

QTM 220 HW #5

Author

Veronica Vargas

Exercise #3

Least Squares Regression Models: Sample

```
library(tidyverse)
```

Warning: package 'tidyverse' was built under R version 4.3.3

— Attaching core tidyverse packages — tidyverse 2.0.0 —

✓ dplyr 1.1.3 ✓ readr 2.1.4

✓ forcats 1.0.0 ✓ stringr 1.5.0

✓ ggplot2 3.4.3 ✓ tibble 3.2.1

✓ lubridate 1.9.2 ✓ tidyr 1.3.0

✓ purrr 1.0.2

— Conflicts — tidyverse_conflicts() —

✗ dplyr::filter() masks stats::filter()

✗ dplyr::lag() masks stats::lag()

i Use the conflicted package (<<http://conflicted.r-lib.org/>>) to force all conflicts to become errors

```
library(ggplot2)
```

```
library(dplyr)
```

```
nba_2023 <- read.csv("C:/Users/13015/OneDrive - Emory University/Documents/Fall 2024/QTM
220/nba.sample.data.csv")
```

```
nba_2023
```

	X	POS	Team	Age	GP	W	L	Min	PTS	FGM
1	354.0	PF	WAS	30	59	21	38	624.6	195	71
2	19.0	SG	GSW	23	82	44	38	2458.1	1675	550
3	427.0	F	MIA	19	15	7	8	204.5	82	28
4	55.0	SF	DET	34	59	15	44	1892.9	1273	430
5	368.0	F	NYK	25	42	9	33	473.6	172	67
6	132.0	PG	ORL	22	60	28	32	1551.8	781	277
7	50.0	SG	IND	20	78	33	45	2222.4	1302	413
8	158.0	PF	MEM	22	77	47	30	1681.7	696	247
9	37.0	C	CHI	32	82	40	42	2746.4	1447	597
10	447.0	C	IND	31	7	1	6	108.8	49	21
11	8.0	SG	CLE	26	68	44	24	2432.4	1922	679
12	510.0	PF	WAS	21	6	2	4	61.4	9	3
13	418.0	G	DAL	27	40	19	21	323.0	95	31
14	284.0	SG	PHX	26	40	19	21	806.9	346	113
15	483.0	G	GSW	20	12	5	7	62.1	23	7
16	425.0	F	CHI	20	38	19	19	213.9	85	32
17	33.0	SF	ORL	21	80	33	47	2608.7	1485	542
18	334.0	C	NOP	22	47	22	25	610.1	233	86
19	127.0	SG	NYK	22	71	41	30	2120.9	799	282
20	393.0	F	MIN	25	38	19	19	290.7	139	46
21	101.0	SF	SAC	22	80	47	33	2381.7	976	354
22	21.0	PG	GSW	35	56	30	26	1941.2	1648	559
23	348.0	PF	CLE	26	44	30	14	891.6	206	73
24	300.0	SG	POR	26	71	38	33	1200.4	293	110

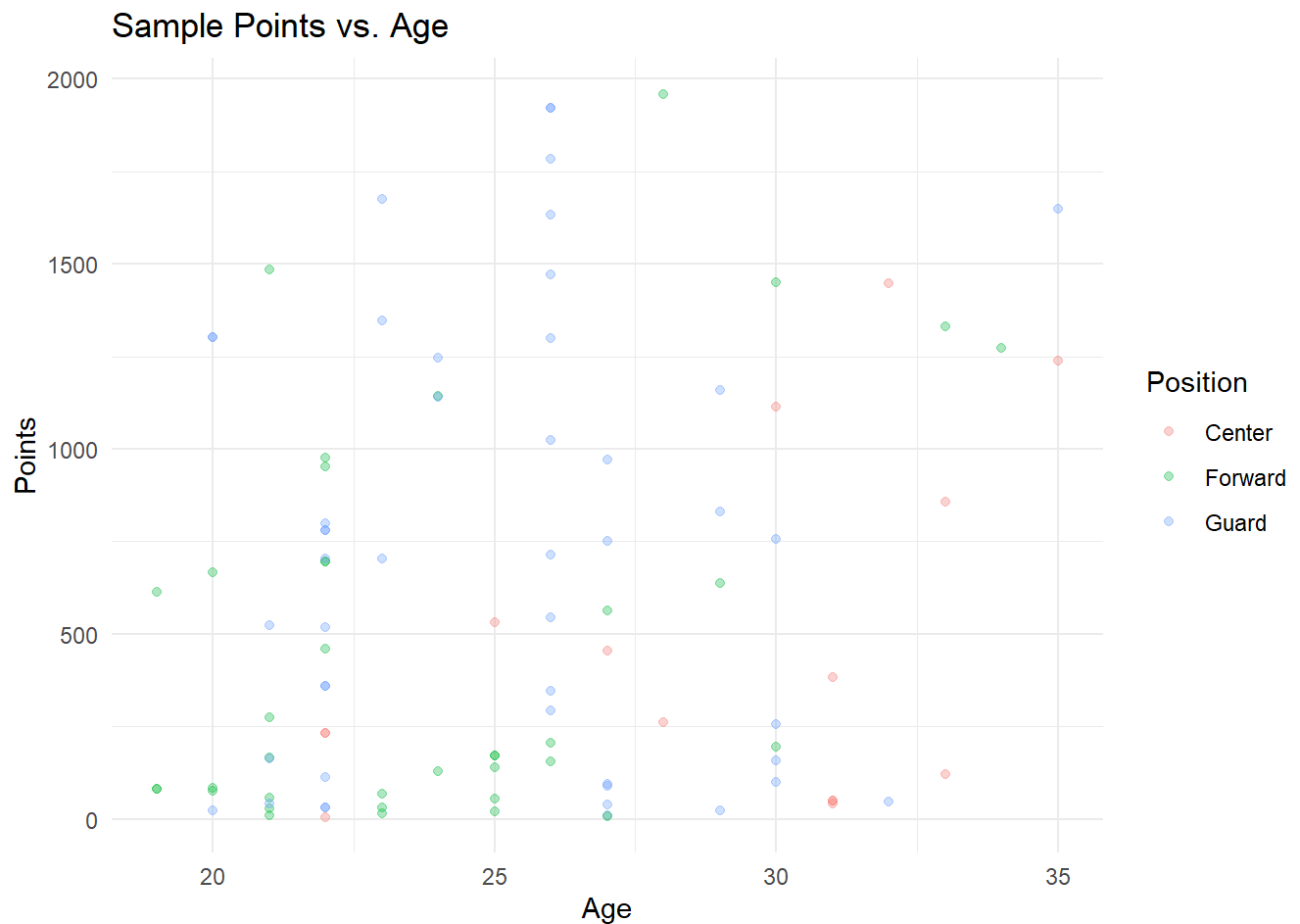
25	471.0	G	MEM	22	15	7	8	104.6	30	12
26	152.0	SG	MIN	23	65	34	31	1251.7	704	280
27	375.0	F	SAS	21	17	7	10	320.1	165	59
28	147.0	SG	LAC	26	81	44	37	1872.2	713	272
29	60.0	C	MIL	35	78	57	21	2372.5	1239	477
30	486.0	F	DEN	25	17	13	4	66.0	21	8
31	140.0	SG	MIL	27	72	53	19	1972.1	750	245
32	219.0	SG	ORL	21	53	20	33	1245.9	524	186
33	435.0	F	LAC	21	22	10	12	195.5	59	24
34	537.0	N/A	UTA	24	1	0	1	5.0	0	0
35	105.0	PF	MIN	22	79	41	38	2416.5	953	370
36	158.1	PF	MEM	22	77	47	30	1681.7	696	247
37	59.0	SG	MEM	24	58	38	20	1841.5	1247	450
38	379.0	PG	CLE	30	48	31	17	505.2	157	57
39	470.0	F	CLE	23	12	8	4	84.2	31	12
40	471.1	G	MEM	22	15	7	8	104.6	30	12
41	223.0	PG	OKC	22	67	31	36	1183.4	517	197
42	334.1	C	NOP	22	47	22	25	610.1	233	86
43	431.0	F	UTA	23	7	2	5	160.8	69	26
44	267.0	C	BOS	31	63	32	31	945.1	383	131
45	70.0	SG	WAS	29	50	24	26	1672.9	1160	444
46	8.1	SG	CLE	26	68	44	24	2432.4	1922	679
47	14.0	SG	BOS	26	67	46	21	2404.9	1784	679
48	514.0	G	DAL	27	3	2	1	8.3	9	4
49	50.1	SG	IND	20	78	33	45	2222.4	1302	413
50	500.0	F	BKN	23	1	0	1	35.1	16	6
51	242.0	C	PHX	27	69	35	34	978.5	456	178
52	515.0	F	SAS	27	4	1	3	29.5	7	3
53	459.0	C	MIL	31	9	6	3	113.7	43	14
54	241.0	PF	POR	22	62	26	36	1181.6	459	181
55	44.0	PG	MIA	23	67	37	30	2335.4	1347	487
56	114.0	C	LAC	33	79	28	51	2052.9	857	329
57	421.0	SG	LAL	27	43	29	14	342.5	89	28
58	427.1	F	MIA	19	15	7	8	204.5	82	28
59	521.0	C	UTA	22	11	8	3	28.5	6	2
60	75.0	PF	CHA	24	73	24	49	2379.6	1144	434
61	448.0	PG	SAC	32	32	19	13	212.8	47	17
62	439.0	PF	ORL	25	11	8	3	124.0	55	22
63	281.0	G	DEN	22	76	49	27	1181.1	360	143
64	79.0	C	NOP	30	79	40	39	1968.2	1115	446
65	447.1	C	IND	31	7	1	6	108.8	49	21
66	36.0	PF	LAL	30	56	31	25	1904.5	1451	542
67	404.0	C	SAS	33	31	3	28	358.1	121	45
68	480.0	G	IND	29	3	1	2	55.8	24	8
69	312.0	F	OKC	21	34	16	18	701.3	276	108
70	51.0	PG	DEN	26	65	43	22	2133.4	1298	473
71	429.0	F	DEN	20	23	13	10	186.1	75	29
72	47.0	F	LAC	33	56	32	24	1938.9	1332	459
73	206.0	PF	SAC	27	74	43	31	1247.2	562	187
74	324.0	SG	MIN	30	52	25	27	1016.3	255	91
75	34.0	SG	PHX	26	53	34	19	1835.4	1471	527
76	321.0	C	NOP	28	38	23	15	457.7	262	89
77	102.0	SG	CHA	27	48	16	32	1547.5	972	353
78	5.0	PF	MIL	28	63	47	16	2023.6	1959	707
79	414.0	SG	GSW	30	22	13	9	367.6	101	41
80	137.0	SG	ATL	30	54	27	27	1508.6	756	273
81	407.0	PG	NOP	22	25	11	14	234.8	114	40
82	380.0	SF	ORL	26	37	14	23	451.3	155	55
83	472.0	PF	POR	21	16	10	6	93.1	28	11
84	170.0	PF	GSW	20	67	38	29	1394.4	666	261
85	213.0	SG	MEM	26	59	37	22	1315.1	546	188
86	217.0	C	CHA	25	65	21	44	1217.7	532	197
87	153.0	SG	SAS	22	38	12	26	1178.1	703	261
88	461.0	G	MIN	21	29	16	13	152.7	42	18
89	132.1	PG	ORL	22	60	28	32	1551.8	781	277

90	464.0	G	WAS	27	10	2	8	125.8	38	17
91	22.0	PG	NYK	26	68	40	28	2378.7	1633	587
92	121.0	PG	LAL	29	66	37	29	1985.9	830	270
93	195.0	F	SAS	19	56	15	41	1457.7	614	250
94	368.1	F	NYK	25	42	9	33	473.6	172	67
95	397.0	PF	ORL	24	27	8	19	518.0	128	43
96	376.0	G	WAS	21	28	10	18	422.6	163	66
97	186.0	SF	PHI	29	78	51	27	1511.8	637	222
98	281.1	G	DEN	22	76	49	27	1181.1	360	143
99	93.0	SG	LAL	26	81	45	36	2093.1	1025	370
100	76.0	SG	SAC	24	75	44	31	2202.8	1140	420

