Game Playing AI for Simulated DnD Encounters

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June 8, 2022

Abstract

DnD simulator with game-playing agents for automatic play testing. It currently implements creatures with basic stats such as HP, AC, and speed. Creatures also have actions available to them, which currently is limited to the attack action. Two general game playing agents are implemented, along with one rule based and random agent. Currently the Shyne agent, which simulates random games and eliminates poor preforming actions, is able to out-preform both the rule based agent while being faster then the JinJerry agent.

1 Simulation

This is a prototype version of a DnD encounter simulator (see 1). It currently allows creatures to complete one movement and one action (in that order) per turn. The movement available is determined by a speed, which determine how many spaces a creature can move in a turn. The way I implemented it, a space is worth 10 ft, but it would be easy to make this larger or smaller. The only action available current is attack, where the attacking creature rolls (with a bonus) to beat their opponents AC. The game runs until all of one party is dead (at 0 hp) or a turn limit is reached. The turn limit was determined by the thrown food theory, which is the estimated amount of time it would take for a party to be feed up with an encounter and decide to throw food at the GM.

1.1 Grid

A grid (or map) is defined by a width and a height. Pieces can be added to the grid, as long as they have a position attribute. The grid class allows you to do things such as find the distance between two points, get the pieces that are in a range of position, or get the enemy closest to a creature.

1.2 Creature

There are 4 main attributes of a creature:

- HP: The max amount of health that the creature can have and what health it has when it takes a long rest. This can be a discrete value or a dice string that is rolled.
- AC: This is the armor class of the creature, which signifies how difficult it is to damage the creature.
- Speed: This is how many tiles a creature can move in a turn. This is loosely related to 10ft in 5e.
- Actions: This is a list of actions available to a creature. They can choose from these actions and the NullAction (does nothing) when deciding on a action per turn.

Every implementation of a creature must also have a turn method that decides what movement and action a creature makes given a game state. I talk below about what agents are implemented in this demo.

Figure 1: An example of what an DnD encounter might look like. This uses a grid based system with physical miniatures to represent creatures

1.3 Action

A action is something a creature can do on it's turn. It must have a avail actions method that gives every combination of action and movement possible given a creature. Actions are given as new instances of a action object.

1.3.1 Attack

An attack has 3 main properties.

- Modifier: How much is added to a 1d20 hit roll. This value must beat the target's AC to inflict damage
- Damage Dice: This is a string in the form of "2d8 + 6" that tells how much and what value of dice should be rolled to deal damage. This will be rolled each time damage is done.
- Distance: This is how far from the creature the attack can reach. There is also an optional parameter for min distance which tells the smallest distance a creature can be from creature for attack to work.

Side-effects (such as a target being knocked prone) is not implemented in this simulation. Additionally

2 Monster Manual

A very small subset is implemented in this simulation. The monsters were chosen based on what would be most easily represented in this simulation, along with having a range of challenge ratings and abilities.

The Monster Manual file includes the following monsters along with a function to create a new creature given a monster template (dictionary) and a creature class.

2.1 Attacks (From least to most Powerful)

- Spear: range 0-6, damage: "1d6", hit: +2
- Bite: range 0-1, damage: "1d4 + 2", hit + 4
- scimitar: range 0-1, damage: 1d6 + 1
- shortsword: range: 1, damage: 1d6 + 2, hit +4
- shortbow: range: 8-32, damage: 1d6+2, hit +4

- ram: hit + 5, damage: 1d6 +3, range 0-1
- javelin: hit: +5, damage: 1d6 + 3, distance: 3-12
- crossbow: hit: +3, 1d8 + 1, range: 0-1
- longbow: hit: +3, damage: 1d8 +1, range: 15-60
- claws: hit: +4, damage: 2d4 + 2, range: 0-1
- midbite: hit + 2, damage: 2d6 + 2, range: 0-1
- great ax: hit + 5, damage: 1d12 + 3, range: 0-1
- bigbite: hit +5, damage: 2d6 + 3, range: 0-1

2.2 Creatures

Below I describe what creatures are implemented from the monster manual, listed in order of challenge rating. Note not all features of all creatures are fully actualized in this prototype.

