R Notebook

Small project using data visualization to provide evidence on why tennis matches take so long and how the surface, each player and tournament are signifcant factors

In general, players are only active (point in progress) for 15 minutes out of every hour on the court due to the given time inbetween each point

```r
#install.packages("tidyverse")

#library(tidyverse)

# Install the ggplot2 package if not already installed
if (!requireNamespace("ggplot2", quietly = TRUE)) {
  install.packages("ggplot2")
}

# Load the ggplot2 package
library(ggplot2)
```

```r
players_time <- read.csv("players_time.csv")
serve_times <- read.csv("serve_times.csv")
events_time <- read.csv("events_time.csv")

players_time
```

```
##                        player seconds_added_per_point
## 1              Dustin Brown                     -6.37
## 2             Rohan Bopanna                     -4.95
## 3             Chris Guccione                    -4.63
## 4              Benoit Paire                     -4.56
## 5              Lukas Dlouhy                     -4.35
## 6             Brendan Evans                     -4.25
## 7              Igor Sijsling                    -4.19
## 8               Lukas Rosol                     -4.13
## 9       Alexander Kudryavtsev                   -4.05
## 10               Sam Querrey                    -3.99
## 11              Carsten Ball                    -3.99
## 12             Kristian Pless                   -3.95
## 13         Alexandr Dolgopolov                 -3.73
## 14              Peter Wessels                   -3.61
## 15             Robert Kendrick                  -3.57
## 16              Daniel Brands                   -3.54
## 17              Bernard Tomic                   -3.54
```

```
## 18             Zack Fleishman                    -3.48
## 19                Ivo Minar                      -3.38
## 20               James Blake                     -3.36
## 21               Eric Prodon                     -3.18
## 22            Goran Ivanisevic                   -3.15
## 23              Florian Mayer                    -3.15
## 24              Nick Kyrgios                     -3.15
## 25              Samuel Groth                     -2.84
## 26                Todd Reid                      -2.84
## 27            Stephane Robert                    -2.82
## 28              Juan Balcells                    -2.80
## 29            Andrei Olhovskiy                   -2.78
## 30          Alberto Berasategui                  -2.77
## 31              Robby Ginepri                    -2.73
## 32              Wayne Arthurs                    -2.72
## 33              Frank Dancevic                   -2.54
## 34                Kevin Kim                      -2.53
## 35                Jan Hajek                      -2.45
## 36              Roger Federer                    -2.43
## 37               Taylor Dent                     -2.43
## 38            Andrey Kuznetsov                   -2.40
## 39              Jeff Morrison                    -2.39
## 40                John Isner                     -2.33
## 41          Marc Kevin Goellner                  -2.31
## 42            Ricardas Berankis                  -2.30
## 43              Michael Llodra                   -2.27
## 44              Florent Serra                    -2.25
## 45                Jiri Novak                     -2.24
## 46               Andres Gomez                    -2.21
## 47           Matthias Bachinger                  -2.16
## 48               Ivo Karlovic                    -2.12
## 49                Gary Muller                    -2.09
## 50                Amer Delic                     -2.09
## 51              Magnus Larsson                   -2.08
## 52              Michal Tabara                    -2.01
## 53             Nicolas Almagro                   -2.01
## 54                Robin Haase                    -1.97
## 55                Harel Levy                     -1.95
## 56           Christophe Rochus                   -1.94
## 57             Thierry Ascione                   -1.94
## 58             Robin Soderling                   -1.91
## 59              Mischa Zverev                    -1.89
## 60               Jordi Burillo                   -1.88
## 61          Philipp Petzschner                   -1.88
## 62             Jarkko Nieminen                   -1.76
## 63               Filip Dewulf                    -1.74
## 64               Jan Kroslak                     -1.74
## 65          Daniel Gimeno Traver                 -1.64
## 66              Greg Rusedski                    -1.59
## 67               Donald Young                    -1.55
## 68             Bohdan Ulihrach                   -1.55
## 69             Feliciano Lopez                   -1.49
## 70             Filippo Volandri                  -1.42
## 71             Gustavo Kuerten                   -1.41
```

```
## 72            Stefan Koubek            -1.40
## 73            Fabio Fognini            -1.40
## 74         Richard Krajicek            -1.30
## 75            Jakob Hlasek            -1.26
## 76          Albert Montanes            -1.23
## 77      Juan Carlos Ferrero             1.21
## 78        Rainer Schuettler             1.32
## 79            Ronald Agenor             1.36
## 80           Sjeng Schalken             1.37
## 81              Marin Cilic             1.38
## 82              Todd Martin             1.41
## 83          Mikhail Youzhny             1.42
## 84             Jamie Morgan             1.46
## 85           Arnaud Boetsch             1.49
## 86          Bernd Karbacher             1.49
## 87        Nikolay Davydenko             1.52
## 88              Henrik Holm             1.52
## 89          Andrea Gaudenzi             1.57
## 90          Sargis Sargsian             1.57
## 91        Jean Rene Lisnard             1.58
## 92              Martin Damm             1.60
## 93               Guy Forget             1.61
## 94       Christian Bergstrom             1.62
## 95             Gaston Gaudio             1.63
## 96             Albert Costa             1.65
## 97            Alex Calatrava             1.67
## 98            Jerome Golmard             1.68
## 99          Todd Woodbridge             1.76
## 100            Patrick Rafter            1.78
## 101            Mark Woodforde            1.82
## 102          Janko Tipsarevic            1.83
## 103         Sebastien Grosjean          1.86
## 104        Stefano Pescosolido          1.87
## 105          Mariano Zabaleta          1.87
## 106          Lars Burgsmuller          1.87
## 107              Juan Monaco            1.89
## 108             Karol Kucera           1.95
## 109            Omar Camporese          1.96
## 110            Felix Mantilla          1.97
## 111            Pablo Andujar           2.00
## 112     Emilio Benfele Alvarez         2.00
## 113     Guillermo Garcia Lopez         2.04
## 114            Brett Steven            2.09
## 115            Nicklas Kulti           2.10
## 116        Juan Antonio Marin          2.11
## 117           Oscar Hernandez          2.12
## 118              Mario Ancic           2.13
## 119          Thierry Champion          2.13
## 120            Markus Zoecke           2.15
## 121             Anders Jarryd          2.15
## 122             Patrick Baur           2.16
## 123              Blaz Kavcic           2.17
## 124            Novak Djokovic          2.21
## 125             Diego Nargiso          2.23
```

```
## 126          Malivai Washington          2.24
## 127          Patrick McEnroe             2.25
## 128            Wayne Black               2.25
## 129          Magnus Norman               2.28
## 130         Leonardo Lavalle             2.31
## 131           Alex O'Brien               2.32
## 132         Claudio Pistolesi            2.34
## 133          Gianluca Pozzi              2.39
## 134            Tim Henman                2.43
## 135         Guillermo Coria              2.44
## 136         Fabrice Santoro              2.44
## 137           Lukasz Kubot               2.44
## 138         Alexander Mronz              2.45
## 139         Emilio Sanchez               2.45
## 140          Jaime Oncins                2.50
## 141           Andy Murray                2.53
## 142        Marcel Granollers             2.53
## 143           Horst Skoff                2.54
## 144       Sebastien De Chaunac           2.57
## 145          Daniel Orsanic              2.60
## 146      Ruben Ramirez Hidalgo           2.61
## 147          Danny Sapsford              2.62
## 148           Luiz Mattar                2.63
## 149        Paul Henri Mathieu            2.64
## 150            Eyal Ran                  2.65
## 151          Flavio Saretta              2.69
## 152          Cedric Pioline              2.71
## 153       Marcos Aurelio Gorriz          2.74
## 154          David Wheaton               2.78
## 155            Joao Souza                2.80
## 156        Marcelo Filippini             2.84
## 157         Francisco Clavet             2.85
## 158           Tomas Nydahl               2.85
## 159           Todd Witsken               2.85
## 160         Kenneth Carlsen              2.92
## 161          Christian Ruud              2.96
## 162         Daniel Koellerer             2.98
## 163           George Bastl               3.01
## 164           Brad Gilbert               3.05
## 165           Gilad Bloom                3.05
## 166        Horacio De La Pena            3.07
## 167         Claudio Mezzadri             3.07
## 168         Mark Koevermans              3.09
## 169          Arnaud Clement              3.11
## 170          Markus Naewie               3.13
## 171           Bart Wuyts                 3.16
## 172           Borna Coric                3.18
## 173          Lleyton Hewitt              3.22
## 174       Juan Martin Del Potro          3.23
## 175           Pablo Arraya               3.26
## 176            Jim Grabb                 3.27
## 177          Mats Wilander               3.30
## 178           Jordi Arrese               3.30
## 179         Guillermo Canas              3.31
```

```
## 180          Justin Gimelstob                   3.32
## 181             Lionel Roux                     3.36
## 182            Renzo Furlan                     3.37
## 183          Illya Marchenko                    3.40
## 184           Nicolas Kiefer                    3.51
## 185      Christo Van Rensburg                   3.55
## 186            Boris Becker                     3.55
## 187            Martin Jaite                     3.63
## 188             Marc Lopez                      3.67
## 189 Martin Vassallo Arguello                    3.69
## 190         Nicolas Lapentti                    3.72
## 191               Pat Cash                      3.73
## 192          Markus Hantschk                    3.77
## 193            Attila Savolt                    3.81
## 194           Shuzo Matsuoka                    3.90
## 195    Jean Philippe Fleurian                   3.92
## 196          Marcos Ondruska                    3.93
## 197          Gilbert Schaller                   3.93
## 198         Thierry Guardiola                   3.97
## 199           Carlos Berlocq                    4.08
## 200       Jan Frode Andersen                    4.12
## 201           Roberto Jabali                    4.35
## 202             Ivan Lendl                      4.35
## 203             Jim Courier                     4.51
## 204            Alex Corretja                    4.64
## 205          Thomas Hogstedt                    4.77
## 206             Hernan Gumy                     4.86
## 207            Jimmy Connors                    4.90
## 208          Andrei Cherkasov                   4.92
## 209           Michael Chang                     4.94
## 210          Joao Cunha Silva                   5.10
## 211            Julian Knowle                    5.15
## 212             John McEnroe                    5.22
## 213          Lucas Arnold Ker                   5.35
## 214           T.J. Middleton                    5.60
## 215          Martin Stringari                   5.68
## 216             Rafael Nadal                    5.92
## 217            Nicolas Massu                    6.21
## 218           Emanuel Couto                     6.35
```

