Eric Agyemang

MAT 455

Final Project

**USING THE POISSON PROCESS TO SIMULATE OUTCOME OF ICE HOCKEY GAMES**

**Introduction**

Ice hockey is a contact sport played on ice, where two teams of skaters use their sticks to shoot a puck into the opponents net to score points. The teams usually consist of six players each. Each team has a goaltender and five who skate on the ice take the puck and score against the opposing team. Ice hockey is typically popular in countries with cooler climates such as Canada, Russia, the United States, the Baltic states, etc. The sport is typically played during the fall, winter and spring. Teams can only score one point at a time. Each team can also play defense to thwart the opponent from scoring points. This is typically done through defendants matching their backward speed to the opponent’s forward speed. This makes it less convoluted for the defendants to obtain the puck and go on offense.

The Poisson process is a stochastic counting process that models the time at which arrivals occur. Arrivals may occur at arbitrary positive times. This means that the Poisson process is a non-decreasing, non-negative process. It is derived from the fact that if a collection of random points in some space forms a Poisson process, then the number of points in a region of finite size follows a Poisson distribution. The Poisson process can be useful for modeling radioactive decay, telephone calls, number of customers entering a shop, scoring in sports such as basketball, football soccer etc.

This project used the Poisson process to calculate probabilities for the outcome of ice hockey games. For events to follow Poisson process, the events must be random, rare and memoryless. For hockey, this is mostly the case except when teams pull their goalies. The scoring is random, rare and memoryless. If the scoring was not memoryless, then the goals would occur in bunches analogous to baseball. Pulling the goalie occurs when teams need an extra attacker. Teams typically pull their goalies towards the end of games or during a delayed penalty call. Therefore, because pulling the goalie does not satisfy the conditions of a Poisson process, this project did not include it.

The goal was to determine the probability of one team winning a game against another team. To determine this probability, a method developed by (DeJardine, 2013) was used to generate a function that considers the difference in score using the Skellam distribution. Probabilities were calculated for two National Hockey League (NHL) teams, the St. Louis Blues and the Boston Bruins. Because the study by (DeJardine, 2013) was theoretical, no simulations or code were provided. Therefore, a second goal of this project was to develop code to simulate those methods. A discussion of the results and the code is given.

**Methods**

Two teams are compared during a hockey game. The goal was to determine which team wins a game, given a regular season game or a playoff game. This was calculated using a method developed by (DeJardine, 2013). It is known that scoring for each team has a Poisson process with parameter . Thus, scoring for teams one and two follow Poisson distributions and , with parameters and . Therefore, the objective was to determine and . To find these probabilities, the goal differential between teams was considered. To account for this, the Skellam distribution was introduced.

Definition: If and are two independent random variables with rates and , then the difference follows a Skellam distribution with probability density function

,

where is the modified Bessel function of the first kind of order . This function is defined as

.

Here, is the goal differential at time . If , team one is winning by goals and if , team two is winning by goals. Analogous to (DeJardine, 2013), each scenario is covered briefly.

At the end of the third quarter or at sixty minutes, the probability of team one winning is

,

and the probability of team two winning is

.

In the case that there is a tie, there are two overtime scenarios considered. The first scenario is when overtime occurs in a playoff game. Each team plays for twenty minutes quarters until one team scores (i.e. they continue to play twenty minutes quarters until the first team scores). The first team to score, wins the game. The probability that team one wins a playoff game in overtime is

,

and the probability of team two winning a playoff game in overtime is

,

where is the probability that the teams will be tied at the end of regulation (i.e. .

In the case of a regular season game, each team plays for a five-minute quarter until the first team scores. Since and represent the average number of goals over sixty minutes, is used to represent the five-minute quarter. Thus, the probability that team one will win within the five-minute regular season overtime is

,

and the probability of team two winning is

.

Shootouts are also considered during overtime in regular season games. If no team scores within the five-minute overtime, then they move on to a shootout. Shootouts are like penalty shots, where the goalie must defend against a scorer on the other team who attempts to shoot the puck into the goal from a specified distance. This is analogous penalty shots in soccer. The probability of a shootout occurring is , and each team has an equal chance of winning. Thus, the probability of a team winning after a shootout is

.

Now to determine who wins a game, the probability for each scenario is summed up for each team. Thus, the probability of team one winning a regular season game is

.

The probability of team two winning a regular season game is

.

The probability of team one winning a playoff game is

.

The probability of team two winning a playoff game is

.

The data for the average number of goals for each team was collected from the NHL website. Data from the 2018-2019 season was used and can be found in Appendix B. The and values were calculated by averaging the scores from each hockey game in the regular season and playoffs. The code for this project was developed using R.

**Results**

The code is provided in the Appendix A, along with the call functions. It suffices to provide some examples of the Skellam distribution using two NHL teams. In the 2019 playoffs, the St. Louis Blues averaged 3 goals per game and the Boston Bruins averaged 3.3125 goals per game before the start of the championship series. Given that the Blues are up by two goals, the probability that the Blues win is

.

The probability of the Bruins winning, given that they are up by two goals is

Now consider the playoffs, when each team wins given that they are tied. The probability of the Blues winning is

and the probability of the bruins winning is

Now Consider the case of a regular season game when the teams are tied. The Blues averaged 3.0121 goals per game during the 2018-2019 season, while the Bruins averaged 3.1585 goals in the same season. The probability of the Blues winning is

and the probability of the Bruins winning is

**Discussion**

From the results above, the Blues have a higher chance of winning a game against the Bruins when they are ahead opposed to when they are tied. These probabilities can fluctuate with changes in the and (number of goals that the selected team is leading by) parameters. Given that the teams are tied, the probability of a Blues winning a playoff game against the Bruins are analogous to the probability of the Blues winning against the Bruins a regular season game. In both scenarios, this probability can fluctuate, depending on the values of and .

