_model <- rstanarm::stan_glm(Pts. ~ ., family = gaussian(), data=scaled_new_df)

##
## SAMPLING FOR MODEL 'continuous' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 9.5e-05 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 0.95 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [ 0%] (Warmup)
## Chain 1: Iteration:   200 / 2000 [ 10%] (Warmup)
## Chain 1: Iteration:   400 / 2000 [ 20%] (Warmup)
## Chain 1: Iteration:   600 / 2000 [ 30%] (Warmup)
## Chain 1: Iteration:   800 / 2000 [ 40%] (Warmup)
## Chain 1: Iteration:  1000 / 2000 [ 50%] (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%] (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 1:
## Chain 1: Elapsed Time: 3.34457 seconds (Warm-up)
## Chain 1:                2.74686 seconds (Sampling)
## Chain 1:                6.09143 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'continuous' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 3.3e-05 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0.33 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [ 0%] (Warmup)
## Chain 2: Iteration:   200 / 2000 [ 10%] (Warmup)
## Chain 2: Iteration:   400 / 2000 [ 20%] (Warmup)
## Chain 2: Iteration:   600 / 2000 [ 30%] (Warmup)
## Chain 2: Iteration:   800 / 2000 [ 40%] (Warmup)
## Chain 2: Iteration:  1000 / 2000 [ 50%] (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%] (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 2:
## Chain 2: Elapsed Time: 3.0021 seconds (Warm-up)
## Chain 2:                3.11312 seconds (Sampling)

```

```

## Chain 2:                6.11522 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'continuous' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 2.8e-05 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 0.28 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%] (Warmup)
## Chain 3: Iteration:   200 / 2000 [ 10%] (Warmup)
## Chain 3: Iteration:   400 / 2000 [ 20%] (Warmup)
## Chain 3: Iteration:   600 / 2000 [ 30%] (Warmup)
## Chain 3: Iteration:   800 / 2000 [ 40%] (Warmup)
## Chain 3: Iteration:  1000 / 2000 [ 50%] (Warmup)
## Chain 3: Iteration:  1001 / 2000 [ 50%] (Sampling)
## Chain 3: Iteration:  1200 / 2000 [ 60%] (Sampling)
## Chain 3: Iteration:  1400 / 2000 [ 70%] (Sampling)
## Chain 3: Iteration:  1600 / 2000 [ 80%] (Sampling)
## Chain 3: Iteration:  1800 / 2000 [ 90%] (Sampling)
## Chain 3: Iteration:  2000 / 2000 [100%] (Sampling)
## Chain 3:
## Chain 3: Elapsed Time: 3.60717 seconds (Warm-up)
## Chain 3:                4.93764 seconds (Sampling)
## Chain 3:                8.54481 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'continuous' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 1.6e-05 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0.16 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%] (Warmup)
## Chain 4: Iteration:   200 / 2000 [ 10%] (Warmup)
## Chain 4: Iteration:   400 / 2000 [ 20%] (Warmup)
## Chain 4: Iteration:   600 / 2000 [ 30%] (Warmup)
## Chain 4: Iteration:   800 / 2000 [ 40%] (Warmup)
## Chain 4: Iteration:  1000 / 2000 [ 50%] (Warmup)
## Chain 4: Iteration:  1001 / 2000 [ 50%] (Sampling)
## Chain 4: Iteration:  1200 / 2000 [ 60%] (Sampling)
## Chain 4: Iteration:  1400 / 2000 [ 70%] (Sampling)
## Chain 4: Iteration:  1600 / 2000 [ 80%] (Sampling)
## Chain 4: Iteration:  1800 / 2000 [ 90%] (Sampling)
## Chain 4: Iteration:  2000 / 2000 [100%] (Sampling)
## Chain 4:
## Chain 4: Elapsed Time: 3.42231 seconds (Warm-up)
## Chain 4:                4.0514 seconds (Sampling)
## Chain 4:                7.47371 seconds (Total)
## Chain 4:

```

View a summary of the model:


