

# SYNCS Bot Battle - Ryno

## 1 Game Engine

See `my_match_simulator.py`

Modified `match_simulator.py` such that

- With no arguments, continually matches bots from the submissions folder.
- With arguments, chooses those players and additional random players to play a match.

This means that I can write many strategies and battle them locally. This is especially helpful to test parameter tweaking.

## 2 API helpers

See `results.ipynb`

Lets me track my win rate and win rate against different players since my last submission. The first cell looks at match id's between THRESHL and THRESHR. (This damn Shikanokonokonokokoshitantan is messing up my formatting.) The format is

```
{user_id} {username} {winrate}%-{num_matches} [{num_1sts}, {num_2nds}, {num_3rds}, {num_4ths}, {num_5ths}].
```

The second cell tells me the games against a certain user since my last submission.

## 3 Meta

I tried to have my submission running for the least time possible so other strategies can't react to my strategy :p

To try new ideas, I try to use the scientific method as much as possible - change a small amount and get the winrate over a predetermined number of matches. It is important the number of matches is predetermined because it means that winrates can be directly compared (same variance), and that my procedure has less survivorship bias.

When I get to redeem cards at the start of my turn, I get the option to continue redeeming cards even if I have less than 5 cards. I do so if the number of card sets redeemed so far is above some threshold. As I increase this threshold my winrate increases then drops off sharply, and I suspect that this has to do with the thresholds of top players.

Winrate is very dependant on the opening (e.g. where initial troops are placed, whether you contest for a continent if there are enemy troops).

## 4 Graph theory

See `test/earth.py`

```
# saves/57%
# THRESHL, THRESHR = 338289, 33828
THRESHL = 553955
THRESHR = 1e19

rankings = getRankings(500)
printLeaderboard(rankings)
```

|     |                      |                           |
|-----|----------------------|---------------------------|
| 80  | ryno                 | 61.4% 83 [5, 0, 13, 6, 5] |
| 89  | Banana               | 58.0% 10 [5, 0, 3, 1, 1]  |
| 88  | Alpha Team           | 33.3% 12 [4, 3, 2, 1, 2]  |
| 90  | しかのこのこのここしたんたん       | 30.8% 13 [4, 5, 1, 1, 2]  |
| 78  | Gcha Funds           | 23.1% 12 [7, 6, 2, 2, 0]  |
| 113 | BOB                  | 20.0% 10 [2, 1, 5, 2, 0]  |
| 93  | The Bots             | 20.0% 05 [1, 0, 4, 0, 0]  |
| 56  | winning team         | 18.2% 11 [2, 5, 1, 3, 0]  |
| 66  | Team Name            | 18.2% 11 [2, 5, 1, 3, 0]  |
| 63  | MIB                  | 13.3% 15 [2, 2, 3, 4, 4]  |
| 117 | Holla                | 12.5% 16 [2, 5, 2, 2, 5]  |
| 112 | Team 1               | 11.3% 09 [1, 4, 1, 3, 0]  |
| 87  | Burt Picklejuice     | 8.3% 12 [1, 9, 1, 1, 0]   |
| 55  | RISK1001             | 7.7% 13 [1, 2, 1, 2, 7]   |
| 88  | Butter Paneer        | 6.7% 15 [1, 3, 2, 7, 2]   |
| 105 | pikachu              | 6.2% 16 [1, 0, 3, 5, 7]   |
| 61  | Existential Birds    | 0.0% 11 [0, 1, 2, 5, 3]   |
| 125 | Peanots              | 0.0% 14 [0, 0, 2, 5, 7]   |
| 221 | pikopoko             | 0.0% 13 [0, 1, 4, 5, 3]   |
| 106 | RiskTakers           | 0.0% 18 [0, 5, 4, 5, 4]   |
| 103 | JohnFon Coders       | 0.0% 11 [0, 1, 1, 4, 5]   |
| 127 | Double Descent       | 0.0% 16 [0, 0, 3, 3, 10]  |
| 289 | squad buster         | 0.0% 17 [0, 6, 3, 5, 3]   |
| 72  | Logic and Functions  | 0.0% 10 [0, 4, 3, 1, 2]   |
| 96  | Apex                 | 0.0% 18 [0, 4, 5, 1, 0]   |
| 75  | ILTS5.5              | 0.0% 09 [0, 2, 4, 2, 1]   |
| 62  | Co n fusion reaction | 0.0% 08 [0, 0, 2, 1, 5]   |
| 116 | Destiny              | 0.0% 09 [0, 1, 4, 2, 2]   |
| 69  | Gala Team            | 0.0% 05 [0, 0, 1, 1, 3]   |

```
stalk(89)

https://syncs.org.au/competition/game/history/585255 89-player1 is 0th place me-player3 an 2th place
https://syncs.org.au/competition/game/history/585248 89-player3 is 2th place me-player1 an 0th place
https://syncs.org.au/competition/game/history/585162 89-player4 is 0th place me-player3 an 4th place
https://syncs.org.au/competition/game/history/585177 89-player1 is 3th place me-player2 an 0th place
https://syncs.org.au/competition/game/history/585136 89-player3 is 0th place me-player0 an 3th place
https://syncs.org.au/competition/game/history/585132 89-player3 is 4th place me-player0 an 0th place
https://syncs.org.au/competition/game/history/585108 89-player0 is 0th place me-player1 an 2th place
https://syncs.org.au/competition/game/history/584992 89-player0 is 2th place me-player4 an 0th place
https://syncs.org.au/competition/game/history/584971 89-player1 is 2th place me-player4 an 4th place
https://syncs.org.au/competition/game/history/584928 89-player0 is 0th place me-player1 an 2th place
```

