

Greedy Algorithm implementation for finding the best move in Slay the Spire

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Abstract— There are a multitude of options in a single turn in Slay the Spire, this paper aims to try and find the best moves in a turn of Slay the Spire.

Keywords— Greedy, Algorithm, Slay the Spire, Turn, Move

I. INTRODUCTION

In its simplest, Slay the Spire is a deckbuilding roguelike video game. A roguelike is a genre of games characterized by permanent death and randomly generated content. Slay the Spire was created by Mega Crit and released in 2019.

Before you start a run, if its not your first ever, you can choose between four different characters. In this paper, I will use the character 'Ironclad' since he is the character one starts with and also the simplest out of the four.

II. THEORETICAL BASIS

A. Greedy Algorithm

The Greedy Algorithm is defined as an algorithm that takes the most optimal step every step so that it hopefully returns the most optimal set of steps possible. The elements of the Greedy Algorithm are as follow [2]:

1. Candidate Set, C: The candidates to be chosen in each step.
2. Solution Set, S: The set of chosen candidates.
3. Solution Function: Checking if the solution is a solution.
4. Selection Function: Choosing the best candidate at the current step based on a Greedy Strategy. The chosen strategy is heuristic in nature.
5. Feasibility Function: A check to see if the candidate chosen by the selection function breaks any predetermined rules.
6. Objective Function: Minimizing of Maximizing the output

III. SLAY THE SPIRE

A. Cards

A card is a playable element that costs energy and affects combat. There are a multitude of ways to get cards in slay the spire. The most common are from combat rewards and the shop. A card consists of 6 elements which are color, cost, name, type, rarity, and description [1].

There are 3 types of cards, which are attacks, skills, and powers. There are 4 rarities of cards: Starter, which are cards that you start with when you begin a playthrough; common, which has a gray border; uncommon, which has a light blue border; rare, which has a golden border. There are 6 colors of card. One color for each of the character, colorless/gray for cards that are accessible by all characters or nonrandom cards that are created by another card, and curse/black for cards that have a negative effect [1].

Every card in the game, other than curses and statuses, can be upgraded by the player. Upgrading a card usually increases the numerical value of a card e.g. upgrading a strike makes it deal 9 damage instead of six. An upgraded card has a plus sign beside its name and its name will be colored green [1].



Fig 3.1 Card Elements. 1. Cost, 2. Name, 3. Type, 4. Description, 5. Colour, 6. Rarity
(Source: Author's Personal Collection)

B. Relics

Relics are permanent buffs in the form of a collectible item. Every character starts with a unique relic. The most common way to obtain relics are treasure rooms and elite rooms [1].

In this paper, relics will not be considered in the greedy strategy due to its sheer complexity where each relic can synergize with each other and/or with each individual keywords of a card.

There is one exception to this which is the starting relic of ironclad, the burning blood.

C. Health Point (HP)

Each run you start with the maximum amount of health points for your character. Your run will be over when your HP reaches zero, unless you have a certain relic or potion that revives you when your health reaches zero.



Fig 3.2 Ironclad Character Model and HP Bar
(Source: Author's Personal Collection)

D. Potions

Potions are single-use items that are usable in combat to help you gain an edge against the enemies. Potions offer a multitude of effects, such as healing you, blocking damage, drawing cards, etc. Potions are obtainable after combat or at a shop and certain events.

The player starts with 40% potion chance, the chance the player would obtain a potion after a victorious combat. This chance increases by 10% when the player wasn't given a potion and decreases by 10% after the player was given a potion.

The player has 3 potion slots that can be filled. If the potion slot is full, the player can decide to discard the potion without using it to free up space for another potion.