The probabilities were calculated for only two NHL teams. It is important to note that the two values and need to be calculated for each pair of teams. They should not be used as a national average. It is also important to remember that there is a difference between regular season games and playoff games. Playoff games tend to be more competitive than regular season games, because teams are competing for the championship. Therefore, the and values must be calculated to for both scenarios to reflect this. These values will ultimately affect the probability of one team winning over another.

Examining the probabilities calculated and the questions asked, it can be seen that (DeJardine, 2013) method was developed to only calculate the probabilities for one team to win against the other given a lead or a tie. The probabilities for a team to lead given a deficit have not been considered but should be considered in a future project. Also, the probability of one team loosing against another given a lead, a tie or a deficit has not been considered and should be considered for a future project. This limitation is reflected in the code below, where negatives values of the parameter will return a null value. This way the function will not return false probabilities.

**Appendix A**

**Code for Skellam Distribution**

# Skellam Dist Pr(D = X-Y = d)

# Skellam\_win(L1,L2,x,team, type)

# L1 = average number of goals for team 1

# L2 = average number of goals for team 2

# x = number of goals that the selected team is winning by (Team is selected with 'team' parameter)

# team = team we are calculating probability of win for {1 if team 1, 2 if team 2}

# type = Type of game{ 'r' for regular season, 'p' for playoffs}

Skellam\_Win <- function(L1, L2, x, team, type) {

S <- 0

bess <- function(theta) {

exp(2\*sqrt(L1\*L2)\*cos(theta))\*cos(theta)

}

I <- integrate(bess, lower = 0, upper = pi)

I <- (1/pi)\*I$value

S0 = exp(-(L1+L2))\*I

# For Team 1 Winning a regular season Game

if (x >= 0 &type == 'r' & team == 1) {

for (i in 0:x) {

S = S + exp(-(L1+L2))\*((L1/L2)^(i/2))\*I

}

S = S +S0\*((L1/(L1+L2))\*(1-exp(-(L1+L2)/12)) + 0.5\*exp(-(L1+L2)/12))

if (S > 1) {

S = 1

}

return(S)

}

#Probability of Team 2 Winning a regular season game.

else if (x >= 0 & type == 'r' & team == 2){

for (i in 0:x) {

S = S + exp(-(L1+L2))\*((L2/L1)^(i/2))\*I

}

S = S +S0\*((L2/(L1+L2))\*(1-exp(-(L1+L2)/12))+0.5\*exp(-(L1+L2)/12))

if (S > 1) {

S = 1

}

return(S)

}

#Probability of Team 1 winning a playoff game

else if (x >= 0 & type == 'p' & team == 1) {

for (i in 0:x) {

S = S + exp(-(L1+L2))\*((L1/L2)^(i/2))\*I

}

S = S + S0\*(L1/(L1+L2))

if (S > 1) {

S = 1

}

return(S)

}

#Probabiltiy of Team 2 winning a playoff game

else if (x >= 0 & type == 'p' & team == 2) {

for (i in 0:x) {

S = S + exp(-(L1+L2))\*((L2/L1)^(i/2))\*I

}

S = S + S0\*(L2/(L1+L2))

if (S > 1) {

S = 1

}

return(S)

}

else {

return(NULL)

}

}

**Probability of Blues winning playoff game against Bruins while up by 2**Skellam\_Win(3, 3.3125, 2, 1, type = "p")

**Probability of Bruins winning playoff game against Blues while up by 2**

Skellam\_Win(3, 3.3125, 2, 2, type = "p")

**Probability of Blues winning playoff game against Bruins while tied**

Skellam\_Win(3, 3.3125, 0, 1, type = "p")

**Probability of Bruins winning playoff game against Blues while tied**

Skellam\_Win(3, 3.3125, 0, 2, type = "p")

**Probability of Blues winning regular season game against Bruins while tied**

Skellam\_Win(3.0121, 3.1585, 0, 1, type = "r")

**Probability of Bruins winning regular season game against Blues while tied**

Skellam\_Win(3.0121, 3.1585, 0, 2, type = "r")