`serve_times`

```
##                 server seconds_before_next_point        day
## 1      Nicolas Almagro                         22 28-May-15
## 2      Nicolas Almagro                         19 28-May-15
## 3      Nicolas Almagro                         23 28-May-15
## 4      Nicolas Almagro                         24 28-May-15
## 5      Nicolas Almagro                         19 28-May-15
## 6        Pablo Andujar                         34 28-May-15
## 7        Bernard Tomic                         21 28-May-15
## 8        Bernard Tomic                         17 28-May-15
## 9        Bernard Tomic                         17 28-May-15
## 10        Rafael Nadal                         34 28-May-15
## 11        Rafael Nadal                         29 28-May-15
## 12        Rafael Nadal                         33 28-May-15
```

```
## 13          Rafael Nadal            23 28-May-15
## 14          Rafael Nadal            27 28-May-15
## 15          Pablo Andujar           26 28-May-15
## 16          Pablo Andujar           24 28-May-15
## 17          Pablo Andujar           32 28-May-15
## 18          Bernard Tomic           21 28-May-15
## 19          Bernard Tomic           15 28-May-15
## 20          Bernard Tomic           18 28-May-15
## 21          Bernard Tomic           37 28-May-15
## 22          Pablo Andujar           38 28-May-15
## 23          Pablo Andujar           31 28-May-15
## 24        Nicolas Almagro           22 28-May-15
## 25        Nicolas Almagro           24 28-May-15
## 26        Nicolas Almagro           22 28-May-15
## 27        Nicolas Almagro           20 28-May-15
## 28      Andrey Kuznetsov            16 28-May-15
## 29      Andrey Kuznetsov            19 28-May-15
## 30      Andrey Kuznetsov            20 28-May-15
## 31      Andrey Kuznetsov            15 28-May-15
## 32          Rafael Nadal            27 28-May-15
## 33           Andy Murray            29 28-May-15
## 34           Andy Murray            20 28-May-15
## 35           Borna Coric            28 28-May-15
## 36           Borna Coric            25 28-May-15
## 37           Borna Coric            29 28-May-15
## 38           Andy Murray            18 28-May-15
## 39           Andy Murray            20 28-May-15
## 40           Andy Murray            23 28-May-15
## 41           Andy Murray            22 28-May-15
## 42        Novak Djokovic            16 28-May-15
## 43        Novak Djokovic            13 28-May-15
## 44        Novak Djokovic            14 28-May-15
## 45        Novak Djokovic            21 28-May-15
## 46           Borna Coric            36 28-May-15
## 47           Borna Coric            21 28-May-15
## 48           Borna Coric            22 28-May-15
## 49           John Isner             27 28-May-15
## 50           Andy Murray            30 28-May-15
## 51           Andy Murray            24 28-May-15
## 52           Andy Murray            30 28-May-15
## 53           Andy Murray            21 28-May-15
## 54           John Isner             22 28-May-15
## 55           Borna Coric            26 28-May-15
## 56         Carlos Berlocq           34 28-May-15
## 57         Carlos Berlocq           28 28-May-15
## 58    Daniel Gimeno Traver          15 28-May-15
## 59    Daniel Gimeno Traver          17 28-May-15
## 60    Daniel Gimeno Traver          26 28-May-15
## 61    Daniel Gimeno Traver          27 28-May-15
## 62    Daniel Gimeno Traver          27 28-May-15
## 63    Daniel Gimeno Traver          15 28-May-15
## 64         Carlos Berlocq           20 28-May-15
## 65         Carlos Berlocq           30 28-May-15
## 66         Carlos Berlocq           28 28-May-15
```

```
## 67           Carlos Berlocq                    28 29-May-15
## 68           Carlos Berlocq                    31 29-May-15
## 69             Lukas Rosol                      15 29-May-15
## 70             Lukas Rosol                      16 29-May-15
## 71             Lukas Rosol                      15 29-May-15
## 72             Lukas Rosol                      22 29-May-15
## 73             Lukas Rosol                      26 29-May-15
## 74             Lukas Rosol                      13 29-May-15
## 75             Lukas Rosol                      14 29-May-15
## 76           Carlos Berlocq                    32 29-May-15
## 77           Roger Federer                     15 29-May-15
## 78           Roger Federer                     15 29-May-15
## 79           Roger Federer                     14 29-May-15
## 80           Roger Federer                     22 29-May-15
## 81           Roger Federer                     17 29-May-15
## 82           Roger Federer                     13 29-May-15
## 83           Roger Federer                     17 29-May-15
## 84           Roger Federer                     18 29-May-15
## 85           Roger Federer                     15 29-May-15
## 86           Roger Federer                     15 29-May-15
## 87           Roger Federer                     18 29-May-15
## 88           Roger Federer                     17 29-May-15
## 89           Roger Federer                     12 29-May-15
## 90           Roger Federer                     13 29-May-15
## 91           Roger Federer                     16 29-May-15
## 92           Roger Federer                     23 29-May-15
## 93            Benoit Paire                     14 29-May-15
## 94            Benoit Paire                     12 29-May-15
## 95            Benoit Paire                     11 29-May-15
## 96            Benoit Paire                     19 29-May-15
## 97            Benoit Paire                     12 29-May-15
## 98            Benoit Paire                     16 29-May-15
## 99            Benoit Paire                     12 29-May-15
## 100           Benoit Paire                     16 29-May-15
## 101           Benoit Paire                     17 29-May-15
## 102           Nick Kyrgios                      9 30-May-15
## 103           Nick Kyrgios                     16 30-May-15
## 104           Nick Kyrgios                     15 30-May-15
## 105           Nick Kyrgios                     22 30-May-15
## 106           Nick Kyrgios                     19 30-May-15
## 107           Nick Kyrgios                     14 30-May-15
## 108           Nick Kyrgios                     23 30-May-15
## 109           Nick Kyrgios                     11 30-May-15
## 110           Nick Kyrgios                      9 30-May-15
## 111           Nick Kyrgios                     14 30-May-15
## 112           Nick Kyrgios                     11 30-May-15
## 113           Nick Kyrgios                      9 30-May-15
## 114           Nick Kyrgios                     14 30-May-15
## 115           Nick Kyrgios                     13 30-May-15
## 116           Nick Kyrgios                     13 30-May-15
## 117           Nick Kyrgios                      9 30-May-15
## 118           Nick Kyrgios                     12 30-May-15
## 119           Nick Kyrgios                     24 30-May-15
## 120           Nick Kyrgios                     12 30-May-15
```

```
##              opponent game_score set game
## 1          Rafael Nadal       15-30   1  0-0
## 2          Rafael Nadal       15-40   1  0-0
## 3          Rafael Nadal       30-40   1  0-0
## 4          Rafael Nadal       Deuce   1  0-0
## 5          Rafael Nadal       Ad-in   1  0-0
## 6   Philipp Kohlschreiber     40-30   5  2-4
## 7     Thanasi Kokkinakis      30-40   3  0-1
## 8     Thanasi Kokkinakis      Deuce   3  0-1
## 9     Thanasi Kokkinakis      Ad-in   3  0-1
## 10      Nicolas Almagro       15-30   1  0-1
## 11      Nicolas Almagro       30-30   1  0-1
## 12      Nicolas Almagro       30-40   1  0-1
## 13      Nicolas Almagro       Deuce   1  0-1
## 14      Nicolas Almagro       Ad-in   1  0-1
## 15  Philipp Kohlschreiber     15-30   5  4-4
## 16  Philipp Kohlschreiber     30-30   5  4-4
## 17  Philipp Kohlschreiber     40-30   5  4-4
## 18    Thanasi Kokkinakis      15-40   3  1-2
## 19    Thanasi Kokkinakis      30-40   3  1-2
## 20    Thanasi Kokkinakis      Deuce   3  1-2
## 21    Thanasi Kokkinakis      Ad-out  3  1-2
## 22  Philipp Kohlschreiber     Deuce   5  4-4
## 23  Philipp Kohlschreiber     Ad-in   5  4-4
## 24         Rafael Nadal       15-0    1  1-3
## 25         Rafael Nadal       30-0    1  1-3
## 26         Rafael Nadal       40-0    1  1-3
## 27         Rafael Nadal       30-40   2  3-5
## 28        Jurgen Melzer       15-0    3  2-2
## 29        Jurgen Melzer       30-0    3  2-2
## 30        Jurgen Melzer       30-15   3  2-2
## 31        Jurgen Melzer       40-15   3  2-2
## 32      Nicolas Almagro       40-0    3  5-1
## 33          Joao Sousa       30-0    1  2-1
## 34          Joao Sousa       40-0    1  2-1
## 35        Tommy Robredo      Ad-out   1  5-4
## 36        Tommy Robredo      Deuce    1  5-4
## 37        Tommy Robredo      Ad-out   1  5-4
## 38          Joao Sousa       40-0    3  0-1
## 39          Joao Sousa       40-15   3  0-1
## 40          Joao Sousa       40-30   3  0-1
## 41          Joao Sousa       Deuce   3  0-1
## 42        Gilles Muller      15-0    3  2-1
## 43        Gilles Muller      30-0    3  2-1
## 44        Gilles Muller      40-0    3  2-1
## 45        Gilles Muller      40-15   3  2-1
## 46        Tommy Robredo      0-30    3  2-2
## 47        Tommy Robredo      15-30   3  2-2
## 48        Tommy Robredo      30-30   3  2-2
## 49        Jeremy Chardy      40-30   2  4-3
## 50          Joao Sousa       30-40   3  1-2
## 51          Joao Sousa       Deuce   3  1-2
## 52          Joao Sousa       Ad-out  3  1-2
## 53          Joao Sousa       Deuce   3  1-2
```

```
## 54         Jeremy Chardy  40-0  2  5-4
## 55        Tommy Robredo   0-30  3  4-2
## 56       Richard Gasquet  15-30  2  0-1
## 57       Richard Gasquet  15-40  2  0-1
## 58          David Ferrer  40-0  2  1-3
## 59          David Ferrer   0-15  2  2-4
## 60          David Ferrer   0-30  2  2-4
## 61          David Ferrer  15-30  2  2-4
## 62          David Ferrer  15-40  2  2-4
## 63          David Ferrer  30-40  2  2-4
## 64       Richard Gasquet  15-15  3  0-0
## 65       Richard Gasquet  15-30  3  0-0
## 66       Richard Gasquet  15-40  3  0-0
## 67       Richard Gasquet  30-30  5  0-3
## 68       Richard Gasquet  40-30  5  0-3
## 69  Teymuraz Gabashvili   15-0  3  3-5
## 70  Teymuraz Gabashvili  15-15  3  3-5
## 71  Teymuraz Gabashvili  30-15  3  3-5
## 72  Teymuraz Gabashvili  30-30  3  3-5
## 73  Teymuraz Gabashvili  30-40  3  3-5
## 74  Teymuraz Gabashvili  Deuce  3  3-5
## 75  Teymuraz Gabashvili  Ad-in  3  3-5
## 76       Richard Gasquet  15-40  5  1-4
## 77         Damir Dzumhur  15-15  2  5-2
## 78         Damir Dzumhur  30-15  2  5-2
## 79         Damir Dzumhur  30-30  2  5-2
## 80         Damir Dzumhur  30-40  2  5-2
## 81         Damir Dzumhur  Deuce  2  5-2
## 82         Damir Dzumhur  Ad-in  2  5-2
## 83         Damir Dzumhur  Deuce  2  5-2
## 84         Damir Dzumhur Ad-out  2  5-2
## 85         Damir Dzumhur   0-15  3  3-1
## 86         Damir Dzumhur  15-15  3  3-1
## 87         Damir Dzumhur  15-30  3  3-1
## 88         Damir Dzumhur  30-30  3  3-1
## 89         Damir Dzumhur  40-30  3  3-1
## 90         Damir Dzumhur  30-15  3  4-2
## 91         Damir Dzumhur  40-15  3  4-2
## 92         Damir Dzumhur  40-30  3  4-2
## 93         Tomas Berdych   30-0  1  0-5
## 94         Tomas Berdych  30-15  1  0-5
## 95         Tomas Berdych  40-15  1  0-5
## 96         Tomas Berdych  40-30  1  0-5
## 97         Tomas Berdych  Deuce  1  0-5
## 98         Tomas Berdych  Ad-in  1  0-5
## 99         Tomas Berdych  30-15  2  0-0
## 100        Tomas Berdych  40-15  2  0-0
## 101        Tomas Berdych  40-30  2  0-0
## 102          Andy Murray   0-15  3  2-2
## 103          Andy Murray  15-15  3  2-2
## 104          Andy Murray  15-30  3  2-2
## 105          Andy Murray  30-30  3  2-2
## 106          Andy Murray  40-30  3  2-2
## 107          Andy Murray   0-40  3  3-3
```

```
## 108            Andy Murray      15-40   3   3-3
## 109            Andy Murray      15-15   3   3-3
## 110            Andy Murray      15-30   3   3-3
## 111            Andy Murray      30-30   3   3-3
## 112            Andy Murray      40-30   3   3-3
## 113            Andy Murray      Deuce   3   3-3
## 114            Andy Murray      Ad-in   3   3-3
## 115            Andy Murray      Deuce   3   3-3
## 116            Andy Murray     Ad-out   3   3-3
## 117            Andy Murray      Deuce   3   3-3
## 118            Andy Murray      Ad-in   3   3-3
## 119            Andy Murray      Deuce   3   3-3
## 120            Andy Murray     Ad-out   3   3-3
```

