Damage Optimization for Rogue Class in Dungeons and Dragons with Greedy Algorithm Approach

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***Abstract*—Dungeons & Dragons, also known as D&D, is a tabletop role-playing game with fantasy setting. The game is quite popular for its endless creativity in its world-building and story progression as its story-telling is collaborative. The game usually is played with 1 Dungeon Master or Game Master (DM/GM) and around 4 players. Each player usually plays a character of their own creation with the game's guidebooks. The character creation often involves optimization so that they are strong and useful for the game. This paper discuss on how the damage for a rogue class character can be optimized using greedy algorithm approach with several exceptions.**

Keywords—D&D; Greedy Algorithm; Class; Damage

I. Introduction

People love to manifest their imagination into something more than just thoughts, especially teenagers, but not excluding adults. The tabletop game Dungeons & Dragons or D&D allows its players to play with their creativity and use their imaginations to shape the game which is why it's a game that can get people hooked once they know how the game works.

Fig. 1. Dungeons and Dragons Logo
(Source: https://dnd.wizards.com, accessed on May 21st, 2022)

D&D is a collaborative story-telling tabletop role-playing game with every player actions can determine how the game progression with go. It's not your usual game hard-bound with how the game is programmed or its logic. The game can be played offline as it is a tabletop game, but softwares that can assist the gameplay do exist. How the story of the game progreses and the written rule is decided by the game's Dungeon/Game Master (DM/GM). The DM usually starts with a setting and synopsis of the story, as well as the baseline for how the story might progress. Each player creates their own character called Player Character (PC) following guidelines given by D&D modules, usually in form of a book or its soft copy. The DM might have additional rules for the game or home-brewed rules (unofficial D&D rules) for the game to be more enjoyable.

There are several player character races as well as classes from the official D&D books to choose from. Consisting dragonborn, dwarf, elf, gnome, half-elf, halfling, half-orc, human, and tiefling for the races. As for the classes, D&D has barbarian, bard, cleric, druid, fighter, monk, paladin, ranger, rogue, sorcerer, warlock, and wizard. The paper will only be discussing the rogue class as it is known for its high damage output.

Each players decides how their character (PC) would become. PCs have a wide range of traits and attributes to choose from. Optimization by the player often takes place when deciding on which traits and attributes to pick for their own character. This paper tries to implement the greedy algorithm to help in the character optimization for D&D as optimizing of character often happens. Specifically, the optimization of damage for the rogue class in D&D 5e.

II. Methods

A. *Greedy Algorithm*

Greedy algorithm is a simple and popular method to solve optimization problems. It has a straight forward method of finding the least solution or highest solution depending on the goal in every step in hope that it directs toward the best overall solution (global optimum) from doing it in each step. The solution taken for every step is local optimum.

The algorithm takes place in steps. For every step, it tries to choose the best it can get during that time without considering where it would lead. It uses the principle "take what you can get now!". By doing so, the algorithm hopes that the local optimum solution will lead to global optimum.

Greedy algorithm consists of several elements:

1. Candidate set, C: candidates that can be chosen in each step.
2. Solution set, S: chosen candidates for each steps taken.
3. Solution function: determines whether the chosen candidates is the final solution.

4. Selection function: chooses a candidate from the available choices based on greedy algorithm.
5. Feasibility function: checks whether the chosen candidate violate existing rule.
6. Objective function: maximizes or minimizes the solution.

Greedy algorithm does not explore every possible options or outcomes. Hence, it does not always return the best possible solution in finding optimal solution for a problem.

B. Dungeons & Dragons 5e Character

In creating a PC, there are several things to consider: its race, class, ability score, starting items, and background. This paper will only be covering the race options, the rogue class, the starting weapons (excluding other starting items that is not related with weapon), and determining the ability score for the character.

- Damage

  Like most other games, D&D characters have hit points (HP) and damage that can reduce them. Damage in D&D may be a little complex and more random, this paper will always assume the damage would be in its average.

- Weapons

  In D&D 5e, there are several starting weapons to choose from. This paper will only be covering the possible choices for 1st level rogue class. Weapon damage depends on its user's Strength ability score. Some weapons with finesse trait can use Dexterity ability score instead of Strength to modify its damage.

