Halite IV competition
Rule-based bots

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1. State:
At each step, each ship is assigned with a state. The list of states are:

- MINE
- STORE
- ATTACK_SHIP
- ATTACK_YARD
- CONVERT
- PROTECT
- GUARD

- MINE: if a ship's state is MINE, its role is to go to a cell and collect halite there.
- STORE: if a ship's state is STORE, it go back to the nearest shipyard to save its halite there.
- ATTACK_SHIP: if a ship's state is ATTACK_SHIP, it try to attack an opponent ship.
- ATTACK_YARD: similarly, a ship with this state go to attack an opponent yard.
- CONVERT: the ship is supposed to convert to a shipyard at the end of this step.
- PROTECT: this means to protect the shipyard. For each shipyard, there must be 1 ship whose distance to the shipyard is < distance from the nearest opponent ship to that shipyard.
- GUARD: a ship with this state is commanded to go protect another ally ship whose cargo is positive and is in danger (i.e. surrounded by enemy ships).

2. Vicinity:
- The CENTER is the position in the middle of my shipyards.
- The vicinity is the radius around the CENTER that my ships are allowed to maneuver. The value of vicinity is computed from the percentage of my ships over the total number of ships on the board.
- In almost all cases, no ship is allowed to go outside the vicinity. This is to have my ships close to each other and protect each other. The only exception is when a ship has nothing to do in the vicinity: no weaker opponent ship to attack, no mine to collect from. In this case, ships may go outside vicinity, and the value of vicinity is increased.
- To be more specific, the space inside vicinity is a square, not a circle. For example, let's say the CENTER is at (10, 10) and the vicinity is 3. Then ships are allowed to move in a square with (7, 7) as the lower left and (13, 13) as the upper right.

3. Convert:
- Convert at step 0
- Have the second shipyard when my ships >= 20
- Have the third shipyard when my ships >= 30 and my ships are dominant (i.e. my ships >= max opponent ships * 1.25)
- My shipyards are quite close to each other.
- I don't order a ship to come to a place and then convert to a shipyard there. I just check the current ships, if one of them satisfies my conditions then I order it to convert.

4. Spawn:
- Spawn if step < 200
- Spawn if step < 250 and total halite on board >= 8000
- Can spawn up to step 300 if total halite on board is very large.
- Spawn if step < 340 and my halite + my cargo > max opponent's halite + cargo + 2000
- Can have at most 50 ships. More ships may make the bot timeout.

5. Mining halite:
- My ships only mine (collect) from the cells which large-enough halite. The threshold is often the average halite per cell of the board (i.e. the total halite on the board divided by the number of cells with positive halite).
- Some exceptions are:
    + when step >= 350, threshold = avg/2.
    + if I have quite more ships than all other players and step < 300,
threshold = max(avg, min(100, avg+20)). The rationale behind this is: when my ships are dominating the board, I let the mines growth more halite before collecting from them, so I at the end I will have more halite. With this, I can spawn more ships even if the match gets to step 300. Without this, I should stop spawning from step 200 or 250 or when the total halite on the board is small.
- Each cell (i.e. target for my ships to mine from) is targeted by at most 1 ship.
- For a mining ship, to weight cells as mining targets, I use:
+ the cell's halite. Set weight = cell's halite.
+ distance from ship to cell. Set weight *= (0.85 ^ this_distance).
+ distance from cell to the nearest opponent ship whose halite is <= ship's halite. If this distance is 0 or 1, set weight = 0. If distance is 2, set weight*= 2/3. Else pass.
+ distance from cell to my nearest shipyard and ship's halite ranking (over all my ships). Heavier ships are encouraged to collect from cells that are nearer the shipyard.

6. Storing halite:
- A ship will go back to shipyard to store its halite if it has too many halite, or if it has quite a number of halite and some lighter opponent ship is nearby.
- Before step 100, the thresholds of halite to store is fixed. After step 100, the threshold is determined by the percentage: number of my ships divided by total ships on the board.
- Storing ships often have priority over mining ships.