**Appendix B**

**Data for Boston Bruins Regular Season**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GP** | **Date** |  | **Opponent** | **GF** | **GA** |  |  | **W** | **L** | **OL** | **Streak** | **Att.** | **LOG** |
| **1** | 10/3/2018 | @ | Washington Capitals | 0 | 7 | L |  | 0 | 1 | 0 | L 1 | 18,506 | 2:30 |
| **2** | 10/4/2018 | @ | Buffalo Sabres | 4 | 0 | W |  | 1 | 1 | 0 | W 1 | 19,070 | 2:35 |
| **3** | 10/8/2018 |  | Ottawa Senators | 6 | 3 | W |  | 2 | 1 | 0 | W 2 | 17,565 | 2:33 |
| **4** | 10/11/2018 |  | Edmonton Oilers | 4 | 1 | W |  | 3 | 1 | 0 | W 3 | 17,565 | 2:28 |
| **5** | 10/13/2018 |  | Detroit Red Wings | 8 | 2 | W |  | 4 | 1 | 0 | W 4 | 17,565 | 2:40 |
| **6** | 10/17/2018 | @ | Calgary Flames | 2 | 5 | L |  | 4 | 2 | 0 | L 1 | 17,641 | 2:25 |
| **7** | 10/18/2018 | @ | Edmonton Oilers | 2 | 3 | L | OT | 4 | 2 | 1 | L 2 | 18,347 | 2:26 |
| **8** | 10/20/2018 | @ | Vancouver Canucks | 1 | 2 | L | OT | 4 | 2 | 2 | L 3 | 17,871 | 2:30 |
| **9** | 10/23/2018 | @ | Ottawa Senators | 4 | 1 | W |  | 5 | 2 | 2 | W 1 | 15,265 | 2:31 |
| **10** | 10/25/2018 |  | Philadelphia Flyers | 3 | 0 | W |  | 6 | 2 | 2 | W 2 | 17,565 | 2:32 |
| **11** | 10/27/2018 |  | Montreal Canadiens | 0 | 3 | L |  | 6 | 3 | 2 | L 1 | 17,565 | 2:37 |
| **12** | 10/30/2018 | @ | Carolina Hurricanes | 3 | 2 | W |  | 7 | 3 | 2 | W 1 | 11,357 | 2:37 |
| **13** | 11/3/2018 | @ | Nashville Predators | 0 | 1 | L |  | 7 | 4 | 2 | L 1 | 17,535 | 2:38 |
| **14** | 11/5/2018 |  | Dallas Stars | 2 | 1 | W | OT | 8 | 4 | 2 | W 1 | 17,565 | 2:34 |
| **15** | 11/8/2018 |  | Vancouver Canucks | 5 | 8 | L |  | 8 | 5 | 2 | L 1 | 17,565 | 2:38 |
| **16** | 11/10/2018 |  | Toronto Maple Leafs | 5 | 1 | W |  | 9 | 5 | 2 | W 1 | 17,565 | 2:34 |
| **17** | 11/11/2018 |  | Vegas Golden Knights | 4 | 1 | W |  | 10 | 5 | 2 | W 2 | 17,565 | 2:30 |
| **18** | 11/14/2018 | @ | Colorado Avalanche | 3 | 6 | L |  | 10 | 6 | 2 | L 1 | 16,124 | 2:20 |
| **19** | 11/16/2018 | @ | Dallas Stars | 0 | 1 | L | OT | 10 | 6 | 3 | L 2 | 18,532 | 2:37 |
| **20** | 11/17/2018 | @ | Arizona Coyotes | 2 | 1 | W |  | 11 | 6 | 3 | W 1 | 16,386 | 2:23 |
| **21** | 11/21/2018 | @ | Detroit Red Wings | 2 | 3 | L | OT | 11 | 6 | 4 | L 1 | 19,515 | 2:29 |
| **22** | 11/23/2018 |  | Pittsburgh Penguins | 2 | 1 | W | OT | 12 | 6 | 4 | W 1 | 17,565 | 2:41 |
| **23** | 11/24/2018 | @ | Montreal Canadiens | 3 | 2 | W |  | 13 | 6 | 4 | W 2 | 21,302 | 2:37 |
| **24** | 11/26/2018 | @ | Toronto Maple Leafs | 2 | 4 | L |  | 13 | 7 | 4 | L 1 | 19,286 | 2:27 |
| **25** | 11/29/2018 |  | New York Islanders | 2 | 1 | W | SO | 14 | 7 | 4 | W 1 | 17,565 | 2:42 |
| **26** | 12/1/2018 |  | Detroit Red Wings | 2 | 4 | L |  | 14 | 8 | 4 | L 1 | 17,565 | 2:40 |
| **27** | 12/4/2018 | @ | Florida Panthers | 0 | 5 | L |  | 14 | 9 | 4 | L 2 | 12,058 | 2:40 |
| **28** | 12/6/2018 | @ | Tampa Bay Lightning | 2 | 3 | L |  | 14 | 10 | 4 | L 3 | 19,092 | 2:24 |
| **29** | 12/8/2018 |  | Toronto Maple Leafs | 6 | 3 | W |  | 15 | 10 | 4 | W 1 | 17,565 | 2:39 |
| **30** | 12/9/2018 | @ | Ottawa Senators | 2 | 1 | W | OT | 16 | 10 | 4 | W 2 | 13,148 | 2:33 |
| **31** | 12/11/2018 |  | Arizona Coyotes | 4 | 3 | W |  | 17 | 10 | 4 | W 3 | 17,565 | 2:35 |
| **32** | 12/14/2018 | @ | Pittsburgh Penguins | 3 | 5 | L |  | 17 | 11 | 4 | L 1 | 18,549 | 2:32 |
| **33** | 12/16/2018 |  | Buffalo Sabres | 2 | 4 | L |  | 17 | 12 | 4 | L 2 | 17,565 | 2:34 |
| **34** | 12/17/2018 | @ | Montreal Canadiens | 4 | 0 | W |  | 18 | 12 | 4 | W 1 | 21,302 | 2:22 |
| **35** | 12/20/2018 |  | Anaheim Ducks | 3 | 1 | W |  | 19 | 12 | 4 | W 2 | 17,565 | 2:30 |
| **36** | 12/22/2018 |  | Nashville Predators | 5 | 2 | W |  | 20 | 12 | 4 | W 3 | 17,565 | 2:33 |
| **37** | 12/23/2018 | @ | Carolina Hurricanes | 3 | 5 | L |  | 20 | 13 | 4 | L 1 | 17,491 | 2:37 |
| **38** | 12/27/2018 |  | New Jersey Devils | 2 | 5 | L |  | 20 | 14 | 4 | L 2 | 17,565 | 2:31 |
| **39** | 12/29/2018 | @ | Buffalo Sabres | 3 | 2 | W | OT | 21 | 14 | 4 | W 1 | 19,070 | 2:29 |
| **40** | 1/1/2019 | @ | Chicago Blackhawks | 4 | 2 | W |  | 22 | 14 | 4 | W 2 | 76,126 | 2:37 |
