Opleiding Informatica

Finding the best Balatro start decks

using a tool that calculates the best discards

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Abstract

Balatro is a video game with poker elements. Every round, the player needs to beat a certain score. The score gained is tied to the type of the played hand. The player can discard part of their hand to try and get more favorable cards. Our goal is to find out which cards to discard to get the highest odds of getting our desired poker hand. We calculate this using a self-made tool. We simulate a Balatro game where we play 10000 rounds with different starting configurations for every hand type. We conclude that the Painted Deck is the best, but that our experiment does not take into account the downside, so the Abandoned Deck is a good alternative for most decks. We also made a mod for the game that calculates the best discards for the current hand.

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1 Introduction

Video games are extremely popular, coming in a lot of different genres and styles. One of these genres is a roguelike, with games like Slay the Spire, Hades and MegaBonk becoming very popular [Gio]. In a roguelike game, the player has to play through certain levels, and every time the player gets defeated they have to restart from scratch. This is similarly to tabletop games like monopoly, where every game starts from the same beginning. The only advantage a player gets on later runs are the lessons learned from previous defeats.
A common genre that is often combined with roguelikes are deckbuilders. In a deckbuilder, the player starts with a deck of cards and modifies this while playing. They can add or remove cards or obtain combos where playing copies of the same card might give certain bonuses. The player can then, for example, modify the deck so that they only have copies of that card. Combining these is the roguelike deckbuilder where the player has to start with certain starting decks and can modify them during the game. If they are defeated they have to restart again using the same starting decks.
Balatro, created by LocalThunk [Loc], is one of those roguelike deckbuilders. The game is very popular being nominated for the game of the year and winning best indie game of the year at the game awards [Moo24].

Figure 1: The Balatro logo

Balatro is a poker-inspired single-player video game that allows you to build your own deck of standard playing cards. The game contains 15 starting decks, varying from starting with only hearts and spades to starting without face cards. The player chooses one of these to start. After having drawn a hand of 8 cards from their deck, the player gets the opportunity to discard up to 5 cards from their hand. Your intention is to play poker hands, for example, pair or high card, to gain a high enough score to win the round and proceed to the next round.
In this Bachelor thesis conducted at LIACS under the supervision of dr. Mark van den Bergh we answer the following research question: Which starting deck is the best, calculated using a self-made tool that calculates the best discards?

1.1 Related work

A popular card game that uses similar rules as Balatro is poker. Balatro takes elements of both five card draw poker and Texas hold'em poker. In Texas hold'em poker, each player starts with 2 cards. They then choose to keep playing or to fold, after which more cards are drawn. This repeats until there are 5 cards revealed. The process of drawing cards by the dealer is similar to replacing cards in Balatro. The probabilities of getting a certain poker hand have already been calculated and can be found in [Bar11].
In five-card draw poker, the player gets five cards drawn with the option to replace up to five cards. Just like in Texas hold'em poker, the player wants to find the highest scoring hand type. These two poker types are combined in Balatro as the player can replace up to five cards, but also has 3 more cards in hand which is like the card draw stage of Texas hold'em poker, where players have 2 cards in hand. For five-card draw poker, the odds of getting each hand type have also been calculated. These can be found in [Bar07]. The player in Balatro has the advantage of knowing which cards are still in the deck, compared to poker where opponents might have, for example, drawn every 10 from the deck, making it no longer possible for you to get a straight with a 10.

1.2 Thesis overview

We will write about how a Balatro game is played in Section 2. In Section 3 we explain how we calculate which discard is the best. Furthermore in Section 4 we write about the creation of our Balatro mod. Section 5 describes the experiments for the different hand types and their outcomes. Section 6 gives a conclusion of the experiments. Section 7 we suggest some future research that could still be done.

2 Definitions

2.1 A game of Balatro

A game of Balatro is divided into multiple rounds, called antes, each ante consists of three blinds. In a blind the player needs to reach a certain number of points to win that blind and to proceed to the next one. After winning ante 8 the player wins the game.
In a blind the player has 8 cards drawn from their deck. Every turn, the player can either play up to 5 cards or discard up to 5 cards. This allows the player to try to find a better hand type. Every hand type has a certain value consisting of chips and mult. When scoring all the cards that are part of the played hand type are used in the calculation and have their card value added to the chips value. This is then multiplied by the mult value. So the score obtained is

$$Score = (chips + \text{value of scored cards}) * mult$$

Hand type	Starting value		Additional gained on level up	
	mult	**chips**	**mult**	**chips**
High card	1	5	1	10
Pair	2	10	1	15
Two pair	2	20	1	20
Three of a kind	3	30	2	20
Straight	4	30	3	30
Flush	4	35	2	15
Full house	4	40	2	25
Four of a kind	7	60	3	30
Straight flush	8	100	4	40
Five of a kind	12	120	3	35
Flush House	14	140	4	40
Flush Five	16	160	3	50

Table 1: Chips and mult values of every hand type

The player can play up to 4 hands and discard up to 3 times. The goal of the player is to beat a certain blind. Once the combined score of the hands played is equal or greater than the blind the blind is beaten. If the player is not able to beat the blind then they lose the game and have to restart. The three blinds of the ante are called, the small blind, the big blind and the boss blind. The score to beat depends on the ante and the blind. The score of a big blind is 50% higher than a small blind, while the score of the boss blind is double the small blind. The start score for round one is 300, so the big blind is 450 and the boss blind 600. After the player beats a blind they go to the shop. Here they can buy new cards to add to their deck or jokers which have special effects, for example, +50 Chips if played hand contains a Pair. This means that a pair of two's which would normally give

$$(10 + (2 + 2)) * 2 = 28$$

now gives

$$(10 + (2 + 2) + 50) * 2 = 128$$

score. They can also upgrade specific hand types increasing their chips and mult as seen in Table 1. The score of the small blind of ante 8 is 50000. After winning the boss blind they win the game. The player then gets the option to keep playing in the endless mode. In this mode the scores needed grow significantly faster, the small blind of ante 16 requires the player to beat a score of 8.6e20. The current limit is ante 39 where the score overflows to Naneinf. The player can also get a score that overflows into Naneinf, but even a score of Naneinf cannot beat this ante, so the end goal of a Balatro game is to get Naneinf on ante 39, after which the player would be defeated. [Bal] To get such a high score it is important to focus on a specific hand type and to keep leveling it up. This is why we want to know which starting deck gives the greatest advantage for each hand type.

