Is It Luck or Is It Skill?

A Simulation Study Of The NHL

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Intro

The goal of this simulation is to explore the role of luck versus skill/hardwork when it comes to making it to the NHL. We can define luck as the things a player can't control (coach's decision, politics, injuries, etc.) and skill as the thing they can control (talent, contribution when on the ice, physical conditioning, etc). We assume that there are approximately 620 players in the NHL every given year (20 players with 31 teams) and approximately 10000 players who are trying to make it every year from all other professional leagues.

PART 1 - 95% Skill and 5% Luck

For the first simulation, let's explore what happens when luck plays only a 5% role in making it to the NHL. We will generate a random **skill score** from 70 to 100 for each of the 10000 players and a random **luck score** from 0 to 100. Note that theses numbers should reflect approximately the overall scores of the players in NHL video games.

Take a player with a skill score of 85 and a luck score of 27 as an example of how this overall score would be calculated.

$$\begin{aligned}
&\text{Overall Score} = \text{Skill Score} \times \text{Skill Weight} + \text{Luck Score} \times \text{Luck Weight} \\
&\text{Overall Score} = 85 \times 0.95 + 27 \times 0.05 \\
&\text{Overall Score} = 80.75 + 1.35 \\
&\text{Overall Score} = 82.1
\end{aligned}$$

Therefore, this particular player would have an overall score of 82.1. If luck did not play a role at all his overall score would be 85 (pure skill) and if it was all about luck, his overall score would be 27 (pure luck).

We can repeat this calculation for all 10000 players who are competing to make the NHl every year and we will select the top 620 overall scores.

We now have a random skill score between 70 and 100, a random luck score between 0 and 100, and a random overall score between 66.5 and 100. Note that the lowest overall score a player could obtain with these values is with a 70 skill score and a 0 luck score resulting in $70 \times 0.95 + 0 \times 0.05 = 66.5$.

We can create a table of the generated values to better be able to interpret the results. Below are the first 10 players of the 10000 players.

```
##    Number    Skill     Luck  Overall
## 1       1 89.40709 12.13557 85.54351
## 2       2 81.82677 62.39987 80.85543
## 3       3 88.55505 74.55769 87.85519
```

```
## 4       4 84.30673 69.19467 83.55113
## 5       5 74.08292 91.31664 74.94460
## 6       6 72.02153 34.69663 70.15529
## 7       7 73.87458 45.89215 72.47546
## 8       8 81.79354 63.68248 80.88798
## 9       9 70.07748 47.72910 68.96006
## 10     10 88.60618 65.11031 87.43139
```

From the first 10 players above, we can nottice that even at 5%, luck plays a significant role in making it to the show. Just look at player 1 and player 3 for example. They have similar skill, player 1 is slightly more skilled but unlucky resulting in player 3 having an overall score 2 full points higher. A fraction of an overall point could make all the difference at the highest level of sports.

We can now re-order the players so the ones with the best overall scores are on top. That way, we can only select the best 620 players to emulate the NHL who only keep the best. Note that with the assumptions made here only $\frac{620}{10000} = 0.062 = 6.2\%$ of professional hockey players will play in the NHL this year.

```
##    Number    Skill     Luck  Overall
## 1     127 99.97950 97.87884 99.87447
## 2    2857 99.95805 96.75784 99.79804
## 3    1834 99.82773 99.02993 99.78784
## 4    6278 99.98176 94.95759 99.73056
## 5    4122 99.81163 97.97110 99.71961
## 6    1295 99.81252 97.51045 99.69742
## 7    2802 99.94119 94.06491 99.64738
## 8    6450 99.96268 92.93308 99.61120
## 9    6165 99.54550 99.84406 99.56043
## 10   1203 99.58803 98.63762 99.54051
```

Clearly, to be in the top 10 of the NHL, you need to have both luck and skill. There is only 1 player in the top 10 who have a luck score under 95% (player 6278 with a luck score of 94.95759). Keep in mind that this is with luck that only has a 5% role in determining the overall score. Luck could quite possibly plays a significantly greater role in "real life".

Now we get to select to 620 players with the highest overall scores to play in the NHL this year. We will also look at a summary for each variable that played a role in helping those players make it.

```
##      Number         Skill            Luck          Overall
##  Min.   :  34   Min.   : 95.73   Min.   :16.40   Min.   :95.65
##  1st Qu.:2409   1st Qu.: 97.65   1st Qu.:55.31   1st Qu.:96.15
##  Median :4992   Median : 98.61   Median :73.85   Median :96.79
##  Mean   :4903   Mean   : 98.45   Mean   :70.43   Mean   :97.04
##  3rd Qu.:7270   3rd Qu.: 99.45   3rd Qu.:88.78   3rd Qu.:97.78
##  Max.   :9976   Max.   :100.00   Max.   :99.93   Max.   :99.87
```

We can see from the summary that as expected, skill is more important than luck with our assumptions. The least skilled player in the NHL has a 95.73 skill score while the least lucky player in the NHL has a 16.40 luck score. The average NHL player has a skill score of 98.45 and a luck score of 70.42. An overall score of 95.65 was needed to make the cut.