events_time

```
##                 tournament surface seconds_added_per_point      years
## 1                Wimbledon   Grass                   -2.98 1991-2014
## 2          London Olympics   Grass                   -2.62       2012
## 3               Manchester   Grass                   -2.33 1991-1994
## 4               Eastbourne   Grass                   -1.78 2009-2014
## 5               Birmingham  Carpet                   -1.63       1991
## 6             Queen's Club   Grass                   -1.50 1991-2014
## 7                     Lyon    Hard                   -1.35       2009
## 8                Las Vegas    Hard                   -1.32 2006-2008
## 9         Stockholm Masters  Carpet                   -0.90 1991-1994
## 10              Nottingham   Grass                   -0.82 1995-2008
## 11                  Orlando    Hard                   -0.68       1991
## 12             Tokyo Indoor  Carpet                   -0.64 1991-1995
## 13                    Halle   Grass                   -0.58 1993-2014
## 14                   Bogota    Clay                   -0.57 1994-2001
## 15           s-Hertogenbosch   Grass                  -0.54 2008-2014
## 16                  Beijing  Carpet                   -0.54 1993-1996
## 17                 Brussels  Carpet                   -0.53       1991
## 18                  Chicago  Carpet                   -0.52       1991
## 19               Wellington    Hard                   -0.44 1991-1992
## 20                  Newport   Grass                   -0.35 1991-2014
## 21                 US Open     Hard                   -0.17 1991-2014
## 22             Montpellier     Hard                   -0.16 2010-2015
## 23                  Bolzano  Carpet                   -0.14 1992-1993
## 24          Australian Open     Hard                   -0.11 1991-2015
## 25                  Memphis     Hard                   -0.02 1991-2015
## 26                   Bogota     Hard                    0.08 2013-2014
## 27                 Rosmalen   Grass                    0.17 1991-1997
## 28                   London  Carpet                    0.27 1998-1999
## 29                 San Jose     Hard                    0.28 1994-2013
## 30                  Antwerp  Carpet                    0.29 1992-1996
## 31         Stuttgart Masters  Carpet                   0.30 1996-1997
## 32            Sydney Indoor     Hard                    0.30 1991-1994
## 33            Paris Masters  Carpet                    0.32 1991-2006
## 34                 Auckland     Hard                    0.38 1991-2015
## 35             Johannesburg     Hard                    0.38 1992-2011
## 36                   Gstaad    Clay                    0.44 1991-2014
## 37                   Durban     Hard                    0.45       1993
## 38                   Sydney     Hard                    0.46 1999-2015
```

```
## 39        Copenhagen  Carpet          0.50 1991-1999
## 40            Basel   Carpet          0.51 1997-2006
## 41   Sydney Outdoor     Hard          0.52 1991-1998
## 42            Seoul     Hard          0.53 1991-1996
## 43            Milan   Carpet          0.55 1991-2005
## 44 Stuttgart Indoor   Carpet          0.57 1991-1995
## 45     Delray Beach     Hard          0.59 2000-2015
## 46     Philadelphia   Carpet          0.59 1991-1996
## 47             Metz     Hard          0.63 2003-2014
## 48      Tour Finals   Carpet          0.63 1991-1996
## 49           Moscow   Carpet          0.64 1991-2006
## 50     Kuala Lumpur   Carpet          0.66 1994-1995
## 51        New Haven     Hard          0.71 1991-2010
## 52            Basel     Hard          0.73 1991-2014
## 53       Scottsdale     Hard          0.79 1992-2005
## 54     Roland Garros     Clay         0.79 1991-2014
## 55   St. Petersburg   Carpet          0.80 1995-2007
## 56           Berlin   Carpet          0.80      1991
## 57     Tokyo Outdoor     Hard         0.81 1991-1995
## 58      Paris Masters     Hard        0.82 2007-2014
## 59         Adelaide     Hard          0.85 1991-2008
## 60             Lyon   Carpet          0.86 1991-2008
## 61        Stockholm     Hard          0.86 1995-2014
## 62    St Petersburg   Carpet          0.87      1999
## 63         Zaragoza   Carpet          0.91 1993-1994
## 64           Zagreb   Carpet          0.92 1996-2007
## 65    Winston-Salem     Hard          0.93 2011-2014
## 66          Ostrava   Carpet          0.93 1994-1998
## 67        Marseille     Hard          0.97 1996-2015
## 68         Brighton     Hard          1.00      2000
## 69          Bangkok     Hard          1.01 2003-2013
## 70           Zagreb     Hard          1.02 2008-2015
## 71           Moscow     Hard          1.10 2007-2014
## 72 Cincinnati Masters    Hard         1.14 1991-2014
## 73    San Francisco   Carpet          1.15      1991
## 74      Mexico City     Clay          1.15 1993-2000
## 75           London     Hard          1.16      2000
## 76 Stuttgart Masters     Hard         1.17 1998-2001
## 77        New Delhi     Hard          1.21      1996
## 78  Shanghai Masters     Hard         1.21 2009-2014
## 79            Tokyo     Hard          1.21 1996-2014
## 80            Osaka     Hard          1.23 1993-1994
## 81      Long Island     Hard          1.23 1991-2004
## 82     Essen Masters   Carpet         1.25      1995
## 83        Rotterdam     Hard          1.25 2000-2015
## 84           Buzios     Hard          1.26 1991-1992
## 85       Washington     Hard          1.30 1991-2014
## 86         Shanghai   Carpet          1.30 1996-1998
## 87        Singapore   Carpet          1.33 1996-1998
## 88      Los Angeles     Hard          1.38 1991-2012
## 89        Sao Paulo     Hard          1.40 1991-1992
## 90       Copenhagen     Hard          1.43 2000-2003
## 91            Split   Carpet          1.46      1998
## 92        Marseille   Carpet          1.46 1993-1995
```

```
## 93        San Francisco    Hard                    1.46 1992-1993
## 94        Indianapolis     Hard                    1.47 1991-2009
## 95           Rotterdam   Carpet                    1.47 1991-1999
## 96              Vienna   Carpet                    1.53 1991-1998
## 97       Canada Masters    Hard                    1.54 1991-2014
## 98       St. Petersburg    Hard                    1.56 2000-2013
## 99            Tashkent     Hard                    1.58 1997-2002
## 100               Dubai    Hard                    1.58 1993-2015
## 101            Bordeaux    Hard                    1.62 1991-1995
## 102            Brisbane    Hard                    1.63 1991-2015
## 103            Valencia    Hard                    1.63 2009-2014
## 104           Stuttgart    Clay                    1.65 2001-2014
## 105            Brasilia   Carpet                   1.66      1991
## 106       Madrid Masters    Hard                   1.69 2002-2008
## 107        Philadelphia    Hard                    1.70 1997-1998
## 108             Beijing    Hard                    1.71 1997-2014
## 109 Indian Wells Masters   Hard                    1.72 1991-2015
## 110            Toulouse    Hard                    1.74 1991-2000
## 111            Santiago    Clay                    1.82 1993-2013
## 112           Hong Kong    Hard                    1.83 1991-2002
## 113          Schenectady    Hard                   1.84 1991-1994
## 114              Vienna    Hard                    1.84 1999-2014
## 115        Miami Masters    Hard                   1.90 1991-2015
## 116      Power Horse Cup    Clay                   1.93      2013
## 117              Boston    Hard                    1.98 1997-1999
## 118        Kuala Lumpur    Hard                    2.03 2009-2014
## 119            Tel Aviv    Hard                    2.07 1991-1996
## 120            Sun City    Hard                    2.09      1994
## 121             Chennai    Hard                    2.09 1997-2015
## 122           Charlotte    Clay                    2.11 1991-1993
## 123             Atlanta    Clay                    2.11 1992-2001
## 124            Shenzhen    Hard                    2.17      2014
## 125    Stuttgart Outdoor    Clay                   2.19 1991-2000
## 126     Ho Chi Minh City  Carpet                   2.20      2005
## 127         Curitiba CH    Clay                    2.25      2010
## 128    Ecuador Open Quito  Clay                    2.27      2015
## 129           Kitzbuhel    Clay                    2.30 1991-2014
## 130             Munich    Clay                     2.31 1991-2014
## 131         Tour Finals    Hard                    2.33 1997-2014
## 132            Shanghai    Hard                    2.38 1999-2004
## 133                Doha    Hard                    2.39 1993-2015
## 134           Sopot - WS   Clay                    2.40      2001
## 135           Amsterdam    Clay                    2.47 1995-2001
## 136                Nice    Clay                    2.53 1991-2014
## 137       Madrid Masters    Clay                   2.55 2009-2014
## 138             Atlanta    Hard                    2.55 2010-2014
## 139             Houston    Clay                    2.56 2001-2015
## 140          St. Poelten    Clay                   2.56 1994-2005
## 141            Belgrade    Clay                    2.58 2009-2012
## 142               Tampa    Clay                    2.61 1991-1993
## 143          Poertschach    Clay                   2.65 2006-2008
## 144             Hamburg    Clay                    2.70 2009-2014
## 145         Delray Beach    Clay                   2.74      1999
## 146               Sopot    Clay                    2.80 2002-2007
```

```
## 147            Antwerp    Hard          2.82 1997-1998
## 148          Hilversum    Clay          2.86 1991-1994
## 149          Sao Paulo    Clay          2.86 1993-2015
## 150        Bournemouth    Clay          2.88 1996-1999
## 151            Guaruja    Hard          2.88 1991-1992
## 152         Montevideo    Clay          2.89 1994-1995
## 153             Bastad    Clay          2.91 1991-2014
## 154           Valencia    Clay          2.92 1995-2008
## 155          Amersfoort   Clay          2.93 2002-2008
## 156     Hamburg Masters   Clay          2.94 1991-2008
## 157          Singapore    Hard          2.96 1991-1999
## 158          Barcelona    Clay          3.06 1991-2015
## 159        Masters Cup    Hard          3.06 2000-2008
## 160         Dusseldorf    Clay          3.10 1995-2014
## 161            Orlando    Clay          3.13 1997-2000
## 162         Casablanca    Clay          3.17 1992-2015
## 163               Oahu    Hard          3.19      1994
## 164     Beijing Olympics  Hard          3.21      2008
## 165           Marbella    Clay          3.21 1996-1997
## 166             Athens    Clay          3.25 1991-1994
## 167            Estoril    Clay          3.26 1991-2014
## 168       Coral Springs   Clay          3.26 1993-1998
## 169            Bermuda    Clay          3.27 1995-1996
## 170 Monte Carlo Masters   Clay          3.31 1991-2015
## 171           Mallorca    Clay          3.32 1998-2002
## 172               Umag    Clay          3.39 1991-2014
## 173          Pinehurst    Clay          3.45 1994-1996
## 174         San Marino    Clay          3.45 1991-2000
## 175            Jakarta    Hard          3.45 1993-1996
## 176             Geneva    Clay          3.47      1991
## 177             Mumbai    Hard          3.50 2006-2007
## 178           Acapulco    Clay          3.53 2001-2013
## 179             Warsaw    Clay          3.58      2008
## 180             Madrid    Clay          3.61 1991-1994
## 181       Buenos Aires    Clay          3.62 1993-2015
## 182        Masters Cup  Carpet          3.64      2005
## 183            Cologne    Clay          3.67      1992
## 184           Acapulco    Hard          3.71 2014-2015
## 185     Costa Do Sauipe   Hard          3.72 2001-2003
## 186             Taipei  Carpet          3.90      1992
## 187       Vina del Mar    Clay          3.94 2001-2014
## 188            Palermo    Clay          3.98 1991-2006
## 189       Rome Masters    Clay          4.09 1991-2014
## 190           Bordeaux    Clay          4.11      1992
## 191          Bucharest    Clay          4.14 1993-2015
## 192     Kuala Lumpur-2    Hard          4.18      1993
## 193     Kuala Lumpur-1    Hard          4.20      1993
## 194             Prague    Clay          4.29 1991-1999
## 195      Rio de Janeiro   Clay          4.40      2014
## 196         Birmingham    Clay          4.49      1994
## 197             Oporto    Clay          4.69 1995-1996
## 198             Genova    Clay          4.71 1991-1993
## 199            Bologna    Clay          4.74 1991-1998
## 200             Merano    Clay          4.93      1999
```

```
201   Viña del Mar   Clay   4.96   2009
202   Florence   Clay   5.08   1991-1994
203   Costa Do Sauipe   Clay   5.19   2004-2011
204   Maceio   Clay   5.28   1992
205   Rio Open   Clay   5.38   2015
```

```r
# HOW EACH SURFACE CORRELATES TO HOW LONG A TENNIS MATCH LASTS

# Scatter Plot with Smooth Line
ggplot(data = events_time, aes(x = surface, y = seconds_added_per_point)) +
  geom_point(mapping = aes(colour = surface)) +
  geom_smooth()
```

```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```
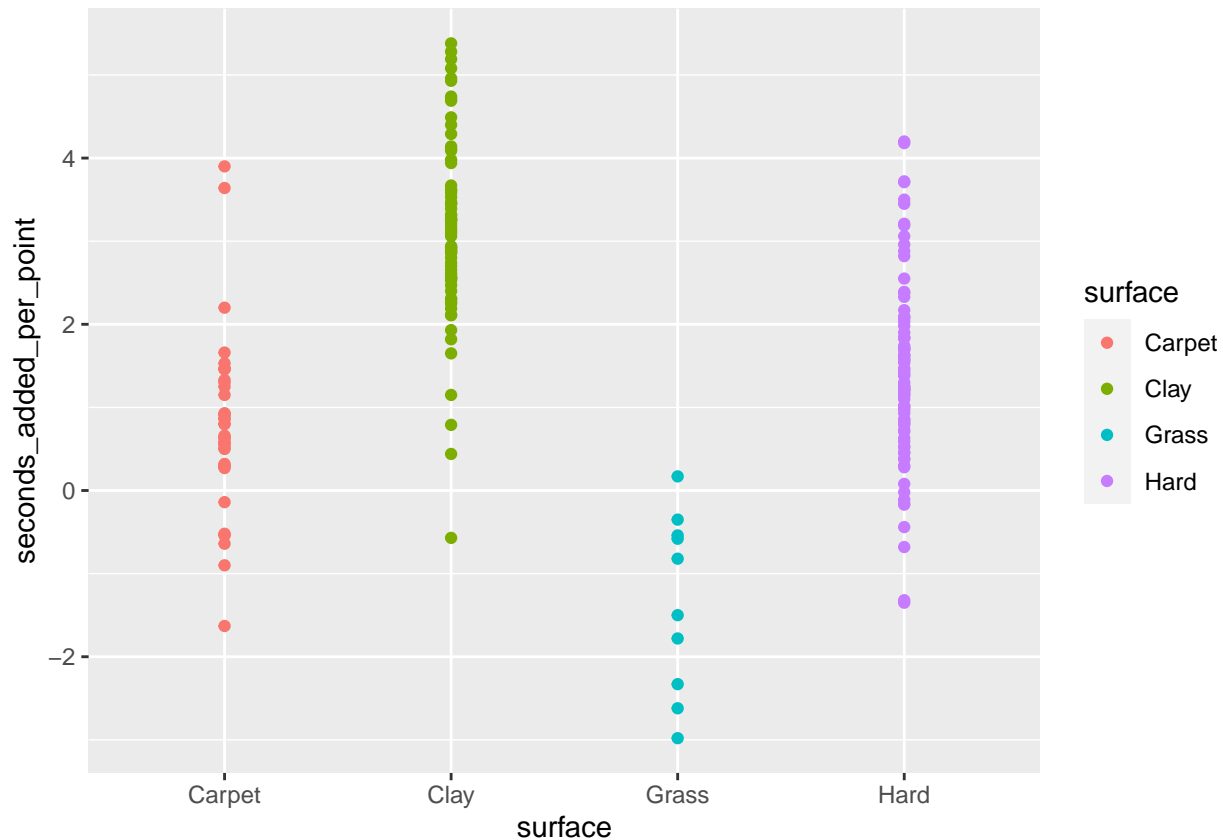