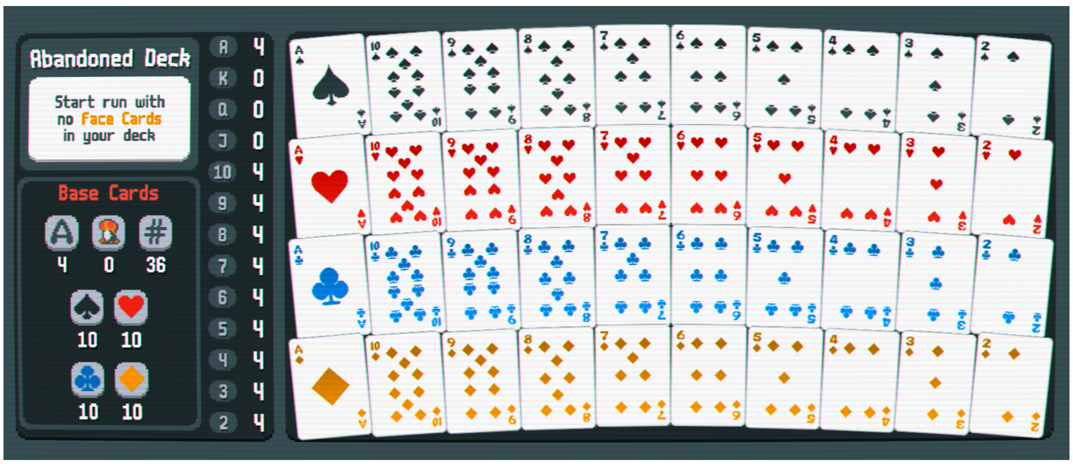

Figure 2: The Abandoned Deck in Balatro.

2.2 Starting decks

A game of Balatro can snowball out of control very fast, so it crucial that you get your desired hands as often as possible. One of the ways to increase your chances is to select a better starting deck. The game contains 15 different starting decks. All of these decks use a standard poker deck or have small variations. A Default poker deck has four suits: hearts, diamonds, clubs and spades. Each suit contains the cards 2 through 10 and the 3 face cards starting with the value of 11, the jack, then the queen with a value of 12, next is the king valued at 13 and lastly the ace which counts as both a 14 and a 1, changing its value depending on which value gives the player the highest scoring hand. This deck also has 5 joker slots allowing the player to have up to 5 jokers at the same time. There are 15 starting decks, but we will only experiment on the following 6.

- Red Deck, which allows the player to discard an extra time.
- Blue Deck, which allows the player to play one extra hand.
- Black Deck, adds 1 Joker slot, decreases played hands by 1.
- Abandoned Deck, start the game without Face Cards in your deck, as seen in Figure 2.

- Checkered Deck, start the game with 26 Spades and 26 Hearts in your deck.
- Painted Deck, adds 2 to hand size and decreases Joker slots by 1 .

3 Calculating the probability of a hand type

The player can choose up to 5 cards from their hand to discard. This means that there are

$$\binom{8}{1} + \binom{8}{2} + \binom{8}{3} + \binom{8}{4} + \binom{8}{5} = 218$$

different discard possibilities for a given hand of 8 cards. We want to know which of these has the highest probability of getting the desired hand type. We can do this by going through every combination of cards and calculate how many combinations there are. We do this using the binomial coefficient. We create a basic formula for when we want to find a single type of card. We use

- t, the number of that card type still left in the deck
- p, the number of that card type that you want to pick
- n, the total number of cards left in the deck
- d, the number of cards discarded in this hand.

We combine this to find the number of possible hands with the card type.

$$\text{Number of hands with exactly p cards of this type} = \binom{t}{p}\binom{n-t}{d-p}$$

So if we want to have a pair of two's, we set p to the number of two's we need, then let us say that we still have 4 two's in our deck so we set t to 4. We get

$$\binom{4}{2} = 6$$

different ways to pick cards that are pairs of card type 2. The formula calculates the number of hands we can draw with exactly one pair of 2's and different cards. For example, a hand that contains $2, 2, 3, 6$ is a different hand than a hand with $2, 2, 4, 8$.
In the second part of the formula above. we subtract t from n because we want to know how many other cards are still left in the deck that are not of the desired type. And we subtract p from d in order to find out the number of extra cards we need to draw to fill up our hand. If we want 2 kings and we only discard 2 cards then $d = p$ and the second part becomes 1. If we need to pick more cards than there are left in the deck, then the hand is no longer possible and the second part will become 0 which means that the entire formula evaluates to 0.

3.1 Matching sets

We define a hand as $x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8$ where we draw a card for each x_i. Let us say that we have a standard poker deck and we get the hand 2,3,4,5,6,7,8,9 and we want to know the probability to get a pair when discarding 2,3,4 and 5. We then apply our created formula for each card type. All the values that we have picked in our hand have 3 cards left while the other cards all have 4 cards left. Since we have drawn 8 cards from our deck n now becomes $52 - 8 = 44$. We go over each card type and calculate the number of hands that exist where this card can create a pair. In Balatro drawing more than 2 of the same type of card also counts as a pair, so we also need to count the times that we have a 3 of a kind and 4 of a kind. For the 6,7,8 and 9 this becomes

$$\binom{3}{1}\binom{44-3}{4-1} + \binom{3}{2}\binom{44-3}{4-2} + \binom{3}{3}\binom{44-3}{4-3}$$

for 2,3,4 and 5 it becomes

$$\binom{3}{2}\binom{44-3}{4-2} + \binom{3}{3}\binom{44-3}{4-3}$$

and for the left over cards it becomes

$$\binom{4}{2}\binom{44-4}{4-2} + \binom{4}{3}\binom{44-4}{4-3} + \binom{4}{4}\binom{44-4}{4-4}$$