| **41** | 1/3/2019 |  | Calgary Flames | 6 | 4 | W |  | 23 | 14 | 4 | W 3 | 17,565 | 2:23 |
| **42** | 1/5/2019 |  | Buffalo Sabres | 2 | 1 | W |  | 24 | 14 | 4 | W 4 | 17,565 | 2:31 |
| **43** | 1/8/2019 |  | Minnesota Wild | 4 | 0 | W |  | 25 | 14 | 4 | W 5 | 17,565 | 2:28 |
| **44** | 1/10/2019 |  | Washington Capitals | 2 | 4 | L |  | 25 | 15 | 4 | L 1 | 17,565 | 2:35 |
| **45** | 1/12/2019 | @ | Toronto Maple Leafs | 3 | 2 | W |  | 26 | 15 | 4 | W 1 | 19,305 | 2:24 |
| **46** | 1/14/2019 |  | Montreal Canadiens | 2 | 3 | L | OT | 26 | 15 | 5 | L 1 | 17,565 | 2:37 |
| **47** | 1/16/2019 | @ | Philadelphia Flyers | 3 | 4 | L |  | 26 | 16 | 5 | L 2 | 19,297 | 2:55 |
| **48** | 1/17/2019 |  | St. Louis Blues | 5 | 2 | W |  | 27 | 16 | 5 | W 1 | 17,565 | 2:24 |
| **49** | 1/19/2019 |  | New York Rangers | 2 | 3 | L |  | 27 | 17 | 5 | L 1 | 17,565 | 2:39 |
| **50** | 1/29/2019 |  | Winnipeg Jets | 3 | 4 | L | SO | 27 | 17 | 6 | L 2 | 17,565 | 2:52 |
| **51** | 1/31/2019 |  | Philadelphia Flyers | 2 | 3 | L | OT | 27 | 17 | 7 | L 3 | 17,565 | 2:34 |
| **52** | 2/3/2019 | @ | Washington Capitals | 1 | 0 | W |  | 28 | 17 | 7 | W 1 | 18,506 | 2:22 |
| **53** | 2/5/2019 |  | New York Islanders | 3 | 1 | W |  | 29 | 17 | 7 | W 2 | 17,565 | 2:33 |
| **54** | 2/6/2019 | @ | New York Rangers | 3 | 4 | L | SO | 29 | 17 | 8 | L 1 | 16,848 | 2:49 |
| **55** | 2/9/2019 |  | Los Angeles Kings | 5 | 4 | W | OT | 30 | 17 | 8 | W 1 | 17,565 | 2:32 |
| **56** | 2/10/2019 |  | Colorado Avalanche | 2 | 1 | W | OT | 31 | 17 | 8 | W 2 | 17,565 | 2:38 |
| **57** | 2/12/2019 |  | Chicago Blackhawks | 6 | 3 | W |  | 32 | 17 | 8 | W 3 | 17,565 | 2:32 |
| **58** | 2/15/2019 | @ | Anaheim Ducks | 3 | 0 | W |  | 33 | 17 | 8 | W 4 | 17,174 | 2:23 |
| **59** | 2/16/2019 | @ | Los Angeles Kings | 4 | 2 | W |  | 34 | 17 | 8 | W 5 | 18,230 | 2:22 |
| **60** | 2/18/2019 | @ | San Jose Sharks | 6 | 5 | W | OT | 35 | 17 | 8 | W 6 | 17,562 | 2:43 |
| **61** | 2/20/2019 | @ | Vegas Golden Knights | 3 | 2 | W | SO | 36 | 17 | 8 | W 7 | 18,222 | 2:38 |
| **62** | 2/23/2019 | @ | St. Louis Blues | 1 | 2 | L | SO | 36 | 17 | 9 | L 1 | 18,425 | 2:39 |
| **63** | 2/26/2019 |  | San Jose Sharks | 4 | 1 | W |  | 37 | 17 | 9 | W 1 | 17,565 | 2:26 |
| **64** | 2/28/2019 |  | Tampa Bay Lightning | 4 | 1 | W |  | 38 | 17 | 9 | W 2 | 17,565 | 2:25 |
| **65** | 3/2/2019 |  | New Jersey Devils | 1 | 0 | W |  | 39 | 17 | 9 | W 3 | 17,565 | 2:21 |
| **66** | 3/5/2019 |  | Carolina Hurricanes | 4 | 3 | W | OT | 40 | 17 | 9 | W 4 | 17,565 | 2:38 |
| **67** | 3/7/2019 |  | Florida Panthers | 4 | 3 | W |  | 41 | 17 | 9 | W 5 | 17,565 | 2:29 |
| **68** | 3/9/2019 |  | Ottawa Senators | 3 | 2 | W |  | 42 | 17 | 9 | W 6 | 17,565 | 2:20 |
| **69** | 3/10/2019 | @ | Pittsburgh Penguins | 2 | 4 | L |  | 42 | 18 | 9 | L 1 | 18,578 | 2:29 |
| **70** | 3/12/2019 | @ | Columbus Blue Jackets | 4 | 7 | L |  | 42 | 19 | 9 | L 2 | 16,554 | 2:30 |
| **71** | 3/14/2019 | @ | Winnipeg Jets | 3 | 4 | L |  | 42 | 20 | 9 | L 3 | 15,321 | 2:28 |
| **72** | 3/16/2019 |  | Columbus Blue Jackets | 2 | 1 | W | OT | 43 | 20 | 9 | W 1 | 17,565 | 2:33 |
| **73** | 3/19/2019 | @ | New York Islanders | 5 | 0 | W |  | 44 | 20 | 9 | W 2 | 13,917 | 2:27 |
| **74** | 3/21/2019 | @ | New Jersey Devils | 5 | 1 | W |  | 45 | 20 | 9 | W 3 | 14,649 | 2:19 |
| **75** | 3/23/2019 | @ | Florida Panthers | 7 | 3 | W |  | 46 | 20 | 9 | W 4 | 17,129 | 2:34 |
| **76** | 3/25/2019 | @ | Tampa Bay Lightning | 4 | 5 | L |  | 46 | 21 | 9 | L 1 | 19,092 | 2:29 |
| **77** | 3/27/2019 |  | New York Rangers | 6 | 3 | W |  | 47 | 21 | 9 | W 1 | 17,565 | 2:36 |
| **78** | 3/30/2019 |  | Florida Panthers | 1 | 4 | L |  | 47 | 22 | 9 | L 1 | 17,565 | 2:25 |
| **79** | 3/31/2019 | @ | Detroit Red Wings | 3 | 6 | L |  | 47 | 23 | 9 | L 2 | 19,515 | 2:29 |
| **80** | 4/2/2019 | @ | Columbus Blue Jackets | 6 | 2 | W |  | 48 | 23 | 9 | W 1 | 18,890 | 2:32 |
| **81** | 4/4/2019 | @ | Minnesota Wild | 3 | 0 | W |  | 49 | 23 | 9 | W 2 | 19,074 | 2:20 |
| **82** | 4/6/2019 |  | Tampa Bay Lightning | 3 | 6 | L |  | 49 | 24 | 9 | L 1 | 17,565 | 2:23 |