(a) Sample Data Cleaning & Overview

```
nba_2023 <- nba_2023 %>%
  mutate(Position = case_when(
    POS == 'C' ~ 'Center',
    POS %in% c('SG','PG','G') ~ 'Guard',
    POS %in% c('SF','PF','F') ~ 'Forward')) %>%
  na.omit()

ggplot(nba_2023, aes(x = Age, y = PTS)) +
  geom_point(aes(x = Age, y = PTS,
                 color = factor(Position)),
            alpha = 0.3) +
  labs(
    title = "Sample Points vs. Age",
    x = "Age",
    y = "Points",
    color = "Position") +
  theme_minimal()
```



(b) Parallel Lines Model: Sample

```
mod.coarsen1 <- lm(PTS ~ Position + Age, data = nba_2023)
mod.coarsen1
```

Call:
lm(formula = PTS ~ Position + Age, data = nba_2023)

Coefficients:

(Intercept)	PositionForward	PositionGuard	Age
-496.84	160.07	375.72	33.44

```
age_seq <- seq(min(nba_2023$Age), max(nba_2023$Age), by = 1)
```

```
pred_data <- expand.grid(
  Age = age_seq,
  Position = c(0, 1, 2))
```

```
pred_data$Position <- factor(pred_data$Position,
  levels = c(0, 1, 2),
  labels = c("Center", "Guard", "Forward"))
```

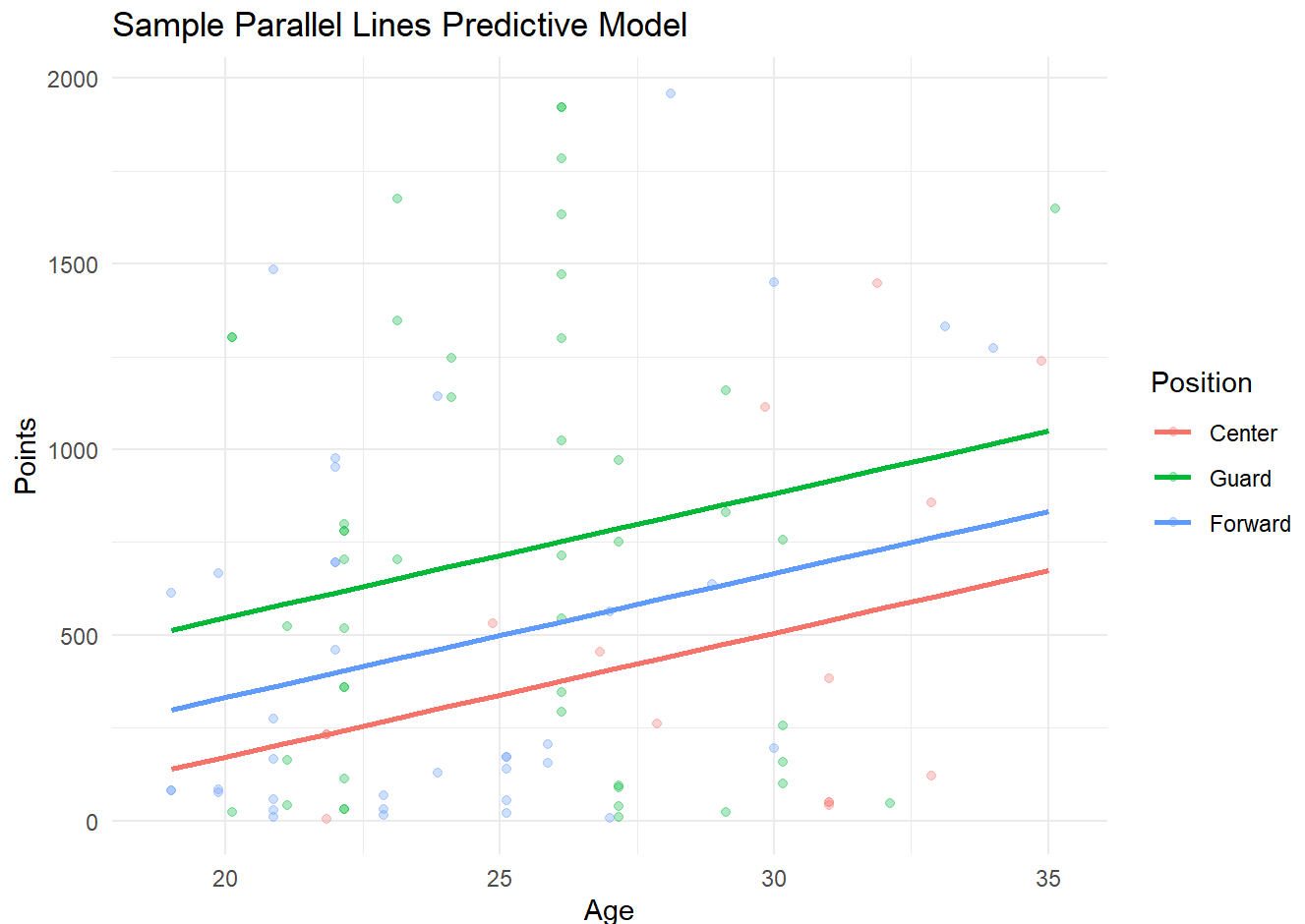
```
pred_data$predicted_PTS <- predict(mod.coarsen1, newdata = pred_data)
```

```
ggplot() +
  geom_point(data = nba_2023, aes(x = Age, y = PTS, color = Position),
    alpha = 0.3, position=position_dodge(width=0.5)) +
  geom_line(data = pred_data, aes(x = Age, y = predicted_PTS,
```

```
color = Position), size = 1) +
```

```
labs(
  title = "Sample Parallel Lines Predictive Model",
  x = "Age",
  y = "Points",
  color = "Position"
) +
theme_minimal()
```

Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
 Please use `linewidth` instead.



(c) Parallel Line Bootstrap: Sample

```
set.seed(42)

B <- 10000

boot_preds <- numeric(B)

for (b in 1:B) {
  boot_sample <- nba_2023[sample(1:nrow(nba_2023), replace = TRUE), ]

  boot_mod <- lm(PTS ~ Position + Age, data = boot_sample)

  boot_preds[b] <- predict(boot_mod,
                           newdata = data.frame(Age = 20,
                                                  Position = "Center"))
}
```

```
lower.bound <- quantile(boot_preds, 0.025)
upper.bound <- quantile(boot_preds, 0.975)

print(paste0("The Bootstrapped 95% CI is {", lower.bound, ", ", upper.bound, "}"))

[1] "The Bootstrapped 95% CI is {-115.093618368173, 496.246422273728}"
```

(d) Non-Parallel Lines Model: Sample

```
mod.coarsen2 <- lm(PTS ~ Age + Position + Age*Position, data = nba_2023)
mod.coarsen2
```

```
Call:
lm(formula = PTS ~ Age + Position + Age * Position, data = nba_2023)
```

Coefficients:

(Intercept)	Age	PositionForward
-875.077	46.538	13.653
PositionGuard	Age:PositionForward	Age:PositionGuard
1427.339	8.832	-39.879

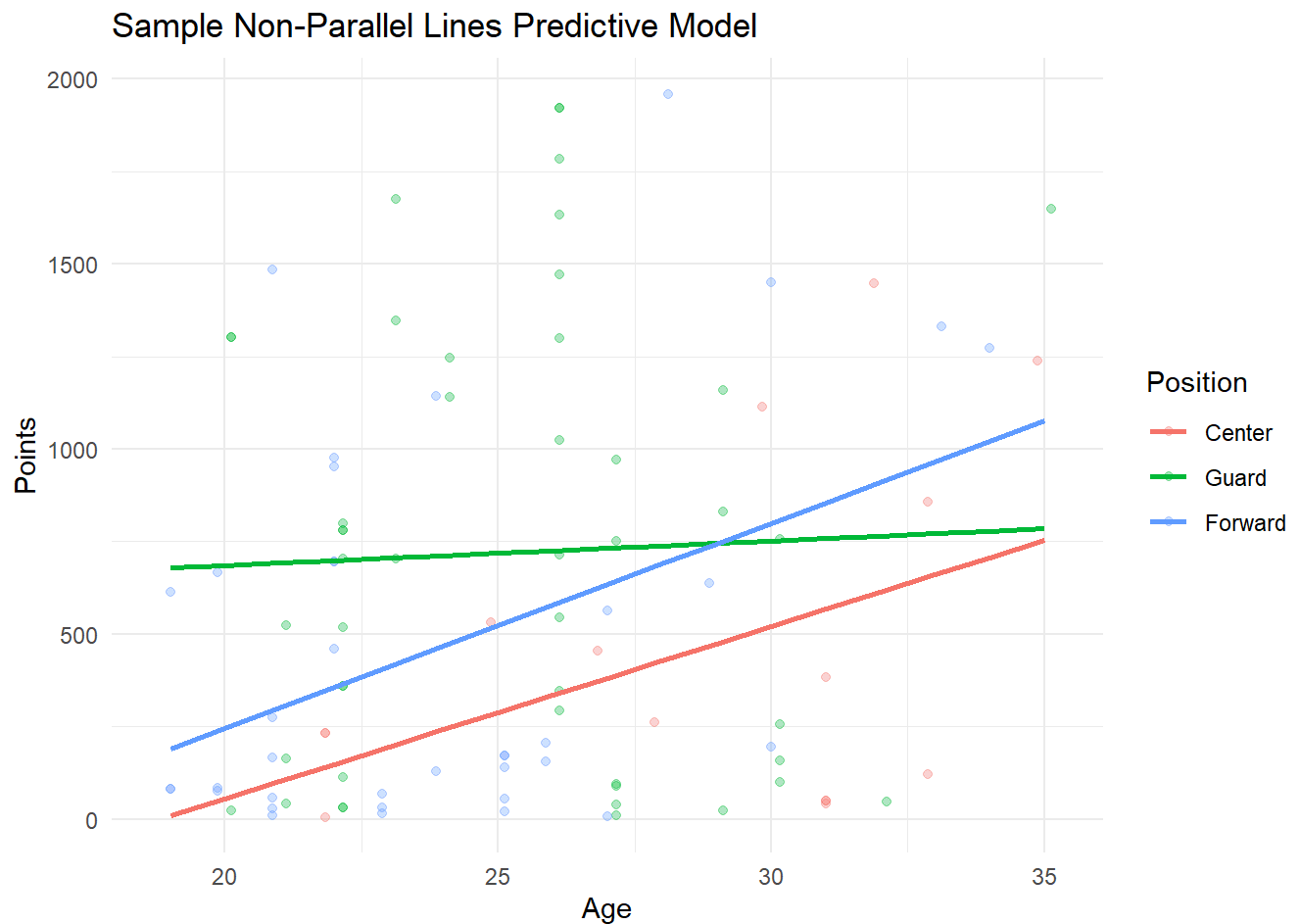
```
age_seq <- seq(min(nba_2023$Age), max(nba_2023$Age), by = 1)

pred_data <- expand.grid(
  Age = age_seq,
  Position = c(0, 1, 2))

pred_data$Position <- factor(pred_data$Position,
  levels = c(0, 1, 2),
  labels = c("Center", "Guard", "Forward"))

pred_data$predicted_PTS <- predict(mod.coarsen2, newdata = pred_data)

ggplot() +
  geom_point(data = nba_2023, aes(x = Age, y = PTS, color = Position),
    alpha = 0.3, position=position_dodge(width=0.5)) +
  geom_line(data = pred_data, aes(x = Age, y = predicted_PTS,
    color = Position), size = 1) +
  labs(
    title = "Sample Non-Parallel Lines Predictive Model",
    x = "Age",
    y = "Points",
    color = "Position"
  ) +
  theme_minimal()
```



(e) Non-Parallel Lines Bootstrap: Sample

```
set.seed(42)

B <- 10000

boot_preds <- numeric(B)

for (b in 1:B) {
  boot_sample <- nba_2023[sample(1:nrow(nba_2023), replace = TRUE), ]

  boot_mod <- lm(PTS ~ Age + Position + Age*Position, data = boot_sample)

  boot_preds[b] <- predict(boot_mod,
                           newdata = data.frame(Age = 20,
                                                  Position = "Center"))
}

boot_ci <- quantile(boot_preds, probs = c(0.025, 0.975))
boot_ci
```

	2.5%	97.5%
boot_ci	-254.9305	368.3993

(f) Additive Model: Sample

```
mod.coarsen3 <- lm(PTS ~ factor(Age) + factor(Position), data = nba_2023)
mod.coarsen3
```

Call:

```
lm(formula = PTS ~ factor(Age) + factor(Position), data = nba_2023)
```

