

National Basketball Association (NBA) and 3-pointers

Final Project, DECS-922: *Data Exploration*, Winter 2019

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1 Introduction

In the 2018-2019 NBA regular season, we observed births of many new 3 pointers records. For example, Klay Thompson from the Golden State Warriors, made 14 3-pointers in Chicago last October. ([link](#)) James Harden, a key player from the Houston Rockets who is known for being deadly at making three pointers, created a record of second longest 30-point games streak, 32 games, in last February. This is the first record change after 1962. ([link](#)) Also, Klay Thompson mentioned earlier succeeded 10 consecutive 3-pointers in last Jan. ([link](#))

These observations made us interested in looking this phenomenon further, especially whether they are exceptions to the normal or they represent a shifting trend in how teams play in the NBA. Thus, we would like to answer the following questions to gain a better understanding how three pointer shooting has evolved since 1986 while taking into considerations of dimensions such as teams' standings, player age, other scoring methods in the game and a few other factors.

1.1 Methodology

To conduct the necessary analysis, we used detailed historical data from the nbastatR package. ([link](#)) This is a comprehensive open-source package that has additional tools to analyze the NBA data. Through some initial testing, we found that not all the tools are effective at helping us understand the questions regarding the three point shooting trend in the NBA and some of the additional functions in the NBA package are duplicated. However, we found the dataset to be helpful and sufficient to conduct the proposed research.

For additional data such as historical standings and salary information, that are not included in nbastatR package, we downloaded CSV files from Basketball-Reference.com ([link](#))

The data from nbastatR (`dataGameLogsPlayer` & `dataGameLogsTeam`) contain all the variables available so we trimmed the data by selecting relevant variables for analysis of each question.

1.2 Key questions

- It seems that players are getting better at making 3-pointers than 10 or 20 years ago (both on average across the league and also top 3-pointer shooters vs. top 3-pointer shooters) Is it true?
- Teams with more 3-pointers tend to be the better performing teams?
- Are there any relationship between players' ages and 3-pointers?
- Players who are good at 3-pointers are also good at 2-pointers or free throws?
- Players with high salaries are good at 3-pointers?
- We want to analyze whether players can drastically improve their three point shooting skills over time or the skill is rather something people are born with.
- Show the 3-pointer statistics geographically based on players' hometowns. Maybe this help illustrates the different basketball playing style across different regions, both domestic and international.
- We would like to explore the importance of three point shooters in a given team by measuring the share of the team's total salary over time.
- What are the expected average points of 3-pointers and 2-pointers?
- If the expected average point from 3-pointers is getting higher than that of 2-pointers, how should each team's strategy change?

2 Team level questions

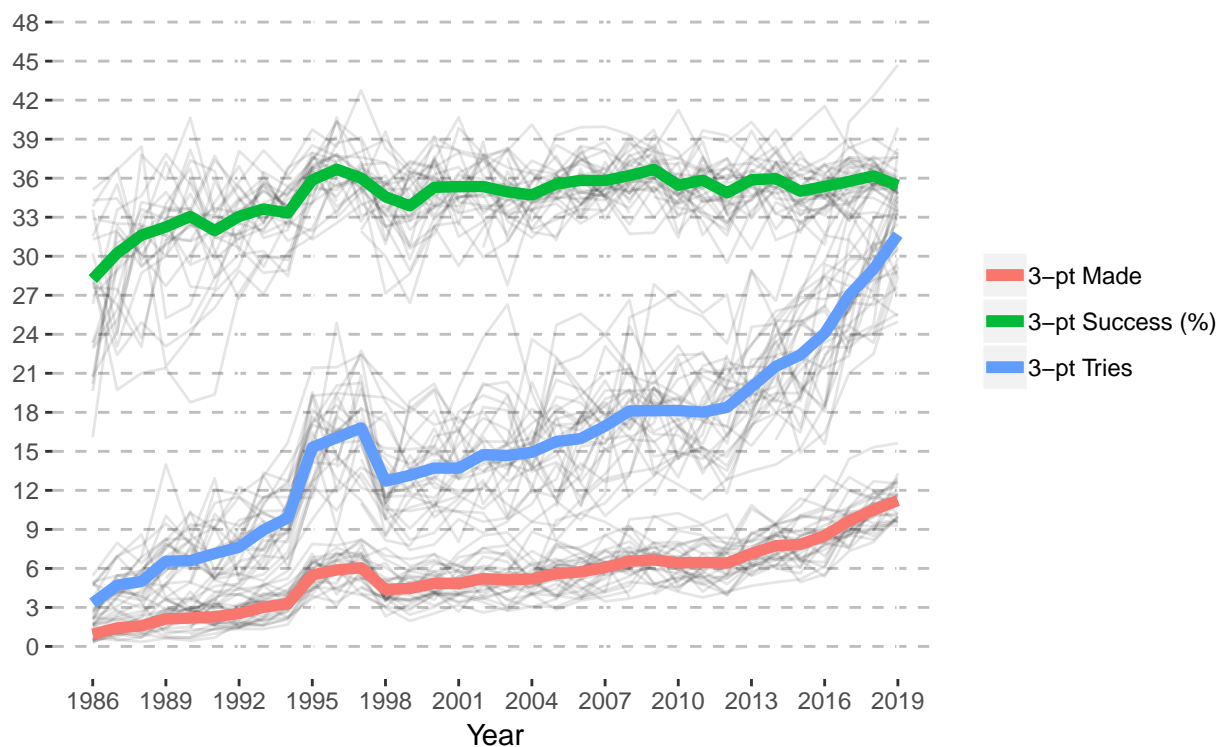
- **Q1. It seems that players are getting better at making 3-pointers than 20 years ago (both on average and also top 3-pointer shooters vs. top 3-pointer shooters) Is it true?**

Yes, the success rate of 3-point field goal has been increased by about 9% since 1986.