2.2.1 1/8 Challenge Rating

- Bandit: close and wide range weapons. HP of 11, and a AC of 12. Average speed. `https://5thsrd.org/gamemaster_rules/monsters/bandit/` (see 2).
- Merfolk: moderate range weapon. HP of 11 and a AC of 11. Slow speed. `https://5thsrd.org/gamemaster_rules/monsters/merfolk/` (see 7)

2.2.2 1/4 Challenge Rating

- Elk: close range attack. AC of 10 and a HP of 15. High speed. `https://5thsrd.org/gamemaster_rules/monsters/elk/` (see 4).
- Skeleton: short and very long range attack. AC of 13 and HP of 13. Average speed. `https://5thsrd.org/gamemaster_rules/monsters/skeleton/` (see 9).

2.2.3 1/2 Challenge Rating

- Orc: close and wide range weapons. AC of 13 and HP of 15. Average speed. `https://5thsrd.org/gamemaster_rules/monsters/orc/` (see 6).
- Gnoll: close mid and wide range attacks, AC of 15, HP of 22. Average speed. `https://5thsrd.org/gamemaster_rules/monsters/gnoll/` (see 8).

2.2.4 1 Challenge Rating

- Dire Wolf: close range attack. AC of 14, HP of 37. High speed. `https://5thsrd.org/gamemaster_rules/monsters/dire_wolf/` (see 3).
- Ghoul: Close attacks. HP of 22 and AC of 12. Average speed. `https://5thsrd.org/gamemaster_rules/monsters/ghoul/` (see 5).

3 Agents

There are five agents implemented in this example. Two, random and aggressive, are used as baselines to test the general game playing AI. JinJerry and Shyne are general game playing AI that are the main focus of this project. There is also an implementation of a human agent, that isn't much explored here.

3.1 Human

The human implementation of creature allows a human player to choose actions for a a creature. The user will be presented the current game state, along with all available movement and action combinations to choose from. However the current implementation of this makes it almost unusable. That being said is it a useful agent for testing purposes.

3.2 Random

As the name implies, the random agent randomly selects a movement and action from the available turn choices.

3.3 Aggressive

The aggressive agent is a rule based agent that is a useful base line for testing other agents. It keeps a rank of it's available actions from most to least powerful (determined by expected damage). Non-attack actions (for example NullAction) are set to 0. The aggressive agent will chose the action with the highest damage that it can complete on it's turn. It will decide on movement based on which movement within range of this action is closest to the closest enemy on the map. Like the name implies, this is an estimate of an aggressive player, most likely a tank of some sort.

3.4 JinJerry

JinJerry is an algorithm made for the 2014 general video game playing competition [1], where it won second place. JinJerry is a very lightweight version of a Monte Carlo search algorithm. It simulates games to a particular depth for each available action and evaluates them. The JinJerry algorithm works as follows.

1: **for** Every action a in available action **do**
2: Create a copy of the game
3: Implement action on copy
4: Starting value = evaluate new game state
5: Forward model to depth D
6: New value = evaluate game state again
7: Set value of action a to max(starting value, new value)
8: Return action a with highest value

The static evaluator I created to implement JinJerry works off the assumption that a party wants to maximize their own health and minimize their opposing parties health. Therefore the static evaluation is set at the HP ratio (current hp total divided by max hp total) for the creatures team minus the opposing teams HP ratio.

As shown the result section below, this algorithm works against random agents, but is not successful against the aggressive agent. Additionally the large amount of available actions per turn (on the order of 40-50), means that this algorithm is significantly slower than aggressive.

3.5 Shyne

I created the Shyne agent to counteract the downfalls of JinJerry, while still being faster than a Monte Carlo game search algorithm. I predicted the single forward modeling, along with the amount of randomness in DnD, was part of the lack of success of JinJerry. However, the large amount of actions available, meant that all actions couldn't be completely explored realistically. Therefore I created the Shyne agent to explore actions initially at shallow depths to eliminate enviable actions early. It works as follows:

1: Set value of every action to 0
2: **for** Every depth d in depths **do**
3: **for** Every action a in available action **do**
4: Create a copy of the game
5: Implement action on copy

6: Forward model to depth D
7: New value = evaluate game state again
8: Set value of action a to average(current value, new value)
9: Sort all actions
10: Eliminate the bottom half of all actions
11: Return action a with highest value

The Shyne agent used the game static evaluation as JinJerry.

This algorithm takes in a list of depths that can effect it's behavior. The list explored in this project was [0, 10, 20, 30, 40], so that more time is spent on actions with high predicted values. However, other depth models could be explored. For example something like [10, 10, 10, 10] would produce a result more similar to Monte Carlo Game Search (except for the elimination of poor preforming actions).