**Data for St. Louis Blues Regular Season**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GP** | **Date** |  | **Opponent** | **GF▼** | **GA** |  |  | **W** | **L** | **OL** | **Streak** | **Att.** | **LOG** | **Notes** |
| **1** | 10/4/2018 |  | Winnipeg Jets | 1 | 5 | L |  | 0 | 1 | 0 | L 1 | 18,292 | 2:35 |  |
| **2** | 10/6/2018 |  | Chicago Blackhawks | 4 | 5 | L | OT | 0 | 1 | 1 | L 2 | 17,429 | 2:39 |  |
| **3** | 10/11/2018 |  | Calgary Flames | 5 | 3 | W |  | 1 | 1 | 1 | W 1 | 16,403 | 2:37 |  |
| **4** | 10/13/2018 | @ | Chicago Blackhawks | 3 | 4 | L | OT | 1 | 1 | 2 | L 1 | 21,634 | 2:38 |  |
| **5** | 10/14/2018 |  | Anaheim Ducks | 2 | 3 | L |  | 1 | 2 | 2 | L 2 | 16,562 | 2:36 |  |
| **6** | 10/17/2018 | @ | Montreal Canadiens | 2 | 3 | L |  | 1 | 3 | 2 | L 3 | 20,137 | 2:22 |  |
| **7** | 10/20/2018 | @ | Toronto Maple Leafs | 4 | 1 | W |  | 2 | 3 | 2 | W 1 | 19,268 | 2:31 |  |
| **8** | 10/22/2018 | @ | Winnipeg Jets | 4 | 5 | L | OT | 2 | 3 | 3 | L 1 | 15,321 | 2:37 |  |
| **9** | 10/25/2018 |  | Columbus Blue Jackets | 4 | 7 | L |  | 2 | 4 | 3 | L 2 | 17,068 | 2:37 |  |
| **10** | 10/27/2018 |  | Chicago Blackhawks | 7 | 3 | W |  | 3 | 4 | 3 | W 1 | 17,201 | 2:32 |  |
| **11** | 11/1/2018 |  | Vegas Golden Knights | 5 | 3 | W |  | 4 | 4 | 3 | W 2 | 16,813 | 2:32 |  |
| **12** | 11/3/2018 |  | Minnesota Wild | 1 | 5 | L |  | 4 | 5 | 3 | L 1 | 17,767 | 2:27 |  |
| **13** | 11/6/2018 |  | Carolina Hurricanes | 4 | 1 | W |  | 5 | 5 | 3 | W 1 | 16,210 | 2:31 |  |
| **14** | 11/9/2018 |  | San Jose Sharks | 4 | 0 | W |  | 6 | 5 | 3 | W 2 | 17,032 | 2:21 |  |
| **15** | 11/11/2018 |  | Minnesota Wild | 2 | 3 | L |  | 6 | 6 | 3 | L 1 | 16,735 | 2:33 |  |
| **16** | 11/14/2018 | @ | Chicago Blackhawks | 0 | 1 | L |  | 6 | 7 | 3 | L 2 | 21,401 | 2:19 |  |
| **17** | 11/16/2018 | @ | Vegas Golden Knights | 4 | 1 | W |  | 7 | 7 | 3 | W 1 | 18,488 | 2:25 |  |
| **18** | 11/17/2018 | @ | San Jose Sharks | 0 | 4 | L |  | 7 | 8 | 3 | L 1 | 17,417 | 2:24 |  |
| **19** | 11/19/2018 |  | Los Angeles Kings | 0 | 2 | L |  | 7 | 9 | 3 | L 2 | 16,860 | 2:21 |  |
| **20** | 11/21/2018 | @ | Nashville Predators | 1 | 4 | L |  | 7 | 10 | 3 | L 3 | 17,558 | 2:39 |  |
| **21** | 11/23/2018 |  | Nashville Predators | 6 | 2 | W |  | 8 | 10 | 3 | W 1 | 16,192 | 2:30 |  |
| **22** | 11/24/2018 |  | Winnipeg Jets | 4 | 8 | L |  | 8 | 11 | 3 | L 1 | 17,028 | 2:35 |  |
| **23** | 11/28/2018 | @ | Detroit Red Wings | 3 | 4 | L |  | 8 | 12 | 3 | L 2 | 18,165 | 2:36 |  |
| **24** | 11/30/2018 | @ | Colorado Avalanche | 3 | 2 | W | OT | 9 | 12 | 3 | W 1 | 18,021 | 2:38 |  |
| **25** | 12/1/2018 | @ | Arizona Coyotes | 1 | 6 | L |  | 9 | 13 | 3 | L 1 | 13,451 | 2:30 |  |
| **26** | 12/5/2018 |  | Edmonton Oilers | 2 | 3 | L | SO | 9 | 13 | 4 | L 2 | 16,551 | 2:37 |  |
| **27** | 12/7/2018 | @ | Winnipeg Jets | 1 | 0 | W |  | 10 | 13 | 4 | W 1 | 15,321 | 2:27 |  |
| **28** | 12/9/2018 |  | Vancouver Canucks | 1 | 6 | L |  | 10 | 14 | 4 | L 1 | 16,841 | 2:22 |  |
| **29** | 12/11/2018 |  | Florida Panthers | 4 | 3 | W |  | 11 | 14 | 4 | W 1 | 16,255 | 2:38 |  |
| **30** | 12/14/2018 |  | Colorado Avalanche | 4 | 3 | W | OT | 12 | 14 | 4 | W 2 | 16,366 | 2:39 |  |
| **31** | 12/16/2018 |  | Calgary Flames | 2 | 7 | L |  | 12 | 15 | 4 | L 1 | 17,064 | 2:26 |  |
| **32** | 12/18/2018 | @ | Edmonton Oilers | 4 | 1 | W |  | 13 | 15 | 4 | W 1 | 18,347 | 2:33 |  |
| **33** | 12/20/2018 | @ | Vancouver Canucks | 1 | 5 | L |  | 13 | 16 | 4 | L 1 | 18,261 | 2:31 |  |
| **34** | 12/22/2018 | @ | Calgary Flames | 3 | 1 | W |  | 14 | 16 | 4 | W 1 | 18,683 | 2:23 |  |
| **35** | 12/27/2018 |  | Buffalo Sabres | 4 | 1 | W |  | 15 | 16 | 4 | W 2 | 17,867 | 2:21 |  |
| **36** | 12/29/2018 |  | Pittsburgh Penguins | 1 | 6 | L |  | 15 | 17 | 4 | L 1 | 17,475 | 2:33 |  |
| **37** | 12/31/2018 |  | New York Rangers | 1 | 2 | L |  | 15 | 18 | 4 | L 2 | 16,849 | 2:29 |  |
| **38** | 1/3/2019 |  | Washington Capitals | 5 | 2 | W |  | 16 | 18 | 4 | W 1 | 17,200 | 2:25 |  |
| **39** | 1/5/2019 |  | New York Islanders | 3 | 4 | L |  | 16 | 19 | 4 | L 1 | 16,801 | 2:30 |  |
| **40** | 1/7/2019 | @ | Philadelphia Flyers | 3 | 0 | W |  | 17 | 19 | 4 | W 1 | 19,021 | 2:25 |  |