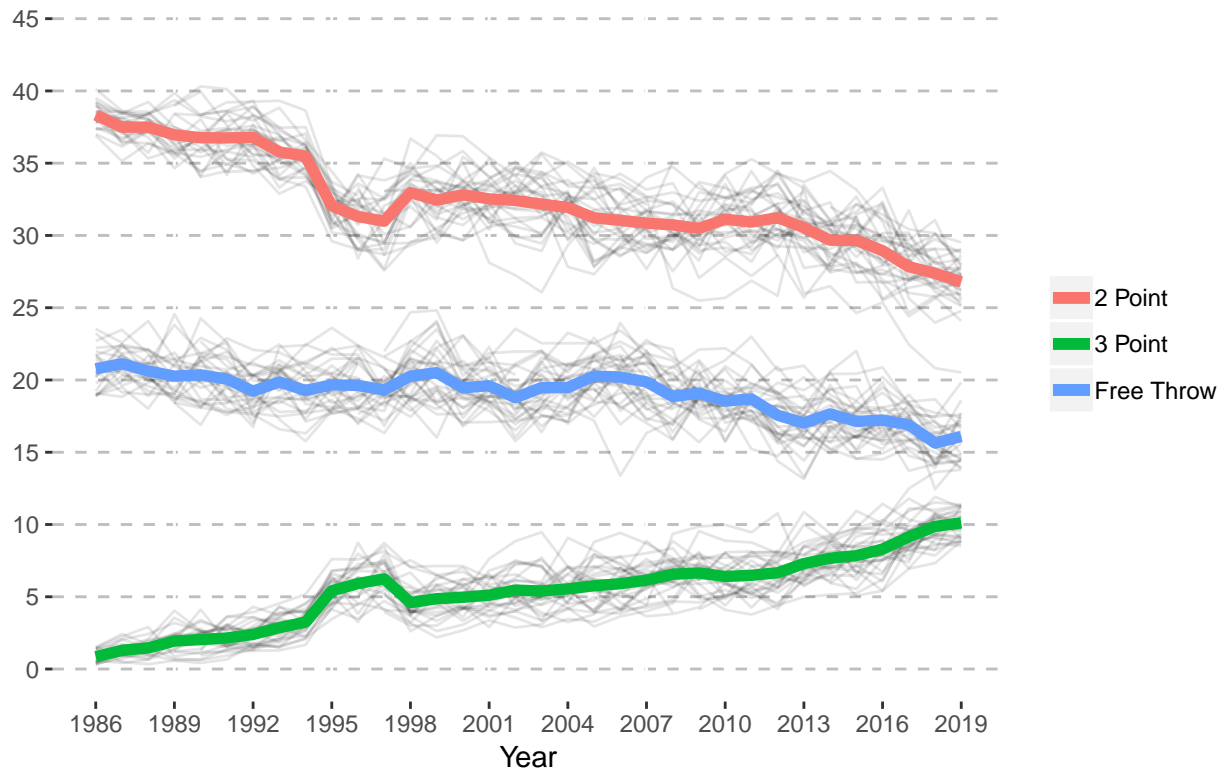
Based on the chart 1 in the report, from 1986 to recent years, the average team in the NBA has improved their three pointer success rate, which is calculated by dividing the number of three pointers made by the number of three pointers attempted in each regular season. With that said, however, the success ratio has stayed largely flat since 1998, likely to the fact that the rules regarding three pointers have not changed and players on average have reached a plateau in terms of the three pointers success rate.

Equally interesting, instead of team average, if we were to look at the top 30 three point shooters in the league by success rate or by number of three pointers made, according to chart 2, the main driver behind their improved contribution to the total points score by their team is through the improvement of their three pointer success rate. Similar to the trend we saw among teams earlier, top three point shooters also improved their success rate over the time period that we specified here.

