Duke Attendance Stats 2022-23

Packages

```
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.3     v readr     2.1.4
v forcats   1.0.0     v stringr   1.5.0
v ggplot2   3.4.3     v tibble    3.2.1
v lubridate 1.9.2     v tidyr     1.3.0
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becor
```

```
library(tidymodels)
```

```
-- Attaching packages --------------------------------------- tidymodels 1.1.1 --
v broom        1.0.5     v rsample      1.2.0
v dials        1.2.0     v tune         1.1.2
v infer        1.0.4     v workflows    1.1.3
v modeldata    1.2.0     v workflowsets 1.0.1
v parsnip      1.1.1     v yardstick    1.2.0
v recipes      1.0.8
-- Conflicts ------------------------------------------ tidymodels_conflicts() --
x scales::discard() masks purrr::discard()
x dplyr::filter()   masks stats::filter()
x recipes::fixed()  masks stringr::fixed()
x dplyr::lag()      masks stats::lag()
```

```
x yardstick::spec() masks readr::spec()
x recipes::step()   masks stats::step()
* Dig deeper into tidy modeling with R at https://www.tmwr.org
```

```
attendance_data <- read_csv("data/Duke Stats - DukeAttendance.csv")
```

```
Rows: 26 Columns: 26
-- Column specification --------------------------------------------------------
Delimiter: ","
chr  (8): OppName, Surface, Day, Site, Result, TV_Coverage, City, State
dbl (12): FPI, FPI_diff, Month, Date, Year, Start_Time, DukePts, OppPts, Poi...
lgl  (6): Rain, 1stSeedQB, SchoolBreak, NatlHoliday, Bowl, UNC_Game

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

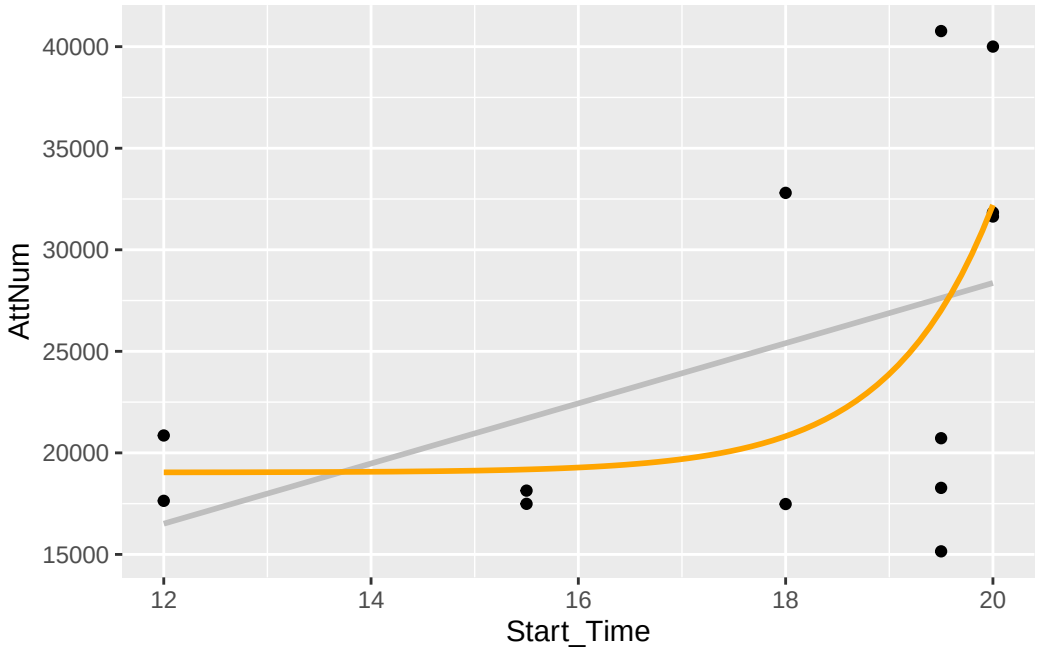
```
attendance_data <- attendance_data |>
  mutate(isHome = if_else(Site == "Home", TRUE, FALSE)) |>
  mutate(Day = as.factor(Day))

home_attendance_data <- attendance_data |>
  filter(isHome == TRUE)

home_attendance_data
```

```
# A tibble: 13 x 27
   OppName         FPI FPI_diff Surface Month  Date  Year Day   Start_Time Site
   <chr>         <dbl>    <dbl> <chr>   <dbl> <dbl> <dbl> <fct>      <dbl> <chr>
 1 Clemson        13.8      4.8 Grass       9     4  2023 Mon         20   Home
 2 Lafayette      NA       NA   Grass       9     9  2023 Sat         18   Home
 3 Northwestern    0.8     -8.2 Grass       9    16  2023 Sat         15.5 Home
 4 Notre Dame     20.7     11.7 Grass       9    30  2023 Sat         19.5 Home
 5 North Caroli~   6.9     -2.1 Grass      10    14  2023 Sat         20   Home
 6 Wake Forest    -1.7    -10.7 Grass      11     2  2023 Thu         19.5 Home
 7 Pittsburgh     -0.5     -9.5 Grass      11    25  2023 Sat         12   Home
 8 Temple        -11.8    -17.1 Grass       9     2  2022 Fri         19.5 Home
 9 N.C. A&T       NA       -5.3 Grass       9    17  2022 Sat         18   Home
10 Virginia       -4       -9.3 Grass      10     1  2022 Sat         19.5 Home
11 North Caroli~   6.2      0.9 Grass      10    15  2022 Sat         20   Home
12 Virginia Tech  -6.2    -11.5 Grass      11    12  2022 Sat         12   Home
```

