A Consideration of Probability and Runs Scored Major League Baseball Extra-Inning Games

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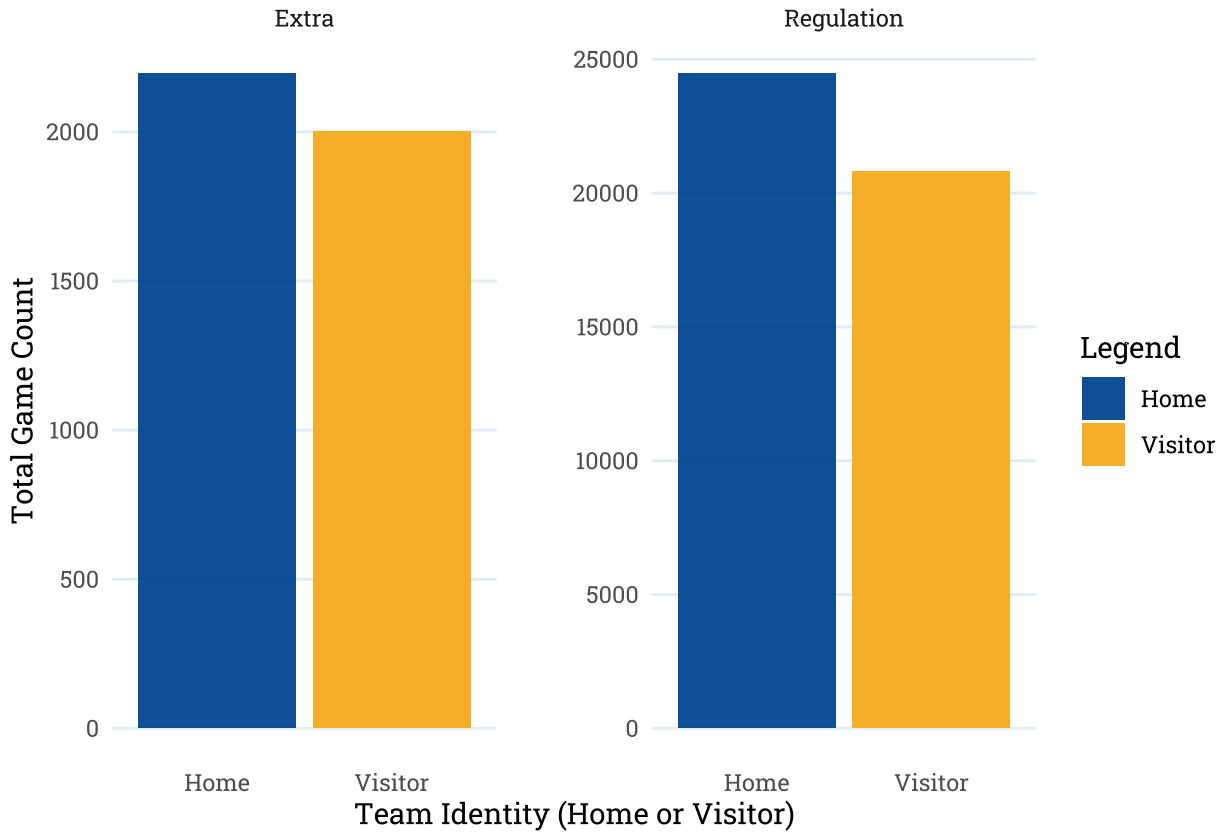
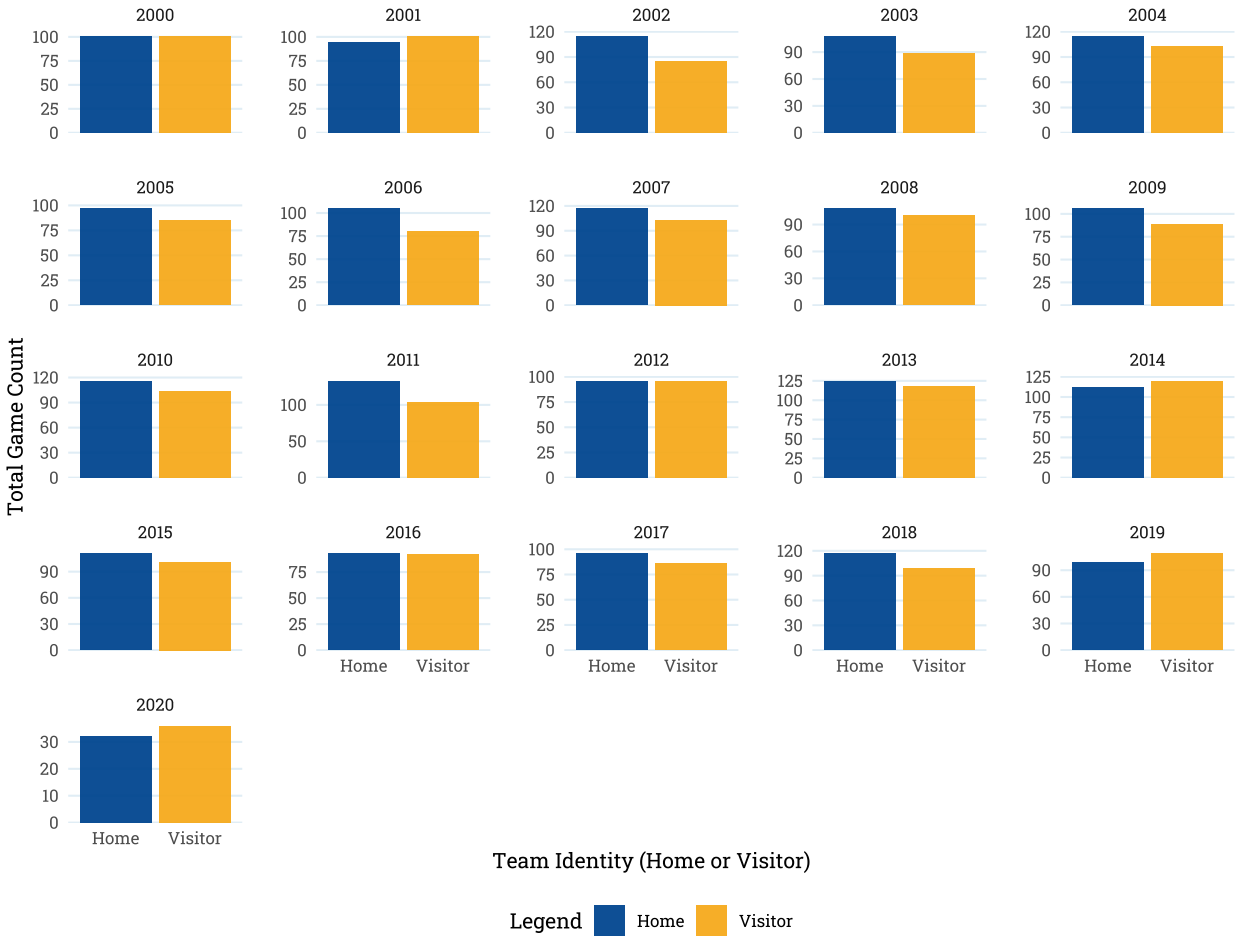
Introduction