Coefficients:

(Intercept)	factor(Age)20	factor(Age)21
220.15	239.47	-4.80
factor(Age)22	factor(Age)23	factor(Age)24
146.81	304.30	578.72
factor(Age)25	factor(Age)26	factor(Age)27
-70.97	635.02	-26.36
factor(Age)28	factor(Age)29	factor(Age)30
870.76	288.37	234.32
factor(Age)31	factor(Age)32	factor(Age)33
-89.15	430.56	536.79
factor(Age)34	factor(Age)35	factor(Position)Forward
1013.67	1127.06	39.19
factor(Position)Guard		
192.59		

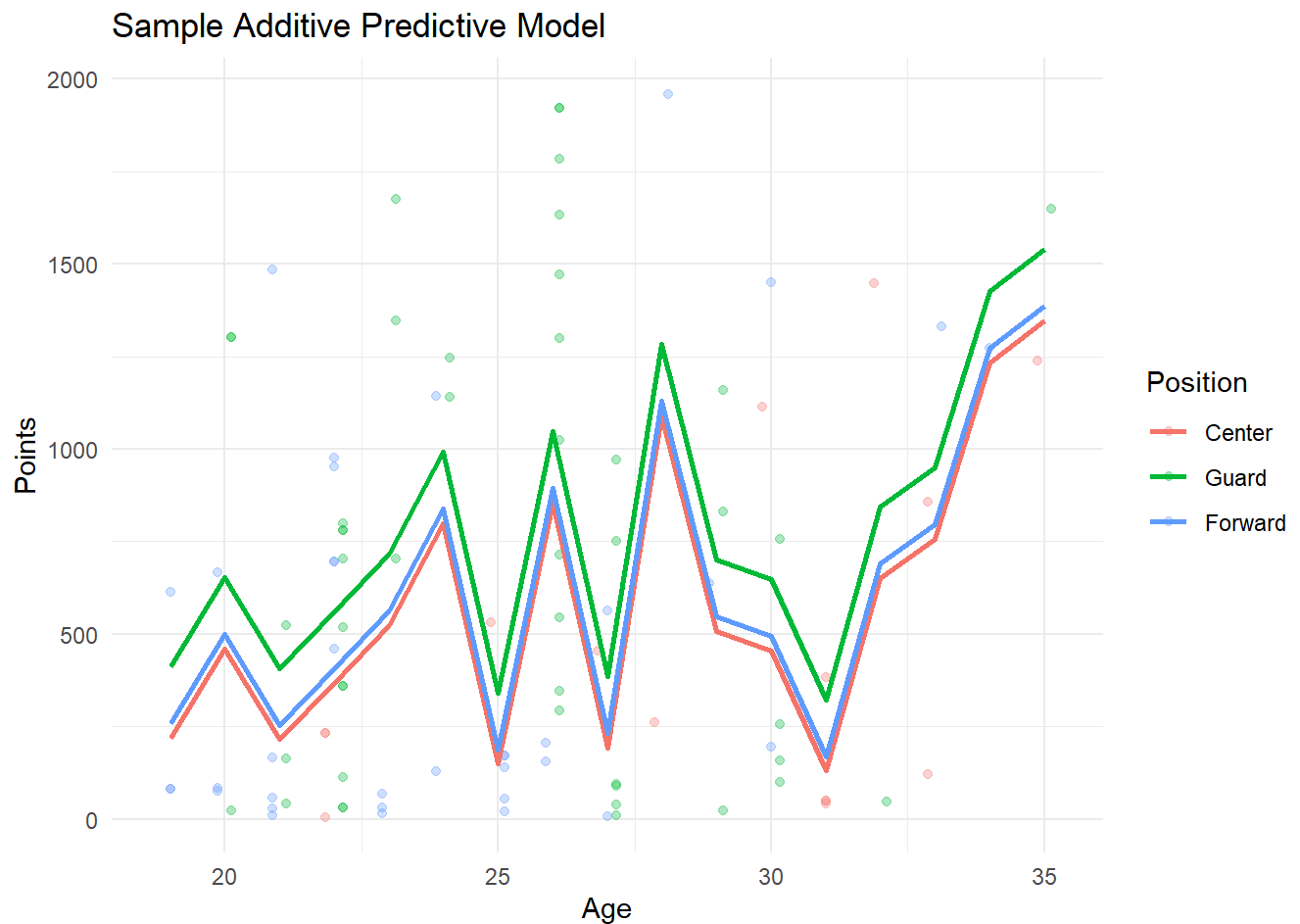
```
age_seq <- seq(min(nba_2023$Age), max(nba_2023$Age), by = 1)
```

```
pred_data <- expand.grid(
  Age = age_seq,
  Position = c(0, 1, 2))
```

```
pred_data$Position <- factor(pred_data$Position,
                             levels = c(0, 1, 2),
                             labels = c("Center", "Guard", "Forward"))
```

```
pred_data$predicted_PTS <- predict(mod.coarsen3, newdata = pred_data)
```

```
ggplot() +
  geom_point(data = nba_2023, aes(x = Age, y = PTS, color = Position),
            alpha = 0.3, position=position_dodge(width=0.5)) +
  geom_line(data = pred_data, aes(x = Age, y = predicted_PTS,
                                color = Position), size = 1) +
  labs(
    title = "Sample Additive Predictive Model",
    x = "Age",
    y = "Points",
    color = "Position"
  ) +
  theme_minimal()
```

(g) Additive Bootstrap: Sample

```
set.seed(42)

B <- 10000

boot_preds <- numeric(B)

for (b in 1:B) {
  boot_sample <- nba_2023[sample(1:nrow(nba_2023), replace = TRUE), ]

  if (any(boot_sample$Age == 20)) {
    boot_mod <- lm(PTS ~ factor(Age) + factor(Position), data = boot_sample)

    boot_preds[b] <- predict(boot_mod,
      newdata = data.frame(Age = 20, Position = "Center"))
  } else {
    boot_preds[b] <- NA
  }
}

boot_ci <- quantile(boot_preds, probs = c(0.025, 0.975), na.rm = TRUE)
boot_ci
```

2.5% 97.5%

-190.2244 1119.2791

Exercise #4 - Least Squares Regression Models: Population

```
nba_pop <- read.csv("C:/Users/13015/OneDrive - Emory University/Documents/Fall 2024/QTM
220/nba.data.csv")
```

```
nba_pop
```

	X	Player	POS	Team	Age	GP	W	L	Min	PTS
1	1	Jayson Tatum	SF	BOS	25	74	52	22	2732.2	2225
2	2	Joel Embiid	C	PHI	29	66	43	23	2284.1	2183
3	3	Luka Doncic	PG	DAL	24	66	33	33	2390.5	2138
4	4	Shai Gilgeous-Alexander	PG	OKC	24	68	33	35	2416.0	2135
5	5	Giannis Antetokounmpo	PF	MIL	28	63	47	16	2023.6	1959
6	6	Anthony Edwards	SG	MIN	21	79	40	39	2841.5	1946
7	7	Julius Randle	PF	NYK	28	77	44	33	2737.3	1936
8	8	Donovan Mitchell	SG	CLE	26	68	44	24	2432.4	1922
9	9	Trae Young	PG	ATL	24	73	38	35	2540.7	1914
10	10	Zach LaVine	SG	CHI	28	77	38	39	2767.9	1913
11	11	Damian Lillard	PG	POR	32	58	27	31	2106.6	1866
12	12	De'Aaron Fox	PG	SAC	25	73	44	29	2435.2	1826
13	13	DeMar DeRozan	SF	CHI	33	74	37	37	2681.6	1816
14	14	Jaylen Brown	SG	BOS	26	67	46	21	2404.9	1784
15	15	Pascal Siakam	PF	TOR	29	71	35	36	2652.0	1720
16	16	Lauri Markkanen	PF	UTA	25	66	32	34	2272.5	1691
17	17	Nikola Jokic	C	DEN	28	69	48	21	2323.0	1690
18	18	Jalen Green	SG	HOU	21	76	20	56	2602.2	1683
19	19	Jordan Poole	SG	GSW	23	82	44	38	2458.1	1675
20	20	Mikal Bridges	SF	BKN	26	83	42	41	2963.2	1671
21	21	Stephen Curry	PG	GSW	35	56	30	26	1941.2	1648
22	22	Jalen Brunson	PG	NYK	26	68	40	28	2378.7	1633
23	23	Kyrie Irving	PG	DAL	31	60	32	28	2240.6	1623
24	24	Ja Morant	PG	MEM	23	61	40	21	1948.3	1596
25	25	LeBron James	SF	LAL	38	55	30	25	1953.9	1590
26	26	CJ McCollum	SG	NOP	31	75	38	37	2649.2	1568
27	27	Bam Adebayo	C	MIA	25	75	40	35	2598.0	1529
28	28	Dejounte Murray	SG	ATL	26	74	38	36	2693.4	1515
29	29	Domantas Sabonis	PF	SAC	26	79	47	32	2735.6	1510
30	30	Klay Thompson	SG	GSW	33	69	38	31	2278.9	1509
31	31	Kristaps Porzingis	C	WAS	27	65	27	38	2119.5	1505
32	32	Darius Garland	PG	CLE	23	69	40	29	2447.2	1490
33	33	Franz Wagner	SF	ORL	21	80	33	47	2608.7	1485
34	34	Devin Booker	SG	PHX	26	53	34	19	1835.4	1471
35	35	Jimmy Butler	SF	MIA	33	64	35	29	2138.0	1466
36	36	Anthony Davis	PF	LAL	30	56	31	25	1904.5	1451
37	37	Nikola Vucevic	C	CHI	32	82	40	42	2746.4	1447
38	38	Paolo Banchero	PF	ORL	20	72	31	41	2429.7	1437
39	39	RJ Barrett	SG	NYK	22	73	40	33	2475.5	1431
40	40	Keldon Johnson	SF	SAS	23	63	17	46	2063.3	1385
41	41	Spencer Dinwiddie	PG	BKN	30	79	41	38	2725.3	1369
42	42	Kevin Durant	PF	PHX	34	47	34	13	1671.8	1366
43	43	Kyle Kuzma	SF	WAS	27	64	29	35	2238.9	1357
44	44	Tyler Herro	PG	MIA	23	67	37	30	2335.4	1347
45	45	Buddy Hield	SG	IND	30	80	35	45	2481.9	1344
46	46	Fred VanVleet	SG	TOR	29	69	34	35	2535.0	1335
47	47	Paul George	F	LAC	33	56	32	24	1938.9	1332
48	48	Terry Rozier	SG	CHA	29	63	19	44	2220.9	1329
49	49	Anfernee Simons	SG	POR	23	62	27	35	2170.7	1306
50	50	Bennedict Mathurin	SG	IND	20	78	33	45	2222.4	1302
51	51	Jamal Murray	PG	DEN	26	65	43	22	2133.4	1298
52	52	Jerami Grant	SF	POR	29	63	28	35	2245.5	1290
53	53	Jrue Holiday	PG	MIL	32	67	50	17	2182.5	1290
54	54	Evan Mobley	PF	CLE	21	79	48	31	2715.3	1277
55	55	Bojan Bogdanovic	SF	DET	34	59	15	44	1892.9	1273
56	56	Jordan Clarkson	PG	UTA	30	61	30	31	1988.3	1271