```
13 Wake Forest     7.6      2.3 Grass       11    26  2022 Sat          15.5 Home
# i 17 more variables: Result <chr>, DukePts <dbl>, OppPts <dbl>,
#   PointDiff <dbl>, AttNum <dbl>, AttPct <dbl>, ESPN_WinPred <dbl>,
#   Rain <lgl>, `1stSeedQB` <lgl>, SchoolBreak <lgl>, NatlHoliday <lgl>,
#   TV_Coverage <chr>, City <chr>, State <chr>, Bowl <lgl>, UNC_Game <lgl>,
#   isHome <lgl>
```

```r
home_attendance_data |>
  ggplot(
    aes(x = Start_Time, y = AttNum)
  ) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE, color = "gray") +
  geom_smooth(method = "glm", formula = y ~ exp(x), se = FALSE, color = "orange") #+
```

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




```r
  #scale_colour_viridis_c()

time_lm <- linear_reg() |>
```

```
  set_engine("lm") |>
  fit(AttNum ~ Start_Time, data = home_attendance_data)

time_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time), data = home_attendance_data)

tidy(time_lm)
```

```
# A tibble: 2 x 5
  term        estimate std.error statistic p.value
  <chr>          <dbl>     <dbl>     <dbl>   <dbl>
1 (Intercept)   -1262.    14851.   -0.0850   0.934
2 Start_Time     1481.      832.    1.78     0.103
```

```
tidy(time_glm)
```

```
# A tibble: 2 x 5
  term                 estimate    std.error statistic  p.value
  <chr>                   <dbl>        <dbl>     <dbl>    <dbl>
1 (Intercept)     19037.        3260.              5.84 0.000112
2 exp(Start_Time)     0.0000271    0.0000114      2.38 0.0365
```

```
glance(time_lm)$AIC
```

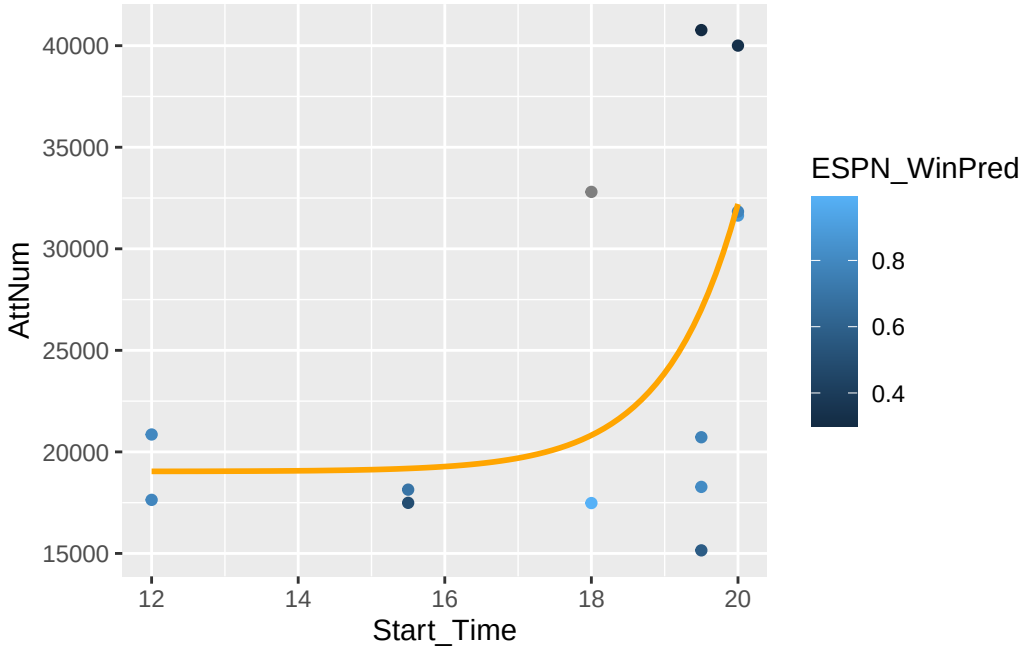
```
[1] 275.8782
```

```
glance(time_glm)$AIC
```

```
[1] 273.7693
```

```
home_attendance_data |>
  ggplot(
    aes(x = Start_Time, y = AttNum, color = ESPN_WinPred)
  ) +
  geom_point() +
```

```
  geom_smooth(method = "glm", formula = y ~ exp(x), se = FALSE, color = "orange") #+
```




```
  #scale_colour_viridis_c()

time_winpred_add_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) + ESPN_WinPred, data = home_attendance_data)

time_winpred_int_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) * ESPN_WinPred, data = home_attendance_data)

tidy(time_winpred_add_glm)
```

```
# A tibble: 3 x 5
  term            estimate     std.error statistic p.value
  <chr>              <dbl>         <dbl>     <dbl>   <dbl>
1 (Intercept)      3.03e+4 7130.              4.25 0.00215
2 exp(Start_Time)  2.76e-5    0.00000954      2.89 0.0180
3 ESPN_WinPred    -1.81e+4 8969.             -2.01 0.0750
```