7. Aggressiveness (attack opponent ships):
- The aggressiveness of my bot is reflected by the maximum percentage of ships whose halite is 0 and state is ATTACK_SHIP.
- For the first 50 steps of the game, my bot has 0 aggressiveness. After that, this value switches between roundly 0.7 and 0.3 each 60 steps. This also depends on the proportion of our ships over all ships on the board. From steps 320 tp 370, the aggressiveness is fixed to be 0.2. Lastly, 0-aggressiveness for the last 30 rounds. I found that the changing aggressiveness is better than a fixed value.
- In most of the cases, my ships only attack opponent ships which have more halite (don't attack opponent ships with equal number of halite). The exception is when a 0-halite opponent ship is very close to one of my shipyards. In this case, one 0-halite ship is assigned the role to chase this opponent ship. The aim is not to die together with the opponent ship, just to make it go far from my shipyards.
- In normal cases,when attacking, a 0-halite opponent ship is targeted by at most 1 of my ships; a positive-halite opponent ship is targeted by at most 4 of my ships (and these four all have less halite than the opponent ship). An exception is at end game, when protecting my shipyards.
- The opponent ships to be targeted (i.e. the freys) with high priority are:
    + those who are not empty and have only 0 or 1 safe move. (At most 4 of my ships attack these freys.)
    + those who are "near" my shipyards. If they are empty, at most 1 of my ships attack them. If they are not empty, at most 4 of my ships attack them. How "near" is near enough to attack is determined by the number of my ships.

- The freys with low priority are those who are not empty and in my vicinity. If my ships have no good mine to collect from, they go attack these freys.

8. Aggressiveness (attack opponent shipyards):
- I don't put much effort on attacking shipyards.
- Only empty ships (i.e. ships with 0 halite) are allowed to attacking shipyards.
- Only attack shipyard of a player whose "worth" is high enough. The worth of a player is computed from the number of his ships, shipyards, halite, cargo and game step. The detail is in the below function. I only attack opponents whose worth is > 0.8 my worth and his worth > my worth - 2000.

```
// function to compute worth
def _approxWorth(self, halite, nship, nyard, cargo):
    if self.board.step < 200:
        worth = halite + nship*500 + nyard*1000 + cargo*0.8
    elif self.board.step < 300:
        worth = halite + nship*400 + nyard*400 + cargo*0.8
    elif self.board.step < 370:
        worth = halite + nship*100 + nyard*100 + cargo*0.9
    else:
        worth = halite + cargo*0.9
    return worth
```

- If at a step, one of my ship is next to a suitable opponent shipyard, I command the ship to attack it. A suitable opponent shipyard is one that:
    + satisfies the "worth condition" described above.
    + The player that own the shipyard either has less than 500 halite (so that he cannot spawn a ship on that shipyard to counter my attack) or he doesn't want to spawn to counter an attack (I record this information from the previous steps of the match).
- From step 370, empty ships which cannot collect a significant amount of halite until end game are commanded to attack opponent shipyards.
- From step 385, empty ships are commanded to attack opponent shipyards.

9. Protect shipyard:
- As stated above, at every step, I try to have 1 ship which is closer to shipyard than all opponent ships.
- Opponent ships that are near my shipyards are chased (as stated above, in the aggressiveness section).
- At the end of the game, opponents may try to send a lot of empty ships to attack my shipyards, and these ships are blindingly choose the shortest path to come to my shipyards. To counter this, for each empty opponent ship which is close to my shipyards, I predict which moves they will take and command my ships to come to collide with them (note that my ships may not be empty).

10. Ship maneuver:
- As stated above, my ships rarely go outside the "vicinity" around CENTER.
- For mining ships, the heavier ships (i.e. ships with more halite) tend to mine from cells that are closer to my shipyards.
- After determining the move of each ship, I check all the remaining ships to see if there are any who have 0 or only 1 safe move.
    + For those who have 1 safe move, they are commanded to take that only safe move.
    + For those who have 0 safe move, they are to take the move that is threatened by the less number of opponent ships. Staying where they are is not preferred.

- For a ship, a safe move satisfies one of the below conditions:
    + no ally ship in that position and no lighter-or-equal opponent ship can go to the same position.
    + no ally ship in that position and a lighter ally ship is next to that position so opponent ships don’t want to go there. Plus, the opponent ship must have at least 1 safe move (if the opponent ship has no safe moves, it may go any direction).
    + an ally is in that position, but this ally can take a safe move. (This condition includes recursion.)
- Also, in case of difficulty, a ship can take a move that is only threatened by equal-halite opponent ships.

11. Protect ship:
- 0-ship, if has nothing to do (no positive-opponent ship to attack, no mine to collect from), may go escort rich-ship to come back to shipyard. These rich ships are ones who have positive halite and are put in danger by opponent ships.