We can expand this table like so:

Skill Weight	**Min. Skill**	**Avg. Skill**	**SE. Skill**	**Luck Weight**	**Min. Luck**	**Avg. Luck**	**SE. Luck**
0.95	95.73	98.45	1.13	**0.05**	16.4	70.43	21.38

This layout is not only cleaner, but it allows us to see that luck varies much more than skill does in the NHL.

PART 2 - 50% Skill and 50% Luck

For the second simulation, let's explore what happens when luck plays a 50% role in making it to the NHL. We will still generate a random **skill score** from 70 to 100 for each of the 10000 players and a random **luck score** from 0 to 100.

Take the same player with a skill score of 85 and a luck score of 27 as an example of how this overall score would be calculated.

$$\text{Overall Score} = \text{Skill Score} \times \text{Skill Weight} + \text{Luck Score} \times \text{Luck Weight}$$
$$\text{Overall Score} = 85 \times 0.5 + 27 \times 0.5$$
$$\text{Overall Score} = 42.5 + 13.5$$
$$\text{Overall Score} = 56$$

Therefore, this particular player would have an overall score of 56 compared to 82.1 in the previous simulation.

We can repeat this calculation for all 10000 players who are competing to make the NHl every year and we will select the top 620 overall scores.

We now have a random skill score between 70 and 100, a random luck score between 0 and 100, and a random overall score between 35 and 100. Note that the lowest overall score a player could obtain with these values is with a 70 skill score and a 0 luck score resulting in $70 \times 0.5 + 0 \times 0.5 = 35$.

We can now re-order the players so the ones with the best overall scores are on top. That way, we can only select the best 620 players to emulate the NHL who only keep the best.

```
##    Number    Skill     Luck  Overall
## 1    6165 99.54550 99.84406 99.69478
## 2    1834 99.82773 99.02993 99.42883
## 3    8355 99.34927 99.47679 99.41303
## 4    7707 98.57143 99.70322 99.13732
## 5      34 98.43936 99.83077 99.13506
## 6    1203 99.58803 98.63762 99.11283
## 7    9893 98.45088 99.49994 98.97541
## 8     127 99.97950 97.87884 98.92917
## 9    4122 99.81163 97.97110 98.89137
## 10   5810 98.13432 99.60898 98.87165
```

Again, to be in the top 10 of the NHL, you need to have both luck and skill. Now we get to select to 620 players with the highest overall scores to play in the NHL this year. We will also look at a summary for each variable that played a role in helping those players make it.

Skill Weight	Min. Skill	Avg. Skill	SE. Skill	Luck Weight	Min. Luck	Avg. Luck	SE. Luck
0.5	81.29	93.29	4.69	**0.5**	81.54	93.84	4.48

The least skilled player in the NHL has a 81.29 skill score while the least lucky player in the NHL has a 81.54 luck score. The average NHL player has a score of 93.56 and an overall score of 90.47 was needed to make the cut. Note that when luck plays a bigger role, the skill level and overall score is more flexible to make it to the NHL.

PART 3 - 5% Skill and 95% Luck

For the third simulation, let's explore what happens when luck plays a 95% role in making it to the NHL. We will still generate a random **skill score** from 70 to 100 for each of the 10000 players and a random **luck score** from 0 to 100.

Take the same player with a skill score of 85 and a luck score of 27 as an example of how this overall score would be calculated.

$$\text{Overall Score} = \text{Skill Score} \times \text{Skill Weight} + \text{Luck Score} \times \text{Luck Weight}$$
$$\text{Overall Score} = 85 \times 0.05 + 27 \times 0.95$$
$$\text{Overall Score} = 4.25 + 25.65$$
$$\text{Overall Score} = 29.9$$

Therefore, this particular player would have an overall score of 29.9 compared to 82.1 in the first simulation and 56 in the second simulation. It is evident that getting lucky in these circumstances is more important than being skilled.

We can repeat this calculation for all 10000 players who are competing to make the NHl every year and we will select the top 620 overall scores.

We now have a random skill score between 70 and 100, a random luck score between 0 and 100, and a random overall score between 3.5 and 100. Note that the lowest overall score a player could obtain with these values is with a 70 skill score and a 0 luck score resulting in $70 \times 0.05 + 0 \times 0.95 = 3.5$.