These are all the ways to get pairs of one card type, but the set of hands that contain the pairs of one value overlaps with the set of all hands of other values. This means that when we add the number of hands for pair one and the number of hands for pair two that we count certain hands double. More specifically we count all the hands that contain two different pairs double. For example the hand 4,5,6,6,7,7,8,9 is counted once for pairs of six's and once for pairs of seven's. This means that we have to use the principle of inclusion-exclusion. We first add all the hands that we calculated for one pair. We then subtract all the hands that contain two different pairs. We then add all the hands that contain 3 different pairs, subtract for all the hands of 4 different pairs, and so on until we have reached our maximum number of different pairs in one hand. In order to calculate the hands that contain two pairs we need to make sure that we don't count these double as the pairs 2,2,3,3 and 3,3,2,2 are the same. We calculate this for our example as follows:

$$\text{Number of Hands with a pair of 2's and a pair of 3's} = \binom{3}{2}\binom{3}{2}\binom{44-3-3}{4-2-2}$$

This can be generalized to:

$$\text{Number of hands with two different pairs, } x_1 \text{and } x_2 = \binom{t_{x_1}}{p_{x_1}}\binom{t_{x_2}}{p_{x_2}}\binom{n - t_{x_1} - t_{x_2}}{d - p_{x_1} - p_{x_2}}$$

where x_1 is the first pair, x_2 is the second pair, n is the number of cards left in the deck and d is the number of cards discarded. We combine this for up to 5 pairs and get the formula in Figure 3, which calculates the number of pairs, three of a kinds four of a kinds or five of a kinds for a single discard option.

$$\sum_{x_1=1}^{13}\sum_{j_1=p_{x_1}}^{t_{x_1}}\binom{t_{x_1}}{j_1}\binom{n-t_{x_1}}{d-j_1}$$

$$-\sum_{x_1=1}^{13}\sum_{x_2=x_1+1}^{13}\sum_{j_1=p_{x_1}}^{t_{x_1}}\sum_{j_2=p_{x_2}}^{t_{x_2}}\binom{t_{x_1}}{j_1}\binom{t_{x_2}}{j_2}\binom{n-t_{x_1}-t_{x_2}}{d-j_1-j_2}$$

$$+\sum_{x_1=1}^{13}\sum_{x_2=x_1+1}^{13}\sum_{x_3=x_2+1}^{13}\sum_{j_1=p_{x_1}}^{t_{x_1}}\sum_{j_2=p_{x_2}}^{t_{x_2}}\sum_{j_3=p_{x_3}}^{t_{x_3}}\binom{t_{x_1}}{j_1}\binom{t_{x_2}}{j_2}\binom{t_{x_3}}{j_3}\binom{n-t_{x_1}-t_{x_2}-t_{x_3}}{d-j_1-j_2-j_3}$$

$$-\sum_{x_1=1}^{13}\sum_{x_2=x_1+1}^{13}\sum_{x_3=x_2+1}^{13}\sum_{x_4=x_3+1}^{13}\sum_{j_1=p_{x_1}}^{t_{x_1}}\sum_{j_2=p_{x_2}}^{t_{x_2}}\sum_{j_3=p_{x_3}}^{t_{x_3}}\sum_{j_4=p_{x_4}}^{t_{x_4}}\binom{t_{x_1}}{j_1}\binom{t_{x_2}}{j_2}\binom{t_{x_3}}{j_3}\binom{t_{x_4}}{j_4}\binom{n-t_{x_1}-t_{x_2}-t_{x_3}-t_{x_4}}{d-j_1-j_2-j_3-j_4}$$

$$+\sum_{x_1=1}^{13}\sum_{x_2=x_1+1}^{13}\sum_{x_3=x_2+1}^{13}\sum_{x_4=x_3+1}^{13}\sum_{x_5=x_4+1}^{13}\sum_{j_1=p_{x_1}}^{t_{x_1}}\sum_{j_2=p_{x_2}}^{t_{x_2}}\sum_{j_3=p_{x_3}}^{t_{x_3}}\sum_{j_4=p_{x_4}}^{t_{x_4}}\sum_{j_4=p_{x_4}}^{t_{x_5}}\binom{t_{x_1}}{j_1}\binom{t_{x_2}}{j_2}\binom{t_{x_3}}{j_3}\binom{t_{x_4}}{j_4}\binom{t_{x_5}}{j_5}$$
$$\binom{n-t_{x_1}-t_{x_2}-t_{x_3}-t_{x_4}-t_{x_5}}{d-j_1-j_2-j_3-j_4-j_5}$$

Figure 3: general formula for pairs

When using this formula we set the ace as 1, the jack as 11, the queen as 12 and the king as 13. When calculating the number of hands that contain two pair, we only need to take into account the pairs that can be in a hand of two pairs. For example if a card type did not have a hand with one pair, it cannot have a hand with two pairs. Or if a pair was not in a hand that contained two pairs, it then also cannot be in a hand with three pairs. This means that x_1 through x_5 can skip the card types that were not in a hand x_1 through x_4 in the layer above.
This formula can also be used in order to calculate three of a kind, four of a kind, five of a kind and flushes. The difference is in the p_i, where p_i starts as a 2 for a pair. It needs to start as a 3 for a three of a kind. For flushes we swap the 13 card types for the 4 different suits and then calculate the number of hands that contain a five of a kind: five cards of the same suit.

Using the formula in Figure 3 we will calculate the number of possible hands that have a pair for a given discard using a small hand size of 6 and a smaller deck. We start with the hand $1, 2, 3, 4, 5, 6$ where we will discard $4, 5, 6$. So our hand remaining hand is $1, 2, 3$ and our deck contains the cards

$$\text{Deck} = \{1, 2, 3, 3, 4, 4, 5, 5, 5\}$$

Using this we determine the t and p for every number.