The outbreak of COVID-19 and the subsequent pandemic led to a plethora of questions and concerns in the sporting world, including whether leagues would commit to a 2020 season. For those leagues that did decide to host a 2020 seasons, various protocols were required to ensure the health and safety of the athletes and staff. For instance, the National Hockey League (NHL) Implemented bubbles with all teams within the Western Conference playing within Edmonton, Alberta and all teams within the Eastern Conference within Toronto, Ontario (Gatto, 2020). In a similar move, the National Basketball Association (NBA) established a bubble in Orlando, Florida within which teams could play out the season (Haislop, 2020). However, unlike the use of a bubbled league like the NHL and NBA, Major League Baseball (MLB) permitted teams to play games within their own stadiums, excluding the Toronto Blue Jays who were denied access to play within Canada by the Canadian federal government (McNamara, 2020; Wagner, 2020). In choosing this approach, MLB implemented other policies such as no spitting, masks being required in the dugout and bullpen, and no saunas, and twice-a-day temperature and symptom checks to name a few (Wagner, 2020). One such policy was to also introduce a new rule regarding extra-inning games, tied games that go beyond the regulation nine innings, in hopes of shortening the exposure experienced by players between teams (Allen, 2020). The rule was that if at the completion of the regulation innings a game was tied, each team would begin the subsequent half-inning with the last player to make an out on second base (Allen, 2020). As a rule change to a sport or game should ensure the fairness of the playing field, this paper looks to examine this rule change regarding whether it provides an advantage to the away team in extra-inning games through the probabilities of runs scored based on the state of events in a half-inning. Moreover, it considers whether extra-inning games in general provide an advantage to the away team through the probabilities of runs scored based on the state of events in a half-inning, and discusses strategy within the context of extra-inning games.