  Table 1. List of Weapons and Its Average Damage

No	Weapon	Average Damage
1	Club	2
2	Dagger (Finesse)	2
3	Greatclub	4
4	Handaxe	3
5	Javelin	3
6	Light Hammer	2
7	Mace	3
8	Quarterstaff	3
9	Sickle	2
10	Spear	3
11	Hand Crossbow	4
12	Longsword	4
13	Rapier (Finesse)	4
14	Shortsword (Finesse)	3

- Ability Scores

  Ability scores are the character's primary statistics. It determines how good the character is at doing activity related to the ability score. The higher the score, the better a character is doing the said activity. There are six ability scores in D&D 5e:

  1. Strength: determines a character's physical prowess. Most weapons deal more damage when the character that uses it have more strength.
  2. Dexterity: determines a character's agility. Rogue primarily uses Dexterity to deal more damage when using weapon with finesse attribute.
  3. Constitution: determines a character's endurance and health points.
  4. Intelligence: determines a character's intellectual capabilities.
  5. Wisdom: determines a character's intuition.
  6. Charisma: determines a character's force of personality.

When determining an ability score of a character, usually you can only add up to 15 base ability score for each attribute. Every even number adds the ability modifier by 1, starting -5 modifier at 0 ability score. So if you have 15 ability score for Strength or Dexterity, and have addition 1 Strength or Dexterity ability score from racial trait, you have an ability modifier of 3 for the attribute.

- Race

  A character can be one of several races to choose from. Here are the list of common and offical races for D&D and its racial traits:

  1. Dragonborn: +2 Strength, +1 Charisma
  2. Dwarf: +2 Constitution
  3. Elf: +2 Dexterity
  4. Gnome: +2 Intelligence
  5. Half-Elf: +2 Charisma, +1 to Two Other Ability Scores
  6. Halfling: +2 Dexterity
  7. Half-Orc: +2 Strength, +1 Constitution
  8. Human: +1 to All Ability Scores
  9. Tiefling: +2 Charisma, +1 Intelligence

- Rogue Class

  In D&D, a PC can go up to level 20. Leveling up depends on how the game is set up. This paper will only discuss on which choices from leveling up as a pure rogue class that be taken to get highest damage using greedy algorithm. The detail on possible choices for rogue class will be shown at the implementation for the algorithm later in the paper.

- Subclass

  A character of a class can choose an available subclass of the class. Each have their own features and changes. Some might have traits that further increases the damage output of the character.

- Feat

  Additional trait for a character that can be taken on certain levels or from racial trait. Some feat have the capability to increase a character's damage. A character can not have more than 1 same feat. List of available feats:

Table 2. List of Available Feats

Name	Prerequisite	Description
Actor	-	+1 in Cha., advantage on Deception and Performance checks, mimic the speech of a person or the sounds made by a creature.
Alert	-	+5 to initiative, you can't be surprised, and creatures you don't see don't gain advantage on attack roll against you.
Athlete	-	+1 in Str. or Dex., you stand up and climb more quickly, and you can jump with only a 5-ft run.
Charger	-	As part of the Dash action you can make a melee attack with a +5 bonus if you move at least 10 ft before.
Crossbow Expert	-	You ignore the loading property of crossbows and don't have disadvantage for being in contact with a creature when you shoot.
Dual Wielder	-	+1 to AC if you're wielding a melee weapon in each hand, two-weapon fighting with non-light weapon, draw two weapons.
Dungeon Delver	-	Advantage to Perception and Investigation checks, to saving throws vs traps, and search for traps at normal pace.
Durable	-	+1 in Con. and for each Hit Dice you regain a minimum of hit points equals to 2 x your Constitution modifier.
Great Weapon Master	-	Extra attack after a melee critical hit and you can choose to take -5 to attack roll to add +10 to damage with an heavy weapon.
Healer	-	You can stabilize a creature and restore it to 1 hp, or restore [1d6+4+its number of Hit Dice] hp to it.
Keen Mind	-	+1 in Int., you know which way is north, when is the next sunrise/sunset, and recall any events within the past month.
Lightly Armored	-	+1 in Str. or Dex. and you gain profociency with light armor.
Linguist	-	+1 in Int., you learn three languages, and you can ably create ciphers.
Lucky	-	You can reroll one d20 or force to reroll an attack roll against you (3/long rest).
Mage Slayer	-	You can use a reaction to make a melee attack against a spellcaster and advantage on saving throws against spell within 5 ft.
Magic Initiate	-	You learn two cantrips and one 1st-level spell from one class.
Martial Adept	-	You learn two maneuvers from Battle Master archetype and gain one superiority die (d6).
Mobile	-	Your speed increase by 10 ft, you can Dash on difficult terrain without malus, and don't provoke opportunity attacks in melee.
Mounted Combatant	-	Advantage on melee attacks against unmounted creature and force an attack to target you instead of your mount.
Observant	-	+1 in Int. or Wis., you can read on lips, and you have a +5 bonus in passive Perception and passive Investigation.
Polearm Mastery	-	You can make an extra attack with a polearm weapon, and make an opportunity attack if a creature enter your reach.
Resilient	-	+1 in one ability and you gain proficiency in saving throws using this ability.
Savage Attacker	-	You can reroll melee weapon attack damage once per turn.
Sentinel	-	A successful OA reduce creature's speed to 0 for this turn and possibility to make an OA even if the ennemy take Disengage.
Sharpshooter	-	Your ranged attacks ignore some cover, no disavantage at long range, and possibility to take -5 to hit for +10 on ranged damage.
Shield Master	-	Attack also allows to shove, shield bonus to Dex. saving throws againts spells, and no 1/2 damage on successful saving throw.
Skilled	-	You gain proliciency with three skills or tools.
Tavern Brawler	-	+1 in Str. or Con., proficiency with improvised weapons, d4 for unarmed strike, and grapple with a bonus action.
Tough	-	Your hit point maximum increases by an amount equal to twice your level then by +2 at each level.