Initial tests showed that this algorithm was not significantly slower than JinJerry and it has been able to outperform both JinJerry and the Aggressive agent.

4 Tournament

The tournament was designed to test the performance of different decision algorithms against each other. It plays a specified number of games, each time randomizing the parties. The parties are creating by first randomly selecting a party size, p (by default is between 2 and 5 players). Then it randomly selects p creatures from the Monster Manual described above. For every game identical creatures sets are used for both parties, so that differences are due to agent ability and not power difference. Once creatures are decided, creatures are creating using the given creature class for each team. Creatures are placed in starting positions so that teams are on opposite sides of the grid. After a game is played, the winner is recorded and the parties are randomized again.

5 Results

It should be noted that it took up to several minutes to play a single game in this prototype, so trial sizes are fairly small. However, in the instances where more games were played I found similar results as with the smaller trial sizes demonstrating the validity of even these small trials. The goal of this project was to create an agent that is able to beat both a random and a rule based agent, without any explicit knowledge of the game (except for success metrics such as HP ratios).

5.1 JinJerry

5.1.1 Against Random

JinJerry successful out-preforms Random agents. Out of 10 trials (and a depth of 40), it won 5 and 5 timed out. While this shows the superiority of JinJerry, the amount of times it timed out (exceeded the turn limit) is concerning regarding it's success.

5.1.2 Against Aggressive

Even with a depth set to 40, JinJerry is unable out-preform Aggressive. Turing a trial of ten games, JinJerry won three times, Aggressive also one three times, and 4 times the turn limit was exceeded. At any lower depth level JinJerry consistently loses to Aggressive. Setting a depth beyond 40 is unrealistic, as even with a party size of 4 this would simulate 10 turns (half of maximum turns). It is also important to note that JinJerry runs on several scales of magnitude slower then aggressive. The lack of success from JinJerry shows that the additional computation costs are not worth it for this algorithm.

5.2 Shyne

5.2.1 Against Random

Shyne, similar to JinJerry, out preforms Random but with a signicant amount of ties. From 10 games, Shyne won 5 times and tied 5 times. It is likely the random agent's lack of strategy makes games last longer and be more likely to time out.

5.2.2 Against JinJerry

The Shyne agent is competitive with the JinJerry agent. With depths set to [0, 10, 20, 30, 40] and a JinJerry depth of 20, Shyne won 5 games out of 9, where JinJerry won only 1 (3 games timed out). However, with JinJerry at depth 40 Shyne tied with JinJerry with 2 wins, with the vast majority (6) games ending with ties. That being said, Shyne has similar time cost with JinJerry at depth 20 but faster times than JinJerry at depth 40. I'm confident with the speed-up and competitiveness of Shyne against JinJerry, that it is more effective algorithm for this purpose. Further experimentation can be done for choosing depths to increase the success of the Shyne agent.

5.2.3 Against Aggressive

Shyne preforms very well against the aggressive agent. Over 9 trials it won 6 times, Aggressive won once and the game tied twice. To validate the success of Shyne, I ran a trial of 50 games over night. In this trial Shyne won 70% of it's games, where Aggressive only won once, and the games tied for 28% of the time.

6 Conclusion

This prototype has been able to demonstrate the viably of general game playing agents for games like DnD. It is clear a challenge of any general game playing agent is the large amount of actions available per turn, which will only increase as the simulation approaches a full DnD encounter. This project demonstrated that using a simulations with shallow depths to eliminate actions can produce behavior complex enough to outperform rule based behavior. My hope is that similar approaches can be used on more elaborate simulation environments, and work on a variety of character types while still be relatively fast.

Appendices

A Game Logs

A.1 JinJerry Against Random

```
Game 0 of 10
Party Size 2

Monsters:
skeleton
elk

Time: 6.5160
Winner: JinJerry


Game 1 of 10
Party Size 2
```

Bandit

Medium humanoid (any race), any non-lawful alignment

Armor Class 12 (leather armor)
Hit Points 11 (2d8 + 2)
Speed 30 ft.

STR	DEX	CON	INT	WIS	CHA
11 (+0)	12 (+1)	12 (+1)	10 (+0)	10 (+0)	10 (+0)

Senses passive Perception 10
Languages any one language (usually Common)
Challenge 1/8 (25 XP)

Actions

Scimitar. *Melee Weapon Attack:* +3 to hit, reach 5 ft., one target. *Hit:* 4 (1d6 + 1) slashing damage.