Extra
Regulation
Total Game Count
2000
1500
1000
500
0
25000
20000
15000
10000
5000
0
Home
Visitor
Home
Visitor
Team Identity (Home or Visitor)
Legend
Home
Visitor


2000
2001
2002
2003
2004
2005
2006
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2008
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2011
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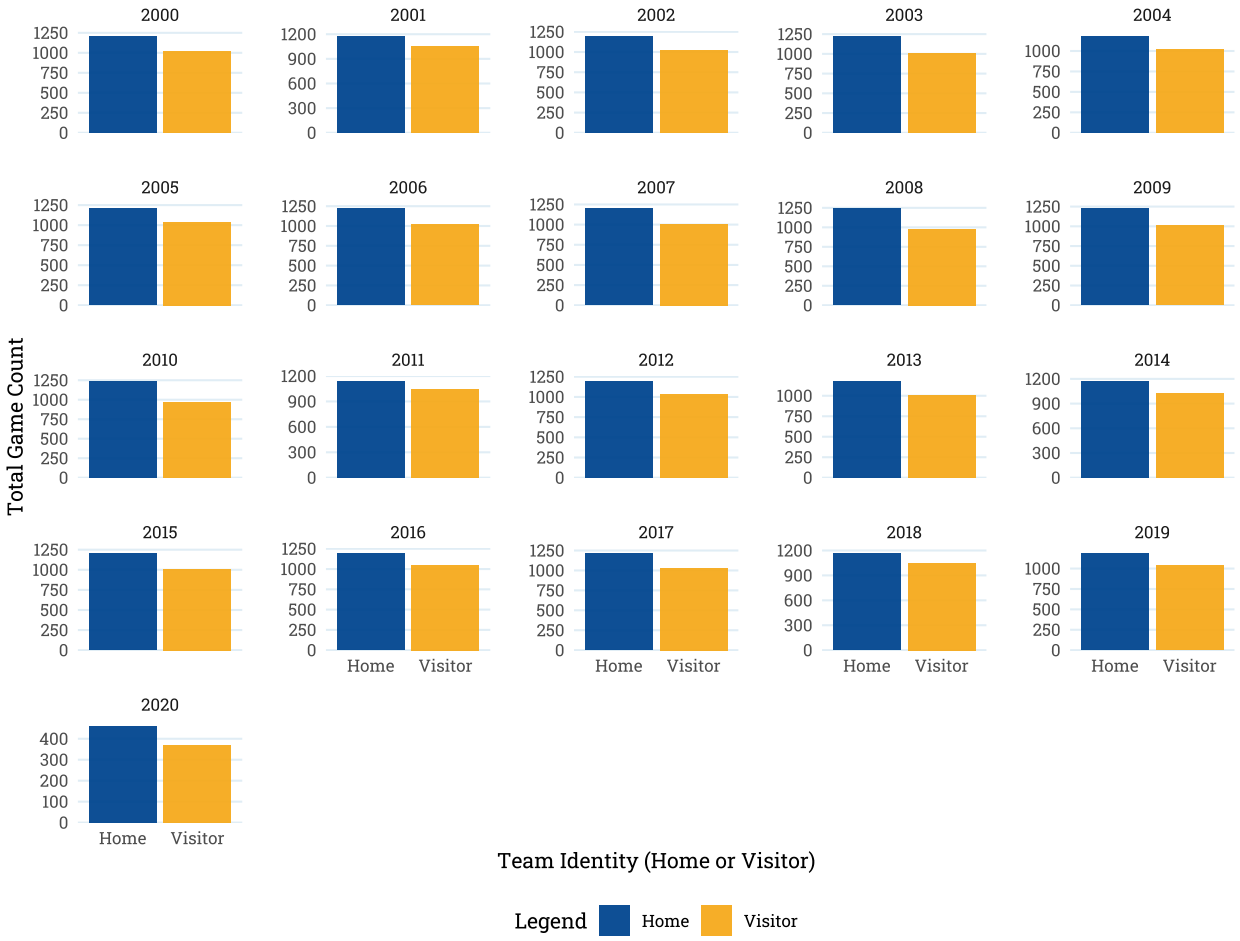
2017
2018
2019
2020
Home
Visitor
Total Game Count
Team Identity (Home or Visitor)
Legend
Home
Visitor