Weapon Master	-	+1 in Str. or Dex. and you gain proficiency with four weapons.
Inspiring Leader	Charisma 13 or higher	Up to 6 creatures within 30 ft of you can gain temporary hp equal to your level + your Cha. modifier.
Defensive Duelist	Dexterity 13 or higher	You can add your proficiency bonus to your AC if you are wielding a finesse weapon, in reaction to a melee attack.
Skulker	Dexterity 13 or higher	Ranged weapon attack doesn't reveal your position and possibility to hide in a lighlly obscured area.
Ritual Caster	Intelligence or Wisdom 13 or higher	You have a ritual book with two 1-st level ritual spells from one class and you can later on add other ritual spells you found.
Heavy Armor Master	Proficiency with heavy armor	+1 in Str. and bludgeoning, piercing, and slashing damage are reduced by 3 if you are wearing an heavy armor.
Moderately Armored	Proficiency with light armor	+1 in Str. or Dex. and you gain proficiency with medium armor and shields.
Heavily Armored	Proficiency with medium armor	+1 in Str. and you gain proficiency with heavy armor.
Medium Armor Master	Proficiency with medium armor	No disadvantage to Stealth checks wearing medium armor and Dexterity bonus max to +3 instead of +2.
Grappler	Strength 13 or higher	You have advantage on attack rolls when grappling, and can try to restrained a creature grappled by you.
Elemental Adept	The ability to cast at least one spell	Your spells ignore resistance to a damage type (acid, cold, fire, lightning, or thunder) and treat any 1 in damage as a 2.
Spell Sniper	The ability to cast at least one spell	Offensive spell's range doubled, these spells ignore some cover, and you learn one offensive cantrip.
Warcaster	The ability to cast at least one spell	You have advantage on saving throws to maintain concentration and you can cast some spells as part of an OA with a reaction.

III. Implementation and Analysis

Rogue

Level	Proficiency Bonus	Features	Sneak Attack
1st	+2	Expertise, Sneak Attack, Thieves' Cant	1d6
2nd	+2	Cunning Action	1d6
3rd	+2	Roguish Archetype, Steady Aim	2d6
4th	+2	Ability Score Improvement	2d6
5th	+3	Uncanny Dodge	3d6
6th	+3	Expertise	3d6
7th	+3	Evasion	4d6
8th	+3	Ability Score Improvement	4d6
9th	+4	Roguish Archetype feature	5d6
10th	+4	Ability Score Improvement	5d6
11th	+4	Reliable Talent	6d6
12th	+4	Ability Score Improvement	6d6
13th	+5	Roguish Archetype feature	7d6
14th	+5	Blindsense	7d6
15th	+5	Slippery Mind	8d6
16th	+5	Ability Score Improvement	8d6
17th	+6	Roguish Archetype feature	9d6
18th	+6	Elusive	9d6
19th	+6	Ability Score Improvement	10d6
20th	+6	Stroke of Luck	10d6

Fig. 2. Rogue Features Table
(Source: https://5etools-mirror-1.github.io/classes.html#rogue_phb,state:feature=s16-0~sub-assassin-phb=b1, accessed on May 23rd, 2022)

The decision making to reach optimum damage as a rogue class with greedy approach comes with different steps. The greedy algorithm will take form of maximization. The step will start with race selection, ability score allocation, weapon selection, then leveling up the character. The decision making only consider the possible choices in each step without considering any consequences after.

A. Race Selection

Rogue mainly utilizes Dexterity to deal damage and to perform other actions. Therefore, we'll find the class with highest Dexterity increase. Elf and Halfling both gives 2 Dexterities, Human and Half-Elf can give 1 Dexterity, and the rest doesn't give any. Therefore we'll choose Elf or Halfling. For this case, we'll decide with Elf.

B. Ability Score Allocation

Rogue will deal more damage when it has more Dexterity. Hence allocating maximum possible Dexterity score in hope that it leads to having highest possible damage. The Dexterity score from allocation will go to the base of 15 Dexterity score. In addition from the race, the total would be 17 Dexterity with its modifier of +3.