	1	2	3	4	5	6
t	1	1	2	2	3	0
p	1	1	1	2	2	2

We then fill in the formula in Figure 3 to get 83, which is the total number of possible hands that contain a pair for this discard. We calculate this for every possible discard. The discards with the highest possible hands is the one most likely to get a pair and thus the best.

$$\begin{gathered}
2\binom{1}{1}\binom{9-1}{2} + \binom{2}{1}\binom{9-2}{2} + \binom{2}{2}\binom{9-2}{1} + \binom{2}{2}\binom{9-2}{1} + \binom{3}{2}\binom{9-3}{1} + \binom{3}{3}\binom{9-3}{0} \\
-\binom{1}{1}\binom{1}{1}\binom{9-2}{1} - 2\binom{1}{1}\binom{2}{1}\binom{9-3}{1} - 4\binom{1}{1}\binom{2}{2}\binom{9-3}{0} \\
-\binom{2}{1}\binom{2}{2}\binom{9-3}{0} - 2\binom{1}{1}\binom{3}{2}\binom{9-4}{0} - \binom{2}{1}\binom{3}{2}\binom{9-5}{0} \\
+\binom{1}{1}\binom{1}{1}\binom{2}{1}\binom{9-4}{0} \\
= 83
\end{gathered}$$

3.2 Straights

Pairs have many combinations, but these are simple to calculate. The straight is the opposite. There are only 10 possible straights in the game and with the standard hand size of 8 it is not possible for the same straight to be pulled twice. It is also possible to check if a straight is possible before starting the calculation. This means that we can go over every straight and check if is still possible to get. This results in less calculations to be done.
Lets take the same hand as before where x_1,x_2,x_3,x_4,x_5,x_6,x_7,x_8 are 2,3,4,5,6,7,8,9 and we discard 2,3,4,5, which means that we still have 6,7,8,9. So the straights A,2,3,4,5 and 10,11,12,13,1 are not possible. For the other straights we can calculate the number of hands using the following formula.

$$\binom{t_{x_1}}{p_{x_1}}\binom{t_{x_2}}{p_{x_2}}\binom{t_{x_3}}{p_{x_3}}\binom{t_{x_4}}{p_{x_4}}\binom{t_{x_5}}{p_{x_5}}\binom{n-t_{x_1}-t_{x_2}-t_{x_3}-t_{x_4}-t_{x_5}}{d-p_{x_1}-p_{x_2}-p_{x_3}-p_{x_4}-p_{x_5}}$$

In this formula we only look at the cards that we need. If we only need 4 cards to get a straight then we only go up to t_{x_4}. If we need 5 cards then the last part of the equation becomes 1. So in our example for the straight 3,4,5,6,7 the formula is

$$\binom{t_{x_1}}{p_{x_1}}\binom{t_{x_2}}{p_{x_2}}\binom{t_{x_3}}{p_{x_3}}\binom{n-t_{x_1}-t_{x_2}-t_{x_3}}{d-p_{x_1}-p_{x_2}-p_{x_3}}$$

which becomes

$$\binom{3}{1}\binom{3}{1}\binom{3}{1}\binom{44-9}{4-3}$$

However, since we only need 3 of our 4 discards to create the straight, we also need to calculate the hands which contain duplicate values of 3,4 and 5, as these would also create the straight. This means that we need to add this to our previous calculation. This now becomes

$$\binom{3}{1}\binom{3}{1}\binom{3}{1}\binom{44-9}{4-3}+\binom{3}{2}\binom{3}{1}\binom{3}{1}+\binom{3}{1}\binom{3}{2}\binom{3}{1}+\binom{3}{1}\binom{3}{1}\binom{3}{2}$$

Just as the pairs we have to possibility to get multiple straights in one hand. In our previous example we got the straight 3,4,5,6,7, but since we already had an 8 and a 9 in hand, we also have the straights 4,5,6,7,8 and 5,6,7,8,9. This means that this hand has been counted multiple times. So just as with the pairs we now need to subtract the hands that contain two straights. This means that we need to calculate the number of hands for every straight combination. Take the straight 5,6,7,8,9 and the straight 8,9,10,11,12. In order for this combination to be possible, we need to draw the cards 5,10,11,12. For this the same calculation can be done as in the previous example, so we get

$$\binom{t_5}{p_5}\binom{t_{10}}{p_{10}}\binom{t_{11}}{p_{11}}\binom{t_{12}}{p_{12}}$$

However, the straight 3,4,5,6,7 and 8,9,10,11,12 are not both possible. This means that we do not have to continue with this combination. After we have subtracted all the hands that contain 2 straights, we then need to add all the hands that contain 3 straights and subtract all the hands that contain 4 straights. For a normal hand size we can stop after hands that contain 4 straights,

but if the hand size has been increased, then we need to continue on adding every odd straight count and subtracting every even straight count.
We can use the same formula as for the pairs, but we need to know which t_i we need to use. This removes the need to preemptively check which cards the straights need. We then get the general formula for calculating the hands for one straight as follows

$$\sum_{x_1=1}^{10} \sum_{j_1=p_{x_1}}^{t_{x_1}} \sum_{j_2=p_{x_{1+1}}}^{t_{x_{1+1}}} \sum_{j_3=p_{x_{1+2}}}^{t_{x_{1+2}}} \sum_{j_4=p_{x_{1+3}}}^{t_{x_{1+3}}} \sum_{j_5=p_{x_{1+4}}}^{t_{x_{1+4}}} \binom{t_{x_1}}{j_1} \binom{t_{x_{1+1}}}{j_2} \binom{t_{x_{1+2}}}{j_3} \binom{t_{x_{1+3}}}{j_4} \binom{t_{x_{1+4}}}{j_5} \binom{n - t_{x_1} - t_{x_{1+1}} - t_{x_{1+2}} - t_{x_{1+3}} - t_{x_{1+4}}}{d - j_1 - j_2 - j_3 - j_4 - j_5}$$