57	57	D'Angelo Russell	PG	LAL	27	71	39	32	2304.1	1263
58	58	Josh Giddey	SG	OKC	20	76	34	42	2367.3	1260
59	59	Desmond Bane	SG	MEM	24	58	38	20	1841.5	1247
60	60	Brook Lopez	C	MIL	35	78	57	21	2372.5	1239
61	61	Kawhi Leonard	SF	LAC	31	52	33	19	1747.5	1239
62	62	Harrison Barnes	SF	SAC	30	82	48	34	2662.0	1230
63	63	Tyrese Maxey	PG	PHI	22	60	39	21	2015.8	1218
64	64	James Harden	SG	PHI	33	58	39	19	2135.0	1216
65	65	Immanuel Quickley	SG	NYK	23	81	47	34	2344.1	1209
66	66	Jaden Ivey	PG	DET	21	74	16	58	2304.3	1204
67	67	Deandre Ayton	C	PHX	24	67	36	31	2035.3	1203
68	68	Scottie Barnes	SF	TOR	21	77	38	39	2677.6	1179
69	69	Jaren Jackson Jr.	PF	MEM	23	63	41	22	1787.5	1173
70	70	Bradley Beal	SG	WAS	29	50	24	26	1672.9	1160
71	71	Tyrese Haliburton	PG	IND	23	56	28	28	1882.9	1160
72	72	Russell Westbrook	PG	LAC	34	73	36	37	2125.8	1159
73	73	Gary Trent Jr.	SG	TOR	24	66	31	35	2118.0	1148
74	74	Trey Murphy III	SG	NOP	22	79	39	40	2448.0	1148
75	75	P.J. Washington	PF	CHA	24	73	24	49	2379.6	1144
76	76	Kevin Huerter	SG	SAC	24	75	44	31	2202.8	1140
77	77	Kevin Porter Jr.	SG	HOU	22	59	18	41	2023.9	1130
78	78	O.G. Anunoby	SF	TOR	25	67	33	34	2385.7	1124
79	79	Jonas Valanciunas	C	NOP	30	79	40	39	1968.2	1115
80	80	Christian Wood	F	DAL	27	67	33	34	1738.4	1114
81	81	Myles Turner	C	IND	27	62	29	33	1825.2	1113
82	82	Brandon Ingram	SF	NOP	25	45	23	22	1538.1	1112
83	83	Aaron Gordon	PF	DEN	27	68	45	23	2055.1	1109
84	84	Alperen Sengun	C	HOU	20	75	18	57	2170.7	1109
85	85	Tobias Harris	PF	PHI	30	74	47	27	2435.9	1085
86	86	Michael Porter Jr.	SF	DEN	24	62	41	21	1797.9	1080
87	87	Saddiq Bey	SF	ATL	24	77	24	53	2128.7	1062
88	88	Jalen Williams	F	OKC	22	75	36	39	2275.6	1056
89	89	Dillon Brooks	SF	MEM	27	73	46	27	2214.3	1047
90	90	Malik Monk	SG	SAC	25	77	47	30	1719.2	1041
91	91	Kenyon Martin Jr.	F	HOU	22	82	22	60	2292.2	1039
92	92	De'Andre Hunter	SF	ATL	25	67	35	32	2125.6	1029
93	93	Malik Beasley	SG	LAL	26	81	45	36	2093.1	1025
94	94	Norman Powell	G	LAC	29	60	31	29	1567.1	1019
95	95	Tim Hardaway Jr.	SF	DAL	31	71	37	34	2152.2	1019
96	96	Derrick White	PG	BOS	28	82	57	25	2319.3	1017
97	97	Luguentz Dort	G	OKC	24	74	36	38	2272.4	1013
98	98	Jabari Smith Jr.	PF	HOU	19	79	21	58	2450.5	1010
99	99	Malcolm Brogdon	PG	BOS	30	67	46	21	1743.8	1000
100	100	Bobby Portis	F	MIL	28	70	47	23	1818.4	987
101	101	Keegan Murray	SF	SAC	22	80	47	33	2381.7	976
102	102	Kelly Oubre Jr.	SG	CHA	27	48	16	32	1547.5	972
103	103	Jarrett Allen	C	CLE	25	68	44	24	2220.1	969
104	104	Nic Claxton	C	BKN	24	76	41	35	2270.7	961
105	105	Jaden McDaniels	PF	MIN	22	79	41	38	2416.5	953
106	106	Rudy Gobert	C	MIN	30	70	34	36	2148.5	939
107	107	John Collins	PF	ATL	25	71	37	34	2129.6	931
108	108	Bruce Brown	SF	DEN	26	80	53	27	2279.5	923
109	109	Max Strus	SG	MIA	27	80	42	38	2272.0	923
110	110	Caris LeVert	SG	CLE	28	74	45	29	2237.3	897
111	111	Jakob Poeltl	C	TOR	27	72	26	46	1906.1	897
112	112	Tre Jones	PG	SAS	23	68	20	48	1983.7	875
113	113	Wendell Carter Jr.	C	ORL	24	57	26	31	1689.5	868
114	114	Mason Plumlee	C	LAC	33	79	28	51	2052.9	857
115	115	Eric Gordon	SG	LAC	34	69	25	44	1965.5	856
116	116	Kelly Olynyk	PF	UTA	32	68	28	40	1941.6	847
117	117	LaMelo Ball	PG	CHA	21	36	13	23	1267.8	838
118	118	Markelle Fultz	PG	ORL	24	60	29	31	1777.9	837
119	119	Austin Reaves	SG	LAL	24	64	35	29	1843.2	833
120	120	Patrick Williams	PF	CHI	21	82	40	42	2322.8	833
121	121	Dennis Schroder	PG	LAL	29	66	37	29	1985.9	830

122	122	Kentavious Caldwell-Pope	SG	DEN	30	76	51	25	2381.2	822
123	123	Tyus Jones	PG	MEM	26	80	51	29	1939.4	822
124	124	Corey Kispert	SF	WAS	24	74	31	43	2093.3	820
125	125	Chris Paul	PG	PHX	37	59	33	26	1888.6	819
126	126	Ivica Zubac	C	LAC	26	76	43	33	2169.4	818
127	127	Quentin Grimes	SG	NYK	22	71	41	30	2120.9	799
128	128	Mike Conley	PG	MIN	35	67	34	33	2028.1	798
129	129	Onyeka Okongwu	PF	ATL	22	80	41	39	1848.6	791
130	130	Shaedon Sharpe	SG	POR	19	80	32	48	1778.6	789
131	131	Killian Hayes	PG	DET	21	76	16	60	2153.6	786
132	132	Cole Anthony	PG	ORL	22	60	28	32	1551.8	781
133	133	Naz Reid	C	MIN	23	68	32	36	1250.9	781
134	134	De'Anthony Melton	SG	PHI	24	77	50	27	2149.8	780
135	135	Clint Capela	C	ATL	28	65	35	30	1730.1	779
136	136	Tari Eason	F	HOU	21	82	22	60	1767.2	760
137	137	Bogdan Bogdanovic	SG	ATL	30	54	27	27	1508.6	756
138	138	Jalen McDaniels	PF	PHI	25	80	31	49	1912.9	755
139	139	Zion Williamson	PF	NOP	22	29	17	12	956.1	754
140	140	Grayson Allen	SG	MIL	27	72	53	19	1972.1	750
141	141	Josh Hart	SG	NYK	28	76	42	34	2454.0	743
142	142	Aaron Nesmith	SF	IND	23	73	30	43	1816.4	738
143	143	Gordon Hayward	SF	CHA	33	50	20	30	1576.9	733
144	144	Zach Collins	PF	SAS	25	63	20	43	1440.6	731
145	145	Marcus Morris Sr.	SF	LAC	33	65	35	30	1825.1	728
146	146	Coby White	PG	CHI	23	74	37	37	1730.2	715
147	147	Terance Mann	SG	LAC	26	81	44	37	1872.2	713
148	148	Chris Boucher	PF	TOR	30	76	39	37	1523.5	712
149	149	Andrew Nembhard	PG	IND	23	75	32	43	2073.5	709
150	150	Rui Hachimura	PF	LAL	25	63	38	25	1466.0	707
151	151	Daniel Gafford	C	WAS	24	78	32	46	1604.2	705
152	152	Jaylen Nowell	SG	MIN	23	65	34	31	1251.7	704
153	153	Devin Vassell	SG	SAS	22	38	12	26	1178.1	703
154	154	Marcus Smart	PG	BOS	29	61	43	18	1956.8	703
155	155	Naji Marshall	SF	NOP	25	77	40	37	1792.0	698
156	156	Talen Horton-Tucker	SG	UTA	22	65	30	35	1313.2	698
157	157	Deni Avdija	SF	WAS	22	76	33	43	2020.4	697
158	158	Santi Aldama	PF	MEM	22	77	47	30	1681.7	696
159	159	Jusuf Nurkic	C	POR	28	52	24	28	1391.4	694
160	160	Reggie Jackson	PG	DEN	33	68	36	32	1656.9	693
161	161	Isaiah Joe	SG	OKC	23	73	36	37	1395.3	691
162	162	Ayo Dosunmu	SG	CHI	23	80	40	40	2097.6	687
163	163	Collin Sexton	PG	UTA	24	48	24	24	1145.2	685
164	164	Caleb Martin	SF	MIA	27	71	38	33	2077.7	683
165	165	Walker Kessler	C	UTA	21	74	34	40	1703.2	679
166	166	Donte DiVincenzo	SG	GSW	26	72	42	30	1894.4	678
167	167	Malaki Branham	G	SAS	19	66	15	51	1549.6	673
168	168	Royce O'Neale	PF	BKN	29	76	42	34	2409.2	671
169	169	Cedi Osman	SF	CLE	28	77	48	29	1548.3	669
170	170	Jonathan Kuminga	PF	GSW	20	67	38	29	1394.4	666
171	171	Bones Hyland	PG	LAC	22	56	36	20	1085.5	659
172	172	Doug McDermott	SF	SAS	31	64	19	45	1314.2	654
173	173	Josh Richardson	SG	NOP	29	65	24	41	1529.6	654
174	174	Lonnie Walker IV	G	LAL	24	56	27	29	1297.0	654
175	175	Alec Burks	SG	DET	31	51	12	39	1122.4	652
176	176	Jevon Carter	PG	MIL	27	81	57	24	1811.8	651
177	177	Cameron Johnson	SF	BKN	27	42	25	17	1199.8	650
178	178	T.J. McConnell	PG	IND	31	75	31	44	1526.4	650
179	179	Herbert Jones	SF	NOP	24	66	31	35	1950.5	649
180	180	Keita Bates-Diop	SF	SAS	27	67	18	49	1452.6	647
181	181	Kyle Anderson	SF	MIN	29	69	36	33	1956.6	647
182	182	Jalen Smith	PF	IND	23	68	31	37	1278.8	642
183	183	Gabe Vincent	PG	MIA	26	68	37	31	1758.7	641
184	184	Grant Williams	PF	BOS	24	79	55	24	2044.8	641
185	185	AJ Griffin	F	ATL	19	72	34	38	1401.4	639
186	186	Georges Niang	SF	PHI	29	78	51	27	1511.8	637