```r
# Summary Statistic Plot
ggplot(data = events_time) +
  stat_summary(mapping = aes(x = surface, y = seconds_added_per_point),
              fun.ymin = min,
              fun.ymax = max,
              fun.y = median)
```

```
## Warning: The `fun.y` argument of `stat_summary()` is deprecated as of ggplot2 3.3.0.
## i Please use the `fun` argument instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

```
## Warning: The `fun.ymin` argument of `stat_summary()` is deprecated as of ggplot2 3.3.0.
```

```
## i Please use the `fun.min` argument instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

```
## Warning: The `fun.ymax` argument of `stat_summary()` is deprecated as of ggplot2 3.3.0.
## i Please use the `fun.max` argument instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```
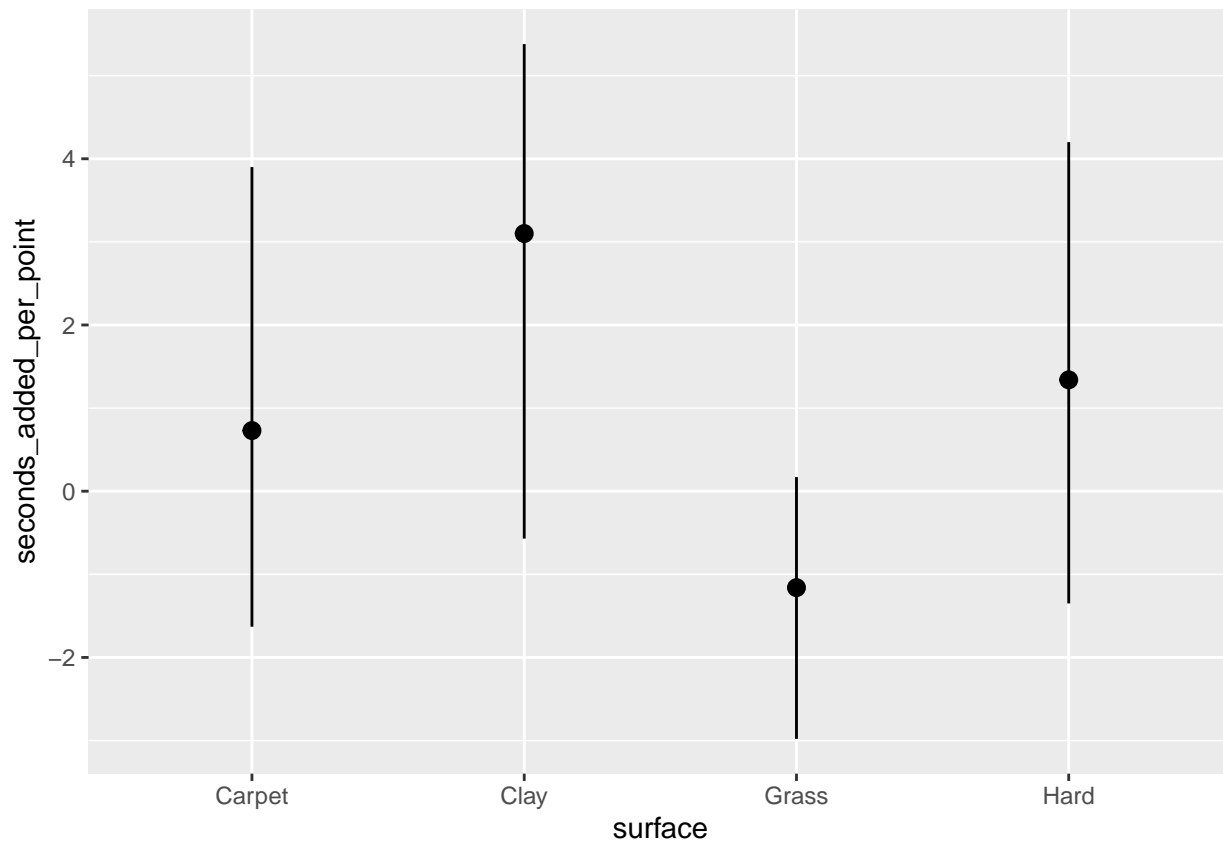


```r
# Analysis of Variance (ANOVA)
result <- aov(seconds_added_per_point ~ surface, data = events_time)

# Perform the ANOVA test
summary(result)
```

```
##               Df Sum Sq Mean Sq F value Pr(>F)
## surface        3  276.6   92.21   75.41 <2e-16 ***
## Residuals    201  245.8    1.22
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

As we can see above, the court surface is significant at 1% and 5% significance level.

tennis balls travel slower on clay court surfaces in comparison to grass and this hypothesis is proved correctly in both graphs above.

serve_times

```
##                   server seconds_before_next_point        day
## 1      Nicolas Almagro                        22 28-May-15
## 2      Nicolas Almagro                        19 28-May-15
## 3      Nicolas Almagro                        23 28-May-15
## 4      Nicolas Almagro                        24 28-May-15
## 5      Nicolas Almagro                        19 28-May-15
## 6        Pablo Andujar                        34 28-May-15
## 7        Bernard Tomic                        21 28-May-15
## 8        Bernard Tomic                        17 28-May-15
## 9        Bernard Tomic                        17 28-May-15
## 10        Rafael Nadal                        34 28-May-15
## 11        Rafael Nadal                        29 28-May-15
## 12        Rafael Nadal                        33 28-May-15
## 13        Rafael Nadal                        23 28-May-15
## 14        Rafael Nadal                        27 28-May-15
## 15       Pablo Andujar                        26 28-May-15
## 16       Pablo Andujar                        24 28-May-15
## 17       Pablo Andujar                        32 28-May-15
## 18       Bernard Tomic                        21 28-May-15
## 19       Bernard Tomic                        15 28-May-15
## 20       Bernard Tomic                        18 28-May-15
## 21       Bernard Tomic                        37 28-May-15
## 22       Pablo Andujar                        38 28-May-15
## 23       Pablo Andujar                        31 28-May-15
## 24     Nicolas Almagro                        22 28-May-15
## 25     Nicolas Almagro                        24 28-May-15
## 26     Nicolas Almagro                        22 28-May-15
## 27     Nicolas Almagro                        20 28-May-15
## 28    Andrey Kuznetsov                        16 28-May-15
## 29    Andrey Kuznetsov                        19 28-May-15
## 30    Andrey Kuznetsov                        20 28-May-15
## 31    Andrey Kuznetsov                        15 28-May-15
## 32        Rafael Nadal                        27 28-May-15
## 33         Andy Murray                        29 28-May-15
## 34         Andy Murray                        20 28-May-15
## 35         Borna Coric                        28 28-May-15
## 36         Borna Coric                        25 28-May-15
## 37         Borna Coric                        29 28-May-15
## 38         Andy Murray                        18 28-May-15
## 39         Andy Murray                        20 28-May-15
## 40         Andy Murray                        23 28-May-15
## 41         Andy Murray                        22 28-May-15
## 42      Novak Djokovic                        16 28-May-15
## 43      Novak Djokovic                        13 28-May-15
## 44      Novak Djokovic                        14 28-May-15
```

```
## 45          Novak Djokovic              21 28-May-15
## 46            Borna Coric               36 28-May-15
## 47            Borna Coric               21 28-May-15
## 48            Borna Coric               22 28-May-15
## 49             John Isner               27 28-May-15
## 50            Andy Murray               30 28-May-15
## 51            Andy Murray               24 28-May-15
## 52            Andy Murray               30 28-May-15
## 53            Andy Murray               21 28-May-15
## 54             John Isner               22 28-May-15
## 55            Borna Coric               26 28-May-15
## 56          Carlos Berlocq             34 28-May-15
## 57          Carlos Berlocq             28 28-May-15
## 58  Daniel Gimeno Traver               15 28-May-15
## 59  Daniel Gimeno Traver               17 28-May-15
## 60  Daniel Gimeno Traver               26 28-May-15
## 61  Daniel Gimeno Traver               27 28-May-15
## 62  Daniel Gimeno Traver               27 28-May-15
## 63  Daniel Gimeno Traver               15 28-May-15
## 64          Carlos Berlocq             20 28-May-15
## 65          Carlos Berlocq             30 28-May-15
## 66          Carlos Berlocq             28 28-May-15
## 67          Carlos Berlocq             28 29-May-15
## 68          Carlos Berlocq             31 29-May-15
## 69             Lukas Rosol              15 29-May-15
## 70             Lukas Rosol              16 29-May-15
## 71             Lukas Rosol              15 29-May-15
## 72             Lukas Rosol              22 29-May-15
## 73             Lukas Rosol              26 29-May-15
## 74             Lukas Rosol              13 29-May-15
## 75             Lukas Rosol              14 29-May-15
## 76          Carlos Berlocq             32 29-May-15
## 77           Roger Federer             15 29-May-15
## 78           Roger Federer             15 29-May-15
## 79           Roger Federer             14 29-May-15
## 80           Roger Federer             22 29-May-15
## 81           Roger Federer             17 29-May-15
## 82           Roger Federer             13 29-May-15
## 83           Roger Federer             17 29-May-15
## 84           Roger Federer             18 29-May-15
## 85           Roger Federer             15 29-May-15
## 86           Roger Federer             15 29-May-15
## 87           Roger Federer             18 29-May-15
## 88           Roger Federer             17 29-May-15
## 89           Roger Federer             12 29-May-15
## 90           Roger Federer             13 29-May-15
## 91           Roger Federer             16 29-May-15
## 92           Roger Federer             23 29-May-15
## 93            Benoit Paire             14 29-May-15
## 94            Benoit Paire             12 29-May-15
## 95            Benoit Paire             11 29-May-15
## 96            Benoit Paire             19 29-May-15
## 97            Benoit Paire             12 29-May-15
## 98            Benoit Paire             16 29-May-15
```

```
## 99            Benoit Paire                    12 29-May-15
## 100           Benoit Paire                    16 29-May-15
## 101           Benoit Paire                    17 29-May-15
## 102           Nick Kyrgios                     9 30-May-15
## 103           Nick Kyrgios                    16 30-May-15
## 104           Nick Kyrgios                    15 30-May-15
## 105           Nick Kyrgios                    22 30-May-15
## 106           Nick Kyrgios                    19 30-May-15
## 107           Nick Kyrgios                    14 30-May-15
## 108           Nick Kyrgios                    23 30-May-15
## 109           Nick Kyrgios                    11 30-May-15
## 110           Nick Kyrgios                     9 30-May-15
## 111           Nick Kyrgios                    14 30-May-15
## 112           Nick Kyrgios                    11 30-May-15
## 113           Nick Kyrgios                     9 30-May-15
## 114           Nick Kyrgios                    14 30-May-15
## 115           Nick Kyrgios                    13 30-May-15
## 116           Nick Kyrgios                    13 30-May-15
## 117           Nick Kyrgios                     9 30-May-15
## 118           Nick Kyrgios                    12 30-May-15
## 119           Nick Kyrgios                    24 30-May-15
## 120           Nick Kyrgios                    12 30-May-15
##                     opponent game_score set game
## 1            Rafael Nadal       15-30   1  0-0
## 2            Rafael Nadal       15-40   1  0-0
## 3            Rafael Nadal       30-40   1  0-0
## 4            Rafael Nadal       Deuce   1  0-0
## 5            Rafael Nadal       Ad-in   1  0-0
## 6   Philipp Kohlschreiber       40-30   5  2-4
## 7      Thanasi Kokkinakis       30-40   3  0-1
## 8      Thanasi Kokkinakis       Deuce   3  0-1
## 9      Thanasi Kokkinakis       Ad-in   3  0-1
## 10        Nicolas Almagro       15-30   1  0-1
## 11        Nicolas Almagro       30-30   1  0-1
## 12        Nicolas Almagro       30-40   1  0-1
## 13        Nicolas Almagro       Deuce   1  0-1
## 14        Nicolas Almagro       Ad-in   1  0-1
## 15  Philipp Kohlschreiber       15-30   5  4-4
## 16  Philipp Kohlschreiber       30-30   5  4-4
## 17  Philipp Kohlschreiber       40-30   5  4-4
## 18     Thanasi Kokkinakis       15-40   3  1-2
## 19     Thanasi Kokkinakis       30-40   3  1-2
## 20     Thanasi Kokkinakis       Deuce   3  1-2
## 21     Thanasi Kokkinakis      Ad-out   3  1-2
## 22  Philipp Kohlschreiber       Deuce   5  4-4
## 23  Philipp Kohlschreiber       Ad-in   5  4-4
## 24           Rafael Nadal        15-0   1  1-3
## 25           Rafael Nadal        30-0   1  1-3
## 26           Rafael Nadal        40-0   1  1-3
## 27           Rafael Nadal       30-40   2  3-5
## 28           Jurgen Melzer       15-0   3  2-2
## 29           Jurgen Melzer       30-0   3  2-2
## 30           Jurgen Melzer       30-15   3  2-2
## 31           Jurgen Melzer       40-15   3  2-2
```