In order to get multiple straights from discarding, there needs to be at least one x_i that is already in your hand. To get the t_1 through t_5 we add $\{i,\ i+1\ ...\ i+4\}$ to a list and we check if this list has more than d items. If this is the case then this i, $i+1$ to $i+4$ would require more discarded cards, and is thus not possible. After getting a i, $i+1$ to $i+4$ that fits, we calculate it using the Formula 4, where every x_i is a start index for a straight.
To show how we find all the straights, we have a small example where we have a hand size of 5 and are looking for straights that are three long. We have already discarded cards and our current hand is $1, 2, 3$ and our deck contains $2, 4, 6, 7$. There are 5 different straights possible, namely $\{1, 2, 3\}$, $\{2, 3, 4\}$, $\{3, 4, 5\}$, $\{4, 5, 6\}$ and $\{5, 6, 7\}$. To find the hands with two straights we take the starting points x_1 and x_2 where $x_2 > x_1$ and try all possibilities to check if they are allowed. So we first have all the possibilities where x_1 is 1, namely ($\{1, 2, 3\}$, $\{2, 3, 4\}$), ($\{1, 2, 3\}$, $\{3, 4, 5\}$), ($\{1, 2, 3\}$, $\{4, 5, 6\}$) and ($\{1, 2, 3\}$, $\{5, 6, 7\}$). Of these, only the first two are possible. We then check every combination where x_1 is 2, ($\{2, 3, 4\}$, $\{3, 4, 5\}$), ($\{2, 3, 4\}$, $\{4, 5, 6\}$) and ($\{2, 3, 4\}$, $\{5, 6, 7\}$). Here only the first one is possible. We keep doing this until x_1 is the starting index of the highest straight. We then do the same for three straights except we have $x_1 < x_2 < x_3$, which for our example is only possible once for ($\{1, 2, 3\}$, $\{2, 3, 4\}$, $\{3, 4, 5\}$).

$$\sum_{x_{i1}=1}^{10}\sum_{j_1=p_{x_1}}^{t_{x_1}}\sum_{j_2=p_{x_2}}^{t_{x_2}}\sum_{j_3=p_{x_3}}^{t_{x_3}}\sum_{j_4=p_{x_4}}^{t_{x_4}}\sum_{j_5=p_{x_5}}^{t_{x_5}}\binom{t_{x_1}}{j_1}\binom{t_{x_2}}{j_2}\binom{t_{x_3}}{j_3}\binom{t_{x_4}}{j_4}\binom{t_{x_5}}{j_5}$$
$$\binom{n-t_{x_1}-t_{x_2}-t_{x_3}-t_{x_4}-t_{x_5}}{d-j_1-j_2-j_3-j_4-j_5}$$
$$-\sum_{x_{i1}=1}^{10}\sum_{x_{i2}=x_{i1}+1}^{10}\sum_{j_1=p_{x_1}}^{t_{x_1}}\sum_{j_2=p_{x_2}}^{t_{x_2}}\sum_{j_3=p_{x_3}}^{t_{x_3}}\sum_{j_4=p_{x_4}}^{t_{x_4}}\sum_{j_5=p_{x_5}}^{t_{x_5}}\binom{t_{x_1}}{j_1}\binom{t_{x_2}}{j_2}\binom{t_{x_3}}{j_3}\binom{t_{x_4}}{j_4}\binom{t_{x_5}}{j_5}$$
$$\binom{n-t_{x_1}-t_{x_2}-t_{x_3}-t_{x_4}-t_{x_5}}{d-j_1-j_2-j_3-j_4-j_5}$$
$$+\sum_{x_{i1}=1}^{10}\sum_{x_{i2}=x_{i1}+1}^{10}\sum_{x_{i3}=x_{i2}+1}^{10}\sum_{j_1=p_{x_1}}^{t_{x_1}}\sum_{j_2=p_{x_2}}^{t_{x_2}}\sum_{j_3=p_{x_3}}^{t_{x_3}}\sum_{j_4=p_{x_4}}^{t_{x_4}}\sum_{j_5=p_{x_5}}^{t_{x_5}}\binom{t_{x_1}}{j_1}\binom{t_{x_2}}{j_2}\binom{t_{x_3}}{j_3}\binom{t_{x_4}}{j_4}\binom{t_{x_5}}{j_5}$$
$$\binom{n-t_{x_1}-t_{x_2}-t_{x_3}-t_{x_4}-t_{x_5}}{d-j_1-j_2-j_3-j_4-j_5}$$
$$-\sum_{x_{i1}=1}^{10}\sum_{x_{i2}=x_{i1}+1}^{10}\sum_{x_{i3}=x_{i2}+1}^{10}\sum_{x_{i4}=x_{i3}+1}^{10}\sum_{j_1=p_{x_1}}^{t_{x_1}}\sum_{j_2=p_{x_2}}^{t_{x_2}}\sum_{j_3=p_{x_3}}^{t_{x_3}}\sum_{j_4=p_{x_4}}^{t_{x_4}}\sum_{j_5=p_{x_5}}^{t_{x_5}}\binom{t_{x_1}}{j_1}\binom{t_{x_2}}{j_2}\binom{t_{x_3}}{j_3}\binom{t_{x_4}}{j_4}\binom{t_{x_5}}{j_5}$$
$$\binom{n-t_{x_1}-t_{x_2}-t_{x_3}-t_{x_4}-t_{x_5}}{d-j_1-j_2-j_3-j_4-j_5}$$
$$+\sum_{x_{i1}=1}^{10}\sum_{x_{i2}=x_{i1}+1}^{10}\sum_{x_{i3}=x_{i2}+1}^{10}\sum_{x_{i4}=x_{i4}+1}^{10}\sum_{x_{i5}=x_{i4}+1}^{10}\sum_{j_1=p_{x_1}}^{t_{x_1}}\sum_{j_2=p_{x_2}}^{t_{x_2}}\sum_{j_3=p_{x_3}}^{t_{x_3}}\sum_{j_4=p_{x_4}}^{t_{x_4}}\sum_{j_5=p_{x_5}}^{t_{x_5}}\binom{t_{x_1}}{j_1}\binom{t_{x_2}}{j_2}\binom{t_{x_3}}{j_3}\binom{t_{x_4}}{j_4}\binom{t_{x_5}}{j_5}$$
$$\binom{n-t_{x_1}-t_{x_2}-t_{x_3}-t_{x_4}-t_{x_5}}{d-j_1-j_2-j_3-j_4-j_5}$$

Figure 4: General formula for straights

4 Creating the Balatro mod

Currently our program tries to simulate the Balatro game and we only take into account the different starting decks. However, in the actual game it is also possible to add to or remove cards from your deck during the game. To find out if our program still workes when this is done and for players to use the program in practice while playing the game, we decided to rewrite our program into a mod that directly interacts with the game. This allows us to calculate the highest value discards directly using the current state of the hand and deck.