```
summary(bayes_reg_model)
```

```
##
## Model Info:
## function:      stan_glm
## family:        gaussian [identity]
## formula:       Pts. ~ .
## algorithm:     sampling
## sample:        4000 (posterior sample size)
## priors:        see help('prior_summary')
## observations:  140
## predictors:    53
##
## Estimates:
##               mean    sd   10%   50%   90%
## (Intercept)   52.2    0.8   51.2  52.2  53.2
## overall       3.6     7.4   -5.8   3.5  13.3
## potential     -1.6     7.3  -11.1  -1.7   7.8
## value_eur      7.1     4.4    1.6   7.1  12.8
## wage_eur      -3.8     2.7   -7.2  -3.7  -0.3
## age           -2.3     2.4   -5.4  -2.3   0.7
## height_cm      1.2     2.0   -1.2   1.2   3.7
## weight_kg     -0.3     1.6   -2.4  -0.3   1.7
## weak_foot      0.0     1.5   -2.0   0.0   1.9
## skill_moves    -0.3     2.4   -3.4  -0.3   2.9
## international_reputation 12.5    2.9    8.9  12.5  16.2
## release_clause_eur -4.2    2.0   -6.7  -4.1  -1.7
## pace          16.2     7.8    6.4  16.2  26.1
## shooting     -11.5    13.9  -29.1 -11.2   6.4
## passing       -2.6    13.1  -19.2  -2.8  14.1
## dribbling    -48.1    18.6  -71.9 -48.1 -24.2
## defending       32.9    17.0   11.2  32.7  54.9
## physic        -2.5     7.2  -11.5  -2.5   6.8
## attacking_crossing  0.9     3.3   -3.4   1.0   5.2
## attacking_finishing  8.2     7.6   -1.5   8.2  18.0
## attacking_heading_accuracy -0.7    2.2   -3.5  -0.7   2.1
## attacking_short_passing  4.6     5.3   -2.2   4.7  11.1
## attacking_volleys  0.7     2.7   -2.7   0.7   3.9
## skill_dribbling 22.8    11.0    8.6  22.9  36.8
## skill_curve    -1.4     3.2   -5.4  -1.4   2.8
## skill_fk_accuracy  0.3     2.2   -2.5   0.3   3.1
## skill_long_passing -2.7     4.0   -7.9  -2.7   2.3
## skill_ball_control  9.2     5.6    2.2   9.2  16.1
## movement_acceleration -13.8    5.1  -20.5 -13.8  -7.3
## movement_sprint_speed -8.3     5.9  -15.6  -8.4  -0.5
## movement_agility  10.2    3.5    5.7  10.2  14.6
## movement_reactions  1.2     3.8   -3.6   1.1   6.0
## movement_balance  3.6     2.7    0.1   3.6   7.0
## power_shot_power  2.7     2.9   -0.9   2.7   6.5
## power_jumping    0.3     2.0   -2.2   0.4   2.8
## power_stamina    3.8     3.2   -0.2   3.9   7.8
## power_strength   0.6     4.0   -4.6   0.6   5.8
## power_long_shots  1.7     4.2   -3.8   1.7   7.1
## mentality_aggression  0.7     2.2   -2.1   0.6   3.5
```

