ID: Description of State

The state encapsulates the state of the game as well as its history. Since the game history is relatively small, the adjudicator will send the history of all the past states in an additional field at the end. In this way, the bots can parse what happened if they wish.

What should be in the state?

1. Turn number (integer, capped in practice)
    a. Starts at 0 because we are CS
    b. To interpret, if turn number is even, then it is P1's turn, else P2's turn
2. Status of each property (represented as a tuple of 40 + 2 = 42 integers)
   I will include Get Out of Jail Free cards as "property", one from chance and one from community chest (indexed 40 and 41).
   https://monopoly.fandom.com/wiki/List_of_Monopoly_Properties
   Of course, railroads, utilities, and jail cards cannot have houses or hotels.
    a. 0: unowned
    b. 1: owned by player 1, no houses
    c. 2: owned by player 1, 1 house
    d. 3: owned by player 1, 2 houses
    e. 4: owned by player 1, 3 houses
    f. 5: owned by player 1, 4 houses
    g. 6: owned by player 1, hotel
    h. 7: owned by player 1 and mortgaged
    i. -1: owned by player 2, no houses
    j. -2: owned by player 2, 1 house
    k. -3: owned by player 2, 2 houses
    l. -4: owned by player 2, 3 houses
    m. -5: owned by player 2, 4 houses
    n. -6: owned by player 2, hotel
    o. -7: owned by player 2 and mortgaged
3. Position of P1 and P2 (tuple of 2 integers)
    a. each square is labeled from -1 to 39 (40 squares in total) where 0 is GO and -1 is actual jail (not visiting jail) and every other square is consecutively increasing by 1 from GO
4. Current cash holdings of P1 and P2 (tuple of 2 integers)
    a. In theory, values can be unlimited, but unlikely in practice

5. The current phase (below lists all possible phases): the value in the tuple will be a number from 0 to 8
    a. Build House, Sell House, Mortgage, Trade (BSMT)
        i. Comes with precomputed debt that needs to be paid based on previous event if one exists in the debt field
    b. Trade Offer
        i. Additional field contains the trade offer from the other player
        ii. Almost the same format as when creating trade
        iii. Instead of having “T” in the beginning, replace with True or False in the beginning representing whether the trade was accepted or not
    c. Dice Roll
        i. Include the values of the dice roll in the additional field
        ii. Tuple of two integers
    d. Buying unowned property
        i. Property number in the additional field
    e. Auction of property
        i. Tuple of two integers (property number, winner) in the additional field
        ii. Property number refers to the integer of the property
        iii. Winner: 0 means asking for bid, 1 means player 1 won, 2 means player 2 won
    f. Paying rent on owned property
        i. Property number in the additional field
    g. Jail
        i. Either roll to get out, pay, or use Get Out of Jail card
        ii. Additional field: Boolean
            1. True means you got out of jail
            2. False means you are staying in jail
    h. Chance card
        i. https://monopoly.fandom.com/wiki/Chance
        ii. 16 cards - meaning an integer from 0 to 15 in additional field
        iii. If payment necessary, BSMT
        iv. Order of the cards is the same as in the link
    i. Community Chest card
        i. https://monopoly.fandom.com/wiki/Community_Chest
        ii. 16 cards - meaning an integer from 0 to 15 in additional field
        iii. If payment necessary, BSMT
        iv. Order of the cards is the same as in the link
6. Contains additional information depending on the phase as described above

7. Debt field if phase is BSMT
    a. ~~OLD: Contains a tuple of two integers - first is the debt for player 1, and second is the debt for player 2 : OLD~~
    b. Contains a tuple of 4 integers - first is who agent 1 is paying the debt to, 0 means to bank, 1 means to player 1, 2 means to player 2, and the second value is the debt itself for agent 1, same thing for third and fourth section for agent 2
    c. This should only be sent to the player who is in debt, which should be handled by the adjudicator
    d. Will be collected once they choose to do no actions for their BSMT
8. List of all past states (in case the agent wants to read them)
    a. This is a list of tuples consisting of (id, state) in increasing order where the first state in the list is the start of the game and the last state in the list is the latest one
    b. Id refers to the id of the agents who is participating in that state. This is to avoid ambiguity with the BSTM phase states.
    c. Make this a global list and only pass in a reference to this part of the tuple
    d. For simplicity sakes, people requested that this be part of the state

Methods of Agent

To make life seem more modular when building the agent, we will create a separate function for each phase that the adjudicator will call respectively. This may make building a bot seem a bit easier.