We can now re-order the players so the ones with the best overall scores are on top. That way, we can only select the best 620 players to emulate the NHL who only keep the best.

```
##    Number    Skill     Luck  Overall
## 1    6165 99.54550 99.84406 99.82913
## 2     223 97.73218 99.93473 99.82460
## 3      34 98.43936 99.83077 99.76120
## 4    2687 95.42385 99.97514 99.74758
## 5    2059 97.64796 99.83208 99.72287
## 6     314 97.22883 99.82639 99.69652
## 7    7707 98.57143 99.70322 99.64663
## 8    2957 96.29958 99.72416 99.55293
## 9     104 97.91785 99.62192 99.53671
## 10   5810 98.13432 99.60898 99.53525
```

Again, to be in the top 10 of the NHL, you need to have both luck and skill. Now we get to select to 620 players with the highest overall scores to play in the NHL this year. We will also look at a summary for each variable that played a role in helping those players make it.

Skill Weight	Min. Skill	Avg. Skill	SE. Skill	Luck Weight	Min. Luck	Avg. Luck	SE. Luck
0.05	70.07	85.6	8.52	**0.95**	93.27	96.94	1.76

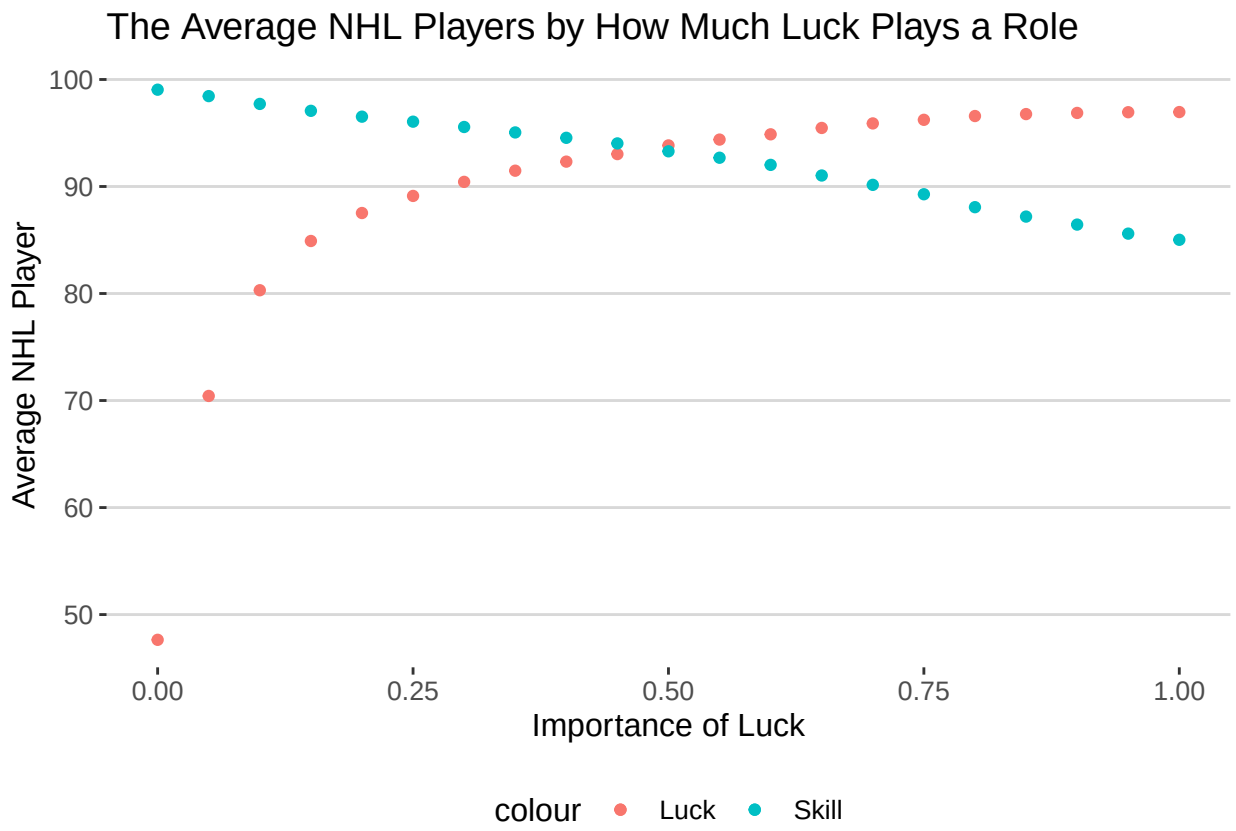
The least skilled player in the NHL has a 70.07 skill score while the least lucky player in the NHL has a 93.27 luck score. The average NHL player has a score of 96.94 and an overall score of 93.53 was needed to make the cut.