```

## mentality_interceptions      -4.7    4.7 -11.0  -4.6    1.3
## mentality_positioning        0.8    2.6  -2.5    0.7    4.1
## mentality_vision             2.3    4.5  -3.4    2.2    8.0
## mentality_penalties          1.5    2.1  -1.1    1.5    4.1
## mentality_composure          -4.2    2.3  -7.1   -4.2   -1.3
## defending_marking_awareness -12.5    7.0 -21.6 -12.4   -3.7
## defending_standing_tackle     -8.6    6.1 -16.3  -8.6   -0.8
## defending_sliding_tackle      -5.8    3.9 -10.7  -5.9   -0.9
## goalkeeping_diving           3.9    2.6   0.5    3.9    7.1
## goalkeeping_handling         1.0    2.7  -2.4    1.0    4.5
## goalkeeping_kicking          -1.1    2.1  -3.8   -1.1    1.5
## goalkeeping_positioning       3.5    2.6   0.2    3.5    6.8
## goalkeeping_reflexes         -6.6    3.1 -10.6  -6.6   -2.7
## goalkeeping_speed            -0.8    1.3  -2.5   -0.8    0.8
## sigma                        9.1    0.7   8.3    9.1   10.1
##
## Fit Diagnostics:
##      mean    sd   10%   50%   90%
## mean_PPD 52.2    1.1 50.8  52.2  53.6
##
## The mean_ppd is the sample average posterior predictive distribution of the outcome variable (for de
##
## MCMC diagnostics
##
##      mcse Rhat n_eff
## (Intercept)      0.0  1.0  6208
## overall           0.1  1.0  2475
## potential         0.2  1.0  2270
## value_eur         0.1  1.0  3299
## wage_eur          0.0  1.0  3421
## age               0.0  1.0  2301
## height_cm         0.0  1.0  3305
## weight_kg         0.0  1.0  3745
## weak_foot         0.0  1.0  3335
## skill_moves       0.0  1.0  4189
## international_reputation 0.0  1.0  4726
## release_clause_eur 0.0  1.0  3086
## pace             0.2  1.0  2651
## shooting          0.4  1.0  1321
## passing           0.3  1.0  1669
## dribbling         0.5  1.0  1487
## defending           0.4  1.0  1449
## physic            0.2  1.0  1470
## attacking_crossing 0.1  1.0  2258
## attacking_finishing 0.2  1.0  1312
## attacking_heading_accuracy 0.0  1.0  2131
## attacking_short_passing 0.1  1.0  2470
## attacking_volleys  0.0  1.0  3949
## skill_dribbling    0.3  1.0  1582
## skill_curve        0.1  1.0  3433
## skill_fk_accuracy  0.0  1.0  3679
## skill_long_passing 0.1  1.0  3043
## skill_ball_control 0.1  1.0  2037
## movement_acceleration 0.1  1.0  3147
## movement_sprint_speed 0.1  1.0  2936

```

```
## movement_agility      0.1  1.0  2612
## movement_reactions    0.1  1.0  3671
## movement_balance      0.1  1.0  2580
## power_shot_power       0.1  1.0  1946
## power_jumping          0.0  1.0  2828
## power_stamina          0.1  1.0  1955
## power_strength         0.1  1.0  1789
## power_long_shots       0.1  1.0  1900
## mentality_aggression   0.0  1.0  2450
## mentality_interceptions 0.1  1.0  2000
## mentality_positioning  0.0  1.0  4235
## mentality_vision       0.1  1.0  1850
## mentality_penalties    0.0  1.0  3850
## mentality_composure    0.0  1.0  3035
## defending_marking_awareness 0.2  1.0  1466
## defending_standing_tackle 0.1  1.0  1827
## defending_sliding_tackle 0.1  1.0  2945
## goalkeeping_diving     0.0  1.0  3185
## goalkeeping_handling   0.0  1.0  3428
## goalkeeping_kicking    0.0  1.0  3365
## goalkeeping_positioning 0.0  1.0  3876
## goalkeeping_reflexes   0.1  1.0  3118
## goalkeeping_speed      0.0  1.0  2948
## sigma                  0.0  1.0  2438
## mean_PPD               0.0  1.0  4496
## log-posterior          0.2  1.0  1000
```

For each parameter, mcse is Monte Carlo standard error, n_eff is a crude measure of effective sample

To obtain summary of medians