Our mod uses Steammodded [ste], a framework to allow Balatro modding. This framework, just like the game, is written in the programming language Lua. Lua is a powerful, efficient and lightweight scripting language [Lua]. Our original code was written in Python. Lua is very similar to Python. Both languages use dynamic types and both can be used procedural or object-oriented.

A big difference in Lua in comparison to Python are the data structures. In Lua the only data structure is the Table, a key value pair structure like the Python dictionary. The list in Lua is thus actually a dictionary without a starting or ending point. You can have an item at index 1 and an item at index 10 without having items between them. This would give out of bound errors in Python, but is perfectly fine in Lua. Another difference between Python and Lua are the supporting functions. For example, the len function for dictionaries in Python counts every item, while in Lua it counts the items from index 1 to the first empty element. This means that it misses items with non number keys or when indices are skipped as seen in Figure 5 and Figure 6. This made it a bit more complex to translate the code from Python to Lua. Another difference between Lua and Python is that Lua does not have the continue keyword and uses goto with labels instead. The mod can be found at [Mod]

```
thisdictionary = {
    "x":"xx",
    0:"zero",
    1:"first",
    2:"second",
    5:"fifth"
}
print(len(thisdictionary))
output: 5
```

Figure 5: A Python code example for a dictionary with length 5

```lua
thistable = {}
thistable["x"] = "xx"    --skipped
thistable[0] = "zero"    --skipped
thistable[1] = "first"   --counted
thistable[2] = "second"  --counted
thistable[5] = "fifth"   --skipped
print(#thistable)
output: 2
```

Figure 6: A Lua code example for a table with length 2

After installing the mod the user can press certain key binds when they are in a round as seen in Table 2. This will calculate the best cards to play or discard in order to give the greatest odds of finding the desired hand type.

hand type	keybind
pair	ctrl + 1
two pair	ctrl + 2
three of a kind	ctrl + 3
four of a kind	ctrl + 4
five of a kind	ctrl + 5
full house	ctrl + 6
straight	ctrl + 7
flush	ctrl + 8
straight flush	ctrl + 9
flush house	ctrl + 0
flush five	ctrl + -

Table 2: Keybinds for the Balatro mod

The five of a kind, the flush house and the flush five are hands that are not possible to get with just the starting decks, but it is possible to get them after adding additional cards to your deck. This means that it is possible for the player to have these as a desired hand type and thus we added them to our mod. A flush house is a combination of a flush and a full house meaning that your have a three of a kind and a pair all of the same suit. A flush five is a mix of a flush and a five of a kind. To get a flush five you need to get 5 cards of the same value and suit. In Figure 7 we can see the current deck in the center, the current hand at the bottom and the best discard according to our mod in the last line of the command prompt.