3 Pointer Field Goal made vs tries



Field Goal Percentage



Statistics of top 10 3-point shooters each year

```

Year      Player      fgm      fga
Min. :1986 Length:14714 Min. : 0 Min. : 0
1st Qu.:1995 Class :character 1st Qu.: 49 1st Qu.: 115
Median :2004 Mode  :character Median : 154 Median : 345
Mean :2004      Mean : 200 Mean : 437
3rd Qu.:2012      3rd Qu.: 308 3rd Qu.: 670
Max. :2019      Max. :1098 Max. :2279
NA's :9

fg3m      fg3a      ftm      fta      pctfg3
Min. : 0 Min. : 0.0 Min. : 0 Min. : 0 Min. : 0.0
1st Qu.: 0 1st Qu.: 2.0 1st Qu.: 20 1st Qu.: 29 1st Qu.: 16.0
Median : 5 Median : 21.0 Median : 64 Median : 88 Median : 30.9
Mean : 29 Mean : 82.2 Mean :101 Mean :134 Mean : 26.3
3rd Qu.: 44 3rd Qu.:128.0 3rd Qu.:145 3rd Qu.:194 3rd Qu.: 36.8
Max. :402 Max. :886.0 Max. :833 Max. :972 Max. :100.0
NA's :15 NA's :16 NA's :9 NA's :2300

pctfg2      pctft
Min. : 0.0 Min. : 0.0
1st Qu.: 40.3 1st Qu.: 66.6
Median : 44.3 Median : 75.0
Mean : 44.0 Mean : 72.4
3rd Qu.: 48.5 3rd Qu.: 81.4
Max. :100.0 Max. :100.0
NA's :63 NA's :470

# A tibble: 340 x 12
# Groups:   Year [34]
  Year Player fgm fga fg3m fg3a ftm fta pctfg3 pctfg2 pctft
<int> <chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 1986 Craig~ 284 568 73 161 75 86 45.3 50 87.2
2 1986 Trent~ 349 739 41 91 79 100 45.1 47.2 79
3 1986 Larry~ 796 1606 82 194 441 492 42.3 49.6 89.6

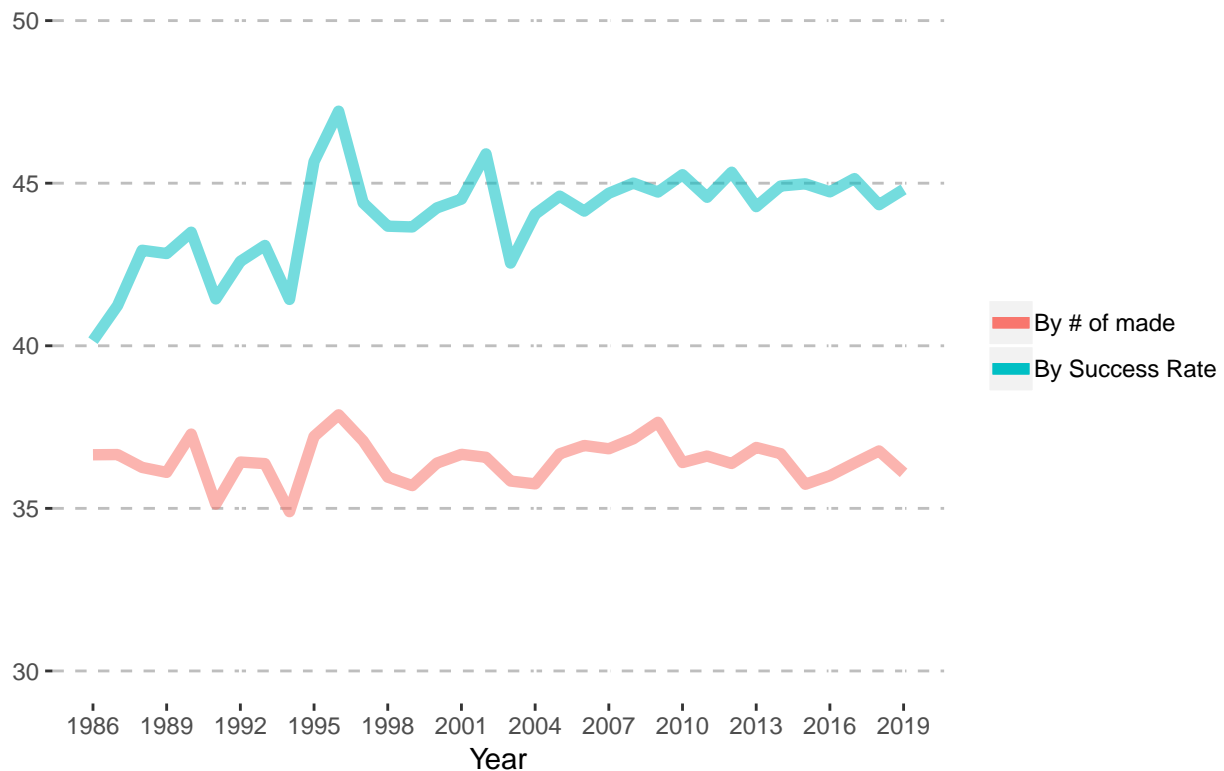
```

```

4 1986 World~ 652 1428 71 169 379 486 42.0 45.7 78.0
5 1986 Kyle ~ 286 592 58 140 73 90 41.4 48.3 81.1
6 1986 Micha~ 274 606 63 163 147 170 38.7 45.2 86.5
7 1986 Leon ~ 184 463 41 112 123 155 36.6 39.7 79.4
8 1986 Dale ~ 193 470 63 174 59 82 36.2 41.1 72.0
9 1986 Mike ~ 252 544 41 114 42 64 36.0 46.3 65.6
10 1986 Brad ~ 267 502 32 89 198 228 36.0 53.2 86.8
# ... with 330 more rows, and 1 more variable: Rank <int>
# A tibble: 4,651 x 12
# Groups:   Year [34]
  Year Player fgm fga fg3m fg3a ftm fta pctfg3 pctfg2 pctft
  <int> <chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 1986 Larry~ 796 1606 82 194 441 492 42.3 49.6 89.6
2 1986 Craig~ 284 568 73 161 75 86 45.3 50 87.2
3 1986 World~ 652 1428 71 169 379 486 42.0 45.7 78.0
4 1986 Dale ~ 193 470 63 174 59 82 36.2 41.1 72.0
5 1986 Micha~ 274 606 63 163 147 170 38.7 45.2 86.5
6 1986 Kyle ~ 286 592 58 140 73 90 41.4 48.3 81.1
7 1986 John ~ 365 818 45 146 231 297 30.8 44.6 77.8
8 1986 Norm ~ 403 921 42 121 131 162 34.7 43.8 80.9
9 1986 Leon ~ 184 463 41 112 123 155 36.6 39.7 79.4
10 1986 Mike ~ 252 544 41 114 42 64 36.0 46.3 65.6
# ... with 4,641 more rows, and 1 more variable: Rank <int>

```

3 point success rate of top 30 players

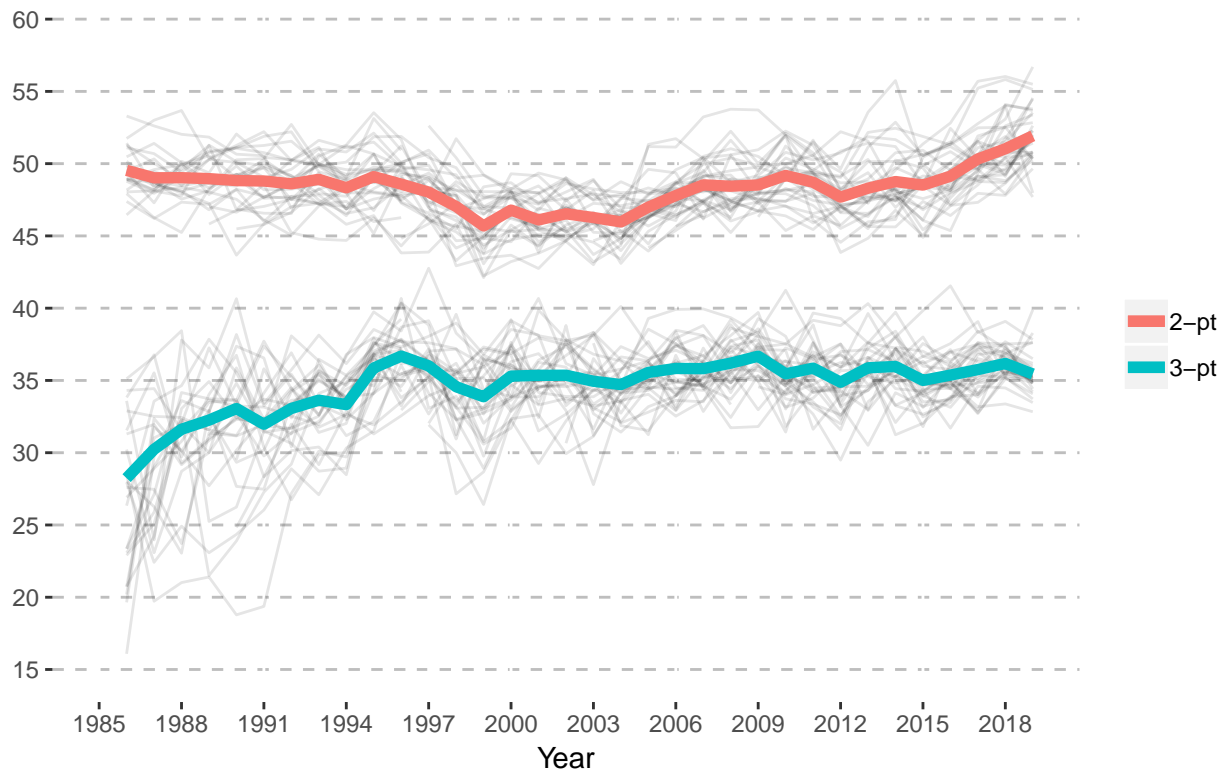


- **Q2. Teams with more 3-pointers tend to be the better performing teams?**

We ran regressions on the team standings during the regular seasons by three pointer success rate and two pointer success rate. If team has a lower standings, in another word, smaller number for its ranking position, it is ranked closer to the top so the better team. Unsurprisingly, the regressions showed that independent variables three pointer success rate and two pointer success rate all have negative coefficients and they are statistically significant at 5%. This means when the three pointer and two pointer success rates increase, the teams tend to have smaller numbers as their rankings, i.e., better rankings.