```
## 32          Nicolas Almagro    40-0   3  5-1
## 33             Joao Sousa      30-0   1  2-1
## 34             Joao Sousa      40-0   1  2-1
## 35          Tommy Robredo    Ad-out   1  5-4
## 36          Tommy Robredo     Deuce   1  5-4
## 37          Tommy Robredo    Ad-out   1  5-4
## 38             Joao Sousa      40-0   3  0-1
## 39             Joao Sousa     40-15   3  0-1
## 40             Joao Sousa     40-30   3  0-1
## 41             Joao Sousa     Deuce   3  0-1
## 42           Gilles Muller     15-0   3  2-1
## 43           Gilles Muller     30-0   3  2-1
## 44           Gilles Muller     40-0   3  2-1
## 45           Gilles Muller    40-15   3  2-1
## 46          Tommy Robredo      0-30   3  2-2
## 47          Tommy Robredo     15-30   3  2-2
## 48          Tommy Robredo     30-30   3  2-2
## 49          Jeremy Chardy     40-30   2  4-3
## 50             Joao Sousa     30-40   3  1-2
## 51             Joao Sousa     Deuce   3  1-2
## 52             Joao Sousa    Ad-out   3  1-2
## 53             Joao Sousa     Deuce   3  1-2
## 54          Jeremy Chardy      40-0   2  5-4
## 55          Tommy Robredo      0-30   3  4-2
## 56        Richard Gasquet     15-30   2  0-1
## 57        Richard Gasquet     15-40   2  0-1
## 58            David Ferrer     40-0   2  1-3
## 59            David Ferrer     0-15   2  2-4
## 60            David Ferrer     0-30   2  2-4
## 61            David Ferrer    15-30   2  2-4
## 62            David Ferrer    15-40   2  2-4
## 63            David Ferrer    30-40   2  2-4
## 64        Richard Gasquet     15-15   3  0-0
## 65        Richard Gasquet     15-30   3  0-0
## 66        Richard Gasquet     15-40   3  0-0
## 67        Richard Gasquet     30-30   5  0-3
## 68        Richard Gasquet     40-30   5  0-3
## 69     Teymuraz Gabashvili     15-0   3  3-5
## 70     Teymuraz Gabashvili    15-15   3  3-5
## 71     Teymuraz Gabashvili    30-15   3  3-5
## 72     Teymuraz Gabashvili    30-30   3  3-5
## 73     Teymuraz Gabashvili    30-40   3  3-5
## 74     Teymuraz Gabashvili    Deuce   3  3-5
## 75     Teymuraz Gabashvili    Ad-in   3  3-5
## 76        Richard Gasquet     15-40   5  1-4
## 77          Damir Dzumhur     15-15   2  5-2
## 78          Damir Dzumhur     30-15   2  5-2
## 79          Damir Dzumhur     30-30   2  5-2
## 80          Damir Dzumhur     30-40   2  5-2
## 81          Damir Dzumhur     Deuce   2  5-2
## 82          Damir Dzumhur     Ad-in   2  5-2
## 83          Damir Dzumhur     Deuce   2  5-2
## 84          Damir Dzumhur    Ad-out   2  5-2
## 85          Damir Dzumhur      0-15   3  3-1
```

```
## 86          Damir Dzumhur    15-15   3   3-1
## 87          Damir Dzumhur    15-30   3   3-1
## 88          Damir Dzumhur    30-30   3   3-1
## 89          Damir Dzumhur    40-30   3   3-1
## 90          Damir Dzumhur    30-15   3   4-2
## 91          Damir Dzumhur    40-15   3   4-2
## 92          Damir Dzumhur    40-30   3   4-2
## 93          Tomas Berdych     30-0   1   0-5
## 94          Tomas Berdych    30-15   1   0-5
## 95          Tomas Berdych    40-15   1   0-5
## 96          Tomas Berdych    40-30   1   0-5
## 97          Tomas Berdych    Deuce   1   0-5
## 98          Tomas Berdych    Ad-in   1   0-5
## 99          Tomas Berdych    30-15   2   0-0
## 100         Tomas Berdych    40-15   2   0-0
## 101         Tomas Berdych    40-30   2   0-0
## 102          Andy Murray      0-15   3   2-2
## 103          Andy Murray     15-15   3   2-2
## 104          Andy Murray     15-30   3   2-2
## 105          Andy Murray     30-30   3   2-2
## 106          Andy Murray     40-30   3   2-2
## 107          Andy Murray      0-40   3   3-3
## 108          Andy Murray     15-40   3   3-3
## 109          Andy Murray     15-15   3   3-3
## 110          Andy Murray     15-30   3   3-3
## 111          Andy Murray     30-30   3   3-3
## 112          Andy Murray     40-30   3   3-3
## 113          Andy Murray     Deuce   3   3-3
## 114          Andy Murray     Ad-in   3   3-3
## 115          Andy Murray     Deuce   3   3-3
## 116          Andy Murray    Ad-out   3   3-3
## 117          Andy Murray     Deuce   3   3-3
## 118          Andy Murray     Ad-in   3   3-3
## 119          Andy Murray     Deuce   3   3-3
## 120          Andy Murray    Ad-out   3   3-3
```

```r
library(ggplot2)

ggplot(data = serve_times, aes(x = factor(game_score), y = seconds_before_next_point)) +
  geom_point(aes(colour = seconds_before_next_point), size = 3) +
  geom_smooth(method = "lm", se = FALSE, color = "blue") +
  labs(title = "Serve Times Analysis",
       x = "Game Score",
       y = "Seconds Before Next Point") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))  # Rotate x-axis labels for better readabili
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

Serve Times Analysis
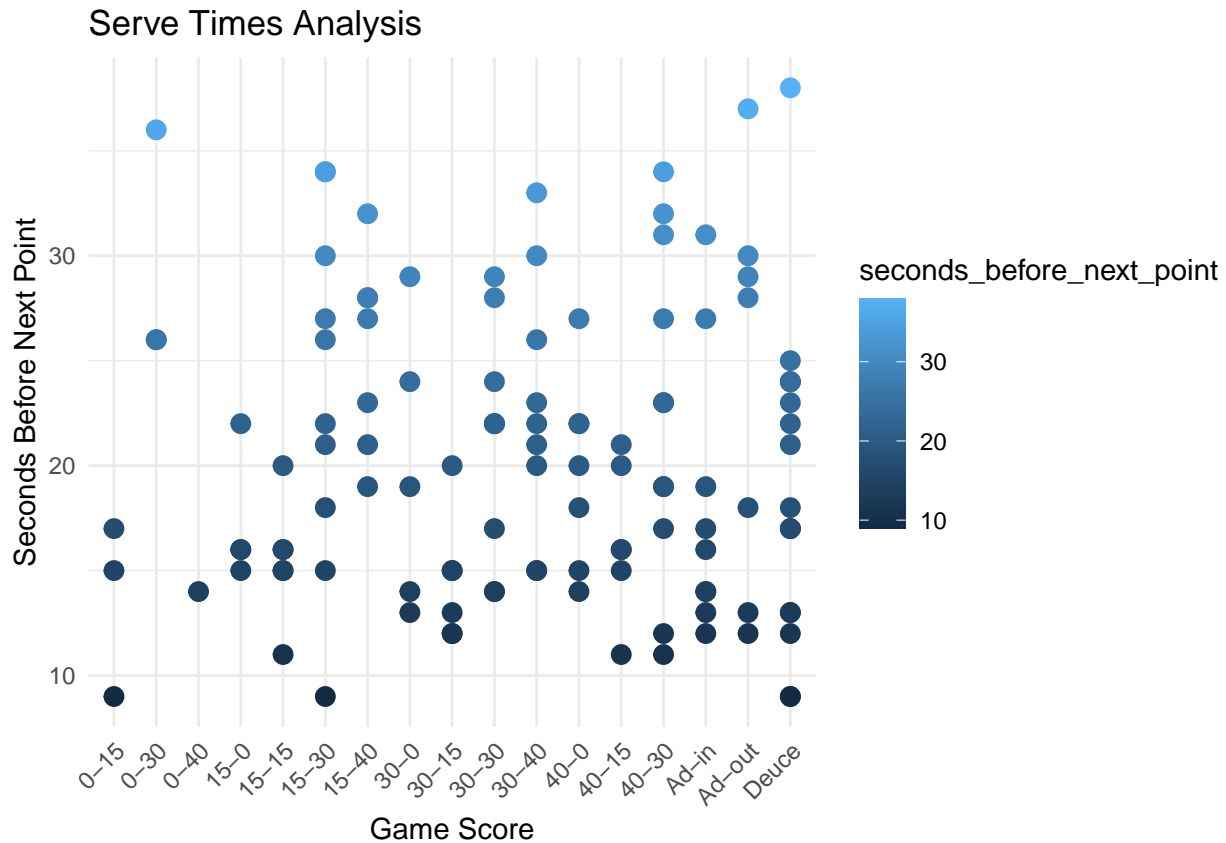
Further evidence for why tennis matches take so long can be shown above by the score in the match being a significant factor.