```
tidy(time_winpred_int_glm)
```

```
# A tibble: 4 x 5
  term                          estimate     std.error statistic p.value
  <chr>                            <dbl>         <dbl>     <dbl>   <dbl>
1 (Intercept)                  21221.        12894.           1.65    0.138
2 exp(Start_Time)                  0.0000586     0.0000378     1.55    0.160
3 ESPN_WinPred                 -5628.        17228.          -0.327   0.752
4 exp(Start_Time):ESPN_WinPred    -0.0000440     0.0000517    -0.850   0.420
```

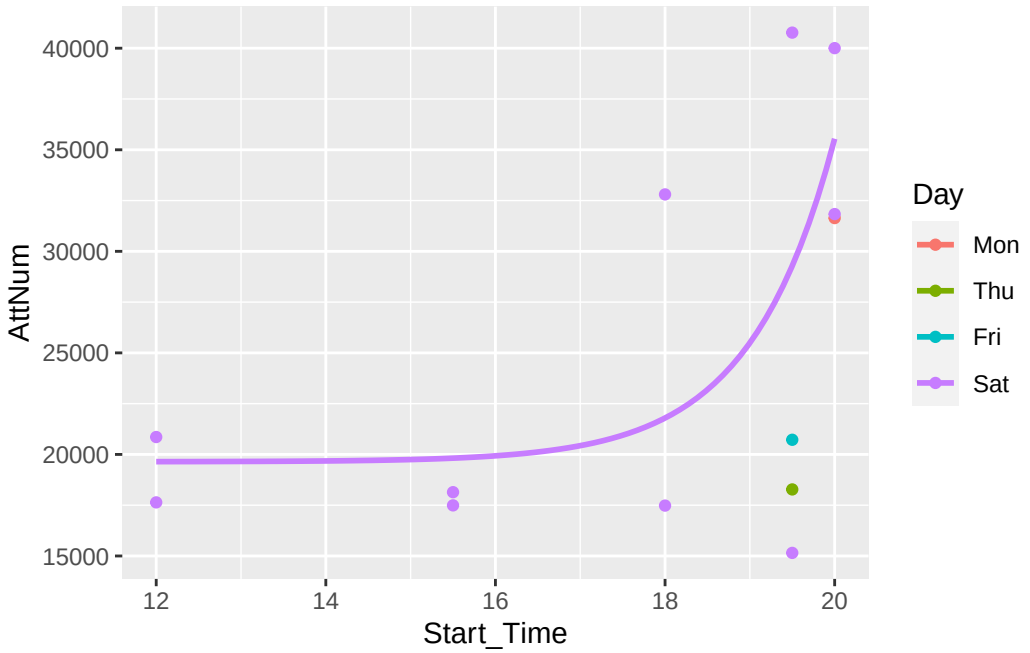
```
glance(time_winpred_add_glm)$AIC
```

```
[1] 248.3154
```

```
glance(time_winpred_int_glm)$AIC
```

```
[1] 249.2786
```

```
home_attendance_data |>
  mutate(Day = fct_relevel(Day, "Mon", "Thu", "Fri", "Sat")) |>
  ggplot(
    aes(x = Start_Time, y = AttNum, color = Day)
  ) +
  geom_point() +
  geom_smooth(method = "glm", formula = y ~ exp(x), se = FALSE) #+
```



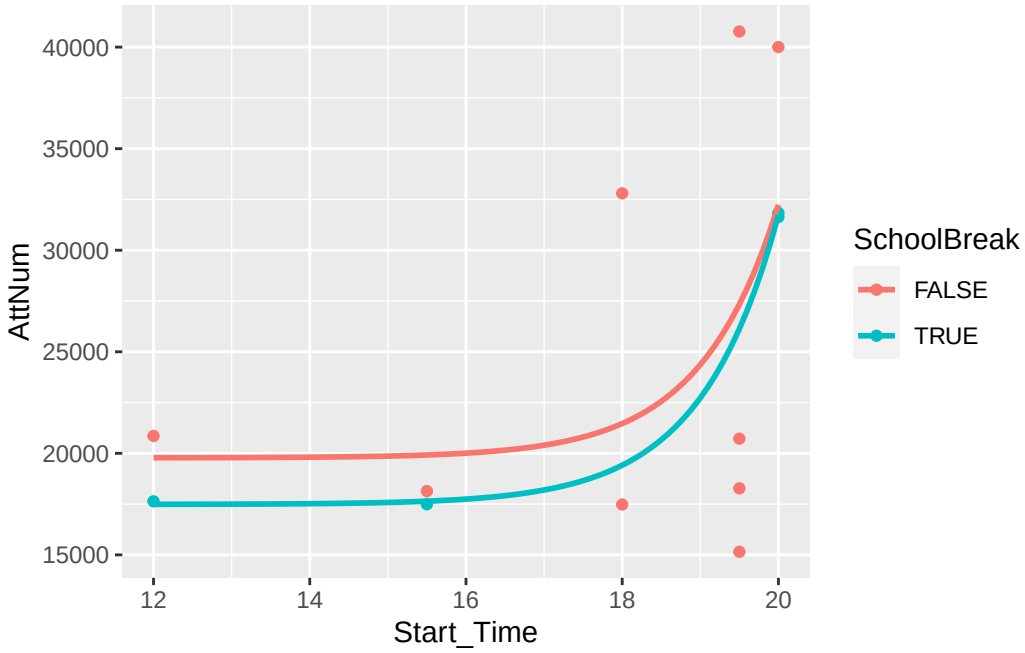

