Dungeons & Dragons Fight Club

Using Monte Carlo Simulation to Determine Outcome of One-on-One Monster vs Player Character Engagements

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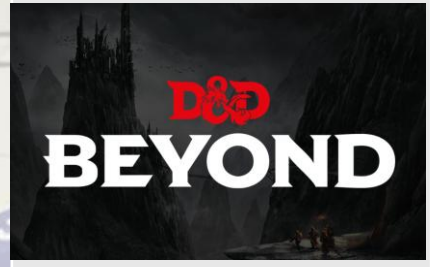
Introduction

- Dungeons & Dragons is a collaborative tabletop role-playing game where players create characters and work together to imagine and resolve adventures using storytelling and dice-based mechanics.

- This project developed a Monte Carlo–based Dungeons & Dragons combat simulator that integrates data from three different sources to model realistic combat outcomes between a player character (PC) and various monsters (non-player character or NPC).

Data Sources

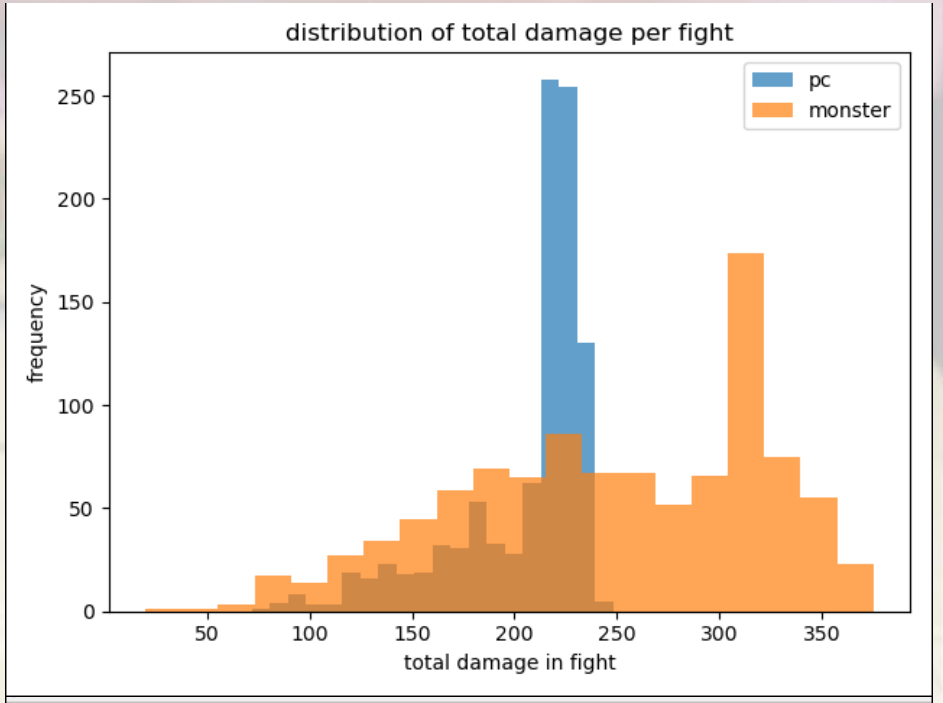
Name		Description	Processing Approach	Purpose
	Player Character XML File	Statistics, attacks, Armor Class, Hit Points, abilities, and bonuses (~500 data points/character)	Parsed with XML parser; normalized attack strings; extracted AC, HP, proficiency, to-hit, and damage	Provides the player character's full combat profile
	Monster Statistics	Armor Class, Hit Points, attacks, recharge abilities, damage dice, and other attributes (25-45 data points/monster with 493 monsters)	Cleaned and extracted structured stat blocks with BeautifulSoup; added recharge logic for limited-use abilities	Defines enemy attack patterns and combat behavior
	Magic Item List Excel File	Item names, rarity, trade value, special (2317 items x 8 attributes each < 18k)	Loaded into dataframe with openpyxl and pandas to sort and count items	Provide item loadout for a specific character, count specific types of items