However, as two pointers still contributed to a larger share of the total points scored by a given team than three pointers do. The absolute value of the coefficient on two point success rate is larger than that of three point success rate. This is not surprising because improving the same percentage of success rate in two point shooting and three point shooting means that the former will have a larger impact on improving the team's ranking than the latter does.

Q1. Historical Field Goal Success Rate



The expected points of 2-point shots in 1986 was $\text{fgyear}\$pctfg2[1986-1985]/100 * 2 = 0.9907$

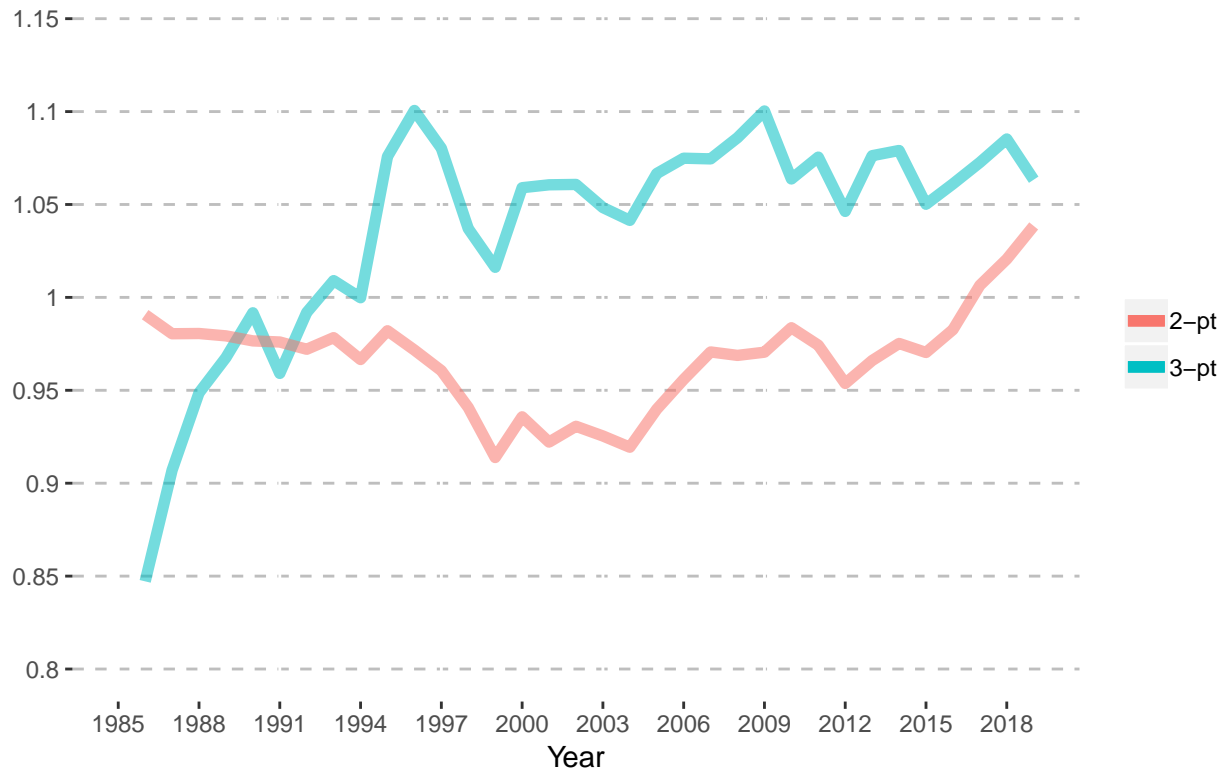
The expected points of 3-point shots in 1986 was $\text{fgyear}\$pctfg3[1986-1985]/100 * 3 = 0.8472$

The expected points of 2-point shots in 2019 was $\text{fgyear}\$pctfg2[2019-1985]/100 * 2 = 1.0385$

The expected points of 3-point shots in 2019 was $\text{fgyear}\$pctfg3[2019-1985]/100 * 3 = 1.0633$

Teams started to focus on 3-point shots after its first introduction in 1979, because the expected points of 3-point shots are higher than that of 2-point shots since early 90's.