```
  #scale_colour_viridis_c()

time_winpred_day_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) + Day + ESPN_WinPred, data = home_attendance_data)

tidy(time_winpred_day_glm)
```

```
# A tibble: 6 x 5
  term             estimate     std.error statistic p.value
  <chr>               <dbl>         <dbl>     <dbl>   <dbl>
1 (Intercept)      2.52e+4 13436.             1.87   0.110
2 exp(Start_Time)  2.81e-5     0.0000132      2.13   0.0768
3 DayMon           7.22e+3 10322.             0.699  0.510
4 DaySat           4.63e+3  7757.             0.597  0.572
5 DayThu          -1.77e+3  9810.            -0.180  0.863
6 ESPN_WinPred    -1.65e+4 11943.            -1.38   0.217
```

```
glance(time_winpred_day_glm)$AIC
```

```
[1] 251.9767
```

```r
home_attendance_data |>
  ggplot(
    aes(x = Start_Time, y = AttNum, color = SchoolBreak)
  ) +
  geom_point() +
  geom_smooth(method = "glm", formula = y ~ exp(x), se = FALSE) #+
```




```r
  #scale_colour_viridis_c()

time_winpred_break_int_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) * SchoolBreak * ESPN_WinPred, data = home_attendance_data)

time_winpred_break_add_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) + SchoolBreak * ESPN_WinPred, data = home_attendance_data)

tidy(time_winpred_break_int_glm)
```

```
# A tibble: 8 x 5
  term                                    estimate std.error statistic p.value
```

```
  <chr>                                       <dbl>     <dbl>     <dbl>   <dbl>
1 (Intercept)                                2.35e+4   1.91e+4     1.23    0.287
2 exp(Start_Time)                            7.60e-5   5.35e-5     1.42    0.228
3 SchoolBreakTRUE                           -6.67e+3   2.73e+4    -0.244   0.819
4 ESPN_WinPred                              -4.53e+3   2.40e+4    -0.188   0.860
5 exp(Start_Time):SchoolBreakTRUE           -4.19e-5   1.67e-4    -0.251   0.814
6 exp(Start_Time):ESPN_WinPred              -1.09e-4   7.60e-5    -1.44    0.224
7 SchoolBreakTRUE:ESPN_WinPred               5.57e+3   3.81e+4     0.146   0.891
8 exp(Start_Time):SchoolBreakTRUE:ESPN_Win~  1.03e-4   2.09e-4     0.492   0.648
```

```
tidy(time_winpred_break_add_glm)
```

```
# A tibble: 5 x 5
  term                         estimate     std.error statistic p.value
  <chr>                           <dbl>         <dbl>     <dbl>   <dbl>
1 (Intercept)                   3.85e+4  9326.             4.12 0.00444
2 exp(Start_Time)               1.70e-5     0.0000122      1.40 0.205
3 SchoolBreakTRUE              -2.79e+4 21839.            -1.28 0.242
4 ESPN_WinPred                 -2.76e+4 11288.            -2.45 0.0443
5 SchoolBreakTRUE:ESPN_WinPred  4.12e+4 30306.             1.36 0.216
```

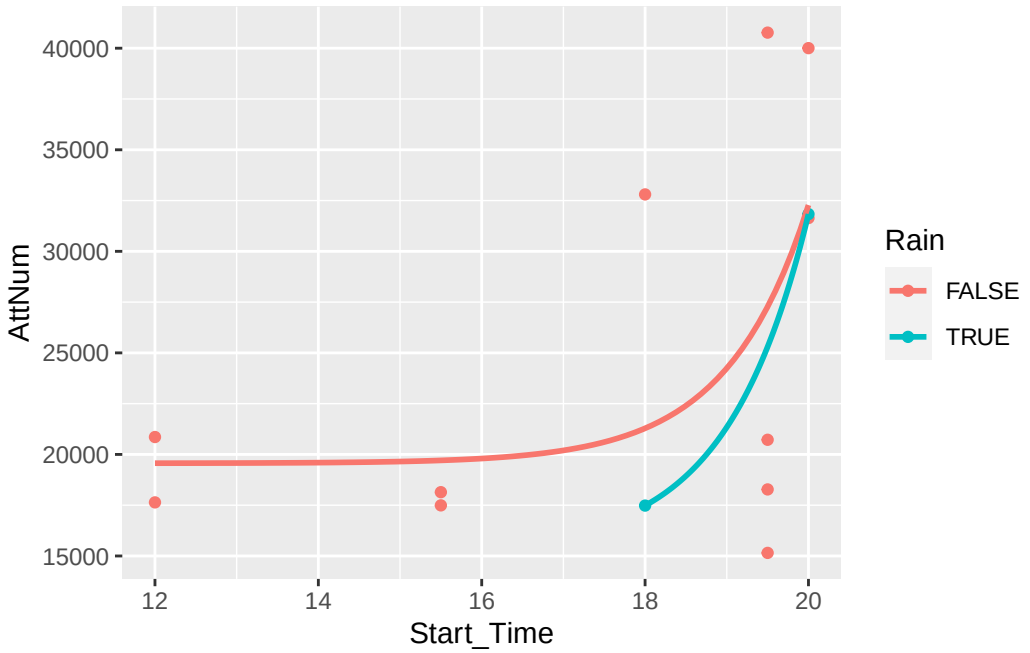
```
glance(time_winpred_break_int_glm)$AIC
```