| **41** | 1/8/2019 |  | Dallas Stars | 1 | 3 | L |  | 17 | 20 | 4 | L 1 | 17,037 | 2:23 |  |
| **42** | 1/10/2019 |  | Montreal Canadiens | 4 | 1 | W |  | 18 | 20 | 4 | W 1 | 17,839 | 2:28 |  |
| **43** | 1/12/2019 | @ | Dallas Stars | 3 | 1 | W |  | 19 | 20 | 4 | W 2 | 18,124 | 2:27 |  |
| **44** | 1/14/2019 | @ | Washington Capitals | 4 | 1 | W |  | 20 | 20 | 4 | W 3 | 18,506 | 2:26 |  |
| **45** | 1/15/2019 | @ | New York Islanders | 1 | 2 | L | OT | 20 | 20 | 5 | L 1 | 10,042 | 2:29 |  |
| **46** | 1/17/2019 | @ | Boston Bruins | 2 | 5 | L |  | 20 | 21 | 5 | L 2 | 17,565 | 2:24 |  |
| **47** | 1/19/2019 |  | Ottawa Senators | 3 | 2 | W |  | 21 | 21 | 5 | W 1 | 17,690 | 2:34 |  |
| **48** | 1/21/2019 | @ | Los Angeles Kings | 3 | 4 | L |  | 21 | 22 | 5 | L 1 | 18,230 | 2:33 |  |
| **49** | 1/23/2019 | @ | Anaheim Ducks | 5 | 1 | W |  | 22 | 22 | 5 | W 1 | 16,795 | 2:21 |  |
| **50** | 2/2/2019 | @ | Columbus Blue Jackets | 4 | 2 | W |  | 23 | 22 | 5 | W 2 | 18,681 | 2:24 |  |
| **51** | 2/5/2019 | @ | Florida Panthers | 3 | 2 | W |  | 24 | 22 | 5 | W 3 | 10,243 | 2:30 |  |
| **52** | 2/7/2019 | @ | Tampa Bay Lightning | 1 | 0 | W | OT | 25 | 22 | 5 | W 4 | 19,092 | 2:32 |  |
| **53** | 2/9/2019 |  | Nashville Predators | 3 | 2 | W |  | 26 | 22 | 5 | W 5 | 18,166 | 2:30 |  |
| **54** | 2/10/2019 | @ | Nashville Predators | 5 | 4 | W | OT | 27 | 22 | 5 | W 6 | 17,622 | 2:50 |  |
| **55** | 2/12/2019 |  | New Jersey Devils | 8 | 3 | W |  | 28 | 22 | 5 | W 7 | 17,509 | 2:28 |  |
| **56** | 2/14/2019 | @ | Arizona Coyotes | 4 | 0 | W |  | 29 | 22 | 5 | W 8 | 12,553 | 2:23 |  |
| **57** | 2/16/2019 | @ | Colorado Avalanche | 3 | 0 | W |  | 30 | 22 | 5 | W 9 | 18,076 | 2:26 |  |
| **58** | 2/17/2019 | @ | Minnesota Wild | 4 | 0 | W |  | 31 | 22 | 5 | W 10 | 19,102 | 2:22 |  |
| **59** | 2/19/2019 |  | Toronto Maple Leafs | 3 | 2 | W | OT | 32 | 22 | 5 | W 11 | 18,598 | 2:37 |  |
| **60** | 2/21/2019 | @ | Dallas Stars | 2 | 5 | L |  | 32 | 23 | 5 | L 1 | 17,945 | 2:33 |  |
| **61** | 2/23/2019 |  | Boston Bruins | 2 | 1 | W | SO | 33 | 23 | 5 | W 1 | 18,425 | 2:39 |  |
| **62** | 2/24/2019 | @ | Minnesota Wild | 1 | 2 | L | OT | 33 | 23 | 6 | L 1 | 18,645 | 2:31 |  |
| **63** | 2/26/2019 |  | Nashville Predators | 2 | 0 | W |  | 34 | 23 | 6 | W 1 | 16,645 | 2:20 |  |
| **64** | 3/1/2019 | @ | Carolina Hurricanes | 2 | 5 | L |  | 34 | 24 | 6 | L 1 | 15,363 | 2:30 |  |
| **65** | 3/2/2019 |  | Dallas Stars | 1 | 4 | L |  | 34 | 25 | 6 | L 2 | 18,166 | 2:32 |  |
| **66** | 3/6/2019 | @ | Anaheim Ducks | 5 | 4 | W |  | 35 | 25 | 6 | W 1 | 16,854 | 2:34 |  |
| **67** | 3/7/2019 | @ | Los Angeles Kings | 4 | 0 | W |  | 36 | 25 | 6 | W 2 | 17,837 | 2:26 |  |
| **68** | 3/9/2019 | @ | San Jose Sharks | 2 | 3 | L | OT | 36 | 25 | 7 | L 1 | 17,562 | 2:19 |  |
| **69** | 3/12/2019 |  | Arizona Coyotes | 1 | 3 | L |  | 36 | 26 | 7 | L 2 | 18,428 | 2:20 |  |
| **70** | 3/14/2019 | @ | Ottawa Senators | 0 | 2 | L |  | 36 | 27 | 7 | L 3 | 13,378 | 2:23 |  |
| **71** | 3/16/2019 | @ | Pittsburgh Penguins | 5 | 1 | W |  | 37 | 27 | 7 | W 1 | 18,641 | 2:24 |  |
| **72** | 3/17/2019 | @ | Buffalo Sabres | 3 | 4 | L | SO | 37 | 27 | 8 | L 1 | 18,486 | 2:34 |  |
| **73** | 3/19/2019 |  | Edmonton Oilers | 7 | 2 | W |  | 38 | 27 | 8 | W 1 | 17,873 | 2:31 |  |
| **74** | 3/21/2019 |  | Detroit Red Wings | 5 | 2 | W |  | 39 | 27 | 8 | W 2 | 18,272 | 2:16 |  |
| **75** | 3/23/2019 |  | Tampa Bay Lightning | 4 | 3 | W |  | 40 | 27 | 8 | W 3 | 18,127 | 2:30 |  |
| **76** | 3/25/2019 |  | Vegas Golden Knights | 3 | 1 | W |  | 41 | 27 | 8 | W 4 | 18,247 | 2:22 |  |
| **77** | 3/29/2019 | @ | New York Rangers | 2 | 4 | L |  | 41 | 28 | 8 | L 1 | 17,567 | 2:21 |  |
| **78** | 3/30/2019 | @ | New Jersey Devils | 3 | 2 | W | OT | 42 | 28 | 8 | W 1 | 16,514 | 2:23 |  |
| **79** | 4/1/2019 |  | Colorado Avalanche | 3 | 2 | W | SO | 43 | 28 | 8 | W 2 | 17,767 | 2:32 |  |
| **80** | 4/3/2019 | @ | Chicago Blackhawks | 3 | 4 | L | SO | 43 | 28 | 9 | L 1 | 21,482 | 2:39 |  |
| **81** | 4/4/2019 |  | Philadelphia Flyers | 7 | 3 | W |  | 44 | 28 | 9 | W 1 | 18,203 | 2:34 |  |
| **82** | 4/6/2019 |  | Vancouver Canucks | 3 | 2 | W | SO | 45 | 28 | 9 | W 2 | 17,970 | 2:35 |  |