PART 4 - All Combinations of Skill and Luck

For the last part of this exploration, we are going to consider all possible combinations of the roles of luck versus skill when it comes to making it to the NHL. The rows in yellow represent the 3 simulations covered earlier in details. The rows in orange represent when it is either only luck that matters or only skill. We can also visualize the results in the table on a graph. The *x-axis* represents the importance (weight) of luck in contributing to the overall score. The *y-axis* represents how much luck or skill the average NHL player

has. You can see that the average NHL player has about the same amount of skill and luck when luck plays a 50% role.

Skill Weight	Min. Skill	Avg. Skill	SE. Skill	Luck Weight	Min. Luck	Avg. Luck	SE. Luck
1.00	98.10	99.05	0.56	**0.00**	0.60	47.64	28.99
0.95	95.73	98.45	1.13	**0.05**	16.40	70.43	21.38
0.90	93.59	97.72	1.58	**0.10**	40.97	80.31	14.24
0.85	91.94	97.07	2.03	**0.15**	55.74	84.91	11.09
0.80	90.45	96.53	2.36	**0.20**	62.36	87.52	9.11
0.75	88.85	96.06	2.67	**0.25**	67.74	89.12	7.91
0.70	87.56	95.56	2.99	**0.30**	71.75	90.43	6.85
0.65	85.63	95.05	3.35	**0.35**	73.62	91.48	6.04
0.60	85.11	94.55	3.75	**0.40**	77.75	92.32	5.47
0.55	83.01	94.03	4.16	**0.45**	79.00	93.03	5.02
0.50	81.29	93.29	4.69	**0.50**	81.54	93.84	4.48
0.45	80.06	92.69	5.07	**0.55**	83.59	94.38	4.08
0.40	78.27	92.02	5.46	**0.60**	84.81	94.87	3.66
0.35	75.10	91.03	6.17	**0.65**	85.99	95.47	3.23
0.30	71.03	90.15	6.79	**0.70**	87.63	95.90	2.89
0.25	70.07	89.28	7.39	**0.75**	89.46	96.23	2.62
0.20	70.07	88.07	7.98	**0.80**	90.25	96.58	2.26
0.15	70.07	87.19	8.22	**0.85**	91.62	96.77	2.02
0.10	70.07	86.44	8.40	**0.90**	92.59	96.87	1.87
0.05	70.07	85.60	8.52	**0.95**	93.27	96.94	1.76
0.00	70.07	85.02	8.58	**1.00**	94.02	96.96	1.74



Discussion

After simulating many combinations of luck and skill for selecting NHL players, there are a few common threads that we can take away.

1. To be one of the best 10 players in the NHL (i.e. highest overall score), you need both luck and skill. Some of the most skilled players did not end up in the top 10 due to bad fortune. The opposite is also true. Some less skilled players made it because they were lucky.
2. Skill scores were randomly generated between 70 and 100 while luck scores were randomly generated between 0 and 100. This imbalance was created to better represent the skill and luck distribution of NHL players. If you watched an NHL practice and had no clue who got paid the big bucks or what each player's stats were, it would be very difficult to rank them. This is because NHL players are very close in terms of skill. So why is there such a difference between player's salaries and stats if the difference between their skill levels is small? I can think of two reasons:

- Small difference in skill might results in large differences in outcome at the highest level of the game. It could be that this small edge compounds over time acting as a self-fulfilling prophecy. A player with a tiny skill advantage could win a battle and score a goal as a result. This goal causes the coach to play this player more because they're "hot" which causes them to score more goals since they are given a greater opportunity. This example illustrates the blurry difference between luck and skill.
- While the variation in NHL players' skill level is small, their luck variation is large. Thus, two players with similar skill but large differences in luck can result as a significantly different overall score.

It does not take long before things get philosophical. Natural questions arise as a result of this simulation.

- What can we actually control in life? Can we control our thoughts, emotions, intelligence, reactions, or even our health?
- How is skill distributed? Is there an equal probability to have 100 skill score as having a 70 skill score?
- How is luck distributed? Is it more likely to be unlucky or lucky? Or is it uniformly distributed as we assumed it was in this simulation?
- Is it conceivable to have negative luck? Or is the lowest luck zero? What do we mean when we say that someone is unlucky?
- What is the correct interpretation of probability? When we say a team has 75% chance of winning a game, do we mean that if they played 100 games, they would win 75 of those? Or do we mean that they actually have a 75% chance of winning this particular game?

An inevitable conclusion or at least a question that we have to ask ourselves is: How does the world and our way of life change if the role of luck is 1 or very close to one? What happens if it is all determined and we do not control anything? I think the answer is twofold:

1. We still need to believe that we control our destiny.
2. We would need to know that this belief is not true but is only serving a useful purpose. This would allow to have compassion for ourselves and others when things don't go our way.