Title

UNO! V.26
Card Game

Course

CIS-17A

Section

43396

Due Date

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Author

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1 Introduction

Title: UNO!

Uno is a shedding-type card game. The player attempts to get rid of cards in their hand while adding cards to other players' hands. A player wins when there are no cards left in their hand. There are several "action" cards in UNO which change the play direction, change the color of discard, and add/remove cards from players' hands.

This version of the game includes a bot with three levels of difficulty to play against. This is accomplished using polymorphism and inheritance.

Github repository:
https://github.com/lm2203793/KislingburyLindsay_CSC17A_43396/tree/master/Proj/Project2

1.1 Summary:

Project Size: ~1300 lines

This project demonstrates the concepts covered in Chapters 13 through 16:

- Implementation of Inheritance and Polymorphism allowed me to introduce a bot player in this version of the game. The Cplayer and Hplayer classes are inherited from the Player class, making it possible for a Cplayer or Hplayer class object to call different versions of the main game functions.
- Because the Cplayer is inherited from the Player class, a Cplayer object can call Player functions to validate a play, play a card, and change the color of discard without asking for input and using its own logic.
- Operator Overloading is used to print formatted cards with the << operator.
- A Card class copy constructor is used to assign cards with the = operator

This project also demonstrates concepts from earlier chapters:

- Memory is dynamically allocated for the array of Player objects, with allows pointers to derived class Cplayer and Hplayer objects to exist in the same array.
- I am particularly proud of the bot logic in this program:
    - The abstract function getPcrd is overridden in Cplayer to allow the bot to make choices.
    - A vector of valid cards is created by calling the Player class function valCrds and storing the valid cards in a vector.
    - Other Cplayer functions assign values to these valid cards based on their frequency.
    - There are three bot levels: 1, 2 and 3.
    - Bot Level 1 "Dumb Bot" simply chooses a random card from the vector of valid cards.
    - Bot Level 2 "Lucky Bot" flips a coin and chooses the best card based on either the frequency of valid cards that match the symbol (type and number) or the color of discard.
    - Bot Level 3: "Smart Bot" chooses the best card after adding the frequencies of both symbol and color.
        - Occasionally this bot will cause issues (playing the same card repeatedly) when run against another bot. Unfortunately, I did not have the time to fix this issue.

2. UNO! Rules

Official Rules published by Mattel can be found here: https://service.mattel.com/instruction_sheets/42001pr.pdf

Setup:
The game is for 2-10 players.
Every player starts with 7 cards.
The rest of the cards are placed in the draw pile.
A discard pile is created by flipping over a card from the draw pile.
If the top card is a Wild or Wild Draw 4, it is returned to the deck and another card is flipped.

Cards:
108 Cards

Number Cards	Action Cards:
19 Blue Cards: 0 to 9	8 Reverse Cards: 2 each in Blue, Green, Red and Yellow
19 Green Cards: 0 to 9	8 Skip Cards: 2 each in Blue, Green, Red and Yellow
19 Red Cards: 0 to 9	8 Draw-2 Cards: 2 each in Blue, Green, Red and Yellow
19 Yellow Cards: 0 to 9	4 Wild Cards
	4 Wild Draw-4 Cards

Game Play:

- Players examine their card and try to match the top card to the discard.
- Cards are matched by color, number, or action.
  For example, if the discard is blue 5, a player has the option of playing any blue card or any color card with a 5.
- Wild cards may be played at any time and the player may choose to the change the leading color with it.
- If the player does not have a playable card, they must draw from the draw pile.
- If the card drawn can be played, the player must play it.

Note: If the draw pile is exhausted, the draw pile is shuffled and becomes the new draw pile. Play continues on the single card from discard as normal.

- Play continues until a player has a single card.
- The moment a player has just one card they must call "UNO!" If they do not call "UNO!" before the next player has taken their turn, that player must draw two new cards as penalty.
  Calling "UNO!" needs to be repeated every time a player is left with one card.
- Once a player has no cards remaining, the game is over and points are scored.

Action Cards:

Reverse	Switch the direction of turns. If the play was moving left, it moves right.
Skip	The next player's turn is skipped.
Draw-2	The next player must draw 2 cards.
Wild	This card can be used to represent any color and can be placed on any card. The player chooses which color it will represent for the next player's turn.
Wild Draw-4	Acts just like a Wild card except that the next player also has to draw 4 cards.

