Settlers of Catan

What is Catan?

Settlers of Catan is a popular board game that involves players taking on the roles of settlers on the fictional island of Catan. The objective of the game is to accumulate points by building settlements and cities, acquiring resources through trade with other players or the game board, and earning special development cards.

The game is played on a modular board randomly generated at the start of each game, allowing for different strategies and gameplay every time. Players must also contend with a limited supply of resources and the potential for conflict with other players as they fight to control the island.

How to Win?

The simple answer is to be the first to get to 10 points!

(Psst… it's easier said than done)

Here are some important things to consider in order to win!

1. Resource Management
2. Trading
3. Expansion
4. Development Cards
5. Risk Assessment

These are some components that are usually considered when playing. Players who are good with those skills often find their way to victory!

Questions of Interest

1. Which resource-related attributes or actions contribute to the most points gained for a player?
2. How important is controlling a harbor in the early game? Does it lead to more points/victory?
3. How important is resource diversity in the early game?

Hypothesis

1. Individual production of resources should be the most important thing in order to gain the most points. Being self-sufficient pays well as there's no need to rely on other players for resources.
2. A harbor in the early games pays off well especially when resource production tiles required for the harbor trade are nearby.
3. Diversity does not affect your win percentage as resource production is the most important aspect of the game.

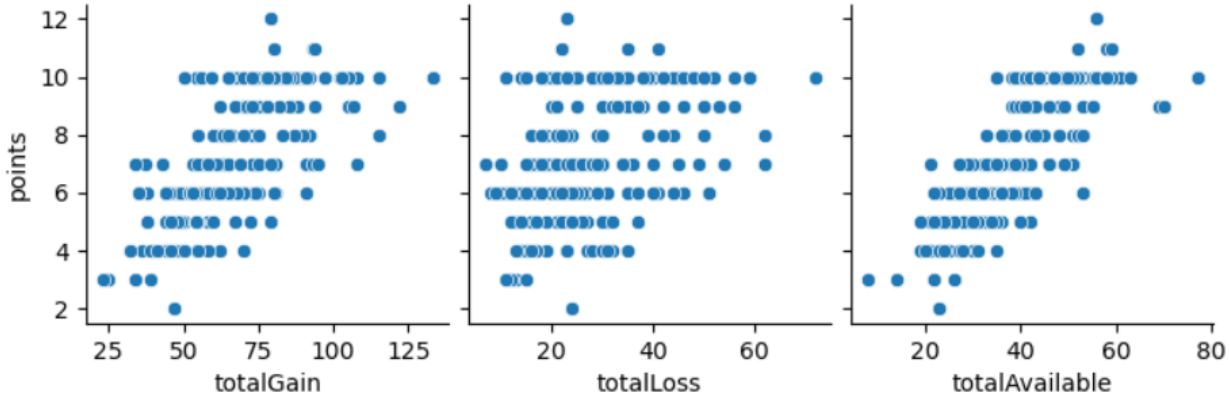
Data Analysis

Question 1

To answer question 1, I decided to choose the features that play a role in resource productions:

1. Production
2. TradeGain
3. RobbersCardsGain
4. TotalGain ~ (Production + TradeGain + RobbersCardsGain)
5. TradeLoss
6. RobberCardsLoss
7. Tribute
8. TotalLoss ~ (TradeLoss - RobberCardsLoss - Tribute)
9. TotalAvailable ~ (TotalGain - TotalLoss)

First, I want to see whether resource availability has any correlation to the points obtained by players. Let's take a look at the features that encompass most of the other features.