```
bayes_reg_model
```

```
## stan_glm
## family:      gaussian [identity]
## formula:     Pts. ~ .
## observations: 140
## predictors:  53
## -----
##              Median MAD_SD
## (Intercept)    52.2    0.8
## overall         3.5    7.3
## potential      -1.7    7.3
## value_eur       7.1    4.3
## wage_eur       -3.7    2.6
## age            -2.3    2.4
## height_cm       1.2    2.0
## weight_kg      -0.3    1.6
## weak_foot       0.0    1.5
## skill_moves    -0.3    2.4
## international_reputation 12.5    2.9
## release_clause_eur -4.1    2.0
## pace           16.2    7.8
## shooting      -11.2   14.0
## passing        -2.8   13.3
```

```
## dribbling -48.1 18.2
## defending 32.7 16.5
## physic -2.5 7.3
## attacking_crossing 1.0 3.4
## attacking_finishing 8.2 7.5
## attacking_heading_accuracy -0.7 2.2
## attacking_short_passing 4.7 5.3
## attacking_volleys 0.7 2.6
## skill_dribbling 22.9 10.8
## skill_curve -1.4 3.1
## skill_fk_accuracy 0.3 2.2
## skill_long_passing -2.7 4.0
## skill_ball_control 9.2 5.6
## movement_acceleration -13.8 5.3
## movement_sprint_speed -8.4 5.8
## movement_agility 10.2 3.4
## movement_reactions 1.1 3.7
## movement_balance 3.6 2.7
## power_shot_power 2.7 2.9
## power_jumping 0.4 2.0
## power_stamina 3.9 3.2
## power_strength 0.6 4.0
## power_long_shots 1.7 4.1
## mentality_aggression 0.6 2.1
## mentality_interceptions -4.6 4.6
## mentality_positioning 0.7 2.6
## mentality_vision 2.2 4.5
## mentality_penalties 1.5 2.1
## mentality_composure -4.2 2.3
## defending_marking_awareness -12.4 7.0
## defending_standing_tackle -8.6 6.0
## defending_sliding_tackle -5.9 3.8
## goalkeeping_diving 3.9 2.5
## goalkeeping_handling 1.0 2.8
## goalkeeping_kicking -1.1 2.0
## goalkeeping_positioning 3.5 2.6
## goalkeeping_reflexes -6.6 3.0
## goalkeeping_speed -0.8 1.3
```

```
##
## Auxiliary parameter(s):
##      Median MAD_SD
## sigma 9.1 0.7
##
## -----
## * For help interpreting the printed output see ?print.stanreg
## * For info on the priors used see ?prior_summary.stanreg
```

To obtain prediction intervals:

```
m= coef(bayes_reg_model)
q= posterior_interval(bayes_reg_model)[1:length(m),]
b.intervals= round(cbind(m, q), 3)
b.intervals
```