Light Crossbow. *Ranged Weapon Attack:* +3 to hit, range 80 ft./320 ft., one target. *Hit:* 5 (1d8 + 1) piercing damage.

Figure 2: Stat block for bandit

Dire Wolf

Large beast, unaligned

Armor Class 14 (natural armor)
Hit Points 37 (5d10 + 10)
Speed 50 ft.

STR	DEX	CON	INT	WIS	CHA
17 (+3)	15 (+2)	15 (+2)	3 (-4)	12 (+1)	7 (-2)

Skills Perception +3, Stealth +4
Senses passive Perception 13
Languages —
Challenge 1 (200 XP)

Keen Hearing and Smell. The wolf has advantage on Wisdom (Perception) checks that rely on hearing or smell.

Pack Tactics. The wolf has advantage on an attack roll against a creature if at least one of the wolf's allies is within 5 ft. of the creature and the ally isn't incapacitated.

Actions

Bite. *Melee Weapon Attack:* +5 to hit, reach 5 ft., one target. *Hit:* 10 (2d6 + 3) piercing damage. If the target is a creature, it must succeed on a DC 13 Strength saving throw or be knocked prone.

Figure 3: Stat block for Dire Wolf

Elk

Large beast, unaligned

Armor Class 10
Hit Points 13 (2d10 + 2)
Speed 50 ft.

STR	DEX	CON	INT	WIS	CHA
16 (+3)	10 (+0)	12 (+1)	2 (-4)	10 (+0)	6 (-2)

Senses passive Perception 10
Languages —
Challenge 1/4 (50 XP)

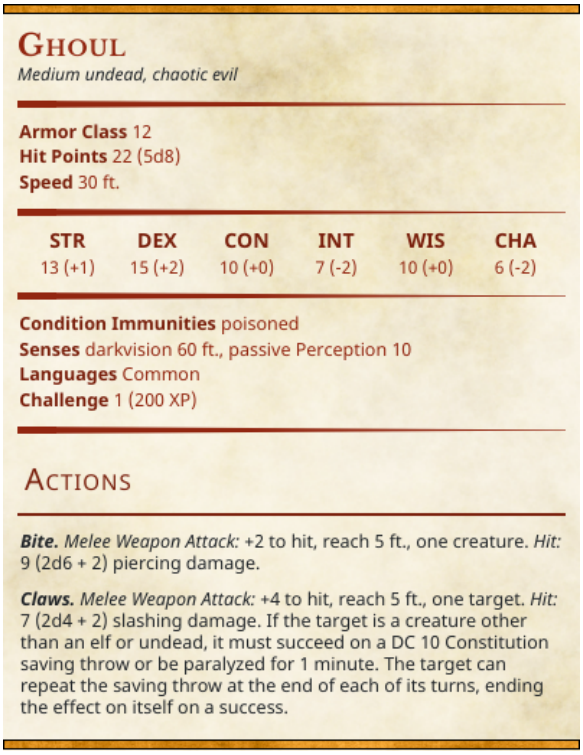
Charge. If the elk moves at least 20 ft. straight toward a target and then hits it with a ram attack on the same turn, the target takes an extra 7 (2d6) damage. If the target is a creature, it must succeed on a DC 13 Strength saving throw or be knocked prone.

Actions

Ram. *Melee Weapon Attack:* +5 to hit, reach 5 ft., one target. *Hit:* 6 (1d6 + 3) bludgeoning damage.

Hooves. *Melee Weapon Attack:* +5 to hit, reach 5 ft., one prone creature. *Hit:* 8 (2d4 + 3) bludgeoning damage.

Figure 4: Stat block for elk



Ghoul

Medium undead, chaotic evil

Armor Class 12
Hit Points 22 (5d8)
Speed 30 ft.

STR	DEX	CON	INT	WIS	CHA
13 (+1)	15 (+2)	10 (+0)	7 (-2)	10 (+0)	6 (-2)

Condition Immunities poisoned
Senses darkvision 60 ft., passive Perception 10
Languages Common
Challenge 1 (200 XP)

Actions

Bite. *Melee Weapon Attack:* +2 to hit, reach 5 ft., one creature. *Hit:* 9 (2d6 + 2) piercing damage.