```
[1] 248.2658
```

```
glance(time_winpred_break_add_glm)$AIC
```

```
[1] 249.3467
```

```
home_attendance_data |>
  ggplot(
    aes(x = Start_Time, y = AttNum, color = Rain)
  ) +
  geom_point() +
  geom_smooth(method = "glm", formula = y ~ exp(x), se = FALSE) #+
```




```
  #scale_colour_viridis_c()

time_winpred_rain_int_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) * Rain + ESPN_WinPred, data = home_attendance_data)

time_winpred_rain_add_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) + Rain + ESPN_WinPred, data = home_attendance_data)

tidy(time_winpred_rain_int_glm)
```

```
# A tibble: 5 x 5
  term                      estimate     std.error statistic p.value
  <chr>                        <dbl>         <dbl>     <dbl>   <dbl>
1 (Intercept)               3.25e+4  8410.             3.87  0.00617
2 exp(Start_Time)           2.65e-5     0.0000117      2.25  0.0588
3 RainTRUE                  5.32e+3  9413.             0.566 0.589
4 ESPN_WinPred             -2.20e+4 11233.            -1.96  0.0911
5 exp(Start_Time):RainTRUE -3.76e-6     0.0000259     -0.145 0.889
```

```
tidy(time_winpred_rain_add_glm)
```

```
# A tibble: 4 x 5
  term            estimate     std.error statistic p.value
  <chr>              <dbl>         <dbl>     <dbl>   <dbl>
1 (Intercept)      3.25e+4  7879.             4.13  0.00331
2 exp(Start_Time)  2.58e-5     0.0000101      2.57  0.0333
3 RainTRUE         4.28e+3  5653.             0.756 0.471
4 ESPN_WinPred    -2.18e+4 10427.            -2.09  0.0702
```

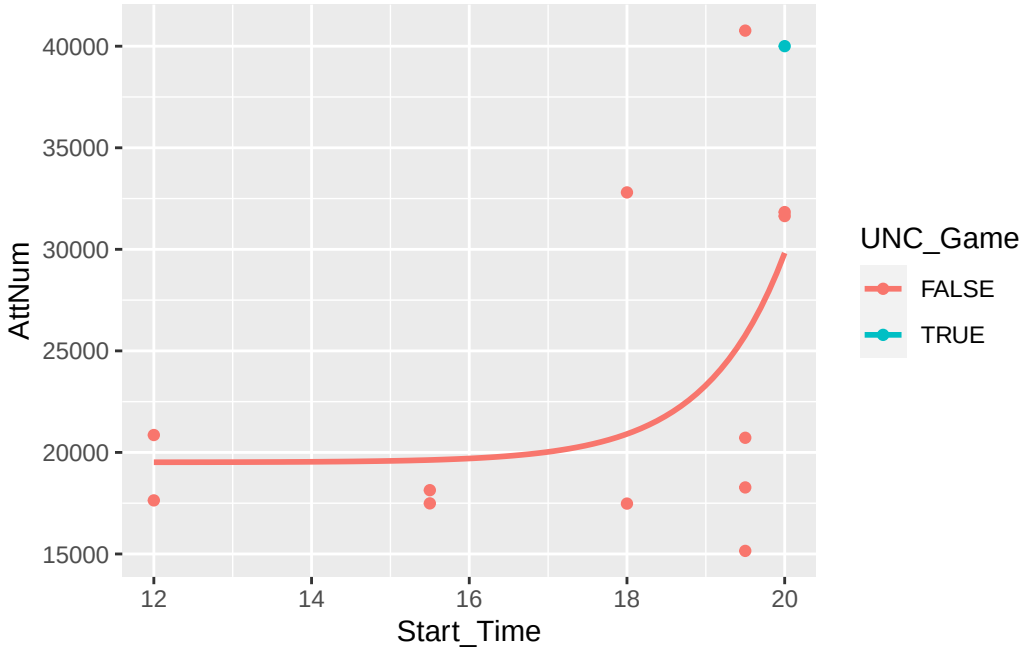
```
glance(time_winpred_rain_int_glm)$AIC
```

```
[1] 251.4506
```

```
glance(time_winpred_rain_add_glm)$AIC
```

```
[1] 249.4866
```

```
home_attendance_data |>
  ggplot(
    aes(x = Start_Time, y = AttNum, color = UNC_Game)
  ) +
  geom_point() +
  geom_smooth(method = "glm", formula = y ~ exp(x), se = FALSE) #+
```




```
  #scale_colour_viridis_c()

time_winpred_UNC_int_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) * UNC_Game + ESPN_WinPred, data = home_attendance_data)

time_winpred_UNC_add_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) + UNC_Game + ESPN_WinPred, data = home_attendance_data)

tidy(time_winpred_UNC_int_glm)
```

```
# A tibble: 5 x 5
  term                          estimate     std.error statistic  p.value
  <chr>                            <dbl>         <dbl>     <dbl>    <dbl>
1 (Intercept)                    2.87e+4  8169.             3.51   0.00796
2 exp(Start_Time)                2.57e-5     0.0000107      2.40   0.0429
3 UNC_GameTRUE                   4.10e+3  8490.             0.482  0.642
4 ESPN_WinPred                  -1.56e+4 10684.            -1.46   0.183
5 exp(Start_Time):UNC_GameTRUE NA           NA              NA     NA
```