When placing initial troops, it may be favourable to select a set of vertices with a small boundary, or where a small number of territories can attack me. This can be done via a randomised brute force, and for each set size I find the optimal set of vertices to be at. This roughly tells me that Australia and South America is good for openings, and North America and Europe are good for mid-game.

The numbers calculated feel similar to the Cheeger constant ([https://en.wikipedia.org/wiki/Cheeger\\_constant\\_\(graph\\_theory\)](https://en.wikipedia.org/wiki/Cheeger_constant_(graph_theory))).

## 5 Dice

See `test/dice_test.py`

For  $A = 1, 2, 3$  and  $B = 1, 2$ , let  $P(d_A, d_B|A, B)$  be the probability that  $d_A$  attacking troops and  $d_B$  defending troops die in a dice roll with  $A$  attacking troops and  $B$  defending troops. This can be pre-computed easily.

Consider a situation where  $A$  attacking troops is  $B$  defending troops. The attacker and defender both put down the optimal amount of troops on each dice roll until one is defeated. Let  $C(A'|A, B)$  be the probability that the attackers have  $A'$  troops left. CLEARLY,

$$C(A'|A, B) = \max_{a \in \{1, 2, 3\}} \min_{b \in \{1, 2\}} \sum_{d_A, d_B} P(d_A, d_B|a, b) \cdot C(A'|A - a, B - b).$$

With the base cases  $C(A'|0, B) = \mathbb{I}_{A'=0}$  and  $C(A'|A, 0) = \mathbb{I}_{A'=A}$ .

Thus, with a bit of dynamic programming, we can simulate the probabilities of outcomes of an attack or a sequence of attacks. Although the computed probabilities are not shown here, they are useful for strategy making.

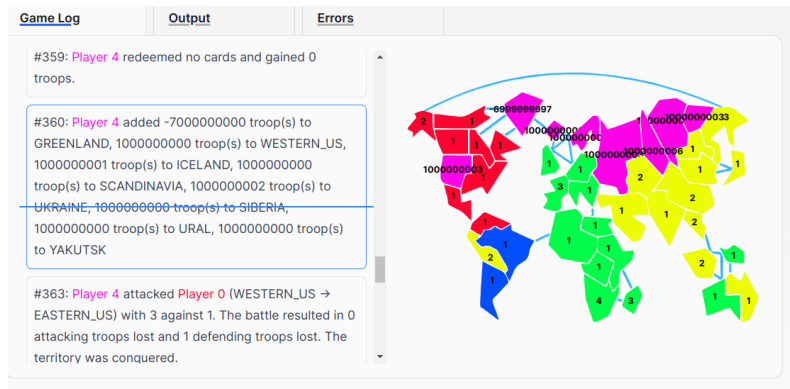
## 6 Hack 1 - Negative troop distributions