187	187	Shake Milton	SG	PHI	26	76	52	24	1567.4	637
188	188	Monte Morris	PG	WAS	27	62	28	34	1696.1	636
189	189	Bol Bol	C	ORL	23	70	26	44	1505.4	634
190	190	Andrew Wiggins	SF	GSW	28	37	19	18	1190.3	633
191	191	Jarred Vanderbilt	PF	LAL	24	78	43	35	1879.7	619
192	192	Draymond Green	PF	GSW	33	73	41	32	2297.6	617
193	193	Al Horford	C	BOS	36	63	44	19	1921.4	616
194	194	Kyle Lowry	PG	MIA	37	55	30	25	1717.7	615
195	195	Jeremy Sochan	F	SAS	19	56	15	41	1457.7	614
196	196	Jalen Duren	C	DET	19	67	16	51	1670.1	612
197	197	Cam Thomas	SG	BKN	21	57	30	27	947.6	604
198	198	Damion Lee	SG	PHX	30	74	40	34	1506.3	604
199	199	Karl-Anthony Towns	C	MIN	27	29	15	14	957.0	602
200	200	Moritz Wagner	C	ORL	26	57	27	30	1109.5	600
201	201	Torrey Craig	SF	PHX	32	79	44	35	1947.8	588
202	202	Thomas Bryant	C	DEN	25	59	33	26	1081.5	579
203	203	Kevon Looney	F	GSW	27	82	44	38	1957.6	578
204	204	Isaiah Stewart	C	DET	21	50	12	38	1414.1	567
205	205	Joe Harris	SF	BKN	31	74	40	34	1527.2	562
206	206	Trey Lyles	PF	SAC	27	74	43	31	1247.2	562
207	207	Reggie Bullock	SF	DAL	32	78	37	41	2364.5	561
208	208	Seth Curry	SG	BKN	32	61	37	24	1210.7	561
209	209	Brandon Clarke	PF	MEM	26	56	32	24	1090.1	559
210	210	Dorian Finney-Smith	PF	BKN	29	66	31	35	2008.8	551
211	211	Jose Alvarado	PG	NOP	25	61	30	31	1310.0	550
212	212	Josh Green	SG	DAL	22	60	27	33	1539.2	546
213	213	Luke Kennard	SG	MEM	26	59	37	22	1315.1	546
214	214	Jordan Nwora	SF	IND	24	62	36	26	1188.1	542
215	215	Troy Brown Jr.	SF	LAL	23	76	40	36	1859.8	541
216	216	Devonte' Graham	PG	SAS	28	73	31	42	1338.4	539
217	217	Nick Richards	C	CHA	25	65	21	44	1217.7	532
218	218	Josh Okogie	SF	PHX	24	72	38	34	1350.6	529
219	219	Jalen Suggs	SG	ORL	21	53	20	33	1245.9	524
220	220	Hamidou Diallo	SG	DET	24	56	12	44	995.9	522
221	221	Terrence Ross	G	PHX	32	63	27	36	1330.5	522
222	222	Drew Eubanks	PF	POR	26	78	31	47	1583.7	518
223	223	Tre Mann	PG	OKC	22	67	31	36	1183.4	517
224	224	Sam Hauser	SF	BOS	25	80	55	25	1289.9	512
225	225	Kevin Love	PF	MIA	34	62	35	27	1239.5	509
226	226	Precious Achiuwa	PF	TOR	23	55	30	25	1140.5	508
227	227	Dwight Powell	C	DAL	31	76	37	39	1457.9	506
228	228	Marvin Bagley III	PF	DET	24	42	7	35	990.5	504
229	229	Khris Middleton	SF	MIL	31	33	25	8	800.8	497
230	230	Obi Toppin	PF	NYK	25	67	37	30	1050.5	497
231	231	Kendrick Nunn	G	WAS	27	70	30	40	963.4	496
232	232	Cameron Payne	PG	PHX	28	48	27	21	968.3	493
233	233	Taurean Prince	PF	MIN	29	54	31	23	1192.5	493
234	234	Isaac Okoro	SF	CLE	22	76	48	28	1652.6	490
235	235	Aaron Wiggins	SG	OKC	24	70	37	33	1297.4	479
236	236	Nicolas Batum	PF	LAC	34	78	44	34	1709.6	478
237	237	Dennis Smith Jr.	PG	CHA	25	54	19	35	1389.8	474
238	238	Ochai Agbaji	G	UTA	23	59	29	30	1209.2	467
239	239	David Roddy	F	MEM	22	70	44	26	1258.5	466
240	240	Pat Connaughton	SG	MIL	30	61	43	18	1442.7	466
241	241	Trendon Watford	PF	POR	22	62	26	36	1181.6	459
242	242	Jock Landale	C	PHX	27	69	35	34	978.5	456
243	243	Isaiah Jackson	SF	IND	21	63	24	39	1042.3	455
244	244	Davion Mitchell	PG	SAC	24	80	47	33	1447.0	450
245	245	James Wiseman	C	DET	22	45	11	34	867.2	450
246	246	Victor Oladipo	SG	MIA	30	42	23	19	1105.6	449
247	247	Larry Nance Jr.	PF	NOP	30	65	34	31	1380.8	441
248	248	Jeff Green	PF	DEN	36	56	33	23	1091.1	437
249	249	Mitchell Robinson	C	NYK	25	59	35	24	1588.8	435
250	250	Terence Davis	SG	SAC	25	64	38	26	841.0	431
251	251	Xavier Tillman	F	MEM	24	61	40	21	1180.1	429

252	252	Cory Joseph	PG	DET	31	62	12	50	1227.4	427
253	253	Kenrich Williams	SF	OKC	28	53	26	27	1206.0	425
254	254	Jaden Hardy	G	DAL	20	48	20	28	708.4	420
255	255	Anthony Lamb	F	GSW	25	62	36	26	1195.0	415
256	256	Kevin Knox II	SF	POR	23	63	12	51	951.7	415
257	257	Patrick Beverley	PG	CHI	34	67	34	33	1816.5	415
258	258	Jordan Goodwin	G	WAS	24	62	22	40	1105.4	407
259	259	Isaiah Hartenstein	C	NYK	24	82	47	35	1628.2	406
260	260	Andre Drummond	C	CHI	29	67	32	35	849.1	399
261	261	Oshae Brissett	SF	IND	24	65	27	38	1083.2	398
262	262	Gary Harris	SG	ORL	28	48	22	26	1184.4	397
263	263	Jalen Johnson	SF	ATL	21	70	35	35	1041.6	395
264	264	Cam Reddish	SF	POR	23	40	14	26	989.6	387
265	265	Mark Williams	C	CHA	21	43	18	25	828.0	387
266	266	John Wall	PG	LAC	32	34	15	19	754.7	386
267	267	Mike Muscala	C	BOS	31	63	32	31	945.1	383
268	268	Will Barton	G	TOR	32	56	27	29	993.0	379
269	269	Edmond Sumner	PG	BKN	27	53	33	20	736.2	378
270	270	Alex Caruso	SG	CHI	29	67	33	34	1575.4	374
271	271	Josh Christopher	SG	HOU	21	64	16	48	786.2	372
272	272	Wenyen Gabriel	F	LAL	26	68	37	31	1023.8	372
273	273	Delon Wright	SG	WAS	31	50	26	24	1221.2	369
274	274	JaMychal Green	F	GSW	32	57	30	27	796.7	366
275	275	Goran Dragic	PG	MIL	36	58	27	31	870.0	365
276	276	John Konchar	SG	MEM	27	72	45	27	1493.8	364
277	277	Nickeil Alexander-Walker	SG	MIN	24	59	29	30	883.9	363
278	278	Chris Duarte	SG	IND	25	46	19	27	897.2	362
279	279	Dario Saric	PF	OKC	29	57	26	31	806.0	362
280	280	Steven Adams	C	MEM	29	42	28	14	1133.3	361
281	281	Christian Braun	G	DEN	22	76	49	27	1181.1	360
282	282	Nassir Little	SF	POR	23	54	22	32	976.1	359
283	283	Isaiah Livers	PF	DET	24	52	10	42	1198.7	346
284	284	Landry Shamet	SG	PHX	26	40	19	21	806.9	346
285	285	Lamar Stevens	F	CLE	25	62	39	23	1120.5	328
286	286	Simone Fontecchio	F	UTA	27	52	25	27	765.8	328
287	287	Mo Bamba	C	LAL	24	49	25	24	768.4	323
288	288	Yuta Watanabe	SF	BKN	28	58	30	28	927.8	322
289	289	Chimezie Metu	PF	SAC	26	66	41	25	689.0	321
290	290	Montrezl Harrell	C	PHI	29	57	35	22	681.1	320
291	291	Derrick Jones Jr.	SF	CHI	26	64	29	35	893.4	319
292	292	Joe Ingles	SG	MIL	35	46	32	14	1043.5	317
293	293	T.J. Warren	SF	PHX	29	42	26	16	686.7	314
294	294	Ty Jerome	SG	GSW	25	45	22	23	815.6	309
295	295	Moses Moody	SG	GSW	20	63	37	26	817.1	302
296	296	R.J. Hampton	PG	DET	22	47	9	38	749.6	302
297	297	Romeo Langford	SG	SAS	23	43	14	29	844.3	297
298	298	Vlatko Cancar	SF	DEN	26	60	38	22	889.0	297
299	299	Theo Maledon	PG	CHA	21	44	14	30	853.7	295
300	300	Matisse Thybulle	SG	POR	26	71	38	33	1200.4	293
301	301	Rudy Gay	SF	UTA	36	56	29	27	815.6	293
302	302	Jeremiah Robinson-Earl	PF	OKC	22	43	16	27	813.7	292
303	303	Ben Simmons	PG	BKN	26	42	24	18	1105.0	291
304	304	Kris Dunn	G	UTA	29	22	8	14	567.5	290
305	305	Jaylin Williams	F	OKC	20	49	23	26	914.2	288
306	306	Robert Covington	PF	LAC	32	48	20	28	778.6	288
307	307	Paul Reed	SF	PHI	23	69	44	25	755.2	287
308	308	Jae'Sean Tate	SF	HOU	27	31	7	24	677.5	283
309	309	Robert Williams III	C	BOS	25	35	24	11	823.5	279
310	310	Eugene Omoruyi	F	DET	26	40	10	30	645.3	278
311	311	Zeke Nnaji	PF	DEN	22	53	34	19	727.8	277
312	312	Aleksej Pokusevski	F	OKC	21	34	16	18	701.3	276
313	313	Payton Pritchard	PG	BOS	25	48	32	16	642.8	270
314	314	Danuel House Jr.	SF	PHI	29	56	38	18	807.0	268
315	315	Duncan Robinson	F	MIA	29	42	19	23	690.5	268
316	316	MarJon Beauchamp	F	MIL	22	52	34	18	701.4	266

317	317	P.J. Tucker	PF	PHI	37	75	48	27	1920.1	266
318	318	Bismack Biyombo	C	PHX	30	61	33	28	874.1	263
319	319	Sandro Mamukelashvili	PF	SAS	23	43	23	20	659.7	263
320	320	JT Thor	F	CHA	20	69	22	47	968.8	262
321	321	Willy Hernangomez	C	NOP	28	38	23	15	457.7	262
322	322	Luke Kornet	C	BOS	27	69	45	24	804.1	261
323	323	Garrison Mathews	SG	ATL	26	54	16	38	686.3	257
324	324	Austin Rivers	SG	MIN	30	52	25	27	1016.3	255
325	325	Ish Wainright	F	PHX	28	60	33	27	915.1	251
326	326	Aaron Holiday	G	ATL	26	63	32	31	845.3	247
327	327	Bryce McGowens	G	CHA	20	46	16	30	787.0	246
328	328	Malachi Flynn	PG	TOR	24	53	29	24	690.8	246
329	329	Patty Mills	PG	BKN	34	40	18	22	566.6	246
330	330	Duane Washington Jr.	PG	NYK	23	31	17	14	393.8	244
331	331	Thaddeus Young	PF	TOR	34	54	23	31	795.5	240
332	332	Cade Cunningham	PG	DET	21	12	3	9	400.2	239
333	333	Haywood Highsmith	F	MIA	26	54	28	26	969.4	236
334	334	Jaxson Hayes	C	NOP	22	47	22	25	610.1	233
335	335	George Hill	PG	IND	36	46	27	19	833.3	232
336	336	Day'Ron Sharpe	C	BKN	21	48	22	26	552.5	227
337	337	Dyson Daniels	G	NOP	20	59	33	26	1042.1	227
338	338	Daishen Nix	SG	HOU	21	57	15	42	914.4	226
339	339	Usman Garuba	PF	HOU	21	75	21	54	970.2	225
340	340	Darius Bazley	PF	PHX	22	43	19	24	616.2	224
341	341	Miles McBride	PG	NYK	22	64	36	28	760.2	222
342	342	Svi Mykhailiuk	SG	CHA	25	32	16	16	467.9	222
343	343	Maxi Kleber	PF	DAL	31	37	18	19	929.8	220
344	344	Jabari Walker	F	POR	20	56	21	35	619.2	216
345	345	Lindy Waters III	F	OKC	25	41	20	21	530.8	214
346	346	Ziaire Williams	F	MEM	21	37	21	16	560.8	210
347	347	Davis Bertans	SF	DAL	30	45	20	25	491.8	206
348	348	Dean Wade	PF	CLE	26	44	30	14	891.6	206
349	349	Justin Holiday	SF	DAL	34	46	18	28	706.1	205
350	350	Charles Bassey	C	SAS	22	35	9	26	507.9	199
351	351	DeAndre Jordan	C	DEN	34	39	23	16	585.9	199
352	352	Dewayne Dedmon	C	PHI	33	38	23	15	426.2	199
353	353	Justise Winslow	PF	POR	27	29	15	14	775.8	196
354	354	Anthony Gill	PF	WAS	30	59	21	38	624.6	195
355	355	Caleb Houston	G	ORL	20	51	20	31	812.2	193
356	356	Ousmane Dieng	F	OKC	19	39	20	19	568.7	193
357	357	James Bouknight	SG	CHA	22	34	9	25	515.5	191
358	358	Keon Johnson	SG	POR	21	40	13	27	416.4	189
359	359	JaVale McGee	C	DAL	35	42	20	22	354.5	186
360	360	Blake Wesley	G	SAS	20	37	9	28	669.1	184
361	361	Rodney McGruder	G	DET	31	32	4	28	523.9	183
362	362	Christian Koloko	C	TOR	22	58	29	29	801.8	182
363	363	Luka Garza	C	MIN	24	28	15	13	243.4	181
364	364	Wesley Matthews	SG	MIL	36	52	37	15	820.4	179
365	365	Jericho Sims	C	NYK	24	52	31	21	812.4	178
366	366	Stanley Johnson	SF	SAS	26	30	5	25	469.5	174
367	367	Amir Coffey	SG	LAC	25	50	26	24	625.3	172
368	368	Isaiah Roby	F	NYK	25	42	9	33	473.6	172
369	369	Ricky Rubio	PG	CLE	32	33	23	10	566.0	171
370	370	Blake Griffin	PF	BOS	34	41	27	14	568.9	170
371	371	Taj Gibson	F	WAS	37	49	21	28	480.4	168
372	372	Goga Bitadze	C	ORL	23	38	13	25	456.8	167
373	373	Evan Fournier	SG	NYK	30	27	15	12	458.7	165
374	374	Javonte Green	SF	CHI	29	32	13	19	480.3	165
375	375	Julian Champagnie	F	SAS	21	17	7	10	320.1	165
376	376	Johnny Davis	G	WAS	21	28	10	18	422.6	163
377	377	Jordan McLaughlin	PG	MIN	27	43	22	21	678.5	161
378	378	Kai Jones	PF	CHA	22	46	13	33	549.6	157
379	379	Raul Neto	PG	CLE	30	48	31	17	505.2	157
380	380	Admiral Schofield	SF	ORL	26	37	14	23	451.3	155
381	381	Juan Toscano-Anderson	SF	UTA	30	52	19	33	700.1	155