```r
tidy(time_winpred_UNC_add_glm)
```

```
# A tibble: 4 x 5
  term            estimate     std.error statistic p.value
  <chr>              <dbl>         <dbl>     <dbl>   <dbl>
1 (Intercept)      2.87e+4  8169.             3.51  0.00796
2 exp(Start_Time)  2.57e-5     0.0000107      2.40  0.0429
3 UNC_GameTRUE     4.10e+3  8490.             0.482 0.642
4 ESPN_WinPred    -1.56e+4 10684.            -1.46  0.183
```

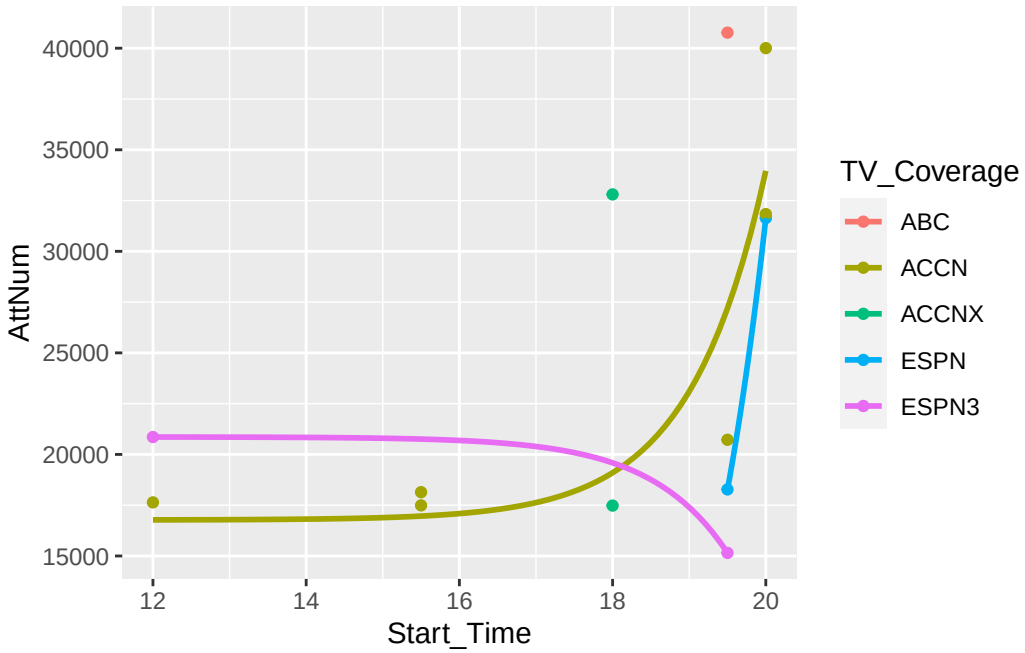
```r
glance(time_winpred_UNC_int_glm)$AIC
```

```
[1] 249.9714
```

```r
glance(time_winpred_UNC_add_glm)$AIC
```

```
[1] 249.9714
```

```r
home_attendance_data |>
  ggplot(
    aes(x = Start_Time, y = AttNum, color = TV_Coverage)
  ) +
  geom_point() +
  geom_smooth(method = "glm", formula = y ~ exp(x), se = FALSE) #+
```




```
  #scale_colour_viridis_c()

time_winpred_TV_int_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) * TV_Coverage * ESPN_WinPred, data = home_attendance_data)

time_winpred_TV_add_glm <- linear_reg() |>
  set_engine("glm") |>
  fit(AttNum ~ exp(Start_Time) + TV_Coverage * ESPN_WinPred, data = home_attendance_data)

tidy(time_winpred_TV_int_glm)
```

```
# A tibble: 20 x 5
   term                                estimate std.error statistic p.value
   <chr>                                  <dbl>     <dbl>     <dbl>   <dbl>
 1 (Intercept)                         4.40e+4   1.22e+4      3.61   0.0689
 2 exp(Start_Time)                     4.65e-6   3.63e-5      0.128  0.910
 3 TV_CoverageACCN                    -2.55e+4   6.31e+3     -4.04   0.0562
 4 TV_CoverageACCNX                   -2.18e+4   7.71e+3     -2.83   0.106
 5 TV_CoverageESPN                    -4.68e+4   1.15e+4     -4.05   0.0558
 6 TV_CoverageESPN3                   -2.14e+4   5.19e+3     -4.13   0.0538
 7 ESPN_WinPred                       -2.14e+3   1.53e+4     -0.140  0.902
```

```
 8 exp(Start_Time):TV_CoverageACCN           5.61e-5   1.93e-5     2.91   0.100
 9 exp(Start_Time):TV_CoverageACCNX         NA        NA          NA     NA
10 exp(Start_Time):TV_CoverageESPN           1.09e-4   3.05e-5     3.58   0.0698
11 exp(Start_Time):TV_CoverageESPN3         NA        NA          NA     NA
12 exp(Start_Time):ESPN_WinPred             -4.49e-5   3.88e-5    -1.16   0.367
13 TV_CoverageACCN:ESPN_WinPred             NA        NA          NA     NA
14 TV_CoverageACCNX:ESPN_WinPred            NA        NA          NA     NA
15 TV_CoverageESPN:ESPN_WinPred             NA        NA          NA     NA
16 TV_CoverageESPN3:ESPN_WinPred            NA        NA          NA     NA
17 exp(Start_Time):TV_CoverageACCN:ESPN_Wi~ NA        NA          NA     NA
18 exp(Start_Time):TV_CoverageACCNX:ESPN_W~ NA        NA          NA     NA
19 exp(Start_Time):TV_CoverageESPN:ESPN_Wi~ NA        NA          NA     NA
20 exp(Start_Time):TV_CoverageESPN3:ESPN_W~ NA        NA          NA     NA
```