**Data for Boston Bruins Playoff Season**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GP** | **Date** |  | **Opponent** | **GF** | **GA** |  |  | **W** | **L** | **Streak** | **Att.** | **LOG** |
| **1** | 4/11/2019 |  | Toronto Maple Leafs | 1 | 4 | L |  | 0 | 1 | L 1 | 17,565 | 2:30 |
| **2** | 4/13/2019 |  | Toronto Maple Leafs | 4 | 1 | W |  | 1 | 1 | W 1 | 17,565 | 2:24 |
| **3** | 4/15/2019 | @ | Toronto Maple Leafs | 2 | 3 | L |  | 1 | 2 | L 1 | 19,611 | 2:34 |
| **4** | 4/17/2019 | @ | Toronto Maple Leafs | 6 | 4 | W |  | 2 | 2 | W 1 | 19,638 | 2:26 |
| **5** | 4/19/2019 |  | Toronto Maple Leafs | 1 | 2 | L |  | 2 | 3 | L 1 | 17,565 | 2:36 |
| **6** | 4/21/2019 | @ | Toronto Maple Leafs | 4 | 2 | W |  | 3 | 3 | W 1 | 19,683 | 2:32 |
| **7** | 4/23/2019 |  | Toronto Maple Leafs | 5 | 1 | W |  | 4 | 3 | W 2 | 17,565 | 2:23 |
| **8** | 4/25/2019 |  | Columbus Blue Jackets | 3 | 2 | W | OT | 5 | 3 | W 3 | 17,565 | 2:55 |
| **9** | 4/27/2019 |  | Columbus Blue Jackets | 2 | 3 | L | 2OT | 5 | 4 | L 1 | 17,565 | 3:49 |
| **10** | 4/30/2019 | @ | Columbus Blue Jackets | 1 | 2 | L |  | 5 | 5 | L 2 | 19,337 | 2:37 |
| **11** | 5/2/2019 | @ | Columbus Blue Jackets | 4 | 1 | W |  | 6 | 5 | W 1 | 19,431 | 2:36 |
| **12** | 5/4/2019 |  | Columbus Blue Jackets | 4 | 3 | W |  | 7 | 5 | W 2 | 17,565 | 2:36 |
| **13** | 5/6/2019 | @ | Columbus Blue Jackets | 3 | 0 | W |  | 8 | 5 | W 3 | 19,219 | 2:40 |
| **14** | 5/9/2019 |  | Carolina Hurricanes | 5 | 2 | W |  | 9 | 5 | W 4 | 17,565 | 2:36 |
| **15** | 5/12/2019 |  | Carolina Hurricanes | 6 | 2 | W |  | 10 | 5 | W 5 | 17,565 | 2:25 |
| **16** | 5/14/2019 | @ | Carolina Hurricanes | 2 | 1 | W |  | 11 | 5 | W 6 | 18,768 | 2:39 |
| **17** | 5/16/2019 | @ | Carolina Hurricanes | 4 | 0 | W |  | 12 | 5 | W 7 | 19,041 | 2:33 |
| **18** | 5/27/2019 |  | St. Louis Blues | 4 | 2 | W |  | 13 | 5 | W 8 | 17,565 | 2:32 |
| **19** | 5/29/2019 |  | St. Louis Blues | 2 | 3 | L | OT | 13 | 6 | L 1 | 17,565 | 2:51 |
| **20** | 6/1/2019 | @ | St. Louis Blues | 7 | 2 | W |  | 14 | 6 | W 1 | 18,789 | 2:34 |
| **21** | 6/3/2019 | @ | St. Louis Blues | 2 | 4 | L |  | 14 | 7 | L 1 | 18,805 | 2:34 |
| **22** | 6/6/2019 |  | St. Louis Blues | 1 | 2 | L |  | 14 | 8 | L 2 | 17,565 | 2:38 |
| **23** | 6/9/2019 | @ | St. Louis Blues | 5 | 1 | W |  | 15 | 8 | W 1 | 18,890 | 2:37 |
| **24** | 6/12/2019 |  | St. Louis Blues | 1 | 4 | L |  | 15 | 9 | L 1 | 17,565 | 2:21 |