Claws. *Melee Weapon Attack:* +4 to hit, reach 5 ft., one target. *Hit:* 7 (2d4 + 2) slashing damage. If the target is a creature other than an elf or undead, it must succeed on a DC 10 Constitution saving throw or be paralyzed for 1 minute. The target can repeat the saving throw at the end of each of its turns, ending the effect on itself on a success.

Figure 5: Stat block for Ghoul

Orc

Medium humanoid (orc), chaotic evil

Armor Class 13 (hide armor)
Hit Points 15 (2d8 + 6)
Speed 30 ft.

STR	DEX	CON	INT	WIS	CHA
16 (+3)	12 (+1)	16 (+3)	7 (-2)	11 (+0)	10 (+0)

Skills Intimidation +2
Senses darkvision 60 ft., passive Perception 10
Languages Common, Orc
Challenge 1/2 (100 XP)

Aggressive. As a bonus action, the orc can move up to its speed toward a hostile creature that it can see.

Actions

Greataxe. *Melee Weapon Attack:* +5 to hit, reach 5 ft., one target. *Hit:* 9 (1d12 + 3) slashing damage.

Javelin. *Melee or Ranged Weapon Attack:* +5 to hit, reach 5 ft. or range 30/120 ft., one target. *Hit:* 6 (1d6 + 3) piercing damage.

Figure 6: Stat block for Orc

Merfolk

Medium humanoid (merfolk), neutral

Armor Class 11
Hit Points 11 (2d8 + 2)
Speed 10 ft., swim 40 ft.

STR	DEX	CON	INT	WIS	CHA
10 (+0)	13 (+1)	12 (+1)	11 (+0)	11 (+0)	12 (+1)

Skills Perception +2
Senses passive Perception 12
Languages Aquan, Common
Challenge 1/8 (25 XP)

Amphibious. The merfolk can breathe air and water.

Actions

Spear. *Melee or Ranged Weapon Attack:* +2 to hit, reach 5 ft. or range 20/60 ft., one target. *Hit:* 3 (1d6) piercing damage, or 4 (1d8) piercing damage if used with two hands to make a melee attack.

Figure 7: Stat block for Merfolk

Gnoll

Medium humanoid (gnoll), chaotic evil

Armor Class 15 (hide armor, shield)
Hit Points 22 (5d8)
Speed 30 ft.

STR	DEX	CON	INT	WIS	CHA
14 (+2)	12 (+1)	11 (+0)	6 (-2)	10 (+0)	7 (-2)

Senses darkvision 60 ft., passive Perception 10
Languages Gnoll
Challenge 1/2 (100 XP)

Rampage. When the gnoll reduces a creature to 0 hit points with a melee attack on its turn, the gnoll can take a bonus action to move up to half its speed and make a bite attack.

Actions

Bite. *Melee Weapon Attack:* +4 to hit, reach 5 ft., one creature. *Hit:* 4 (1d4 + 2) piercing damage.

Spear. *Melee or Ranged Weapon Attack:* +4 to hit, reach 5 ft. or range 20/60 ft., one target. *Hit:* 5 (1d6 + 2) piercing damage, or 6 (1d8 + 2) piercing damage if used with two hands to make a melee attack.

Longbow. *Ranged Weapon Attack:* +3 to hit, range 150/600 ft., one target. *Hit:* 5 (1d8 + 1) piercing damage.

Figure 8: Stat block for Gnoll

Skeleton

Medium undead, lawful evil

Armor Class 13 (armor scraps)
Hit Points 13 (2d8 + 4)
Speed 30 ft.

STR	DEX	CON	INT	WIS	CHA
10 (+0)	14 (+2)	15 (+2)	6 (-2)	8 (-1)	5 (-3)

Damage Vulnerabilities bludgeoning
Condition Immunities poisoned
Senses darkvision 60 ft., passive Perception 9
Languages understands all languages it spoke in life but can't speak
Challenge 1/4 (50 XP)

Actions

Shortsword. *Melee Weapon Attack:* +4 to hit, reach 5 ft., one target. *Hit:* 5 (1d6 + 2) piercing damage.

Shortbow. *Ranged Weapon Attack:* +4 to hit, range 80/320 ft., one target. *Hit:* 5 (1d6 + 2) piercing damage.