382	382	Moses Brown	C	BKN	23	36	17	19	294.1	155
383	383	AJ Green	G	MIL	23	35	27	8	344.9	154
384	384	Bruno Fernando	PF	ATL	24	39	13	26	405.1	153
385	385	Derrick Rose	PG	NYK	34	27	12	15	337.9	152
386	386	Saben Lee	G	PHX	23	25	15	10	373.5	151
387	387	TyTy Washington Jr.	G	HOU	21	31	6	25	432.7	145
388	388	Brandon Boston Jr.	SG	LAC	21	22	9	13	248.3	143
389	389	Dalano Banton	PG	TOR	23	31	17	14	278.5	142
390	390	Damian Jones	C	UTA	27	41	12	29	477.4	142
391	391	Kevon Harris	G	ORL	25	34	12	22	457.0	141
392	392	Furkan Korkmaz	SG	PHI	25	37	24	13	353.5	140
393	393	Nathan Knight	F	MIN	25	38	19	19	290.7	139
394	394	Frank Ntilikina	PG	DAL	24	47	20	27	607.6	135
395	395	Markieff Morris	PF	DAL	33	35	17	18	355.1	132
396	396	Richaun Holmes	F	SAC	29	42	22	20	347.6	130
397	397	Chuma Okeke	PF	ORL	24	27	8	19	518.0	128
398	398	Max Christie	G	LAL	20	41	19	22	512.4	128
399	399	Udoka Azubuike	C	UTA	23	36	17	19	358.5	125
400	400	Jae Crowder	PF	MIL	32	18	13	5	339.7	124
401	401	Juancho Hernangomez	PF	TOR	27	42	20	22	613.5	122
402	402	Matt Ryan	F	MIN	26	34	15	19	310.2	122
403	403	Patrick Baldwin Jr.	F	GSW	20	31	15	16	225.8	122
404	404	Gorgui Dieng	C	SAS	33	31	3	28	358.1	121
405	405	Kenneth Lofton Jr.	F	MEM	20	24	15	9	176.0	120
406	406	Orlando Robinson	C	MIA	22	31	18	13	425.1	116
407	407	Kira Lewis Jr.	PG	NOP	22	25	11	14	234.8	114
408	408	McKinley Wright IV	PG	DAL	24	27	14	13	335.0	114
409	409	Robin Lopez	C	CLE	35	37	25	12	298.5	112
410	410	Dominick Barlow	F	SAS	19	28	5	23	407.6	110
411	411	Ish Smith	PG	DEN	34	43	25	18	397.9	108
412	412	Jake LaRavia	F	MEM	21	35	22	13	414.3	105
413	413	Boban Marjanovic	C	HOU	34	31	7	24	171.1	102
414	414	Gary Payton II	SG	GSW	30	22	13	9	367.6	101
415	415	Kessler Edwards	SF	SAC	22	36	17	19	385.8	100
416	416	Cody Zeller	C	MIA	30	15	6	9	216.6	98
417	417	Jamal Cain	F	MIA	24	18	10	8	240.0	98
418	418	Theo Pinson	G	DAL	27	40	19	21	323.0	95
419	419	Skylar Mays	SG	POR	25	6	1	5	188.8	92
420	420	Bryn Forbes	SG	MIN	29	25	9	16	267.7	89
421	421	Davon Reed	SG	LAL	27	43	29	14	342.5	89
422	422	Frank Kaminsky	PF	HOU	30	36	13	23	234.9	89
423	423	Terry Taylor	F	CHI	23	31	13	18	263.4	89
424	424	Johnny Juzang	G	UTA	22	18	6	12	232.3	87
425	425	Dalen Terry	F	CHI	20	38	19	19	213.9	85
426	426	David Duke Jr.	G	BKN	23	23	10	13	228.0	85
427	427	Nikola Jovic	F	MIA	19	15	7	8	204.5	82
428	428	Kennedy Chandler	G	MEM	20	36	22	14	281.5	78
429	429	Peyton Watson	F	DEN	20	23	13	10	186.1	75
430	430	Kemba Walker	PG	DAL	32	9	5	4	143.9	72
431	431	Luka Samanic	F	UTA	23	7	2	5	160.8	69
432	432	Serge Ibaka	F	MIL	33	16	11	5	185.4	66
433	433	Danny Green	F	CLE	35	11	6	5	138.7	61
434	434	Jeff Dowtin Jr.	PG	TOR	25	25	17	8	258.7	61
435	435	Moussa Diabate	F	LAC	21	22	10	12	195.5	59
436	436	Mamadi Diakite	F	CLE	26	22	15	7	175.9	57
437	437	A.J. Lawson	G	DAL	22	15	5	10	108.3	56
438	438	Quenton Jackson	G	WAS	24	9	3	6	134.6	56
439	439	Jonathan Isaac	PF	ORL	25	11	8	3	124.0	55
440	440	Jeenathan Williams	G	POR	24	5	1	4	126.6	53
441	441	Trent Forrest	G	ATL	24	23	9	14	277.0	52
442	442	James Johnson	PF	IND	36	18	7	11	162.4	51
443	443	Jay Huff	C	WAS	25	7	2	5	94.9	51
444	444	Thanasis Antetokounmpo	SF	MIL	30	37	25	12	206.2	51
445	445	Garrett Temple	SF	NOP	36	25	16	9	161.8	50
446	446	Lindell Wigginton	G	MIL	25	7	4	3	86.7	50

447	447	Daniel Theis	C	IND	31	7	1	6	108.8	49
448	448	Matthew Dellavedova	PG	SAC	32	32	19	13	212.8	47
449	449	Josh Minott	F	MIN	20	15	7	8	96.2	46
450	450	KZ Okpala	SF	SAC	24	35	19	16	248.0	46
451	451	Jared Rhoden	G	DET	23	14	2	12	197.9	45
452	452	John Butler Jr.	F	POR	20	19	4	15	221.1	45
453	453	Dru Smith	G	BKN	25	15	7	8	158.4	44
454	454	Jarrett Culver	G	ATL	24	10	5	5	136.9	44
455	455	Otto Porter Jr.	SF	TOR	29	8	4	4	146.3	44
456	456	Shaquille Harrison	G	LAL	29	5	1	4	119.9	44
457	457	Alex Len	C	SAC	29	26	15	11	161.2	43
458	458	Khem Birch	C	SAS	30	20	9	11	161.8	43
459	459	Meyers Leonard	C	MIL	31	9	6	3	113.7	43
460	460	Jaden Springer	G	PHI	20	16	13	3	89.3	42
461	461	Wendell Moore Jr.	G	MIN	21	29	16	13	152.7	42
462	462	Jason Preston	PG	LAC	23	14	4	10	123.8	41
463	463	Omer Yurtseven	C	MIA	24	9	5	4	83.2	40
464	464	Xavier Cooks	G	WAS	27	10	2	8	125.8	38
465	465	Jared Butler	SG	OKC	22	6	3	3	76.5	37
466	466	Olivier Sarr	C	OKC	24	9	5	4	113.6	36
467	467	Vit Krejci	G	ATL	22	29	15	14	165.4	36
468	468	Cody Martin	SF	CHA	27	7	2	5	133.7	35
469	469	Nerlens Noel	C	BKN	29	17	4	13	194.7	35
470	470	Isaiah Mobley	F	CLE	23	12	8	4	84.2	31
471	471	Vince Williams Jr.	G	MEM	22	15	7	8	104.6	30
472	472	Greg Brown III	PF	POR	21	16	10	6	93.1	28
473	473	Jordan Hall	G	SAS	21	9	1	8	82.7	28
474	474	Joshua Primo	SG	SAS	20	4	3	1	93.4	28
475	475	Udonis Haslem	PF	MIA	42	7	4	3	72.1	27
476	476	Ryan Arcidiacono	G	POR	29	20	9	11	172.4	26
477	477	Mac McClung	SG	PHI	24	2	2	0	41.1	25
478	478	Noah Vonleh	PF	BOS	27	23	17	6	171.6	25
479	479	Sam Merrill	SG	CLE	26	5	4	1	58.5	25
480	480	Gabe York	G	IND	29	3	1	2	55.8	24
481	481	Keon Ellis	G	SAC	23	16	7	9	70.9	24
482	482	Micah Potter	C	UTA	25	7	4	3	52.4	24
483	483	Ryan Rollins	G	GSW	20	12	5	7	62.1	23
484	484	Jarrell Brantley	PF	UTA	26	4	0	4	39.0	22
485	485	PJ Dozier	G	SAC	26	16	11	5	79.3	22
486	486	Jack White	F	DEN	25	17	13	4	66.0	21
487	487	Trevelin Queen	SG	IND	26	7	2	5	70.0	21
488	488	Tyrese Martin	G	ATL	24	16	10	6	65.5	21
489	489	Carlik Jones	G	CHI	25	7	4	3	56.0	20
490	490	Justin Jackson	SF	BOS	28	23	15	8	107.4	20
491	491	Louis King	SF	PHI	24	1	1	0	28.8	20
492	492	Ron Harper Jr.	F	TOR	23	9	6	3	47.5	20
493	493	JD Davison	SG	BOS	20	12	11	1	65.7	19
494	494	Tony Bradley	C	CHI	25	12	5	7	33.4	19
495	495	Andre Iguodala	F	GSW	39	8	3	5	112.6	17
496	496	Justin Minaya	F	POR	24	4	0	4	88.8	17
497	497	Michael Carter-Williams	G	ORL	31	4	1	3	44.5	17
498	498	Xavier Sneed	F	CHA	25	4	0	4	48.2	17
499	499	Buddy Boeheim	F	DET	23	10	2	8	90.1	16
500	500	RaiQuan Gray	F	BKN	23	1	0	1	35.1	16
501	501	Darius Days	F	HOU	23	4	0	4	25.0	15
502	502	Jamaree Bouyea	G	WAS	23	5	2	3	70.5	15
503	503	Scotty Pippen Jr.	G	LAL	22	6	1	5	31.5	14
504	504	Jay Scrubb	G	ORL	22	2	1	1	30.1	13
505	505	Neemias Queta	C	SAC	23	5	1	4	28.7	12
506	506	Justin Champagnie	SF	BOS	21	5	4	1	34.3	11
507	507	Facundo Campazzo	G	DAL	32	8	2	6	52.2	10
508	508	Lester Quinones	G	GSW	22	4	4	0	18.1	10
509	509	Cole Swider	F	LAL	23	7	2	5	41.1	9
510	510	Isaiah Todd	PF	WAS	21	6	2	4	61.4	9
511	511	Joe Wieskamp	SF	TOR	23	9	6	3	49.7	9