**Data for St. Louis Blues Playoff Season**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GP** | **Date** |  | **Opponent** | **GF** | **GA** |  |  | **W** | **L** | **Streak** | **Att.** | **LOG** |
| **1** | 4/10/2019 | @ | Winnipeg Jets | 2 | 1 | W |  | 1 | 0 | W 1 | 15,321 | 2:31 |
| **2** | 4/12/2019 | @ | Winnipeg Jets | 4 | 3 | W |  | 2 | 0 | W 2 | 15,321 | 2:36 |
| **3** | 4/14/2019 |  | Winnipeg Jets | 3 | 6 | L |  | 2 | 1 | L 1 | 18,486 | 2:33 |
| **4** | 4/16/2019 |  | Winnipeg Jets | 1 | 2 | L | OT | 2 | 2 | L 2 | 18,346 | 2:49 |
| **5** | 4/18/2019 | @ | Winnipeg Jets | 3 | 2 | W |  | 3 | 2 | W 1 | 15,321 | 2:26 |
| **6** | 4/20/2019 |  | Winnipeg Jets | 3 | 2 | W |  | 4 | 2 | W 2 | 18,524 | 2:39 |
| **7** | 4/25/2019 |  | Dallas Stars | 3 | 2 | W |  | 5 | 2 | W 3 | 18,014 | 2:31 |
| **8** | 4/27/2019 |  | Dallas Stars | 2 | 4 | L |  | 5 | 3 | L 1 | 18,285 | 2:50 |
| **9** | 4/29/2019 | @ | Dallas Stars | 4 | 3 | W |  | 6 | 3 | W 1 | 18,532 | 2:43 |
| **10** | 5/1/2019 | @ | Dallas Stars | 2 | 4 | L |  | 6 | 4 | L 1 | 18,790 | 2:31 |
| **11** | 5/3/2019 |  | Dallas Stars | 1 | 2 | L |  | 6 | 5 | L 2 | 18,542 | 2:35 |
| **12** | 5/5/2019 | @ | Dallas Stars | 4 | 1 | W |  | 7 | 5 | W 1 | 18,876 | 2:30 |
| **13** | 5/7/2019 |  | Dallas Stars | 2 | 1 | W | 2OT | 8 | 5 | W 2 | 18,531 | 3:49 |
| **14** | 5/11/2019 | @ | San Jose Sharks | 3 | 6 | L |  | 8 | 6 | L 1 | 17,562 | 2:37 |
| **15** | 5/13/2019 | @ | San Jose Sharks | 4 | 2 | W |  | 9 | 6 | W 1 | 17,562 | 2:23 |
| **16** | 5/15/2019 |  | San Jose Sharks | 4 | 5 | L | OT | 9 | 7 | L 1 | 18,360 | 2:53 |
| **17** | 5/17/2019 |  | San Jose Sharks | 2 | 1 | W |  | 10 | 7 | W 1 | 18,496 | 2:30 |
| **18** | 5/19/2019 | @ | San Jose Sharks | 5 | 0 | W |  | 11 | 7 | W 2 | 17,562 | 2:31 |
| **19** | 5/21/2019 |  | San Jose Sharks | 5 | 1 | W |  | 12 | 7 | W 3 | 18,684 | 2:26 |
| **20** | 5/27/2019 | @ | Boston Bruins | 2 | 4 | L |  | 12 | 8 | L 1 | 17,565 | 2:32 |
| **21** | 5/29/2019 | @ | Boston Bruins | 3 | 2 | W | OT | 13 | 8 | W 1 | 17,565 | 2:51 |
| **22** | 6/1/2019 |  | Boston Bruins | 2 | 7 | L |  | 13 | 9 | L 1 | 18,789 | 2:34 |
| **23** | 6/3/2019 |  | Boston Bruins | 4 | 2 | W |  | 14 | 9 | W 1 | 18,805 | 2:34 |
| **24** | 6/6/2019 | @ | Boston Bruins | 2 | 1 | W |  | 15 | 9 | W 2 | 17,565 | 2:38 |
| **25** | 6/9/2019 |  | Boston Bruins | 1 | 5 | L |  | 15 | 10 | L 1 | 18,890 | 2:37 |
| **26** | 6/12/2019 | @ | Boston Bruins | 4 | 1 | W |  | 16 | 10 | W 1 | 17,565 | 2:21 |

Data was obtained from The National Hockey League Website <http://www.nhl.com/stats/team?reportType=season&seasonFrom=20192020&seasonTo=20192020&gameType=2&filter=gamesPlayed,gte,1&sort=points,wins>

**References**

Dejardine, Zachary. “Poisson Processes and Applications in Hockey.” *Https://Scholar.google.com/Scholar?Cluster=8994603499844015940&Hl=En&as\_sdt=0,14&Sciodt=0,14*, 2013, [www.lakeheadu.ca/sites/default/files/uploads/77/docs/DejardineFinal.pdf](http://www.lakeheadu.ca/sites/default/files/uploads/77/docs/DejardineFinal.pdf).