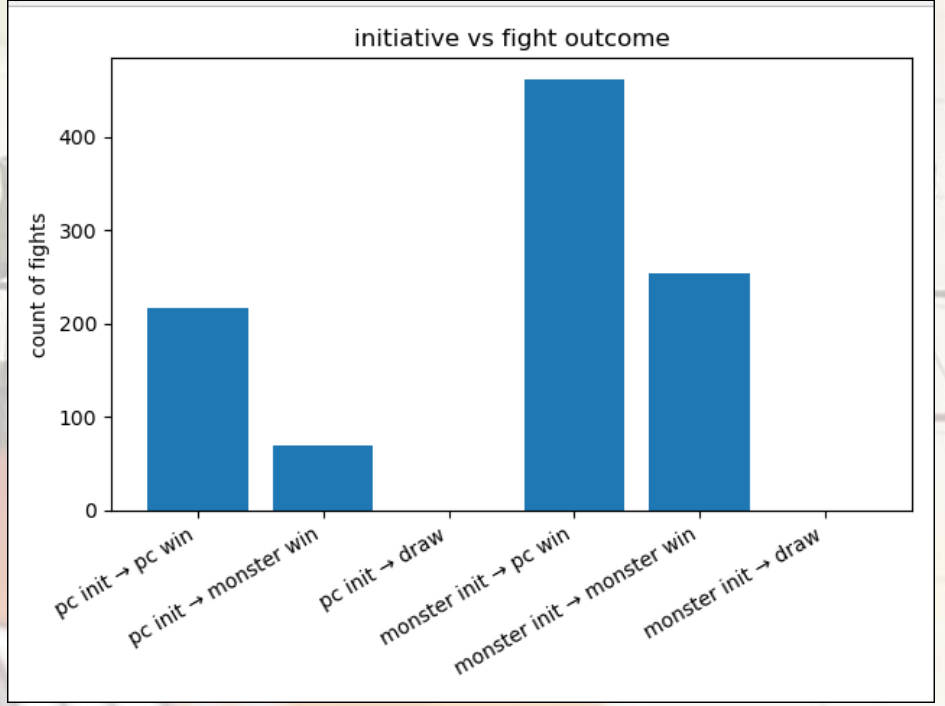
Methodology Overview

- Data Integration: Combined XML, Excel, and scraped text into structured data classes for characters, and monsters, each consisting of classes for attacks, abilities, actions, and so on.
- Combat Engine: turn-by-turn logic including initiative rolls, attack rolls & AC comparisons, rolling damage then reducing HP appropriately, and recharge rolls for limited-use abilities.
- Monte Carlo Simulation: runs independent combats, records win/loss, hits, misses, initiative outcomes, summarized per-fight averages and distributions.
- Statistical Analysis: Computed percentage hit rates, mean attacks per fight, average damage, etc.

Combat Analysis Insights

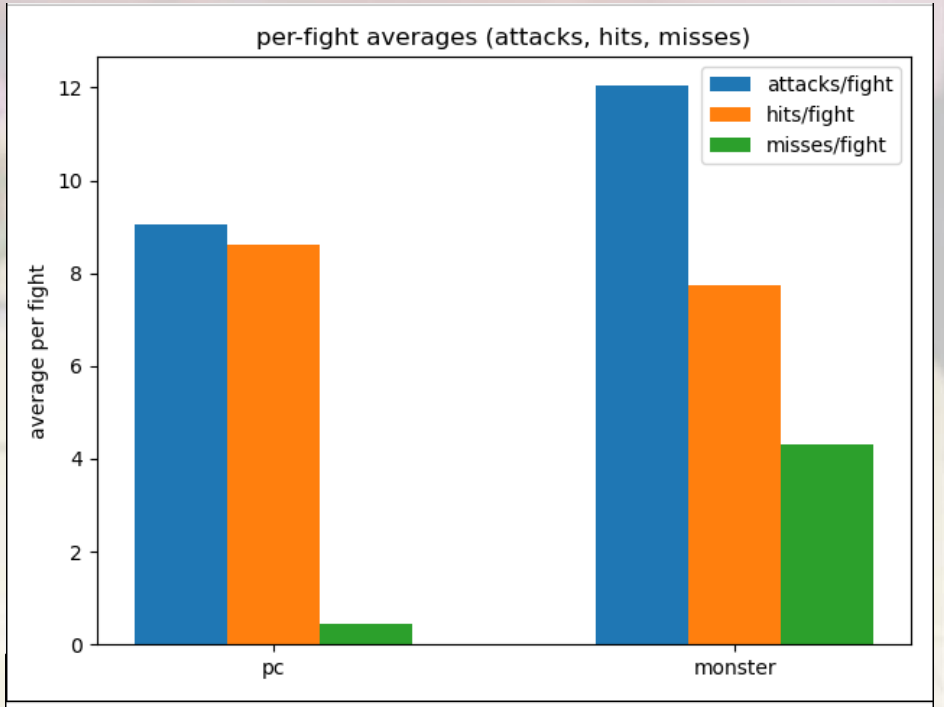
- Hit Rate Comparison: PCs with optimized attack bonuses consistently outperform monsters with lower accuracy.
- Damage Distribution: High-damage monster actions (Breath Weapons, Multiattack, etc.) generate wins for monsters.
- Initiative Impact: A strong initiative bonus from items or class features significantly shifts survival odds in a close matchup.