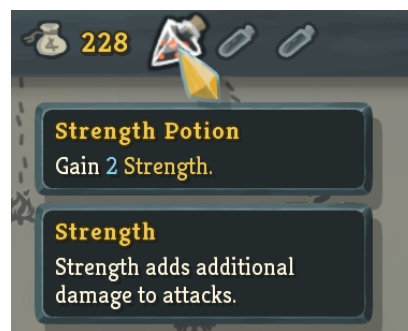


Fig 3.3 A potion and its effect
(Source: Author's Personal Collection)

E. Enemies

Enemies, self explanatorily, are your enemies in slay the spire. There are 3 types of enemies in Slay the Spire:

- **Monsters**
Monsters are the most basic types of enemies in Slay the Spire, contained mostly in normal rooms.
- **Elites**
Elites are Stronger enemies. They are contained in elite rooms, marked by a horned face on the map.
- **Bosses**
Bosses are enemies you'll face at the end of an act. They are the strongest enemies in the game. Each act has 3 different bosses. The player fights one of the three at the end of an act.
- **The Heart**
The Heart is the final boss of Slay the Spire. Unlocked after beating the game once with each character.



Fig 3.4 1. Normal Enemies, 2. Elite Enemies, 3. Bosses, 4. Corrupt Heart
(Source: Author's Personal Collection)

At the end of each turn, an enemy does an action. These actions are signalled by an icon above it called intent. Every enemy has unique intents and can have unique combinations of intents.

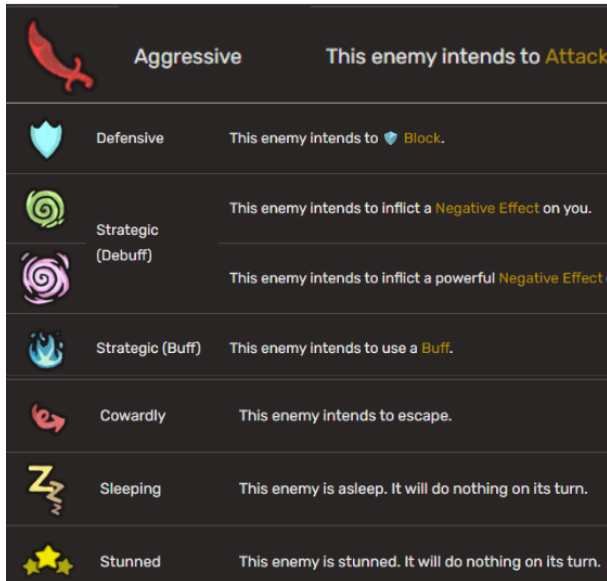


Fig 3.5 Types of Intent
(Source: <https://slay-the-spire.fandom.com/wiki/Intent>)

F. Buffs/Debuffs

Buffs and Debuffs are effects applied on your character and/or the enemies modifying their stats or applying a special effect on them.

IV. APPLICATION

First, let's start by constructing the elements of the greedy algorithm. What is the best move exactly? The best turn is one where the player deals the most damage while taking the least damage. So, the Objective function of the greedy algorithm is minimizing damage.

Next is the feasibility function. This one is easy since the game already implements this for us, which is the energy. Every character starts with 3 energy and can get more from relics and/or cards.

The Candidate Set for the algorithm are all playable cards in the players' hand and potions. If the player has a card that can draw more cards, the candidate set is not expanded, rather the calculation will be reset after using the card that draws.

The Selection Function will be based on attack efficiency, which is Attack Point divided by Energy Cost of the card. If the player can't kill the enemy and the enemy is currently attacking, the Selection Function will be based on block efficiency, which is Block Point divided by Energy Cost of the

card. If there are leftover energy and the player fully blocks all incoming attacks, then The Selection Function will transition back to a function with attack efficiency. Draw plays into this by calculating the average Attack and Block Efficiency of all the cards in the deck. If it exceeds the average of the hand, then the algorithm will choose to draw instead. Potions play into this when it is possible to kill if a potion is used or take less damage if a potion is used. Potion is a last resort item and will only be used if the potion slots are all filled or the player is about to die.

The Solution Function is based on the hp of the enemy. If the enemy dies or the player survives then the solution passes.

The Solution Set is all cards and potions played in the current turn.

V. CONCLUSION

Using the greedy algorithm is feasible on lower ascension and on the most basic of characters. But it is bad practice to just use a greedy algorithm to play the game since the greedy algorithm looks at the game in a shallow manner and doesn't account for all the interactions and synergies with all the cards.

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PERNYATAAN

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