Expected points



- **Q3. Are there any relationship between players' ages and 3-pointers?**

Based on the regression that we ran the three pointer accuracy on a given player's tenure in the NBA, The coefficient is positive and statistically significant at 5%, so we believe as players play longer in the NBA, they tend to have better success rate at shooting three pointers, likely due to continuing training that help improve their three pointer shooting skills and also better understanding of the games and thus know when are the right times to shoot three pointers.

```
# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept)  32.6        2.72        12.0 5.33e-31
2 pctfg3      -0.518      0.0787       -6.58 7.74e-11

# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept)  107.         4.97        21.6 2.14e-84
2 pctfg2      -1.91       0.103       -18.6 3.69e-66

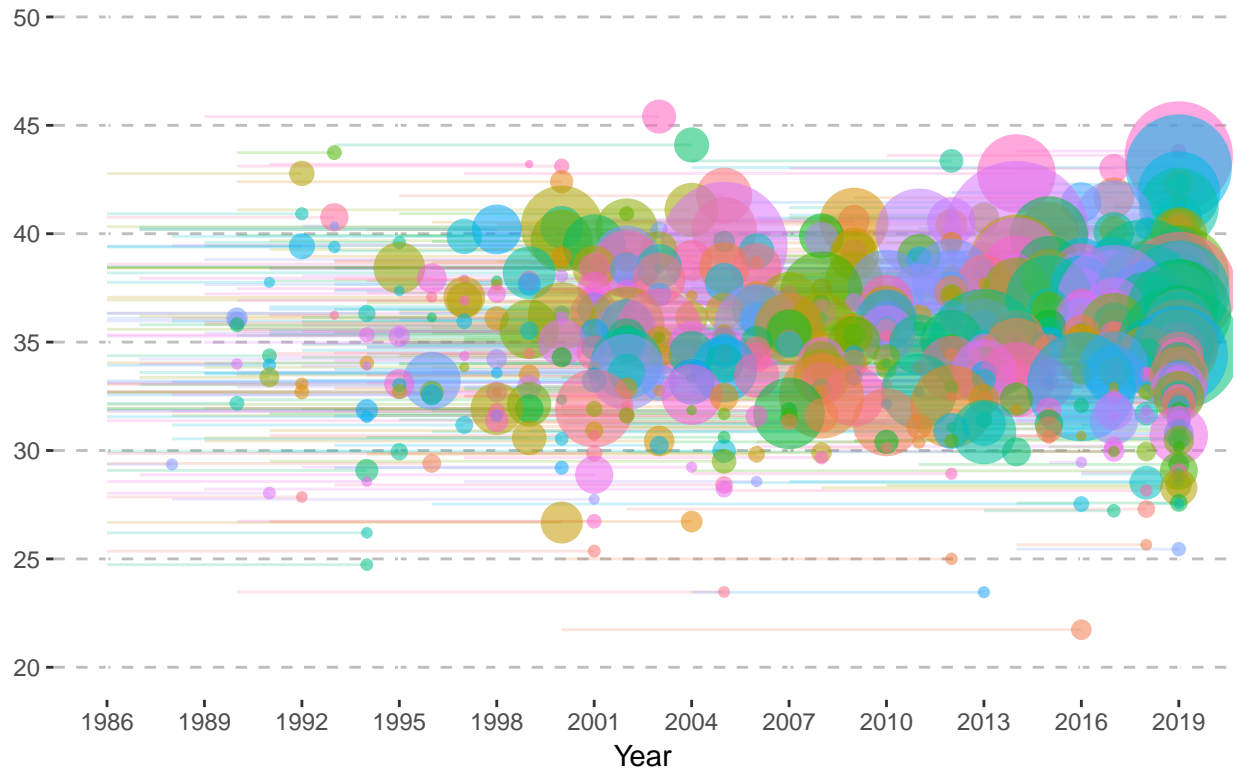
# A tibble: 3 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept)  114.         5.15        22.1 9.52e-88
2 pctfg3      -0.305      0.0694       -4.40 1.23e- 5
3 pctfg2      -1.83       0.103       -17.7 4.80e-61

# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept)  22.0         2.29         9.60 6.40e-21
2 pctfg2       0.257      0.0472        5.45 6.57e- 8
```

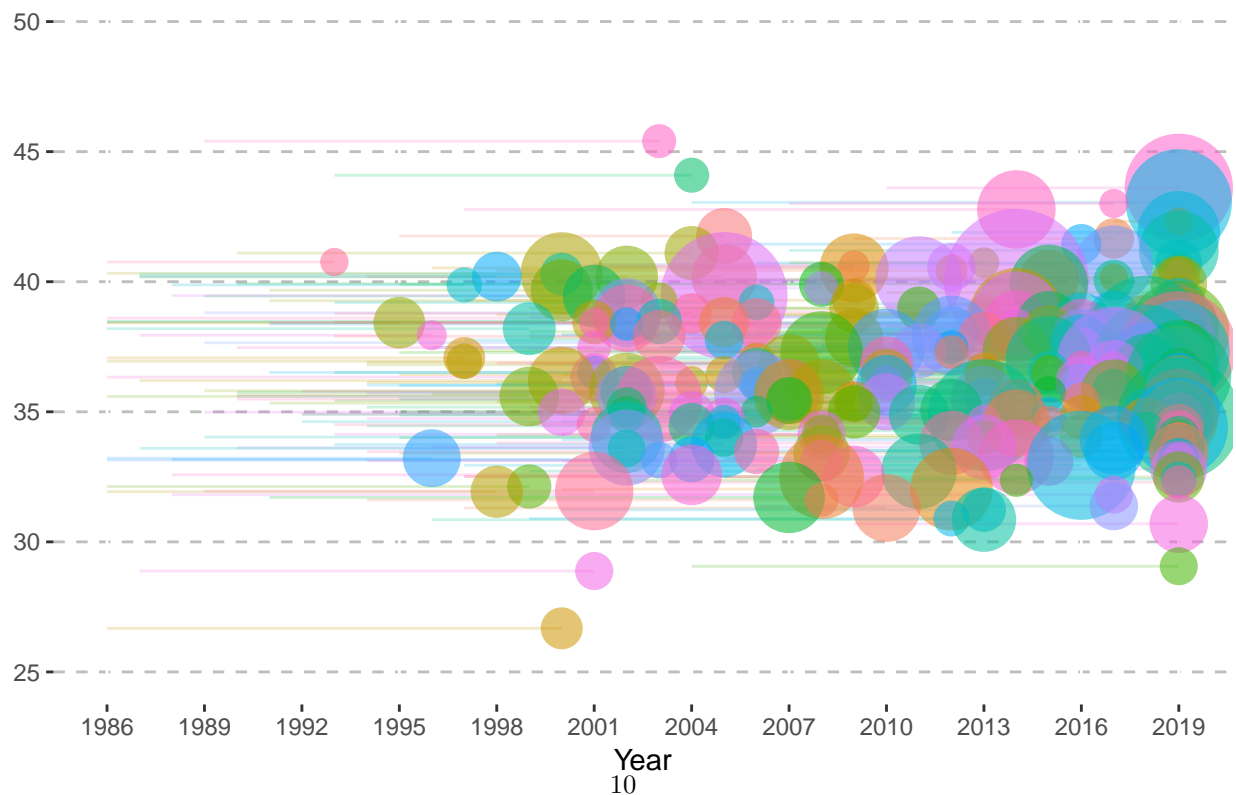
Yes. However, pctfg2 is more relevant than pctfg3 - Focus on three point shooting is a strategy that started fairly recently, we can create a map to show where this strategy initially emerged and how fast it spreaded across the entire country.