```
tidy(time_winpred_TV_add_glm)
```

```
# A tibble: 11 x 5
   term                          estimate std.error statistic p.value
   <chr>                            <dbl>     <dbl>     <dbl>   <dbl>
 1 (Intercept)                    1.06e+4   8.80e+3     1.21   0.313
 2 exp(Start_Time)                3.25e-5   6.68e-6     4.87   0.0165
 3 TV_CoverageACCN                1.78e+4   9.54e+3     1.86   0.160
 4 TV_CoverageACCNX              -6.33e+4   1.67e+4    -3.78   0.0324
 5 TV_CoverageESPN               -9.87e+4   7.25e+4    -1.36   0.266
 6 TV_CoverageESPN3              -4.42e+4   9.80e+3    -4.52   0.0203
 7 ESPN_WinPred                   6.85e+4   2.38e+4     2.88   0.0637
 8 TV_CoverageACCN:ESPN_WinPred  -8.56e+4   2.46e+4    -3.47   0.0402
 9 TV_CoverageACCNX:ESPN_WinPred NA        NA          NA     NA
10 TV_CoverageESPN:ESPN_WinPred   5.07e+4   9.03e+4     0.561  0.614
11 TV_CoverageESPN3:ESPN_WinPred NA        NA          NA     NA
```

```
glance(time_winpred_TV_int_glm)$AIC
```

```
[1] 229.0432
```

```
glance(time_winpred_TV_add_glm)$AIC
```

```
[1] 233.1881
```

```
tidy(time_winpred_add_glm)
```

```
# A tibble: 3 x 5
  term            estimate     std.error statistic p.value
  <chr>              <dbl>         <dbl>     <dbl>   <dbl>
1 (Intercept)      3.03e+4 7130.              4.25 0.00215
2 exp(Start_Time)  2.76e-5    0.00000954      2.89 0.0180
3 ESPN_WinPred    -1.81e+4 8969.             -2.01 0.0750
```

```
tidy(time_winpred_TV_int_glm)
```

```
# A tibble: 20 x 5
   term                                    estimate std.error statistic p.value
   <chr>                                      <dbl>     <dbl>     <dbl>   <dbl>
 1 (Intercept)                             4.40e+4   1.22e+4     3.61   0.0689
 2 exp(Start_Time)                         4.65e-6   3.63e-5     0.128  0.910
 3 TV_CoverageACCN                        -2.55e+4   6.31e+3    -4.04   0.0562
 4 TV_CoverageACCNX                       -2.18e+4   7.71e+3    -2.83   0.106
 5 TV_CoverageESPN                        -4.68e+4   1.15e+4    -4.05   0.0558
 6 TV_CoverageESPN3                       -2.14e+4   5.19e+3    -4.13   0.0538
 7 ESPN_WinPred                           -2.14e+3   1.53e+4    -0.140  0.902
 8 exp(Start_Time):TV_CoverageACCN         5.61e-5   1.93e-5     2.91   0.100
 9 exp(Start_Time):TV_CoverageACCNX       NA         NA          NA     NA
10 exp(Start_Time):TV_CoverageESPN         1.09e-4   3.05e-5     3.58   0.0698
11 exp(Start_Time):TV_CoverageESPN3       NA         NA          NA     NA
12 exp(Start_Time):ESPN_WinPred           -4.49e-5   3.88e-5    -1.16   0.367
13 TV_CoverageACCN:ESPN_WinPred           NA         NA          NA     NA
14 TV_CoverageACCNX:ESPN_WinPred          NA         NA          NA     NA
15 TV_CoverageESPN:ESPN_WinPred           NA         NA          NA     NA
16 TV_CoverageESPN3:ESPN_WinPred          NA         NA          NA     NA
17 exp(Start_Time):TV_CoverageACCN:ESPN_Wi~ NA       NA          NA     NA
18 exp(Start_Time):TV_CoverageACCNX:ESPN_W~ NA       NA          NA     NA
19 exp(Start_Time):TV_CoverageESPN:ESPN_Wi~ NA       NA          NA     NA
20 exp(Start_Time):TV_CoverageESPN3:ESPN_W~ NA       NA          NA     NA
```

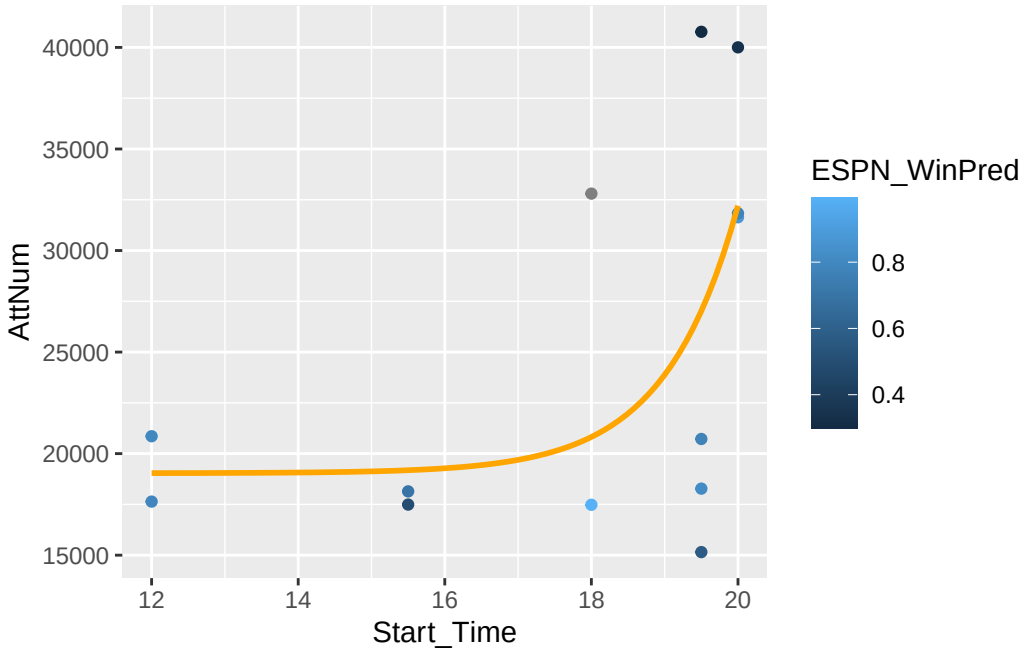
```
glance(time_winpred_add_glm)$AIC
```