Figure 9: Stat block for Skeleton

```
Monsters:
orc
merfolk

Time: 1.7018
Winner: Tie



Game 2 of 10
Party Size 2

Monsters:
direwolf
ghoul

Players:
direwolf1
ghoul1
Time: 15.7640
Winner:Tie



Game 3 of 10
Party Size 3

Monsters:
bandit
gnoll
skeleton

Time: 125.5409
Winner: Tie



Game 4 of 10
Party Size 2

Monsters:
orc
ghoul

Time: 28.1922
Winner: Tie



Game 5 of 10
Party Size 3

Monsters:
```

```
elk
ghoul
merfolf

Time: 20.0030
Winner: JinJerry



Game 6 of 10
Party Size 2

Monsters:
skeleton
bandit

Time: 61.7809
Winner: Tie



Game 7 of 10
Party Size 2

Monsters:
gnoll
ghoul

Time: 111.7872
Winner: Tie



Game 8 of 10
Party Size 4

Monsters:
orc
skeleton
ghoul
gnoll

Time: 166.1774
Winner: JinJerry



Game 9 of 10
Party Size 2

Monsters:
orc
elk
```

```
Time: 89.9569
Winner: JinJerry

Total results:
    JinJerry: 5
    Random: 0
    Tie: 5
```

A.2 JinJerry Against Aggressive

```
JinJerry with Depth 40

Game 0 of 10

Party Size 3
Monsters:
orc
elk
gnoll
Time: 15.2008
Winner: Aggressive

Game 1 of 10:

Party Size 3
Monsters:
bandit
skeleton
bandit1
Time: 21.3690
Winner: Aggressive

Game 2 of 10:
Party Size 2
Monsters:
bandit
orc
Time: 23.7866
Winner: Aggressive

Game 2 of 10:
Party Size 4
Monsters:
skeleton
skeleton1
ghoul
ghoul1
Time: 104.3177
Winner: JinJerry

Game 4 of 10:
Party Size 2
```

```
Monsters:
merfolf
skeleton
Time: 50.7113
Winner: JinJerry


Game 5 of 10:
Party Size 2
Monsters:
bandit
bandit1
Time: 141.2515
Winner: Tie


Game 6 of 10:
Party Size 2
Monsters:
direwolf
gnoll
Time: 148.0730
Winner: Tie


Game 7 of 10:
Party Size 4
Monsters:
merfolf
skeleton
gnoll
skeleton1
Time: 192.6523
Winner: JinJerry


Game 8 of 10:
Party Size 2
Monsters:
merfolk
ghoul
Winner: Tie

Game 9 of 10:
Party Size 2
Monsters:
gnoll
merfolk
Time: 113.3696
Winner: Tie

Total results:
    JinJerry: 3
    Aggressive: 3
```

```
    Tie: 4
```

A.3 Shyne Vs. Random

```
Shyne depths: 0, 10, 20, 30, 40

Game 0 of 10
Party Size 2

Monsters:
skeleton
skeleton1

Time: 3.3341
Winner: Shyne



Game 1 of 10
Party Size 3

Monsters:
bandit
gnoll
bandit1

Time: 13.2854
Winner: Shyne



Game 2 of 10
Party Size 4

Monsters:
bandit
merfolf
direwolf
elk

Time: 74.1670
Winner: Tie



Game 3 of 10
Party Size 2

Monsters:
elk
elk1

Time: 76.1934
Winner: Tie
```

```
Game 4 of 10
Party Size 4

Monsters:
gnoll
merfolf
direwolf
merfolf1

Time: 75.0979
Winner: Shyne



Game 5 of 10
Party Size 2

Monsters:
ghoul
merfolf

Time: 7.7625
Winner: Tie



Game 6 of 10
Party Size 3

Monsters:
skeleton
direwolf
ghoul

Time: 133.8187
Winner: Shyne



Game 7 of 10
Party Size 3

Monsters:
merfolf
elk
direwolf

Time: 128.0853
Winner: Tie
```

```
Game 8 of 10
Party Size 3

Monsters:
merfolf
skeleton
elk

Time: 116.7384
Winner: Shyne



Game 9 of 10
Party Size 3

Monsters:
merfolf
merfolf1
merfolf2

merfolf5
Time: 29.8677
Winner: Tie

Total:
    Shyne: 5
    Random: 0
    Tie: 5
```