C. Weapon Selection

From the list of weapon choices possible for rogue in Table 1, the greedy choice would be Rapier, as it has the higest damage in the list as well as finesse weapon property. The current damage would be 7 (4 average weapon damage + 3 Dexterity modifier).

D. Leveling

Level 1 gives additional 3 average damage from Sneak Attack feature which makes the character deal 10 average damage.

Level 2 does not give any additional damage.

Level 3 rogue gives additional 3 average damage, resulting to 13 average damage, as well as allowing subclass selection. The possible subclasses and its features are:

i. Arcane Trickster: gives the character the ability to cast Wizard class spells. There are no spells that directly improves the regular 13 average damage for weapon.

j. Assasin: allows critical hit on surprised enemies, effectively almost doubling the current damage to 23.

k. Inquisitive: no damage-increasing feature.

l. Mastermind: no damage-increasing feature.

m. Phantom: can deal additional 3 damage to other enemy.

n. Scout: no damage-increasing feature.

o. Soulknife: replaces the weapon with a psychic blade that the character can manifest. Attacks twices with 3 and 2 average damage for each attack. With the modifier and previous features, the damage goes up to 18 average damage.

p. Thief: no damage-increasing feature.

The highest possible damage dealing subclass would be Assassin, allowing the character to deal 23 in a turn when surprising an enemy.

Level 4 allows the option to choose between increasing the character's chosen ability score by 2, which would result in +4 Dexterity modifier and increasing the damage value to 24, or taking a feat. There are too many feats to list, and most does not increase more than 1 damage value, so the only likely choice would be Dual Wielder feat: effectively increasing the total damage value to 31. Hence, taking the feat would be the greedier choice.

Level 5 increases the damage to 37.

Level 6 does not give any additional damage.

Level 7 increases the damage to 43.

Level 8 allows similar choice of taking feat or ability score increase, but since there are no more impactful damage-increasing choice for the feat, the ability score increase would be better, increasing the damage to 45.

Level 9 increases the damage to 51.

Level 10 gives the same option as level 4 and 8, rising the damage to 53.

Level 11 increases the damage to 59.

Level 12 gives the option to take another feat, which can increase the damage to around 60 when taking Savage Attacker feat.

Level 13 increases the damage to 66.

Level 14 does not give any additional damage.

Level 15 increases the damage to 72.

Level 16 does not give any additional damage.

Level 17 increases the damage to 143 when dealing the damage to surprised enemy.

Level 18 does not give any additional damage.

Level 19 increases the damage to 155.

Level 20 does not give any additional damage.

IV. Conclusion

Greedy algorithm approach on finding the highest damage value for pure rogue class allows the class to reach up to 155 average damage. It takes the highest possible damage increase in each choices in character creation and progression as a pure rogue class. The outline for the algorithm goes like the following:

1. Race selection: choose the highest Dexterity will lead to higher damage as rogue primarily uses Dexterity for damage.
2. Ability score allocation: allocate maximum possible Dexterity to maximize Dexterity modifier for damage.
3. Weapon selection: find the highest average damage that is useable for rogue class with finesse property.
4. Leveling:
    a. If there are no available options to make, simply level up rogue.
    b. Subclass selection: choose the subclass with highest damage-increasing feature.

c. Ability score improvement/feat selection: explore possible feats to take that increases more damage, otherwise simply take Dexterity increase.

This algorithm does not explore other possible subclass features that may have given more damage at later levels. As well as multiclasses that could be used as a combination with the rogue class were not explored. Therefore, the current result from using greedy algorithm may not have been the highest possible damage that a rogue character can have. If multiclassing were made possible, it is most likely that leveling up would always increase the damage of the character. However, it would take a lot more option exploration to make as there are even more possibilities to choose from when leveling up a character.

ACKNOWLEDGMENT

I would like to express my deepest gratitude to Allah SWT to be able to finish this paper on time without any extreme obstacles. I must also thank the whole lecturer of Algorithm Strategies, IF2211 2nd Semester of 2020/2021: Dr.Masayu Leylia Khodra, ST,MT and Dr. Nur Ulfa Maulidevi, ST,M.Sc for their guidance and explanations in class, as well as Dr. Rinaldi Munir, MT for the subject materials and references that I use. I would like to thank my friends and families as well as this paper would not have been possible without their continuous support statements and prayers done by them for me to finish it. Lastly, I would like to thank the reader that has been lending their time to read this paper. I hope that this paper may provide inspirations, insights, and usefulness to the reader.

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STATEMENT

With this I acknowledge that this paper that I wrote is a writing of my own, and neither a copy, translation of other papers, nor a plagiarism.

Cimahi, May 23rd 2022

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