High level template:

Global dictionary representing the board
STATIC INFORMATION
A dictionary representing the static information about each position on the Monopoly board would be available to both Agents and the Adjudicator throughout the game. It would have the following variables:

a) type
b) name
c) monopoly (The color group of the monopoly)

d) number of elements in the monopoly
e) price of the property
f) cost for building a house/hotel
g) default rent
h) rent with one house
i) rent with 2 houses
j) rent with 3 houses
k) rent with 4 houses
l) rent with a hotel
m) tax (valid for luxury tax and income tax positions)
n) members of the same monopoly (list containing other members of the same monopoly)

```
Class Agent:
    def __init__(self, id):
        self.id = id
    # Build House, Sell House, Mortgage, Trade (BSMT)
    def getBMSTDecision(self, state):
        return st
    def respondTrade(self, state):
        return action
    def buyProperty(self, state):
        return action
    def auctionProperty(self, state):
        return action
    def jailDecision(self, state):
        return action

    # IMPORTANT TO ALERT AGENTS ABOUT TRADE OR AUCTION RESULTS
    def receiveState(self, state):
        Return None

    # no longer necessary
    # def respondMortgage(self, state):
    #     return action
```

What is “action”? This returns a value depending on what phase the state is indicating. The phase will be one of the 7 phases described above.
If phase equals the following, return the following actions as described.

1. getBMSTDecision
    a. Return a tuple of the form:
        i. (“B”, [(property number, number of houses),...])
        ii. (“S”, [(property number, number of houses),...])
        iii. (“M”, [property number, …])
            1. May be considered mortgaging or un-mortgaging depending on the status of the property
        iv. (“T”, cash offer, [property numbers for offer], cash requesting, [property numbers requesting])
    b. Note that the adjudicator is responsible for ensuring that these actions are legit.
    c. The adjudicator must go back and forth between each player for this phase until neither player chooses to do any more actions. Trades are limited to once per person per phase.
    d. This includes enforcing the fact that houses must be built evenly and sold evenly (meaning that you cannot have a property with n+1 houses until every property has at least n houses)
    e. Note also that if this BSMT contained a value in the additional field representing the debt, that value is subtracted from the cash holdings upon completing the action. This happens at the very end of the back and forth phase.
    f. If erroneous action, by default treat it as None
2. buyProperty
    a. Return an action: True or False
        i. True means buy, False means auction
    b. This will precede BSMT
    c. If erroneous action, by default treat it as False
3. auctionProperty
    a. Return an action: int
    b. This represents the bid amount
    c. These will be **blind** auctions; ties are won by the other player (not the player who chose to not buy)
    d. If erroneous bid, by default treat it as 0
4. respondTrade
    a. Return an action: True or False
    b. This represents either accepting or declining the trade respectively
    c. This will precede BSMT
    d. If erroneous action, by default treat it as False
5. jailDecision

a. Return an action:
    i. (“R”,) : represents rolling to get out
    ii. (“P”,) : represents paying $50 to get out (BSMT should follow)
    iii. (“C”, property number) : represents using a get out of jail card, but in case someone has both, needs to specify which one they are using. In general, should always specify the number (either 28 or 29)
    iv. If erroneous action, by default treat it as (“R”)

Methods of Adjudicator

1. runPlayerOnState(player, state)
    a. Player is the function representing an agent
    b. Returns an action
    c. Once the action is received, you have to determine what to do as described above.
2. broadcastState(player1, player2, state)
    a. Sends state to both players
3. runGame(player1, player2, [dice rolls], [chance cards], [community chest cards])
    a. This function starts the game with both agents
    b. Without the optional arguments, we can assume these will be generated randomly
    c. Optional arguments are in brackets
    d. Dice rolls: list of tuples of two integers
        i. This represents the set of dice rolls that the game will
    e. Chance cards: list of integers
        i. This represents the list of chance cards that will appear. The first element will be the first card that shows, second element second, and so on.
    f. Community chest cards: list of integers
        i. Same idea as chance cards
    g. Returns a tuple: (winner, state)
        i. If dice rolls is specified, the game goes up to either the end of the game or until the dice roll array is exhausted
        ii. Winner is an integer: either 0, 1 or, 2
            1. 0 means no one won
            2. 1 means player 1 won
            3. 2 means player 2 won
        iii. State: returns the state tuple at the end of the last turn (whether it was due to no more dice rolls or the game being over)