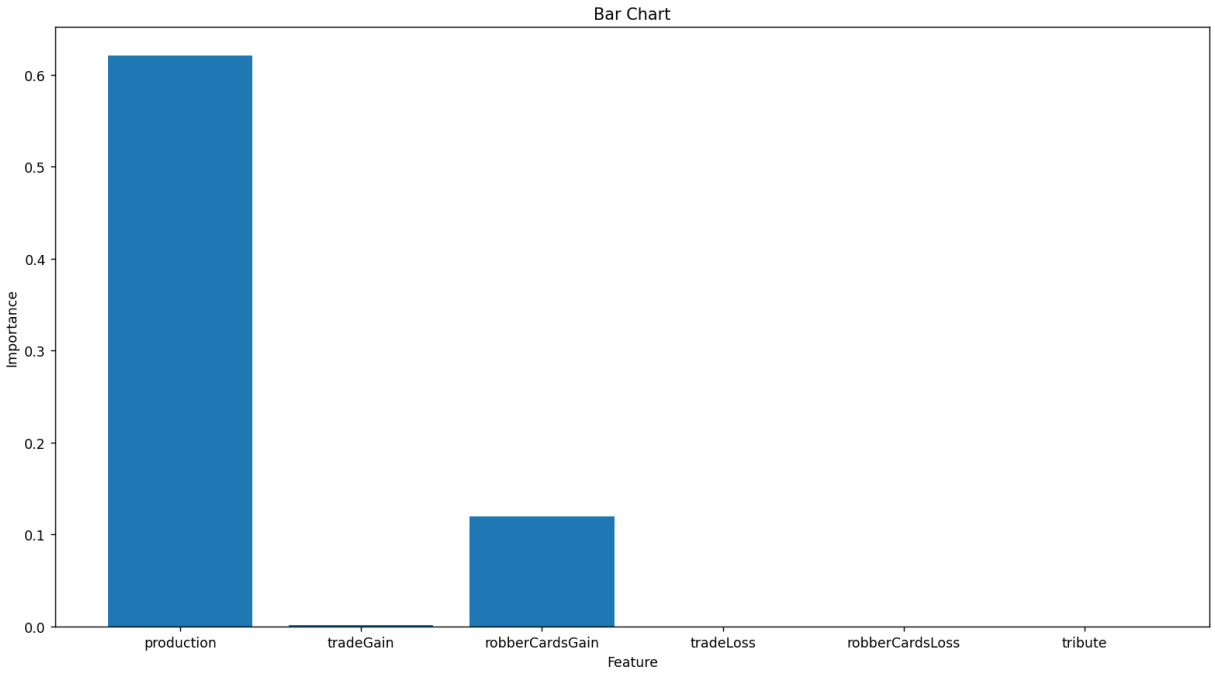


It seems like the TotalGain is somewhat correlated to the number of points obtained. However, even more compelling, the TotalAvailable shows a clearer correlation to the points obtained. This is to be expected as the TotalAvailable is calculated by TotalGain - TotalLoss. This represents the amount of actual usable resources instead of pure resources obtained in the game.

Obtaining resources does seem to play a role in winning the game of Catan! But which resource-obtaining action is most important?

To figure this out, I decided to use Elastic Net Regression to compare different features' abilities in predicting points obtained by players.

The coefficient obtained from Elastic Net regression can be used to determine the importance of features by analyzing the magnitude of the coefficients. A larger magnitude of the coefficient indicates that the corresponding feature has a stronger effect on the target variable, while a smaller magnitude indicates a weaker effect.



The following graph is obtained from the best-performing model. Production and RobberCardsGain are important features to gain points. Overall, the most important aspect is just to produce as many resources as you can on your own!