```
[1] 248.3154
```

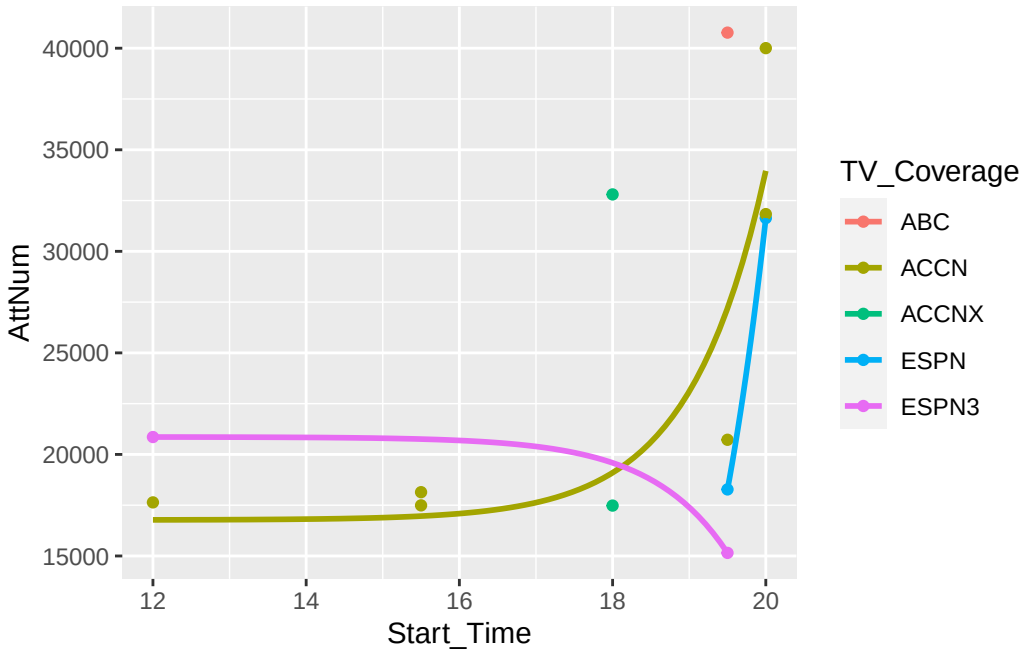
```
glance(time_winpred_TV_int_glm)$AIC
```

```
[1] 229.0432
```

```
home_attendance_data |>
  ggplot(
    aes(x = Start_Time, y = AttNum, color = ESPN_WinPred)
  ) +
  geom_point() +
  geom_smooth(method = "glm", formula = y ~ exp(x), se = FALSE, color = "orange") #+
```




```
  #scale_colour_viridis_c()

home_attendance_data |>
  ggplot(
    aes(x = Start_Time, y = AttNum, color = TV_Coverage)
  ) +
  geom_point() +
  geom_smooth(method = "glm", formula = y ~ exp(x), se = FALSE) #+
```




```
#scale_colour_viridis_c()
```

Model 1 (simpler):

$$\widehat{AttNum} = 30285 + 0.0000276 * e^{(Start\_Time)} - 18051 * (ESPN\_WinPred)$$

The further past 12 PM (earliest) that a game starts, the *more* people are predicted to attend.

The more likely it is that Duke will win, the *less* people are predicted to attend.

Model 2 (better matches observed attendance):

$$\widehat{AttNum} = 44002 + 0.0000047 * e^{(Start\_Time)} - 25470 * ACCN - 21778 * ACCNX - 46798 * ESPN - 21442 * ESPN3 -$$

$$ACCN = \begin{cases} 1 & \text{if broadcast on ACCN} \\ 0 & \text{else} \end{cases} \quad ACCNX = \begin{cases} 1 & \text{if broadcast on ACCNX} \\ 0 & \text{else} \end{cases} \quad ESPN = \begin{cases} 1 & \text{if broadcast o} \\ 0 & \text{else} \end{cases}$$