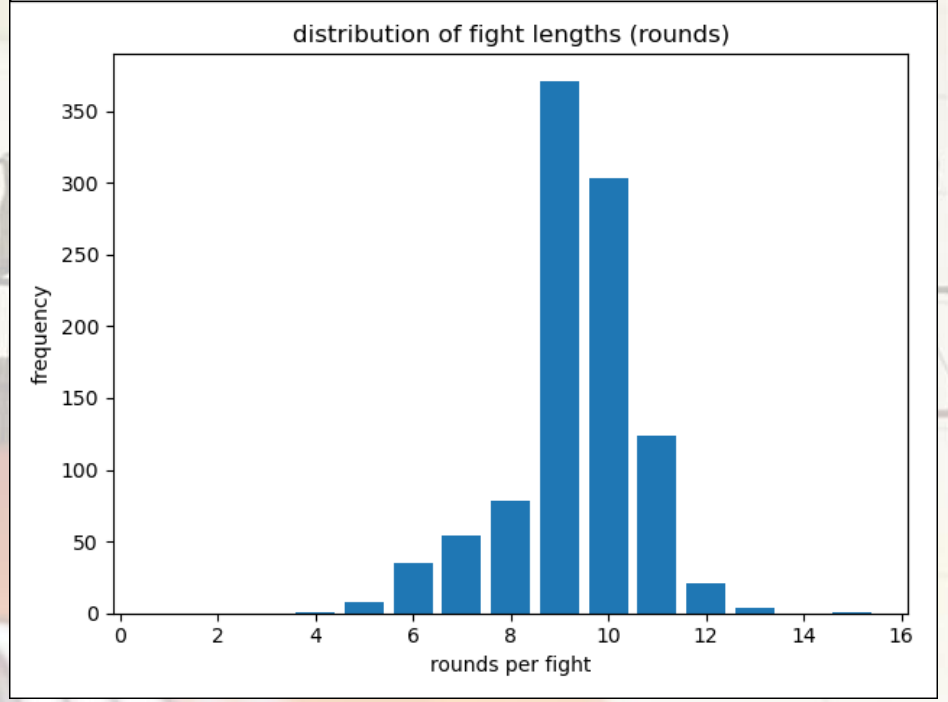




Outlier Influence

- Monster Recharge Events: recharge rolls each round to model breath weapons or other limited-use powers had a large effect on fight outcome.
- Critical Hits: Rare but highly influential spikes in damage can swing a combat unexpectedly.
- Round 1 Volatility: Early monster alpha strikes significantly increase Character loss probability.
- Sustainability Checks: Longer combats favor PCs with high Armor Class and defensive measures.





Challenges & Future Work

- The most difficult part was the scrapping of D&D Beyond as their security actively prevented it from occurring. To complete the project a temporary copy of the monster html pages was stood up and used to scrape.

- The combat engine is very simple and assumes default action patterns.
- Only one PC is simulated at a time; no multi-character party logic.
- Add spellcasting, reactions, and legendary actions to the combat engine.


Questions?
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