3 Player level questions

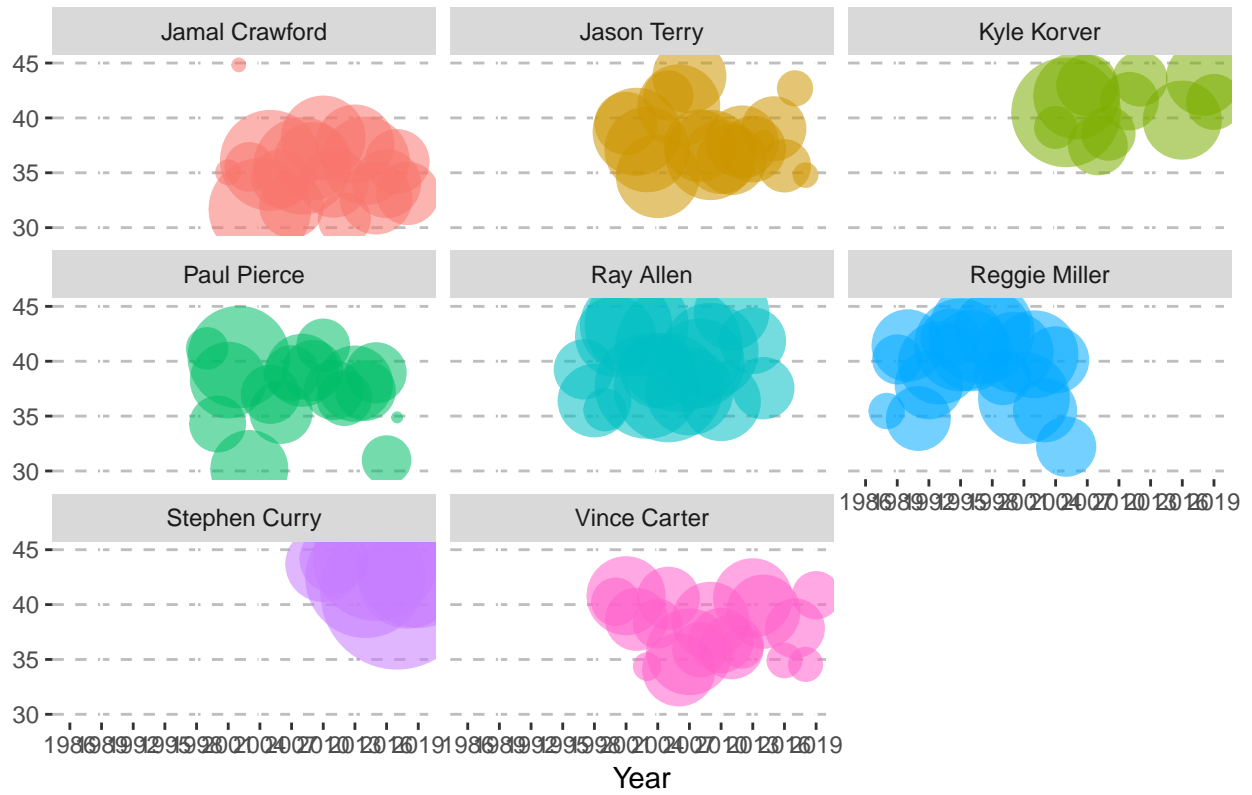
3 point success rate by player and year



3 point success rate by player and year



3 point success rate by player and year



Above graph shows more players are trying 3 point shots than before. even though the average success rate is similar.

- **Q4. Players who are good at 3-pointers are also good at 2-pointers or free throws?**

We ran a series of regressions and found that three pointer success rate has a positive and statistically significant relationship with free throw success rate, however, we are not able to draw such conclusions between the three pointer success rate and two pointer success rate.

A couple of factors that could have contributed to this observation. Players in NBA tend to specialize in three pointer shooting vs two pointer shooting. These two specialization often mean that they need to make a trade off between which style of play to focus on at each other's expense. Also, two pointer plays include lay ups and dunks that usually top three point shooters would not do because they tend to play in the peripheral of the court during the game. One can also argue in the NBA, there is a trade off between explosiveness and three point shooting consistency. The explosive quality is important to have do well in the two pointer style play and thus created this lack of positive correlation between three point success rate and two point success rate.

```
# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept) 33.7        1.75        19.2 2.81e-67
2 pctfg2      0.0330      0.0400      0.823 4.11e- 1

# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept) 184.         19.6         9.41 6.19e-20
2 fgm         0.143     0.00618      23.1 2.24e-89

# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept) 404.         48.0         8.42 1.98e- 16
2 fga         0.197     0.00687      28.6 3.67e-122

# A tibble: 3 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept) 276.         47.4         5.82 8.67e- 9
2 fga         0.347     0.0172      20.2 7.38e-73
3 fta        -0.455     0.0481      -9.47 3.52e-20

# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept) 18.2         1.42        12.8 3.40e-34
2 pctft       0.216     0.0181      11.9 4.54e-30

# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept) 41.9         1.42        29.6 4.07e-128
2 pctft       0.0219     0.0180       1.21 2.25e- 1

# A tibble: 3 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept) 17.7         2.10         8.42 1.86e-16
2 pctfg2      0.0136     0.0368      0.370 7.12e- 1
3 pctft       0.216     0.0182      11.9 6.51e-30
```

When we look at all the players, 2-pointers and 3-pointers are reverse-related. Maybe because of dunk shots?

```
# A tibble: 3 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept) 3.65         2.52         1.45 1.48e- 1
2 pctfg2     -0.0441     0.0415      -1.06 2.88e- 1
3 pctft       0.329     0.0237      13.9 3.19e-42
```