```
## m 5% 95%
```

## (Intercept)	52.174	50.908	53.417
## overall	3.452	-8.775	16.036
## potential	-1.709	-13.334	10.214
## value_eur	7.065	-0.062	14.419
## wage_eur	-3.740	-8.346	0.889
## age	-2.326	-6.237	1.527
## height_cm	1.213	-1.980	4.415
## weight_kg	-0.343	-3.034	2.299
## weak_foot	0.001	-2.455	2.447
## skill_moves	-0.280	-4.234	3.701
## international_reputation	12.517	7.818	17.264
## release_clause_eur	-4.149	-7.471	-0.936
## pace	16.169	3.142	28.728
## shooting	-11.239	-34.408	10.822
## passing	-2.840	-24.176	18.547
## dribbling	-48.090	-78.605	-16.940
## defending	32.724	5.309	61.649
## physic	-2.471	-14.124	9.365
## attacking_crossing	0.957	-4.470	6.372
## attacking_finishing	8.245	-4.153	20.802
## attacking_heading_accuracy	-0.709	-4.410	2.915
## attacking_short_passing	4.679	-4.071	13.002
## attacking_volleys	0.719	-3.765	4.923
## skill_dribbling	22.937	4.219	40.679
## skill_curve	-1.356	-6.515	3.865
## skill_fk_accuracy	0.336	-3.208	3.947
## skill_long_passing	-2.719	-9.401	3.691
## skill_ball_control	9.237	0.031	18.279
## movement_acceleration	-13.796	-22.208	-5.371
## movement_sprint_speed	-8.439	-17.724	1.571
## movement_agility	10.207	4.354	16.017
## movement_reactions	1.150	-5.012	7.437
## movement_balance	3.623	-0.780	7.933
## power_shot_power	2.682	-1.929	7.605
## power_jumping	0.383	-2.852	3.558
## power_stamina	3.883	-1.371	8.874
## power_strength	0.589	-6.037	7.144
## power_long_shots	1.697	-5.243	8.744
## mentality_aggression	0.609	-2.892	4.225
## mentality_interceptions	-4.647	-12.502	2.967
## mentality_positioning	0.702	-3.416	5.005
## mentality_vision	2.183	-4.949	9.652
## mentality_penalties	1.492	-1.939	4.819
## mentality_composure	-4.178	-7.970	-0.442
## defending_marking_awareness	-12.423	-24.204	-1.033
## defending_standing_tackle	-8.646	-18.365	1.642
## defending_sliding_tackle	-5.923	-11.990	0.721
## goalkeeping_diving	3.853	-0.390	8.080
## goalkeeping_handling	1.015	-3.356	5.388
## goalkeeping_kicking	-1.118	-4.493	2.322
## goalkeeping_positioning	3.505	-0.767	7.809
## goalkeeping_reflexes	-6.628	-11.723	-1.563
## goalkeeping_speed	-0.811	-2.965	1.306

Making predictions:

```
# Making predictions:
x_te_df <- as.data.frame(x_te)
predictions_bayes <- predict(bayes_reg_model, newdata = x_te_df)

pred_bayes_compare <- cbind(y_te, predictions_bayes)
pred_bayes_compare
```

```
##               club_name Pts. predictions_bayes
## 1   Athletic Club de Bilbao    55      56.66665
## 2     Atlético de Madrid    71      73.87399
## 3           CA Osasuna    47      46.14914
## 4           Cádiz CF    39      42.45438
## 5   Deportivo Alavés    31      46.35545
## 6           Elche CF    42      49.97121
## 7       FC Barcelona    73      75.04346
## 8           Getafe CF    39      45.18942
## 9           Granada CF    38      44.71812
## 10  Levante Unión Deportiva    35      46.97023
## 11           Rayo Vallecano    42      51.01301
## 12      RC Celta de Vigo    46      43.19493
## 13 RCD Espanyol de Barcelona    42      38.59277
## 14           RCD Mallorca    39      43.86118
## 15      Real Betis Balompié    65      50.99236
## 16      Real Madrid CF    86      65.09661
## 17      Real Sociedad    62      57.34609
## 18           Sevilla FC    70      61.47239
## 19           Valencia CF    48      55.44545
## 20      Villarreal CF    59      48.99848
```

Mean squared error to assess accuracy of Bayesian Regression

```
mse_bayes = mean((pred_bayes_compare$Pts. - pred_bayes_compare$predictions_bayes)^2)
mse_bayes
```

```
## [1] 78.06409
```

Root mean squared error to assess accuracy of Bayesian Regression

```
root_mse_bayes = sqrt(mean((pred_bayes_compare$Pts. - pred_bayes_compare$predictions_bayes)^2))
root_mse_bayes
```

```
## [1] 8.835389
```

Correlation between predicted and actual values of testing set