512	512	Kendall Brown	SG	IND	19	6	1	5	40.3	9
513	513	Trevor Hudgins	G	HOU	24	5	0	5	28.3	9
514	514	Tyler Dorsey	G	DAL	27	3	2	1	8.3	9
515	515	Alize Johnson	F	SAS	27	4	1	3	29.5	7
516	516	Chance Comanche	C	POR	27	1	0	1	20.8	7
517	517	Xavier Moon	PG	LAC	28	4	2	2	19.6	7
518	518	Leandro Bolmaro	F	UTA	22	14	8	6	68.5	6
519	519	Marko Simonovic	C	CHI	23	7	3	4	19.6	6
520	520	Mfiondu Kabengele	C	BOS	25	4	3	1	36.4	6
521	521	Vernon Carey Jr.	C	UTA	22	11	8	3	28.5	6
522	522	Dylan Windler	SG	CLE	26	3	3	0	10.4	5
523	523	Kobi Simmons	G	CHA	25	5	1	4	27.8	5
524	524	Malcolm Hill	F	CHI	27	5	4	1	9.2	5
525	525	Braxton Key	G	DET	26	3	0	3	9.1	4
526	526	Dereon Seabron	G	NOP	22	5	2	3	11.6	4
527	527	Donovan Williams	G	ATL	21	2	1	1	4.3	4
528	528	Devon Dotson	G	WAS	23	6	1	5	53.1	3
529	529	Jacob Gilyard	G	MEM	24	1	0	1	40.8	3
530	530	Jordan Schakel	F	WAS	24	2	0	2	6.2	3
531	531	Trevor Keels	G	NYK	19	3	3	0	8.0	3
532	532	Chima Moneke	F	SAC	27	2	1	1	7.9	2
533	533	Chris Silva	F	DAL	26	1	1	0	3.0	2
534	534	Stanley Umude	G	DET	24	1	0	1	2.1	2
535	535	Alondes Williams	N/A	BKN	23	1	1	0	5.3	0
536	536	Deonte Burton	N/A	SAC	29	2	1	1	6.5	0
537	537	Frank Jackson	N/A	UTA	24	1	0	1	5.0	0
538	538	Michael Foster Jr.	N/A	PHI	20	1	1	0	1.0	0
539	539	Sterling Brown	N/A	LAL	28	4	2	2	24.4	0

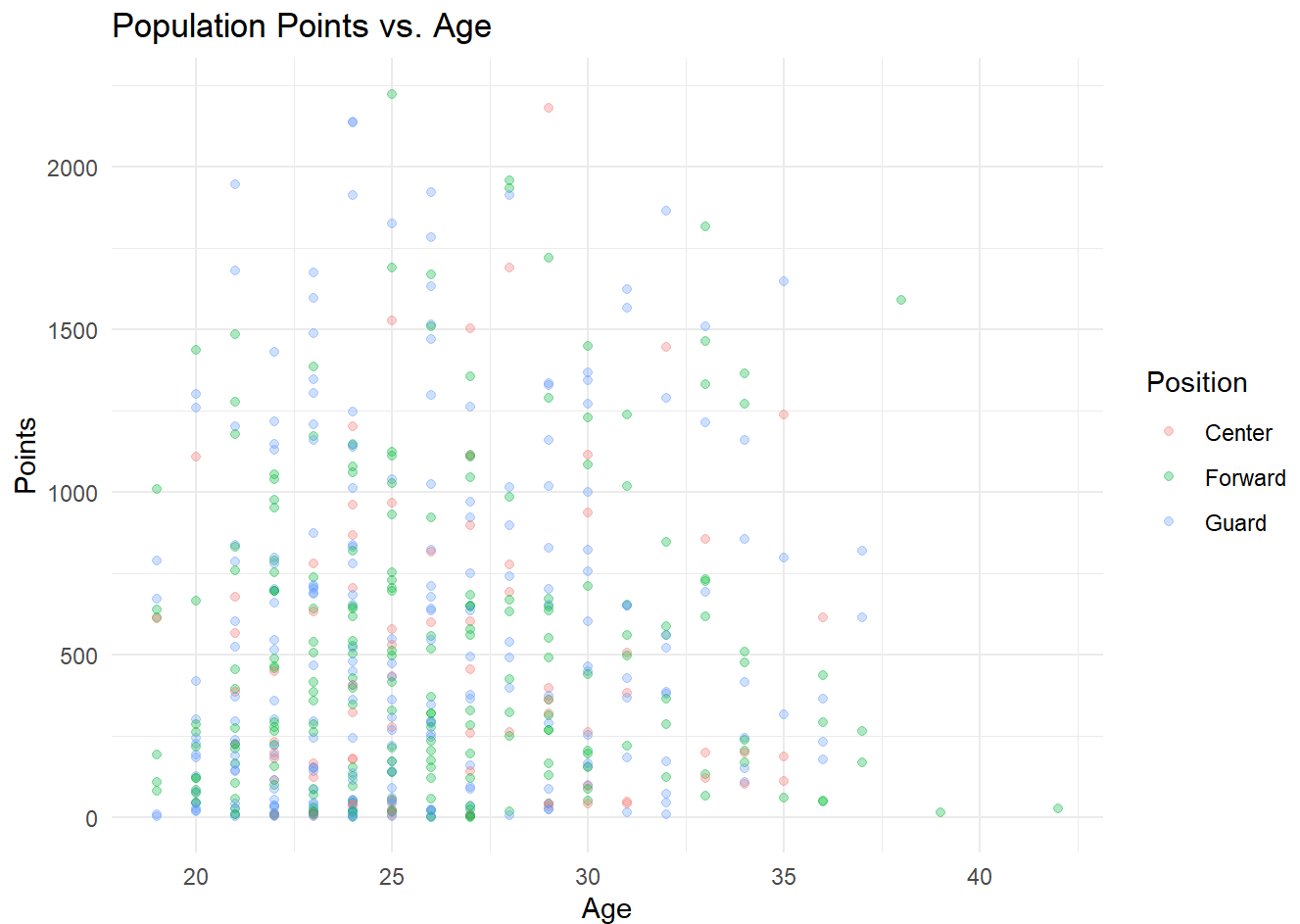
(a) Population Data Cleaning & Overview

```

nba_pop <- nba_pop %>%
  mutate(Position = case_when(
    POS == 'C' ~ 'Center',
    POS %in% c('SG','PG','G') ~ 'Guard',
    POS %in% c('SF','PF','F') ~ 'Forward')) %>%
  na.omit()

ggplot(nba_pop, aes(x = Age, y = PTS)) +
  geom_point(aes(x = Age, y = PTS,
                 color = factor(Position)),
            alpha = 0.3) +
  labs(
    title = "Population Points vs. Age",
    x = "Age",
    y = "Points",
    color = "Position") +
  theme_minimal()

```



(b) Parallel Lines Model: Population

```
mod.coarsen4 <- lm(PTS ~ Position + Age, data = nba_pop)
mod.coarsen4
```

```
Call:
lm(formula = PTS ~ Position + Age, data = nba_pop)
```

```
Coefficients:
  (Intercept) PositionForward PositionGuard      Age
    185.44         32.44         87.57    11.18
```

```
age_seq <- seq(min(nba_pop$Age), max(nba_pop$Age), by = 1)
```

```
pred_data <- expand.grid(
  Age = age_seq,
  Position = c(0, 1, 2))
```

```
pred_data$Position <- factor(pred_data$Position,
                             levels = c(0, 1, 2),
                             labels = c("Center", "Guard", "Forward"))
```

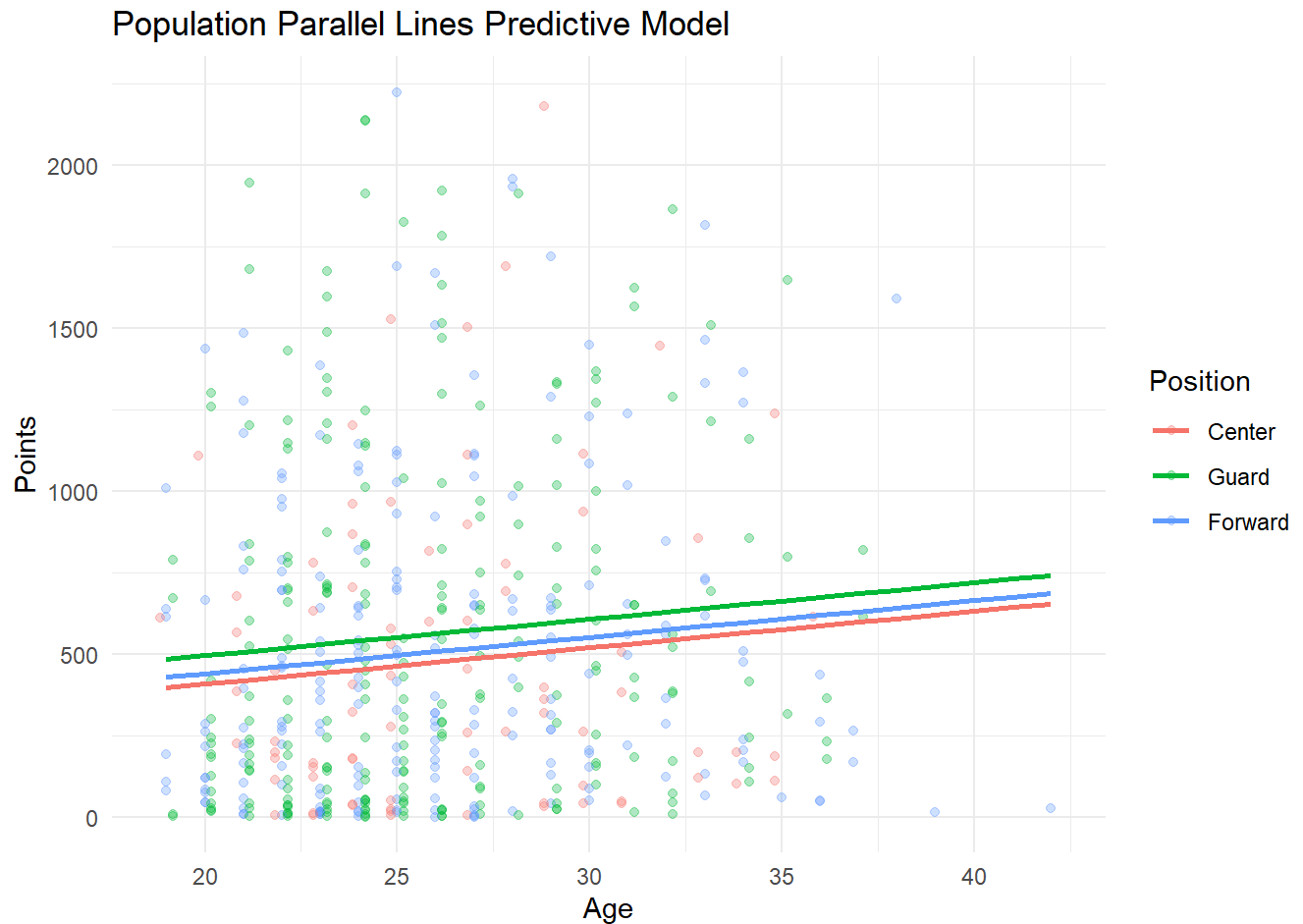
```
pred_data$predicted PTS <- predict(mod.coarsen4, newdata = pred_data)
```

```
ggplot() +
  geom_point(data = nba_pop, aes(x = Age, y = PTS, color = Position),
            alpha = 0.3, position=position_dodge(width=0.5)) +
  geom_line(data = pred_data, aes(x = Age, y = predicted PTS,
```

```

    color = Position), size = 1) +
  labs(
    title = "Population Parallel Lines Predictive Model",
    x = "Age",
    y = "Points",
    color = "Position"
  ) +
  theme_minimal()

```



Parallel Lines Bootstrap: Population

```

set.seed(42)

B <- 10000

boot_preds <- numeric(B)

for (b in 1:B) {
  boot_sample <- nba_pop[sample(1:nrow(nba_pop), replace = TRUE), ]

  boot_mod <- lm(PTS ~ Position + Age, data = boot_sample)

  boot_preds[b] <- predict(boot_mod,
    newdata = data.frame(Age = 20,
      Position = "Center"))
}

boot_ci <- quantile(boot_preds, probs = c(0.025, 0.975))
boot_ci

```

2.5% 97.5%
294.3205 528.8535

Sub-population Mean

```
mean(nba_pop$PTS[nba_pop$Position == "Center" & nba_pop$Age == 20], na.rm = TRUE)

[1] 1109
```