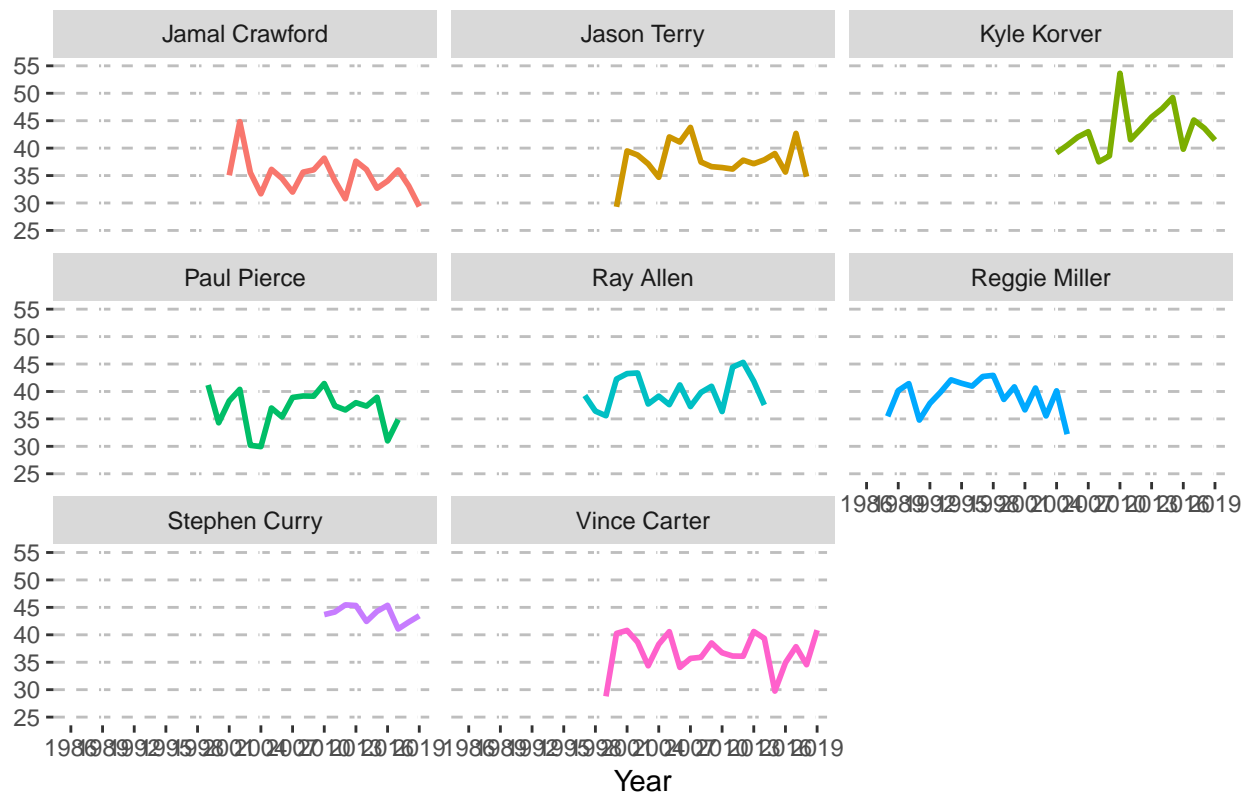
Best players (more than 1,000 career 3-point field goals) are good at 2-pointers as well!!!

```
# A tibble: 3 x 5
  term      estimate std.error statistic    p.value
  <chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept)  3.76        4.06        0.926  0.356
2 pctfg2      0.345       0.0843       4.09  0.0000841
3 pctft       0.226       0.0344       6.58  0.00000000197

# A tibble: 3 x 5
  term      estimate std.error statistic    p.value
  <chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept) -21.5       20.1       -1.07   0.334
2 pctfg2      0.799       0.442       1.81   0.131
3 pctft       0.290       0.231       1.26   0.264
```

-. Are there any relationship between players' ages and 3-pointers? Both total and average.

3 point shot success rate by player



Let's regress.

```
# A tibble: 2 x 5
  term      estimate std.error statistic    p.value
  <chr>      <dbl>      <dbl>      <dbl>    <dbl>
1 (Intercept)  39.6        0.720      55.0  1.01e-95
2 career     -0.0994     0.0656     -1.51  1.32e- 1

# A tibble: 2 x 5
  term      estimate std.error statistic    p.value
```

```

      <chr>      <dbl>      <dbl>      <dbl>      <dbl>
1 (Intercept)  35.4        0.281      126.      0
2 career       0.0730     0.0306      2.38    0.0173
# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>      <dbl>
1 (Intercept)  31.7        0.208      153.      0.
2 career       0.186     0.0280      6.63 3.63e-11
# A tibble: 2 x 5
  term      estimate std.error statistic  p.value
<chr>      <dbl>      <dbl>      <dbl>      <dbl>
1 (Intercept)  24.1        0.252      95.5 0.
2 career       0.414     0.0378     11.0 7.90e-28

```

Really good players are not related with ages/career. Average players' success rate is increased by 0.4% in one year. Not bad...?

- Players with high salaries are good at 3-pointers?

2018-2019 season data only

```

[1] "nbaInsiderSalaries.Rdata loaded."
# A tibble: 2 x 5
  term      estimate std.error statistic p.value
<chr>      <dbl>      <dbl>      <dbl>      <dbl>
1 (Intercept)  1.10       25.9       0.0426  0.966
2 pctfg3      0.580      0.690      0.841    0.403
# A tibble: 2 x 5
  term      estimate std.error statistic p.value
<chr>      <dbl>      <dbl>      <dbl>      <dbl>
1 (Intercept) 16.1        5.69       2.83 0.00587
2 fg3m       0.00460    0.00374     1.23 0.223

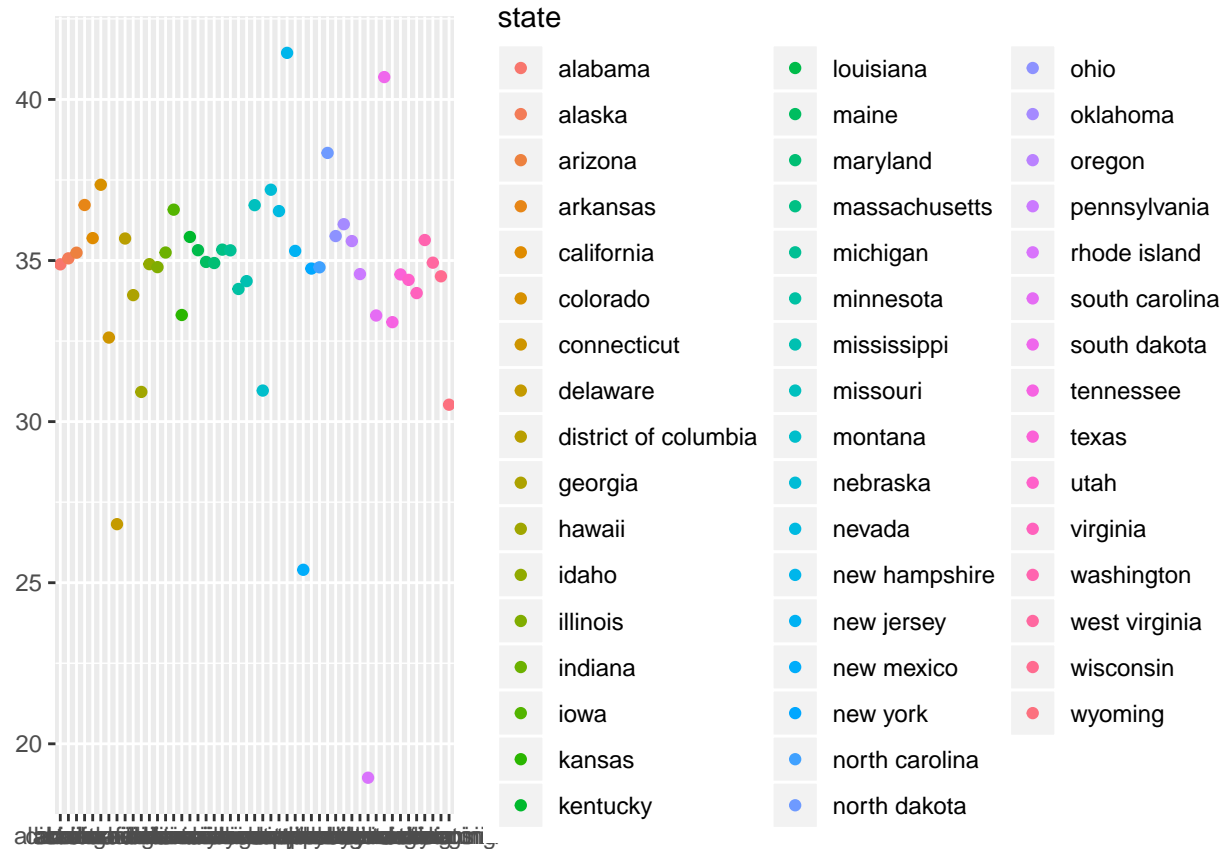
```