```
cor(pred_bayes_compare$Pts., pred_bayes_compare$predictions_bayes)
```

```
## [1] 0.8200798
```

— BAYESIAN MODEL SELECTION —

Fitting the model

```
library(mombf)
```

```
## Loading required package: mvtnorm
```

```
## Loading required package: ncvreg
```

```
## Loading required package: mgcv
```

```
## Loading required package: nlme
```

```
##
```

```
## Attaching package: 'nlme'
```

```
## The following object is masked from 'package:dplyr':
```

```
##
```

```
## collapse
```

```
## The following object is masked from 'package:lme4':
```

```
##
```

```
## lmList
```

```
## This is mgcv 1.8-40. For overview type 'help("mgcv-package")'.
```

```
# Fit Bayesian model selection model
```

```
fit.bayesmodelselection <- modelSelection(Pts. ~ ., data=scaled_new_df, priorCoef=zellnerprior(taustd=1
```

```
## Greedy searching posterior mode... Done.
```

```
## Running Gibbs sampler..... Done.
```

Viewing summary of bayesian model selection

```
head(postProb(fit.bayesmodelselection),10)
```

```
##   modelid family      pp
## 1      11 normal 0.611394250
## 2    11,35 normal 0.054748127
## 3    11,21 normal 0.038237312
## 4      6,11 normal 0.023953269
## 5    11,36 normal 0.016248735
## 6  6,11,21 normal 0.012387920
## 7      3,11 normal 0.011155557
## 8    11,32 normal 0.010848025
## 9    11,12 normal 0.008034734
## 10   11,40 normal 0.007273579
```

VISUALIZATIONS

```
colnames(scaled_new_df)
```

```
## [1] "overall"           "potential"
## [3] "value_eur"         "wage_eur"
## [5] "age"               "height_cm"
## [7] "weight_kg"         "weak_foot"
## [9] "skill_moves"       "international_reputation"
## [11] "release_clause_eur" "pace"
## [13] "shooting"          "passing"
## [15] "dribbling"         "defending"
## [17] "physic"            "attacking_crossing"
## [19] "attacking_finishing" "attacking_heading_accuracy"
## [21] "attacking_short_passing" "attacking_volley"
## [23] "skill_dribbling"   "skill_curve"
## [25] "skill_fk_accuracy" "skill_long_passing"
## [27] "skill_ball_control" "movement_acceleration"
## [29] "movement_sprint_speed" "movement_agility"
## [31] "movement_reactions" "movement_balance"
## [33] "power_shot_power"   "power_jumping"
## [35] "power_stamina"      "power_strength"
## [37] "power_long_shots"   "mentality_aggression"
## [39] "mentality_interceptions" "mentality_positioning"
## [41] "mentality_vision"   "mentality_penalties"
## [43] "mentality_composure" "defending_marking_awareness"
## [45] "defending_standing_tackle" "defending_sliding_tackle"
## [47] "goalkeeping_diving"   "goalkeeping_handling"
## [49] "goalkeeping_kicking"  "goalkeeping_positioning"
## [51] "goalkeeping_reflexes" "goalkeeping_speed"
## [53] "Pts."
```

```
scaled_new_df[1, ]
```

```
## # A tibble: 1 x 53
##   overall potential value_eur wage_eur   age height_cm weigh~1 weak_~2 skill~3
##   <dbl>     <dbl>     <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
## 1  0.282     0.277     0.465  -0.445 -0.0530    1.39    2.24    0.463    2.03
## # ... with 44 more variables: international_reputation <dbl>,
## #   release_clause_eur <dbl>, pace <dbl>, shooting <dbl>, passing <dbl>,
## #   dribbling <dbl>, defending <dbl>, physic <dbl>, attacking_crossing <dbl>,
## #   attacking_finishing <dbl>, attacking_heading_accuracy <dbl>,
## #   attacking_short_passing <dbl>, attacking_volley <dbl>,
## #   skill_dribbling <dbl>, skill_curve <dbl>, skill_fk_accuracy <dbl>,
## #   skill_long_passing <dbl>, skill_ball_control <dbl>, ...
```