As we see above, when each game has just started, the average number of seconds before the next point is drastically lower than further down the line because players are affected by fatigue and pressure from the scoreline

This evidence is subject to each player having different routines and styles however, a link can be made in that when players are in winning positions, they take less time between each point and on pressure points, tend to take longer

```
events_time
```

```
##              tournament surface seconds_added_per_point      years
## 1            Wimbledon   Grass                   -2.98 1991-2014
## 2      London Olympics   Grass                   -2.62       2012
## 3           Manchester   Grass                   -2.33 1991-1994
## 4           Eastbourne   Grass                   -1.78 2009-2014
## 5           Birmingham  Carpet                   -1.63       1991
## 6         Queen's Club   Grass                   -1.50 1991-2014
## 7                 Lyon    Hard                   -1.35       2009
```

```
## 8             Las Vegas    Hard             -1.32 2006-2008
## 9      Stockholm Masters  Carpet             -0.90 1991-1994
## 10            Nottingham   Grass             -0.82 1995-2008
## 11               Orlando    Hard             -0.68      1991
## 12          Tokyo Indoor  Carpet             -0.64 1991-1995
## 13                 Halle   Grass             -0.58 1993-2014
## 14                Bogota    Clay             -0.57 1994-2001
## 15       s-Hertogenbosch   Grass             -0.54 2008-2014
## 16               Beijing  Carpet             -0.54 1993-1996
## 17              Brussels  Carpet             -0.53      1991
## 18               Chicago  Carpet             -0.52      1991
## 19            Wellington    Hard             -0.44 1991-1992
## 20               Newport   Grass             -0.35 1991-2014
## 21               US Open    Hard             -0.17 1991-2014
## 22           Montpellier    Hard             -0.16 2010-2015
## 23               Bolzano  Carpet             -0.14 1992-1993
## 24       Australian Open    Hard             -0.11 1991-2015
## 25               Memphis    Hard             -0.02 1991-2015
## 26                Bogota    Hard              0.08 2013-2014
## 27              Rosmalen   Grass              0.17 1991-1997
## 28                London  Carpet              0.27 1998-1999
## 29              San Jose    Hard              0.28 1994-2013
## 30               Antwerp  Carpet              0.29 1992-1996
## 31     Stuttgart Masters  Carpet              0.30 1996-1997
## 32         Sydney Indoor    Hard              0.30 1991-1994
## 33          Paris Masters  Carpet             0.32 1991-2006
## 34              Auckland    Hard              0.38 1991-2015
## 35          Johannesburg    Hard              0.38 1992-2011
## 36                Gstaad    Clay              0.44 1991-2014
## 37                Durban    Hard              0.45      1993
## 38                Sydney    Hard              0.46 1999-2015
## 39            Copenhagen  Carpet              0.50 1991-1999
## 40                 Basel  Carpet              0.51 1997-2006
## 41        Sydney Outdoor    Hard              0.52 1991-1998
## 42                 Seoul    Hard              0.53 1991-1996
## 43                 Milan  Carpet              0.55 1991-2005
## 44      Stuttgart Indoor  Carpet              0.57 1991-1995
## 45          Delray Beach    Hard              0.59 2000-2015
## 46          Philadelphia  Carpet              0.59 1991-1996
## 47                  Metz    Hard              0.63 2003-2014
## 48           Tour Finals  Carpet              0.63 1991-1996
## 49                Moscow  Carpet              0.64 1991-2006
## 50          Kuala Lumpur  Carpet              0.66 1994-1995
## 51             New Haven    Hard              0.71 1991-2010
## 52                 Basel    Hard              0.73 1991-2014
## 53            Scottsdale    Hard              0.79 1992-2005
## 54          Roland Garros    Clay             0.79 1991-2014
## 55        St. Petersburg  Carpet              0.80 1995-2007
## 56                Berlin  Carpet              0.80      1991
## 57          Tokyo Outdoor    Hard             0.81 1991-1995
## 58          Paris Masters    Hard             0.82 2007-2014
## 59              Adelaide    Hard              0.85 1991-2008
## 60                  Lyon  Carpet              0.86 1991-2008
## 61             Stockholm    Hard              0.86 1995-2014
```

```
## 62         St Petersburg Carpet                    0.87      1999
## 63            Zaragoza Carpet                       0.91 1993-1994
## 64              Zagreb Carpet                        0.92 1996-2007
## 65         Winston-Salem   Hard                      0.93 2011-2014
## 66             Ostrava Carpet                        0.93 1994-1998
## 67            Marseille   Hard                        0.97 1996-2015
## 68            Brighton   Hard                         1.00      2000
## 69             Bangkok   Hard                         1.01 2003-2013
## 70              Zagreb   Hard                         1.02 2008-2015
## 71              Moscow   Hard                         1.10 2007-2014
## 72   Cincinnati Masters   Hard                        1.14 1991-2014
## 73       San Francisco Carpet                         1.15      1991
## 74         Mexico City   Clay                          1.15 1993-2000
## 75              London   Hard                          1.16      2000
## 76    Stuttgart Masters   Hard                         1.17 1998-2001
## 77           New Delhi   Hard                          1.21      1996
## 78     Shanghai Masters   Hard                         1.21 2009-2014
## 79               Tokyo   Hard                          1.21 1996-2014
## 80               Osaka   Hard                          1.23 1993-1994
## 81         Long Island   Hard                          1.23 1991-2004
## 82        Essen Masters Carpet                         1.25      1995
## 83           Rotterdam   Hard                          1.25 2000-2015
## 84              Buzios   Hard                          1.26 1991-1992
## 85          Washington   Hard                          1.30 1991-2014
## 86            Shanghai Carpet                          1.30 1996-1998
## 87           Singapore Carpet                          1.33 1996-1998
## 88         Los Angeles   Hard                          1.38 1991-2012
## 89           Sao Paulo   Hard                          1.40 1991-1992
## 90          Copenhagen   Hard                          1.43 2000-2003
## 91               Split Carpet                          1.46      1998
## 92           Marseille Carpet                          1.46 1993-1995
## 93       San Francisco   Hard                          1.46 1992-1993
## 94        Indianapolis   Hard                          1.47 1991-2009
## 95           Rotterdam Carpet                          1.47 1991-1999
## 96              Vienna Carpet                          1.53 1991-1998
## 97       Canada Masters   Hard                         1.54 1991-2014
## 98       St. Petersburg   Hard                         1.56 2000-2013
## 99            Tashkent   Hard                          1.58 1997-2002
## 100             Dubai   Hard                           1.58 1993-2015
## 101           Bordeaux   Hard                          1.62 1991-1995
## 102           Brisbane   Hard                          1.63 1991-2015
## 103           Valencia   Hard                          1.63 2009-2014
## 104          Stuttgart   Clay                          1.65 2001-2014
## 105           Brasilia Carpet                          1.66      1991
## 106      Madrid Masters   Hard                         1.69 2002-2008
## 107       Philadelphia   Hard                          1.70 1997-1998
## 108            Beijing   Hard                          1.71 1997-2014
## 109 Indian Wells Masters   Hard                        1.72 1991-2015
## 110           Toulouse   Hard                          1.74 1991-2000
## 111           Santiago   Clay                          1.82 1993-2013
## 112          Hong Kong   Hard                          1.83 1991-2002
## 113         Schenectady   Hard                         1.84 1991-1994
## 114             Vienna   Hard                          1.84 1999-2014
## 115      Miami Masters   Hard                          1.90 1991-2015
```