Testing Function

```
def test(adjudicator):
        # hardcode agent1 and agent2
        # hardcode dicerolls, chance, cc
        winner, state = adjudicator.runGame(agent1, agent2, dicerolls, chance, cc)
        Expected_state = (...)
        If expected_state == state:
                return True
        Else:
                return False
```

Sequence of Phases

1. BSMT - send state to both players
2. Dice Roll - done inside adjudicator
    a. If it's the third double in a row, send player to jail and end turn
3. Square effect
    a. Buying unowned property
        i. BSMT
        ii. Can buy or auction
            1. Buy - updates state
            2. Auction
                a. Live auction phase going back and forth between players
    b. Landing on opponent property
        i. Rent needed to pay is fixed now
        ii. BSMT
        iii. Update state
    c. Chance
        i. Update depending on card
        ii. May need BSMT depending on card
    d. Community Chest
        i. Update depending on card
        ii. May need BSMT depending on card
4. BSMT
5. If dice roll was double, we repeat for same player; otherwise, switch to other play

Rules

This section outlines the rules of Monopoly that our adjudicator and agents must follow. Primarily these rules should be based the classic version of the game. Adding a link to the pdf version of the game rules provided by Hasbro:
https://www.hasbro.com/common/instruct/monins.pdf

This section would also include modifications we make to the rules.

1. We are getting rid of the 10% option like in the 2008 board for income tax. You just have to pay a flat $200.
2. If two players want to build houses and there are not enough, we just let the player whose turn it is get to buy (officially, they must fight in an auction)
3. Only one trade per opportunity that arises, meaning you can't renegotiate after a trade is declined (until another BSMT phase)
4. Time limit per move of: 3 seconds for now
5. Turn limit: 100 moves (winner is determined by whoever has highest value at the end)

Chance

1. Advance to "Go". (Collect $200) (Mr. Monopoly hops on both feet.)
2. Advance to Illinois Ave. {Avenue}. If you pass Go, collect $200. *{Second sentence omitted.}* (Mr. Monopoly has tied a cloth bundle onto his cane to make a bindle, carried over his right shoulder, and is smoking a cigar)
3. Advance to St. Charles Place. If you pass Go, collect $200. (Mr. Monopoly hurries along, hauling a little boy by the hand)
4. Advance token to nearest Utility. If unowned, you may buy it from the Bank. If owned, throw dice and pay owner a total 10 times the amount thrown. (Mr. Monopoly trudges along with a huge battleship token on his back)
5. Advance token to the nearest Railroad and pay owner twice the rental to which he/she {he} is otherwise entitled. If Railroad is unowned, you may buy it from the Bank. *(There are 2 of these.)* (At lower left, Mr. Monopoly carries a large flatiron token with two hands; at upper right a railroad crossing is seen)
6. Advance token to the nearest Railroad and pay owner twice the rental to which he/she {he} is otherwise entitled. If Railroad is unowned, you may buy it from the Bank. *(There are 2 of these.)* (At lower left, Mr. Monopoly carries a large flatiron token with two hands; at upper right a railroad crossing is seen)
7. Bank pays you dividend of $50. (With his feet up on a telephone-bearing desk, Mr. Monopoly leans back in an overstuffed chair, blowing cigar smoke rings)