(c) Non-Parallel Lines Model: Population

```
mod.coarsen5 <- lm(PTS ~ Age + Position + Age*Position, data = nba_pop)
mod.coarsen5
```

```
Call:
lm(formula = PTS ~ Age + Position + Age * Position, data = nba_pop)
```

```
Coefficients:
      (Intercept)              Age      PositionForward
          298.518             6.929          -18.376
PositionGuard Age:PositionForward Age:PositionGuard
      -125.863             1.870             8.165
```

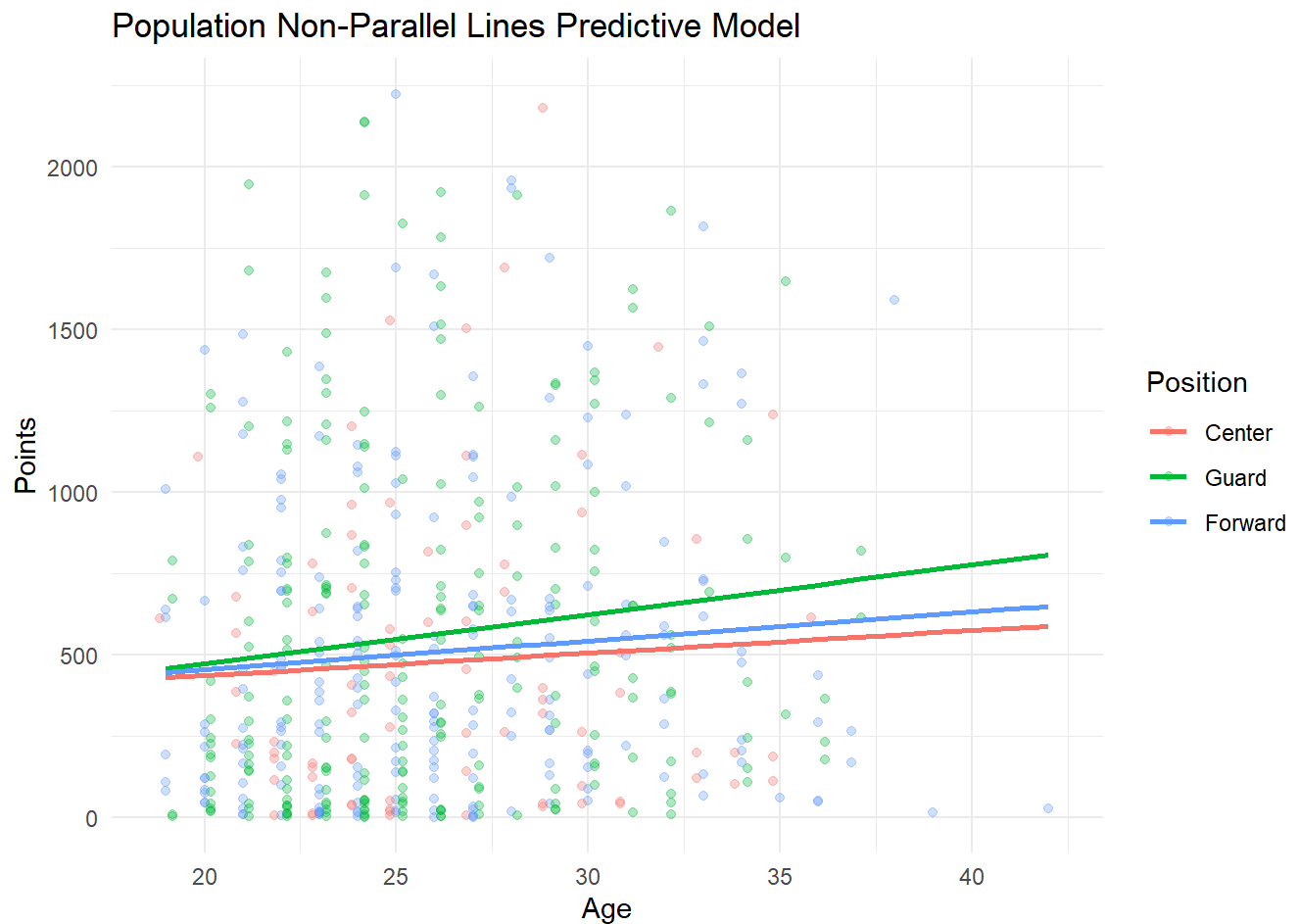
```
age_seq <- seq(min(nba_pop$Age), max(nba_pop$Age), by = 1)
```

```
pred_data <- expand.grid(
  Age = age_seq,
  Position = c(0, 1, 2))
```

```
pred_data$Position <- factor(pred_data$Position,
                             levels = c(0, 1, 2),
                             labels = c("Center", "Guard", "Forward"))
```

```
pred_data$predicted_PTS <- predict(mod.coarsen5, newdata = pred_data)
```

```
ggplot() +
  geom_point(data = nba_pop, aes(x = Age, y = PTS, color = Position),
            alpha = 0.3, position=position_dodge(width=0.5)) +
  geom_line(data = pred_data, aes(x = Age, y = predicted_PTS,
                                color = Position), size = 1) +
  labs(
    title = "Population Non-Parallel Lines Predictive Model",
    x = "Age",
    y = "Points",
    color = "Position"
  ) +
  theme_minimal()
```



Non-Parallel Lines Bootstrap: Population

```
set.seed(42)

B <- 10000

boot_preds <- numeric(B)

for (b in 1:B) {
  boot_sample <- nba_pop[sample(1:nrow(nba_pop), replace = TRUE), ]

  boot_mod <- lm(PTS ~ Age + Position + Age*Position, data = boot_sample)

  boot_preds[b] <- predict(boot_mod,
                           newdata = data.frame(Age = 20,
                                                  Position = "Center"))
}

boot_ci <- quantile(boot_preds, probs = c(0.025, 0.975))
boot_ci
```

2.5%	97.5%
271.2027	598.6814

Sub-population Mean

```
mean(nba_pop$PTS[nba_pop$Position == "Center" & nba_pop$Age == 20], na.rm = TRUE)
```

```
[1] 1109
```

(d) Additive Model: Population

```
mod.coarsen6 <- lm(PTS ~ factor(Age) + factor(Position), data = nba_pop)
mod.coarsen6
```

Call:

```
lm(formula = PTS ~ factor(Age) + factor(Position), data = nba_pop)
```

Coefficients:

(Intercept)	factor(Age)20	factor(Age)21
367.63	-99.75	57.65
factor(Age)22	factor(Age)23	factor(Age)24
11.34	39.51	101.95
factor(Age)25	factor(Age)26	factor(Age)27
74.47	147.31	89.37
factor(Age)28	factor(Age)29	factor(Age)30
365.23	141.06	168.93
factor(Age)31	factor(Age)32	factor(Age)33
163.21	115.39	404.33
factor(Age)34	factor(Age)35	factor(Age)36
67.99	204.29	-151.59
factor(Age)37	factor(Age)38	factor(Age)39
24.54	1176.65	-396.35
factor(Age)42	factor(Position)Forward	factor(Position)Guard
-386.35	45.72	103.94

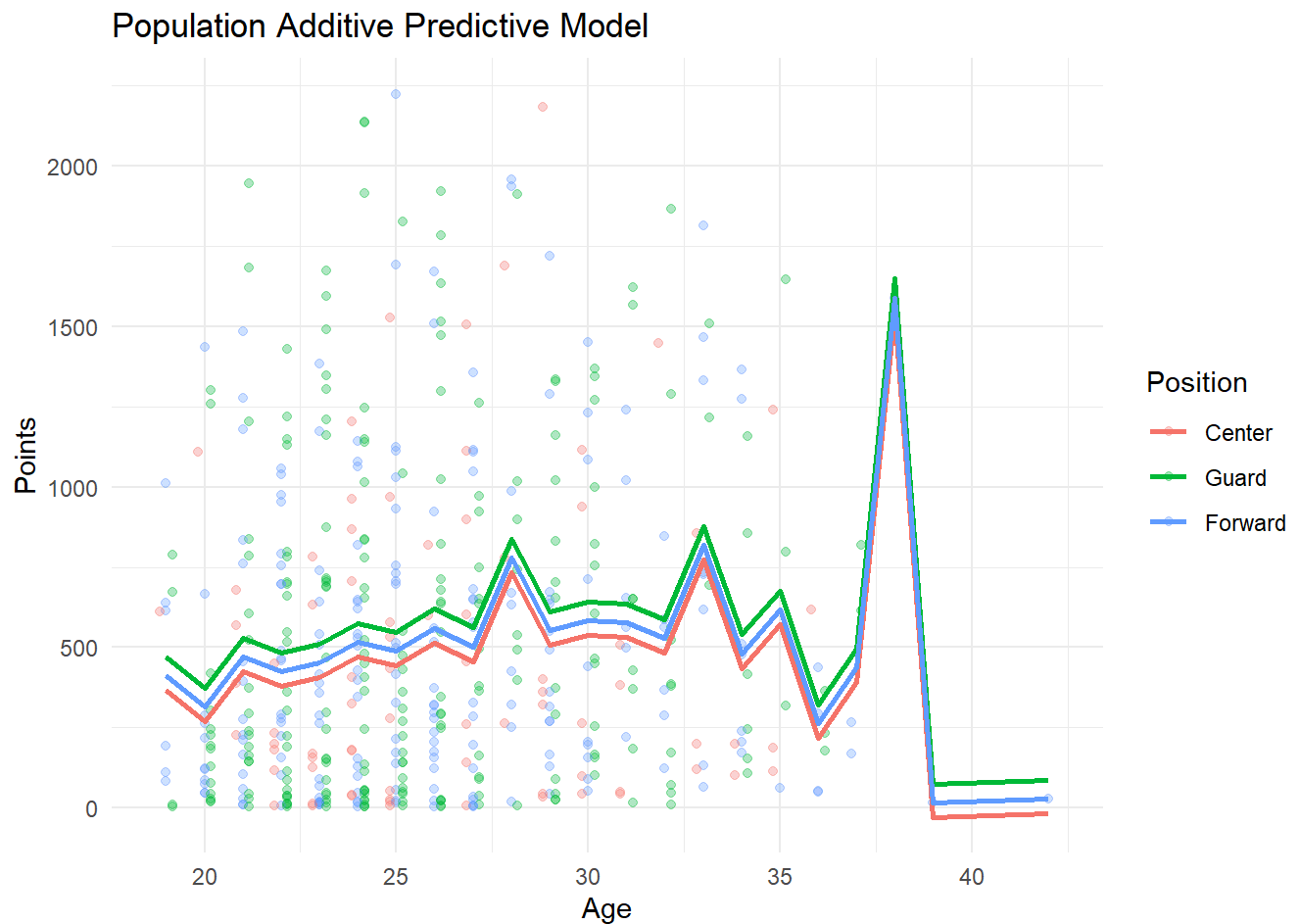
```
age_seq <- unique(nba_pop$Age)
```

```
pred_data <- expand.grid(
  Age = age_seq,
  Position = c(0, 1, 2))
```

```
pred_data$Position <- factor(pred_data$Position,
                             levels = c(0, 1, 2),
                             labels = c("Center", "Guard", "Forward"))
```

```
pred_data$predicted_PTS <- predict(mod.coarsen6, newdata = pred_data)
```

```
ggplot() +
  geom_point(data = nba_pop, aes(x = Age, y = PTS, color = Position),
            alpha = 0.3, position=position_dodge(width=0.5)) +
  geom_line(data = pred_data, aes(x = Age, y = predicted_PTS,
                                   color = Position), size = 1) +
  labs(
    title = "Population Additive Predictive Model",
    x = "Age",
    y = "Points",
    color = "Position"
  ) +
  theme_minimal()
```



Additive Model Bootstrap: Population

```
set.seed(42)

B <- 10000

boot_preds <- numeric(B)

for (b in 1:B) {
  boot_sample <- nba_pop[sample(1:nrow(nba_pop), replace = TRUE), ]

  if (any(boot_sample$Age == 20)) {
    boot_mod <- lm(PTS ~ factor(Age) + factor(Position), data = boot_sample)

    boot_preds[b] <- predict(boot_mod,
      newdata = data.frame(Age = 20, Position = "Center"))
  } else {
    boot_preds[b] <- NA
  }
}

boot_ci <- quantile(boot_preds, probs = c(0.025, 0.975), na.rm = TRUE)
boot_ci
```

2.5%	97.5%
68.6128	483.3128

Sub-population Mean

```
mean(nba_pop$PTS[nba_pop$Position == "Center" & nba_pop$Age == 20], na.rm = TRUE)
```

```
[1] 1109
```