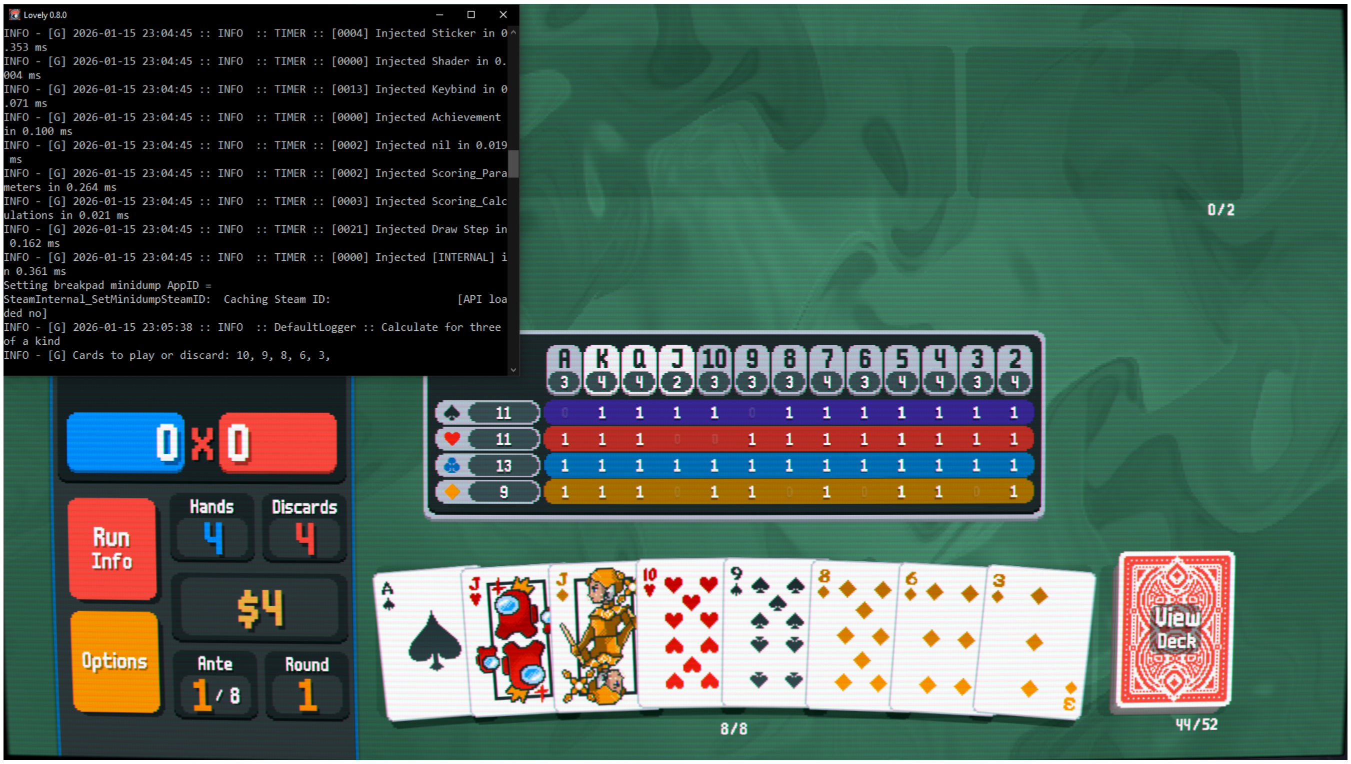

Figure 7: The Balatro mod calculating a three of a kind

5 Experiments

To answer which starting deck is the best can depend on which hand type you would like to play. A flush might be more common in a deck than a pair, while a pair might have a better performance in a different deck. That is why we want to know the best deck for each hand type. We are only looking at decks that would change the number of hands obtained, while the other decks are all represented by the Default deck.

In this experiment, we will simulate a blind of Balatro. We do not look at the score, we only look at whether the desired hand was found. A hand normally contains 8 cards, but the Painted deck adds 2 to this to have a hand of size 10. We then check if we already have our desired hand. If this is the case then we greedily play the cards forming the hand type. If we did not get our desired hand, we start to discard cards. We discard the cards that maximizes our probability of obtaining our desired hand. If after discarding we did not find our hand, we then keep discarding until we run out of discards, which would normally be after 3 discards. If we have used all our discards and still not found our hand, we start discarding cards by playing them. We call this playing a wrong hand. We play this blind 10000 times to minimize the effect of the randomness that is a result of randomly drawing our hand. We do not simulate jokers, so the upside of the black deck and the downside of the Painted Deck are ignored. The results can be found in Table 3 through Table 10. In Figure 8 we have plotted the number of correct hands played with two pairs, straights, four of a kinds and flushes against each other for every deck, to better visualize how each deck performs.

decks	hand found	discards used	wrong hand played
Default poker deck	39969	4602	31
Red Deck	40000	5008	0
Blue Deck	49965	5874	35
Black Deck	29980	3587	20
Abandoned Deck	39998	1478	2
Checkered Deck	39974	4182	26
Painted Deck	40000	1003	0

Table 3: Results of the simulation for pair

decks	hand found	discards used	wrong hand played
Default poker deck	39968	3634	32
Red Deck	40000	3903	0
Blue Deck	49801	4592	189
Black Deck	29982	3509	18
Abandoned Deck	40000	2097	0
Checkered Deck	39968	3592	32
Painted Deck	40000	1203	0

Table 4: Results of the simulation for two pair

decks	hand found	discards used	wrong hand played
Default poker deck	19004	29816	20996
Red Deck	22680	39551	8560
Blue Deck	23260	29880	26740
Black Deck	15240	29180	14760
Abandoned Deck	31367	27045	8633
Checkered Deck	18895	29954	21105
Painted Deck	32676	23700	7324

Table 5: Results of the simulation for three of a kind

decks	hand found	discards used	wrong hand played
Default poker deck	16714	29946	23286
Red Deck	21739	37521	18261
Blue Deck	23726	30000	26274
Black Deck	12615	30000	17385
Abandoned Deck	25863	29594	14137
Checkered Deck	16678	29982	23322
Painted Deck	28331	28923	11669

Table 6: Results of the simulation for straight

decks	hand found	discards used	wrong hand played
Default poker deck	16812	29983	23818
Red Deck	18856	39923	21144
Blue Deck	18991	30000	31009
Black Deck	13481	29786	16519
Abandoned Deck	16604	29996	23396
Checkered Deck	15394	29917	24606
Painted Deck	26866	29376	13134

Table 7: Results of the simulation for flush

decks	hand found	discards used	wrong hand played
Default poker deck	13917	39970	26083
Red Deck	17175	39804	22825
Blue Deck	17554	29991	32446
Black Deck	12048	29728	17952
Abandoned Deck	20053	29434	19947
Checkered Deck	15050	29975	24950
Painted Deck	28737	27800	11263

Table 8: Results of the simulation for full house

decks	hand found	discards used	wrong hand played
Default poker deck	5519	30000	34481
Red Deck	7726	40000	32274
Blue Deck	7620	30000	42380
Black Deck	3938	29999	26062
Abandoned Deck	11013	30000	28987
Checkered Deck	5522	30000	34478
Painted Deck	12682	30000	27318

Table 9: Results of the simulation for four of a kind

decks	hand found	discards used	wrong hand played
Default poker deck	147	30000	39853
Red Deck	137	40000	39863
Blue Deck	120	30000	49880
Black Deck	118	30000	29882
Abandoned Deck	0	30000	40000
Checkered Deck	1270	30000	38730
Painted Deck	1689	30000	38311