2000
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2018
2019
2020
Total Game Count
Home
Visitor
Team Identity (Home or Visitor)
Legend
Home
Visitor

winning_team	year	count	winning_team	year	count
home	2000	101	visitor	2000	101
home	2001	94	visitor	2001	101
home	2002	115	visitor	2002	85
home	2003	108	visitor	2003	89
home	2004	115	visitor	2004	103
home	2005	97	visitor	2005	85
home	2006	105	visitor	2006	80
home	2007	117	visitor	2007	103
home	2008	108	visitor	2008	100
home	2009	106	visitor	2009	89
home	2010	116	visitor	2010	104
home	2011	133	visitor	2011	104
home	2012	96	visitor	2012	96
home	2013	125	visitor	2013	118
home	2014	112	visitor	2014	120
home	2015	111	visitor	2015	101
home	2016	93	visitor	2016	92
home	2017	96	visitor	2017	86
home	2018	117	visitor	2018	99
home	2019	99	visitor	2019	109
home	2020	32	visitor	2020	36

winning_team	year	count	winning_team	year	count
home	2000	1211	visitor	2000	1015
home	2001	1179	visitor	2001	1054
home	2002	1199	visitor	2002	1026
home	2003	1227	visitor	2003	1005
home	2004	1184	visitor	2004	1026
home	2005	1209	visitor	2005	1039
home	2006	1222	visitor	2006	1022
home	2007	1201	visitor	2007	1010
home	2008	1243	visitor	2008	977
home	2009	1227	visitor	2009	1008
home	2010	1242	visitor	2010	968
home	2011	1143	visitor	2011	1049
home	2012	1199	visitor	2012	1039
home	2013	1182	visitor	2013	1006
home	2014	1176	visitor	2014	1022
home	2015	1205	visitor	2015	1012
home	2016	1194	visitor	2016	1048
home	2017	1215	visitor	2017	1033
home	2018	1166	visitor	2018	1049
home	2019	1187	visitor	2019	1034
home	2020	462	visitor	2020	368

```
## [1] 32000
```

Runs scored $RUNS$ is equal to difference between the sum of runners $N_{runners}$ and outs O before (b) the event plus one and the number of runners $N_{runners}$ plus outs O after (a) after the event.

$$RUNS = (N_{runners}^{(b)} + O^{(b)} + 1) - (N_{runners}^{(a)} + o^{(a)})$$

```
## runs_simulation
##     0     1     2     3     4     5     6     7     8     9
## 14760  2837  1276   620   286   128    48    27    11     7
```

```
## [1] 0.262
```

```
## [1] 0.48305
```

```
p3 <- pmatrix_total %*% pmatrix_total %*% pmatrix_total

p3 %>%
  as_tibble(rownames = "state") %>%
  filter(state == "010 0") %>%
  gather(key = "new_state", value = "prob", -state) %>%
  arrange(desc(prob)) %>%
  head()
```

```
## # A tibble: 6 x 3
##   state new_state   prob
##   <chr> <chr>      <dbl>
## 1 010 0 3         0.334
## 2 010 0 100 2     0.122
## 3 010 0 110 2     0.0698
## 4 010 0 101 2     0.0685
## 5 010 0 010 2     0.0663
## 6 010 0 110 1     0.0641
```

References

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Haislop, T. (2020, August 26). *NBA bubble explained: A complete guide to the rules, teams, schedule & more for Orlando games.* Sporting News. https://www.sportingnews.com/us/nba/news/nba-bubble-rules-teams-schedule-orlando/zhap66a9hcwq1khmcex3ggabo

McNamara, A. (2020, July 24). *Toronto Blue Jays to play majority of 2020 home games in Buffalo.* CBS News. https://www.cbsnews.com/news/toronto-blue-jays-home-games-buffalo-2020-season/

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