When the salary increases by a million dollar, career success rate of 3-point shots increases by 0.09% only. It's difficult to say that 3-pointer success rate is the most important factor for one's salary.

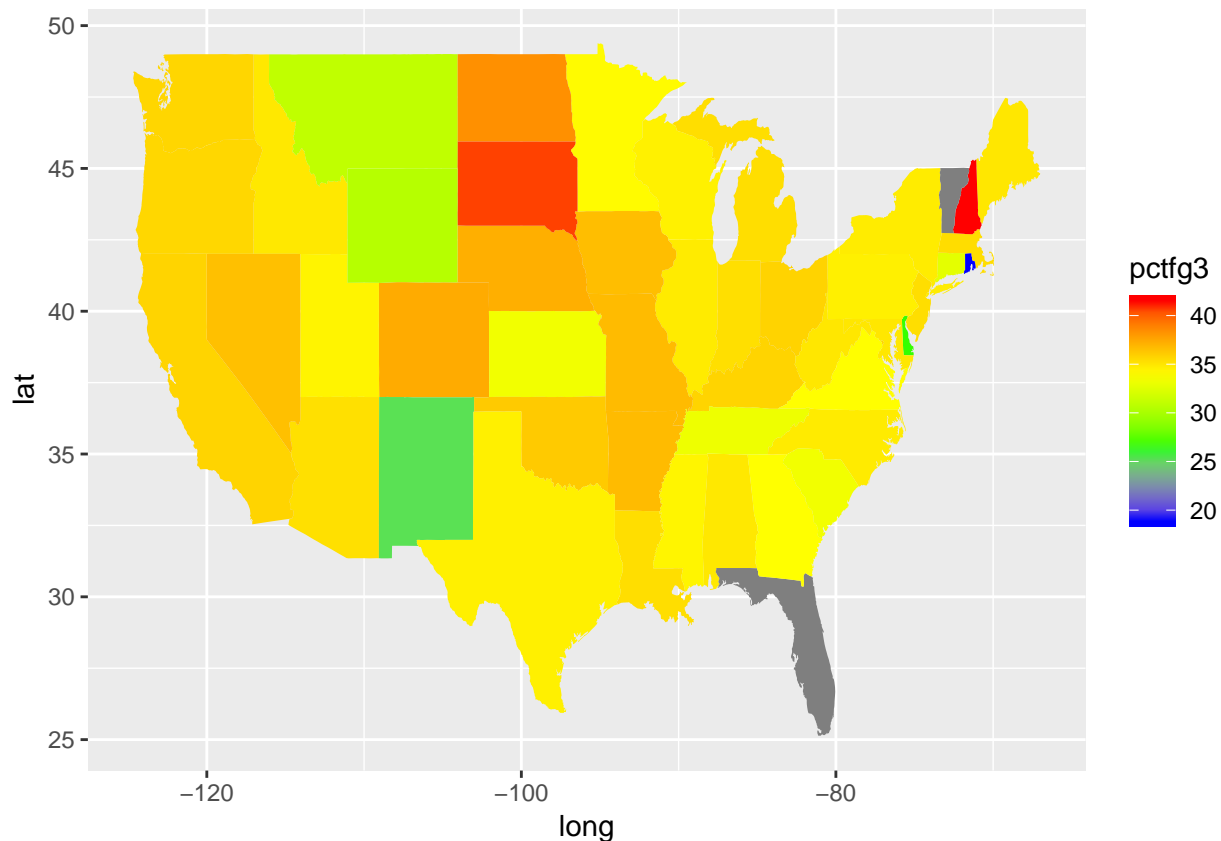
- We would like to explore the importance of three point shooters in a given team by measuring the share of the team's total salary over time.
- We want to analyze whether players can drastically improve their three point shooting skills over time or the skill is rather something people are borned with.

There is no dramatic increase in 3-pointer success rate. Maybe if we can check the players' data from NCAA or high school league, there might be different insight. However, based on NBA data, no big changes.

- Show the 3-pointer statistics geographically based on players' hometowns. Maybe this help illustrates the different basketball playing style across different regions, both domestic and international.



```
<ggproto object: Class CoordMap, Coord, gg>
  aspect: function
  backtransform_range: function
  clip: on
  default: FALSE
  distance: function
  is_free: function
  is_linear: function
  labels: function
  limits: list
  modify_scales: function
  orientation: NULL
  params: list
  projection: lagrange
  range: function
  render_axis_h: function
  render_axis_v: function
  render_bg: function
  render_fg: function
  setup_data: function
  setup_layout: function
  setup_panel_params: function
  setup_params: function
  transform: function
  super: <ggproto object: Class CoordMap, Coord, gg>
```

- What are the expected average points of 3-pointers and 2-pointers? Show the historical data.
- If the expected average point from 3-pointers is getting higher than that of 2-pointers, how should each team's strategy changes

- Then why?

Its debut, in the 1979-80 season, was inauspicious.[\(link\)](#)

There are many reasons for the rise of the 3-point shot, but one may simply be math. It took a while, but coaches finally stopped listening to the traditionalist naysayers and realized that a shot that is worth 50 percent more pays off, even if that shot is a little harder to make.

"Teams have all caught on to the whole points-per-possession argument," Lawrence Frank, the Nets' coach at the time, said in 2009 as the 3 rate began to rapidly increase.