```
## 116        Power Horse Cup    Clay       1.93       2013
## 117                Boston     Hard       1.98 1997-1999
## 118         Kuala Lumpur      Hard       2.03 2009-2014
## 119             Tel Aviv      Hard       2.07 1991-1996
## 120             Sun City      Hard       2.09       1994
## 121              Chennai      Hard       2.09 1997-2015
## 122            Charlotte      Clay       2.11 1991-1993
## 123              Atlanta      Clay       2.11 1992-2001
## 124             Shenzhen      Hard       2.17       2014
## 125     Stuttgart Outdoor     Clay       2.19 1991-2000
## 126     Ho Chi Minh City    Carpet       2.20       2005
## 127          Curitiba CH      Clay       2.25       2010
## 128    Ecuador Open Quito     Clay       2.27       2015
## 129            Kitzbuhel      Clay       2.30 1991-2014
## 130               Munich      Clay       2.31 1991-2014
## 131          Tour Finals      Hard       2.33 1997-2014
## 132             Shanghai      Hard       2.38 1999-2004
## 133                 Doha      Hard       2.39 1993-2015
## 134            Sopot - WS     Clay       2.40       2001
## 135            Amsterdam      Clay       2.47 1995-2001
## 136                 Nice      Clay       2.53 1991-2014
## 137        Madrid Masters     Clay       2.55 2009-2014
## 138              Atlanta      Hard       2.55 2010-2014
## 139              Houston      Clay       2.56 2001-2015
## 140          St. Poelten      Clay       2.56 1994-2005
## 141             Belgrade      Clay       2.58 2009-2012
## 142                Tampa      Clay       2.61 1991-1993
## 143           Poertschach      Clay       2.65 2006-2008
## 144              Hamburg      Clay       2.70 2009-2014
## 145          Delray Beach     Clay       2.74       1999
## 146                Sopot      Clay       2.80 2002-2007
## 147              Antwerp      Hard       2.82 1997-1998
## 148             Hilversum      Clay       2.86 1991-1994
## 149            Sao Paulo      Clay       2.86 1993-2015
## 150           Bournemouth     Clay       2.88 1996-1999
## 151              Guaruja      Hard       2.88 1991-1992
## 152           Montevideo      Clay       2.89 1994-1995
## 153               Bastad      Clay       2.91 1991-2014
## 154              Valencia      Clay       2.92 1995-2008
## 155            Amersfoort      Clay       2.93 2002-2008
## 156       Hamburg Masters     Clay       2.94 1991-2008
## 157            Singapore      Hard       2.96 1991-1999
## 158             Barcelona      Clay       3.06 1991-2015
## 159           Masters Cup      Hard       3.06 2000-2008
## 160            Dusseldorf      Clay       3.10 1995-2014
## 161               Orlando      Clay       3.13 1997-2000
## 162            Casablanca      Clay       3.17 1992-2015
## 163                 Oahu      Hard       3.19       1994
## 164       Beijing Olympics     Hard      3.21       2008
## 165             Marbella      Clay       3.21 1996-1997
## 166               Athens      Clay       3.25 1991-1994
## 167              Estoril      Clay       3.26 1991-2014
## 168         Coral Springs     Clay       3.26 1993-1998
## 169              Bermuda      Clay       3.27 1995-1996
```

```
## 170  Monte Carlo Masters    Clay                       3.31 1991-2015
## 171            Mallorca      Clay                       3.32 1998-2002
## 172               Umag       Clay                       3.39 1991-2014
## 173           Pinehurst      Clay                       3.45 1994-1996
## 174         San Marino       Clay                       3.45 1991-2000
## 175            Jakarta       Hard                       3.45 1993-1996
## 176             Geneva       Clay                       3.47       1991
## 177             Mumbai       Hard                       3.50 2006-2007
## 178           Acapulco       Clay                       3.53 2001-2013
## 179             Warsaw       Clay                       3.58       2008
## 180             Madrid       Clay                       3.61 1991-1994
## 181        Buenos Aires      Clay                       3.62 1993-2015
## 182         Masters Cup      Carpet                     3.64       2005
## 183            Cologne       Clay                       3.67       1992
## 184           Acapulco       Hard                       3.71 2014-2015
## 185     Costa Do Sauipe      Hard                       3.72 2001-2003
## 186             Taipei       Carpet                     3.90       1992
## 187        Vina del Mar      Clay                       3.94 2001-2014
## 188            Palermo       Clay                       3.98 1991-2006
## 189        Rome Masters      Clay                       4.09 1991-2014
## 190            Bordeaux      Clay                       4.11       1992
## 191           Bucharest      Clay                       4.14 1993-2015
## 192       Kuala Lumpur-2     Hard                       4.18       1993
## 193       Kuala Lumpur-1     Hard                       4.20       1993
## 194             Prague       Clay                       4.29 1991-1999
## 195       Rio de Janeiro     Clay                       4.40       2014
## 196          Birmingham      Clay                       4.49       1994
## 197             Oporto       Clay                       4.69 1995-1996
## 198             Genova       Clay                       4.71 1991-1993
## 199            Bologna       Clay                       4.74 1991-1998
## 200             Merano       Clay                       4.93       1999
## 201        Viña del Mar      Clay                       4.96       2009
## 202           Florence       Clay                       5.08 1991-1994
## 203     Costa Do Sauipe      Clay                       5.19 2004-2011
## 204             Maceio       Clay                       5.28       1992
## 205            Rio Open      Clay                       5.38       2015
```

```r
ggplot(data = events_time, aes(x = factor(tournament), y = seconds_added_per_point)) +
  geom_point(aes(colour = seconds_added_per_point), size = 3, position = position_dodge(width = 0.7)) +
  geom_smooth(method = "lm", se = FALSE, color = "blue") +
  labs(title = "Tournament Times Analysis",
       x = "Tournament",
       y = "Seconds Added per Point") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        axis.text = element_text(size = 8),  # Adjust text size for better clarity
        legend.position = "top")  # Move legend to the top for
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

Tournament Times Analysis
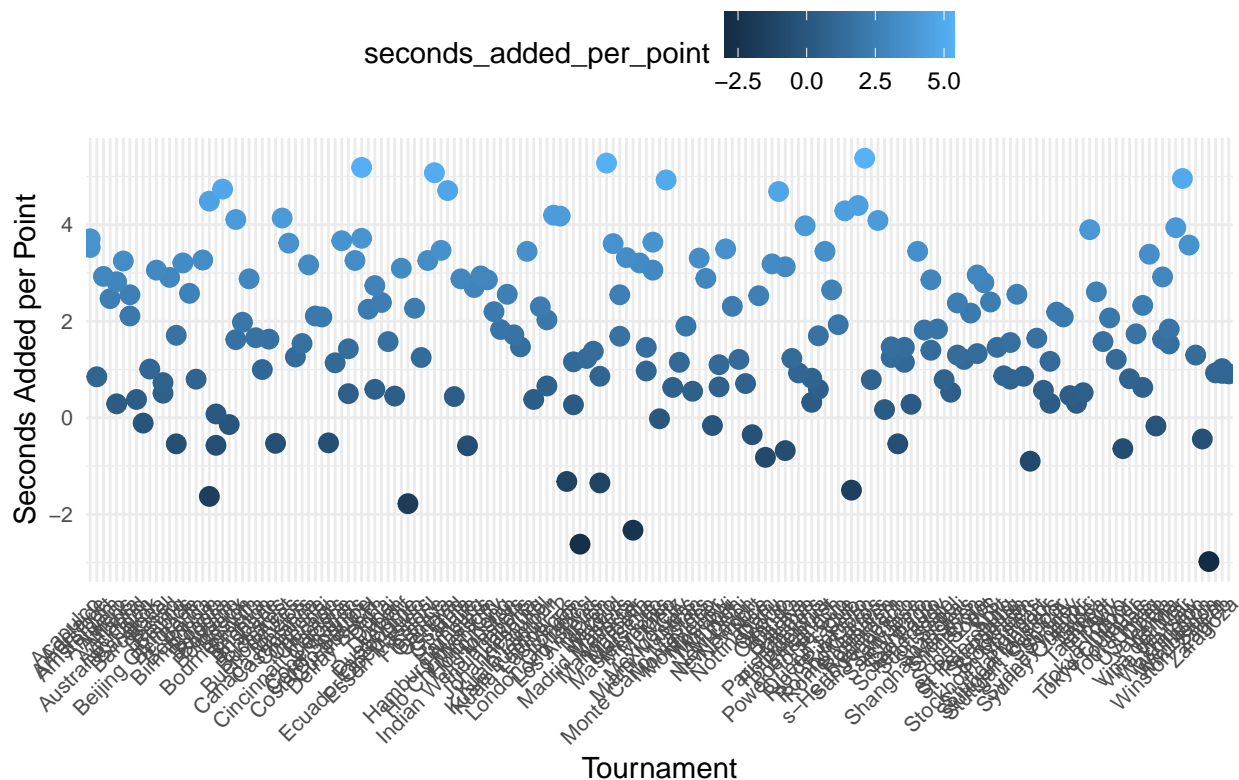
LETS NOW ONLY TAKE THE 10 HIGHEST TOURNAMENTS FOR POINTS ADDED SO WE SEE WHICH LOCATIONS THESE WERE