A.4 Shyne Vs. Aggressive

```
Shyne depths: 0, 10, 20, 30, 40

Game 0 of 10
Party Size 4

Monsters:
bandit
bandit1
gnoll
ghoul

Time: 13.4276
Winner: Aggressive



Game 1 of 10
Party Size 3

Monsters:
```

```
ghoul
orc
gnoll

Time: 13.9778
Winner: Shyne



Game 2 of 10
Party Size 4

Monsters:
elk
skeleton
ghoul
bandit

Time: 58.3937
Winner: Shyne



Game 3 of 10
Party Size 3

Monsters:
bandit
bandit1
merfolf

Time: 38.9060
Winner: Shyne



Game 4 of 10
Party Size 3

Monsters:
direwolf
ghoul
bandit

Time: 112.9775
Winner: Tie



Game 5 of 10
Party Size 4

Monsters:
bandit
```

```
gnoll
direwolf
bandit1

Time: 228.9976
Winner: Shyne



Game 6 of 10
Party Size 4

Monsters:
merfolf
ghoul
gnoll
ghoul1

Time: 131.4392
Winner: Shyne



Game 7 of 10
Party Size 2

Monsters:
gnoll
ghoul

Time: 58.8480
Winner: Shyne



Game 8 of 10
Party Size 2

Monsters:
ghoul
ghoul1

Time: 85.4963
Winner: Tie

Total:
Shyne: 6
Aggressive: 1
Tie: 1
```

A.5 Shyne Against JinJerry

```
JinJerry depth: 20
```

```
Shyne dpeths: 0, 10, 20, 30, 40

Game 0 of 10
Party Size 3

Monsters:
skeleton
orc
merfolf

Time: 18.5165
Winner: Shyne



Game 1 of 10
Party Size 3

Monsters:
merfolf
bandit
merfolf1

Time: 25.6595
Winner: JinJerry



Game 2 of 10
Party Size 2

Monsters:
elk
ghoul

Time: 46.1431
Winner: Tie



Game 3 of 10
Party Size 4

Monsters:
direwolf
bandit
gnoll
merfolf

Time: 240.8033
Winner: Shyne
```

```
Game 4 of 10
Party Size 4

Monsters:
gnoll
ghoul
bandit
bandit1

Time: 223.6957
Winner: Shyne



Game 5 of 10
Party Size 2

Monsters:
skeleton
gnoll

Time: 348.8444
Winner: Shyne



Game 6 of 10
Party Size 4

Monsters:
merfolf
direwolf
merfolf1
direwolf1

Time: 237.9871
Winner: Tie



Game 7 of 10
Party Size 4

Monsters:
merfolf
elk
orc
orc1

Time: 238.1835
Winner: Tie
```

```
Game 8 of 10
Party Size 3

Monsters:
gnoll
skeleton
merfolf

Time: 845.6690
Winner: Shyne

Total wins:
    Shyne: 5
    JinJerry: 1
    Tie: 3
```

A.6 Shyne Vs JinJerry at Depth 40

```
Shyne depths: 0, 10, 20, 30, 40
JinJerry depth: 40

Game 0 of 10
Party Size 2

Monsters:
orc
gnoll

Time: 14.3981
Winner: JinJerry



Game 1 of 10
Party Size 2

Monsters:
ghoul
bandit

Time: 14.9786
Winner: Shyne



Game 2 of 10
Party Size 4

Monsters:
direwolf
ghoul
merfolf
bandit
```

```
Time: 111.6615
Winner: Tie


Game 3 of 10
Party Size 3

Monsters:
skeleton
orc
skeleton1

Time: 203.4215
Winner: Tie


Game 4 of 10
Party Size 3

Monsters:
elk
orc
bandit

Time: 156.3658
Winner: Tie


Game 5 of 10
Party Size 4

Monsters:
bandit
merfolf
bandit1
bandit2

Time: 73.9914
Winner: Shyne


Game 6 of 10
Party Size 2

Monsters:
ghoul
ghoul1

Time: 69.9796
Winner: Tie
```

```
Game 7 of 10
Party Size 4

Monsters:
merfolf
ghoul
gnoll
skeleton

Time: 475.8891
Winner: Tie



Game 8 of 10
Party Size 3

Monsters:
skeleton
gnoll
elk

Time: 313.8598
Winner: JinJerry



Game 9 of 10
Party Size 4

Monsters:
ghoul
gnoll
orc
merfolf

Time: 472.1891
Winner: Tie

Total:
    Shyne: 2
    JinJerry: 2
    Tie: 6
```

References

[1] Diego Perez-Liebana et al. "The 2014 general video game playing competition". In: *IEEE Transactions on Computational Intelligence and AI in Games* 8.3 (2015), pp. 229–243.