Table 10: Results of the simulation for straight flush

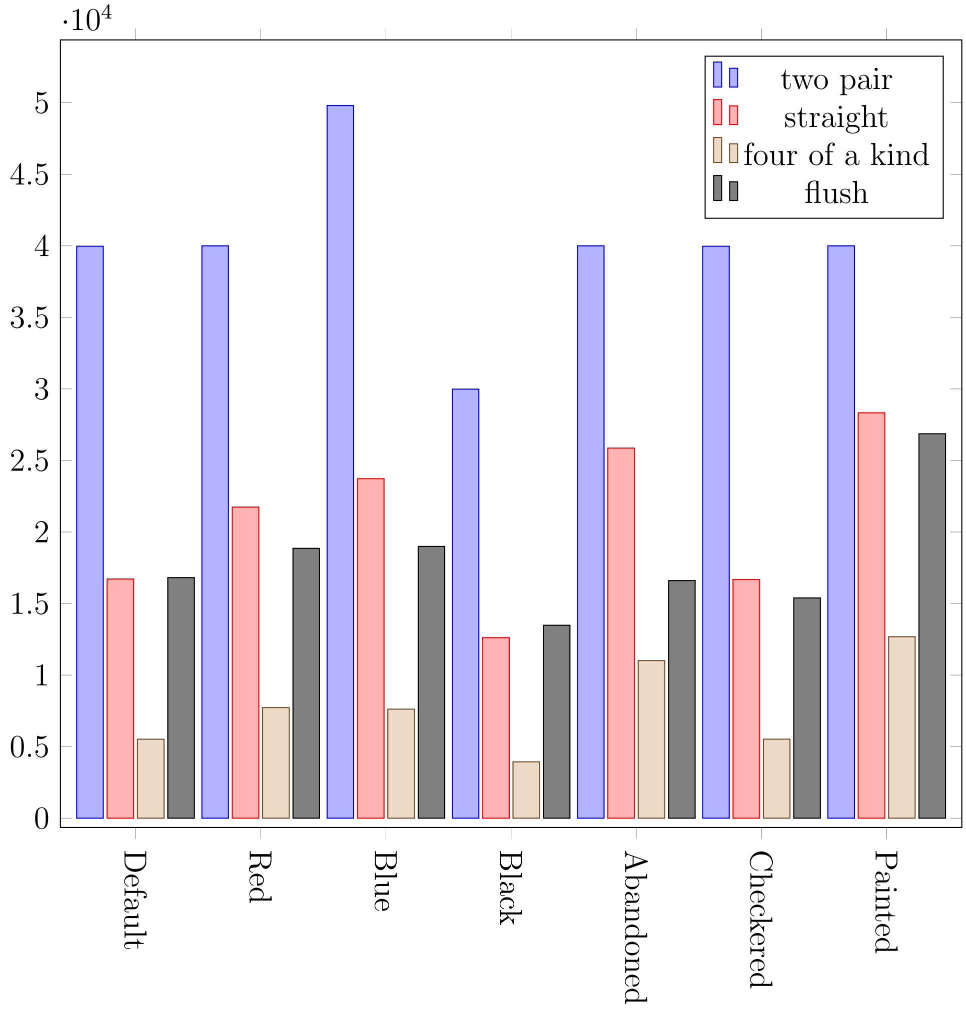

Figure 8: Results of the hand types for each different deck

6 Conclusion

For a lot of the hand types, the Painted Deck is the best. The Painted Deck does have a downside, which is that you have 1 less joker slot. In our experiments we did not take into account jokers. This means that in our experiment the Painted Deck does not have a downside. For the actual game the Painted Deck might not be as good depending on how big of a downside the -1 joker slot is. The Abandoned Deck did perform very good on most hands. The Abandoned Deck does not have a downside, while performing slightly worse compared to the Painted Deck. So if the downside of the Painted Deck is too big, the Abandoned Deck is still a very good option. For most hand types the Checkered Deck does not have any impact compared to the default poker deck. It does however have an effect for the flush and straight flush since it has only 2 suits with double the normal number of cards. So we would expect that for a flush and the straight flush the Checkered Deck would come out as the best deck, but this is not the case as the Painted Deck outperforms the Checkered Deck, though the Checkered Deck for the straight flush is still roughly 10 times better than the other decks as seen in Table 10. So in conclusion: The best deck is the Painted Deck for all hand types, but the Painted Deck has a downside that is not taken into account, it gives the player 1 less joker slot. The second best deck is the Abandoned Deck, which does not have a downside. For the straight flush the Checkered Deck outperforms the Abandoned Deck. So for this hand type the Checkered Deck is better.

7 Future Work

Currently we only used the standard starting decks. However, the game also contains challenges. Some of these challenges also change the deck that the player starts with. For these challenges, it would be interesting to know how much these changed decks affect the probabilities of the different hand types. There are also a variety of jokers that have influence on the probabilities of certain hand types. The interesting jokers are

- Four Fingers: All Flushes and Straights can be made with 4 cards
- DNA: If first hand of round has only 1 card, add a permanent copy to deck and draw it to hand
- Shortcut: Allows Straights to be made with gaps of 1 rank (Example: 10 8 6 5 3)
- Turtle Bean: +5 hand size, reduces by 1 each round
- Juggler: +1 hand size
- Drunkard: +1 discard
- Troubadour: +2 hand size, −1 hand
- Smeared Joker: Hearts and Diamonds count as the same suit, Spades and Clubs count as the same suit
- Merry Andy: +3 discards, −1 hand size

We expect that the Four Fingers and the Shortcut will have a major impact on the performance of straights. The Smeared joker is very similar to the Checkered Deck. Furthermore, we think that the Turtle Bean will have the biggest impact since the Painted Deck with 2 extra hand size already increased the likely hood of getting a specific hand drastically, so with 5 extra hand size we would expect great results.

References

[Bal] Blinds and antes, balatro wiki. https://balatrogame.fandom.com/wiki/Blinds_and_Antes. Accessed: 01/06/2025.

[Bar07] Catalin Barboianu. *Draw poker odds, the Mathematics of Classical Poker*. INFAROM, 2007.

[Bar11] Catalin Barboianu. *Texas Hold'em Poker Odds for Your Strategy, with Probability-Based Hand Analyses*. INFAROM, 2011.

[Gio] Anthony Giovannetti. 'slay the spire': Metrics driven design and balance. https://www.gdcvault.com/play/1025731/-Slay-the-Spire-Metrics. Accessed: 19/11/2025.

[Loc] LocalThunk. Balatro steam page. https://store.steampowered.com/app/2379780/Balatro/. Accessed: 21-02-2025.

[Lua] Lua, the programming language. https://www.lua.org/about.html. Accessed: 20/11/2025.

[Mod] Discard mod. https://github.com/justinw202/BalatroDiscardMod. Accessed: 15/01/2026.

[Moo24] Bo Moore. The game awards 2024 winners: The full list. https://www.ign.com/articles/the-game-awards-2024-winners-the-full-list, 2024.

[ste] Steamodded - a balatro modding framework. https://github.com/Steamodded/smods. Accessed: 20/11/2025.