```r
library(ggplot2)
library(dplyr)
```

```
## 
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
## 
##     filter, lag

## The following objects are masked from 'package:base':
## 
##     intersect, setdiff, setequal, union
```

```r
library(forcats)

# Reorder 'tournament' based on frequency and select top 10
top_tournaments <- events_time %>%
  count(tournament, sort = TRUE) %>%
  slice_head(n = 10) %>%
  pull(tournament)

# Subset the data for the top 10 tournaments
events_time_subset <- events_time[events_time$tournament %in% top_tournaments, ]

# Plot with the top 10 tournaments
```

```
ggplot(data = events_time_subset,
       aes(x = fct_inorder(tournament), y = seconds_added_per_point)) +
  geom_point(aes(colour = seconds_added_per_point), size = 3, position = position_dodge(width = 0.7)) +
  geom_smooth(method = "lm", se = FALSE, color = "blue") +
  labs(title = "Tournament Times Analysis",
       x = "Tournament",
       y = "Seconds Added per Point") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        axis.text = element_text(size = 8),
        legend.position = "top")
```

`geom_smooth()` using formula = 'y ~ x'

Tournament Times Analysis
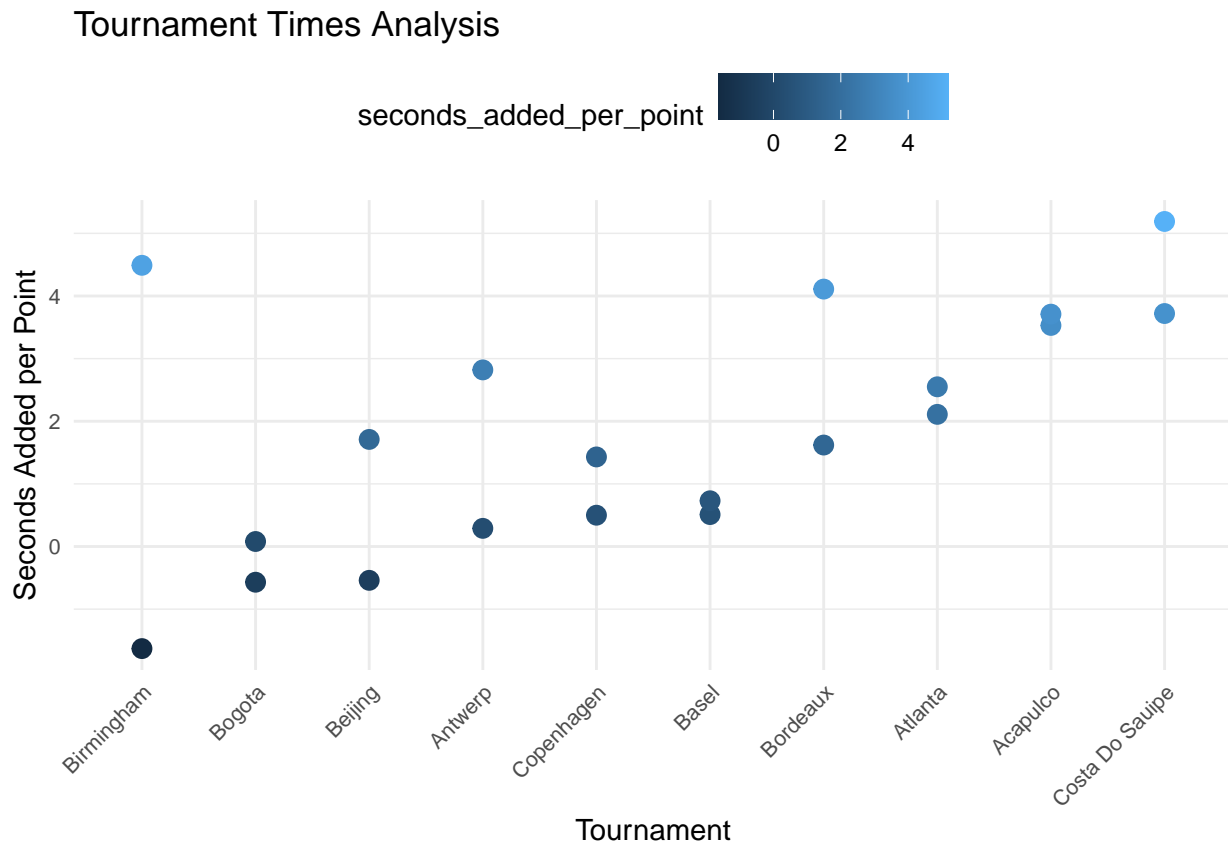
Most of these tournaments above are clay and so we now have further evidence to suggest that the surface does affect the amount of time a tennis match takes