See commits <https://github.com/syncs-usyd/risk-game-engine/commit/82f9b4a3bc62c83b7eb0a3d33ac9d8e6496cba0c> and <https://github.com/syncs-usyd/risk-game-engine/commit/15905baef1b164f47d796e7e56dbfa92dada7780>

I can bypass line 2 of the clientside check in `game.py` by sending the raw response, so that I can send negative numbers.

```
1 def move_distribute_troops(self, query: QueryDistributeTroops, distributions: dict[int, int]) ->
    MoveDistributeTroops:
2     distributions = dict([(x, y) for x, y in distributions.items() if y > 0])
3
4     return MoveDistributeTroops(
5         move_by_player=self.state.me.player_id,
6         cause=query.cause,
7         distributions=distributions
8     )
```

On the server, `move_validator.py` checks that the sum of troops is correct, but does not check if any allocations are 0 or negative. Hence, infinite troop glitch! I make sure to win on the turn where I cause the glitch, otherwise the negative numbers may crash other bots.



## 7 Hack 2 - Large raw messages

I want to write a large amount of valid data to the pipe. To do this, I can respond to claim territory queries with really large integers. I send raw messages like the following:

```
1 if game.state.me.player_id != 0 and isinstance(query, QueryClaimTerritory):
2     data = '{"record_type":"move_claim_territory","move_by_player":' + str(game.state.me.player_id) + ',' +
3         'territory":' + '1'*800 + '"}'
4     game.connection._to_engine_pipe.write(str(len(data)) + ",")
5     game.connection._to_engine_pipe.write(data)
6     game.connection._to_engine_pipe.flush()
```

I intended this to cause a “ValueError: Exceeds the limit (4000 digits) for integer string conversion”, but we are able to send through at most 999 characters in a message :( . Btw, `player_connection.py` is a little broken, because the checks for `MAX_CHARACTERS_READ` are not correct, and the exception message is not grammatically correct. I unsuccessfully attempted to send null bytes, and to send a size of `-1` to read until EOF (<https://docs.python.org/3/library/io.html#io.TextIOBase.read>).

However, it turns out that sending a large integer is sufficient :)



**aogr** Today at 18:39

oh wow

hahahahaha

the exploit is that when the engine banned you, the details field of the ban is too long for the database to store

its over 255 characters

but in the wrong section

like the section that appears in the discord notification

funny that the u were right about the too long int being a problem

but the problem was in the error message and not the engine hahahahaha

ok another \$50 cuz that really good

## 8 Defensive Strategy

See `submissions/defensive_v5.py`

Tries to claim Australia, because it is easy to defend and only 1 point of entry. Then places troops evenly over border territories and tries to maintain a small border.

Times out *Banana* lol :p (until time limit was increased, that is). I had a lot of fun turning on and off this strategy to see *Banana* crash.

## 9 Brute forcing paths Strategy

See `submissions/w.py`

Initially, I place initial troops near New Guinea, and stack them towards Siam. I make sure to only care about the largest connected region of my troops, and I consider the rest of them ‘dead’ unless they survive to future rounds. Focusing resources is typically beneficial.

If possible, I want to do a sequence of attacks along a path. A path is valid if the sum of the path length and the number of enemy troops is at most my total number of troops. This ensures that it is ‘likely’ that I can capture all territories along this path (see probability analysis in 5. Dice). Out of the valid paths, I bruteforce the best path based on these metrics. In terms of priority, they are:

1. The one which completely wipes out the largest number of players. This gives us bonus cards and allows us to do more attacks.
2. The path which controls the most continents, because getting bonus troops is a big advantage.
3. Minimising the number of border troops. This makes defending easier.
4. The length of the path. The attacker will tend to lose less troops than the defender (see probability analysis in 5. Dice), so strike first if possible.

If its not sensible to do a sequence of attacks, I enforce the border as much as possible.