8. Get out of Jail Free. This card may be kept until needed, or traded/sold. {This card may be kept until needed or sold/traded. Get Out of Jail Free.}{The first sentence is much smaller than the second} *(Mr. Monopoly, in close-fitting one-piece prison stripes, is literally kicked out)*
9. Go Back Three {3} Spaces. (Mr. Monopoly is hauled back by a cane hooked around his neck) *{Presumably an allusion to amateur nights at theaters}*
10. Go to Jaill. Go directly to Jail. Do not pass GO, do not collect $200. (A truncheon-carrying policeman in a dark-colored uniform hauls a surprised Mr Monopoly along by the feet)
11. Make general repairs on all your property: For each house pay $25, For each hotel {pay} $100.(Consulting a "How to Fix It" brochure, a hammer-wielding Mr. Monopoly sits astride a house not much larger than he is; it buckles under his weight)
12. Pay poor tax of $15 (His trouser pockets pulled out to show them empty, Mr. Monopoly spreads his hands) *(The video game version replaces this with* Speeding fine $15, *reportedly also in the UK version.)*
13. Take a trip to Reading Railroad. {Take a ride on the Reading. Advance token and} If you pass Go, collect $200. (Mr. Monopoly rides astride the TOOTing engine of a train)
14. Take a walk on the Boardwalk. Advance token to Boardwalk. {Board Walk *in both sentences*} (Mr. Monopoly, a smallish dog hung over one arm, with the other pushes a squalling baby in a small pram; behind them, birds fly in the sky above a low fence)
15. You have been elected Chairman of the Board. Pay each player $50. (A newsboy shouts an Extra with Mr. Monopoly's headshot on its front page)
16. Your building {and} loan matures. Receive {Collect} $150. *{Up until the 1980s a "building and loan" was a financial institution.} (*Mr. Monopoly joyfully embraces an apparent wife)

Community Chest

1. Advance to "Go". (Collect $200) <Mr. Monopoly goes to Go>
2. Bank error in your favor. Collect $200. <Mr. Monopoly falls back in astonishment as an arm presents a sheaf of cash out of a bank teller's window>
3. Doctor's fees. {fee} Pay $50. <Mr. Monopoly angrily brandishes crutches as he stomps with a leg cast>
4. From sale of stock you get $50. {$45.} <Mr. Monopoly, happily entangled in the tape of a stock ticker, waves cash (with no $ sign this time)>

5. Get Out of Jail Free. {Get out of Jail, Free. in previous US editions} – This card may be kept until needed or sold/traded. <A winged Mr. M flutters out of a bird cage>
6. Go to Jail. Go directly to jail. Do not pass Go, Do not collect $200. <A truncheon-wielding policeman in a light-colored uniform lifts a surprised Mr Monopoly by the collar>
7. Grand Opera Night {Opening in previous US editions, not in the deck in UK editions}. Collect $50 from every player for opening night seats. <A wall sign near steps reads "Opera Tonite - 8 PM Sharp"; Mr. Monopoly leans against it checking his pocket watch in annoyance>
8. Holiday {Xmas} Fund matures. Receive {Collect} $100. <Mr. Monopoly carries along a giant Xmas sock containing a sheaf of cash>
9. Income tax refund. Collect $20. <Mr Monopoly faints back against a man displaying the Refund paper>
10. Life insurance matures – Collect $100 <Below an I N S sign stands a bent Mr Monopoly, his long beard brushing the floor>
11. Hospital Fees. Pay $50. {Pay hospital fees of $100.} {Pay hospital $100.} <A bored nurse holds out her hand for payment while Mr. Monopoly holds 2 swaddled infants, one in each arm>
12. School fees. Pay $50. {Pay school fees {tax} of $150} <A bespectacled schoolboy unhappily receives a head pat and a dime ((Rockefeller style) from Mr. Monopoly.>
13. Receive $25 consultancy fee. {Receive for services $25.} <As Justice of the Peace, a stern Mr. M holds out his hand for fee from an embarrassed groom whose bride hold a bouquet behind him>
14. You are assessed for street repairs: Pay $40 per house and $115 per hotel you own. <Mr. Monopoly, supported by his near-ubiquitous cane in his left hand, holds a pick and shovel over his right shoulder>
15. You have won second prize in a beauty contest. Collect $10. <Mr. Monopoly preens with a sash and large bouquet>
16. You inherit $100. <Mr Monopoly. holds his head as unseen people's hands offer brochures titled "Buy Yacht", "World Tour", and "Rolls Royce">