Question 2

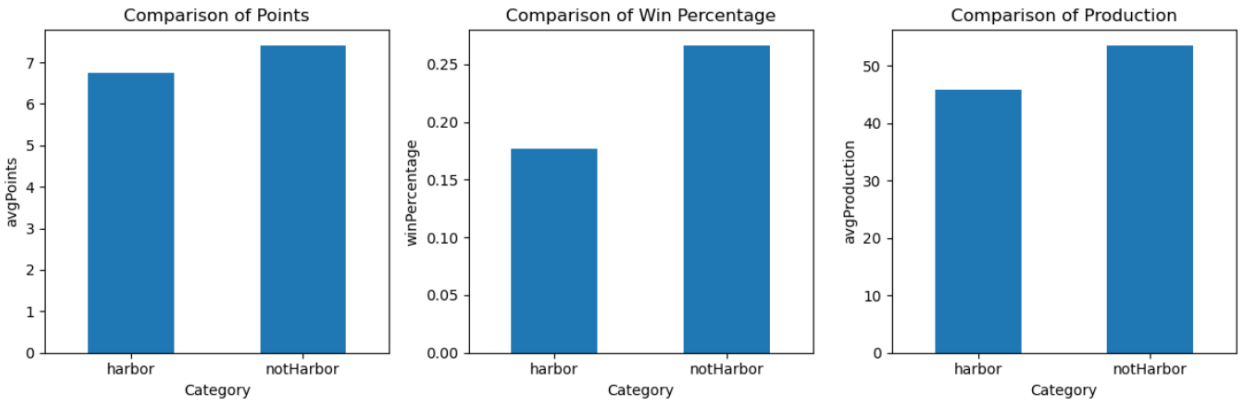
To answer question 2, I divided the dataset into ‘harbor’ and ‘non-harbor’ sets. By splitting the data this way, I can easily compare how good an early harbor strategy is. The metrics I use for comparison to answer the question are the following:

1. Average points
2. Winning percentage
3. Average production

Average points is a good metric as it provides a simple and objective way to evaluate between the two strategies. The average points metric takes into account all the ways to earn victory points and provides a single number to represent a player's overall performance. Furthermore, the average points metric accounts for the fact that different strategies may have different strengths at different stages of the game.

In addition to average points, I also decided to compare winning percentage. By calculating the winning percentage, players can determine whether the strategy is consistently successful over multiple games, rather than just looking at the points they can expect to get in a game. Like average points, it also accounts for different stages of the game and different situations.

Finally, average production is also used to see whether using harbor strategy affects the production of resources. It is important to see whether it has this effect because the production of resources correlates with winning the game. Not to mention, being resource-plenty might also open doors to more strategy options.



The following graphs are obtained, comparing the metrics mentioned before. The numbers for the figures are as follow:

	Harbor	Non-Harbor
Average Points	6.74	7.41
Winning Percentage	17.65%	26.62%
Average Production	45.8	53.6

It turns out the early harbor strategy fails in every metric when compared to the no early harbor strategy!

There could be many reasons for this result. One of the reasons that can be pointed out is that the early harbor strategy hinders the production of resources in the game. On average, the non-harbor produced around 17% more resources than an early harbor strategy. As resource production is an important component of winning the game, hindering this might be the cause of the results above.

Question 3

I decided to change my initial question and hypothesis as the amount of data is not sufficient for the analysis. Instead I'll be looking at how resource diversity in the early game contributes to a successful Catan game.

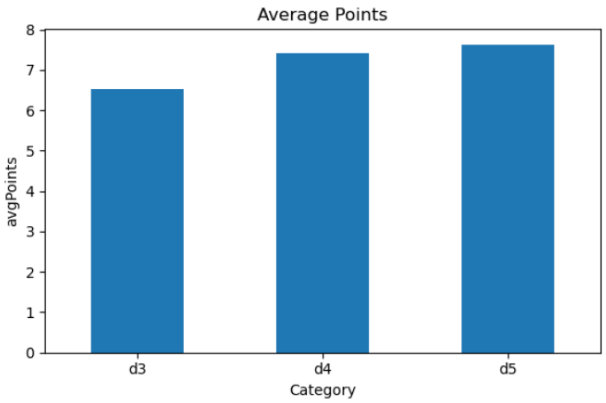
In this part of the analysis, I added two additional features. The features are:

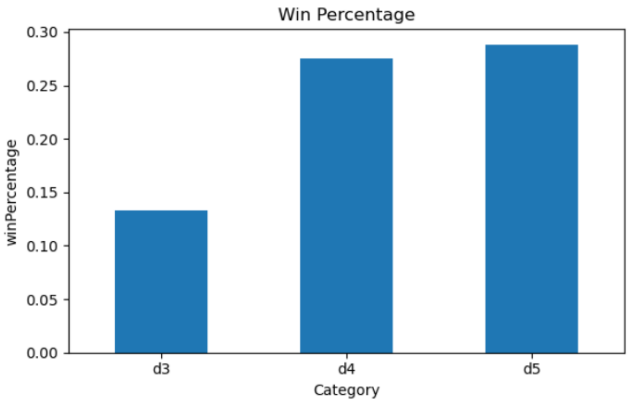
1. Pips
2. dScore

Pips are calculated based on the likelihood of a dice roll. The higher the pip, the higher chance that a resource tile will be rolled. The number of individual pips range from 1 to 5 and the pips column is the sum of the pips from 'settlement1' and 'settlement2'. Pips is a fair estimate of how good the resource production is for a player at the beginning of the game. Using production does not reflect early resource production as it is the sum of production throughout the game.

The dScore is calculated by the number of unique resource tiles a player occupies. A high dScore represents a high diversity early strategy. This is a good measure because it is easy to calculate and compare.

Firstly, in the previous analysis, resource production seemed to play a role in winning. I would like to know what effect diversity of resources has on a few important aspects. I generated the mean for some of the values of interest.

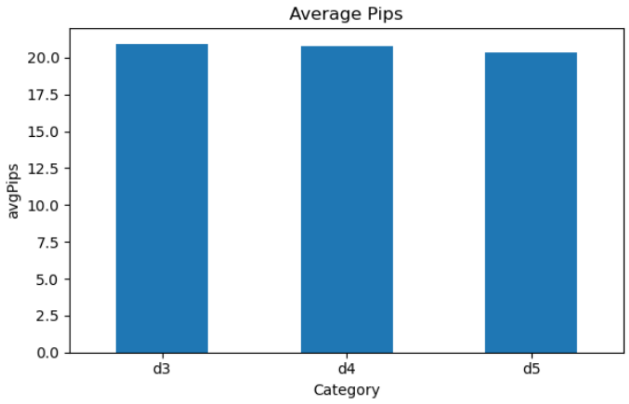


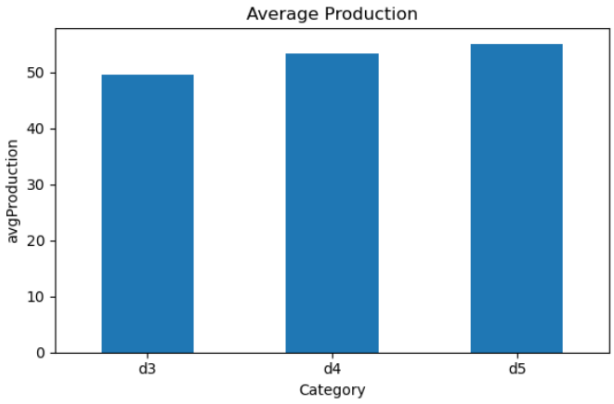


The following graphs are obtained to compare the average points and win percentage of different diversity categories. The numbers for the figures are as follows:

	dScore = 3	**dScore = 4**	**dScore = 5**
Average Points	6.53	7.41	7.62
Win Percentage	13.33%	27.5%	28.81%

To account for production, I calculated the average pips and average production for each category and the result are as follows:





It turns out that settling for only three unique resources is a bad strategy! Always go for four or more!

Between the category, there's no significant difference in resource production attributes. The average pips for all categories seems to be the same. This means that going for higher diversity does not necessarily hinder a player from higher production tile and going for lower diversity does not necessarily grant a player higher production tile.