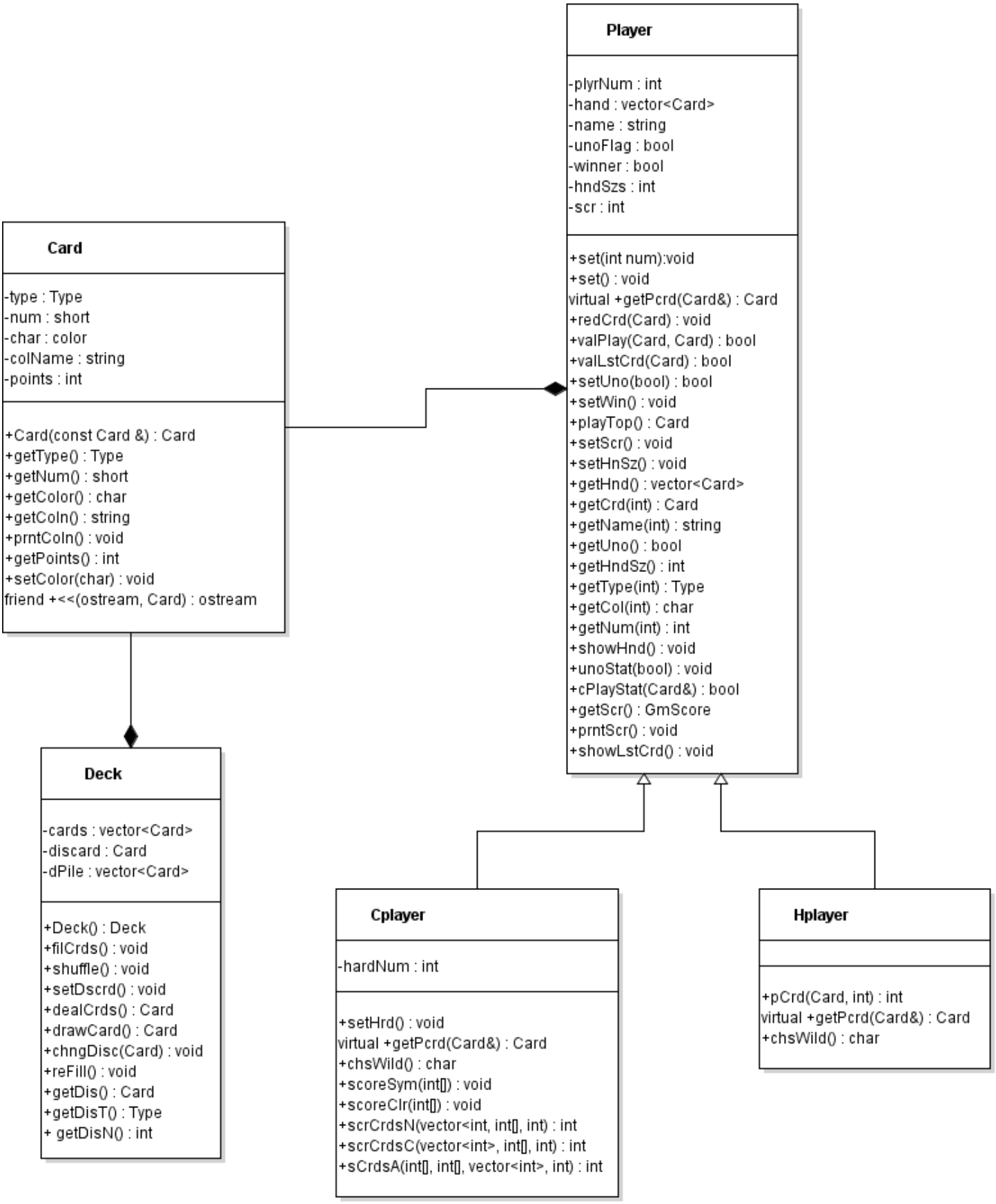
Scoring:
When a player no longer has any cards the game ends and that player is the winner.
The winner receives points for the cards left in all other players' hands.

Points:

All Number Cards	Face Value	Reverse	20 Points
Draw-2	20 Points	Wild	50 Points
Skip	20 Points	Wild Draw-4	50 Points

3 Development

3.1 Class Hierarchy



3.2 plyGame Function

3.2.1 plyGame() pseudo code

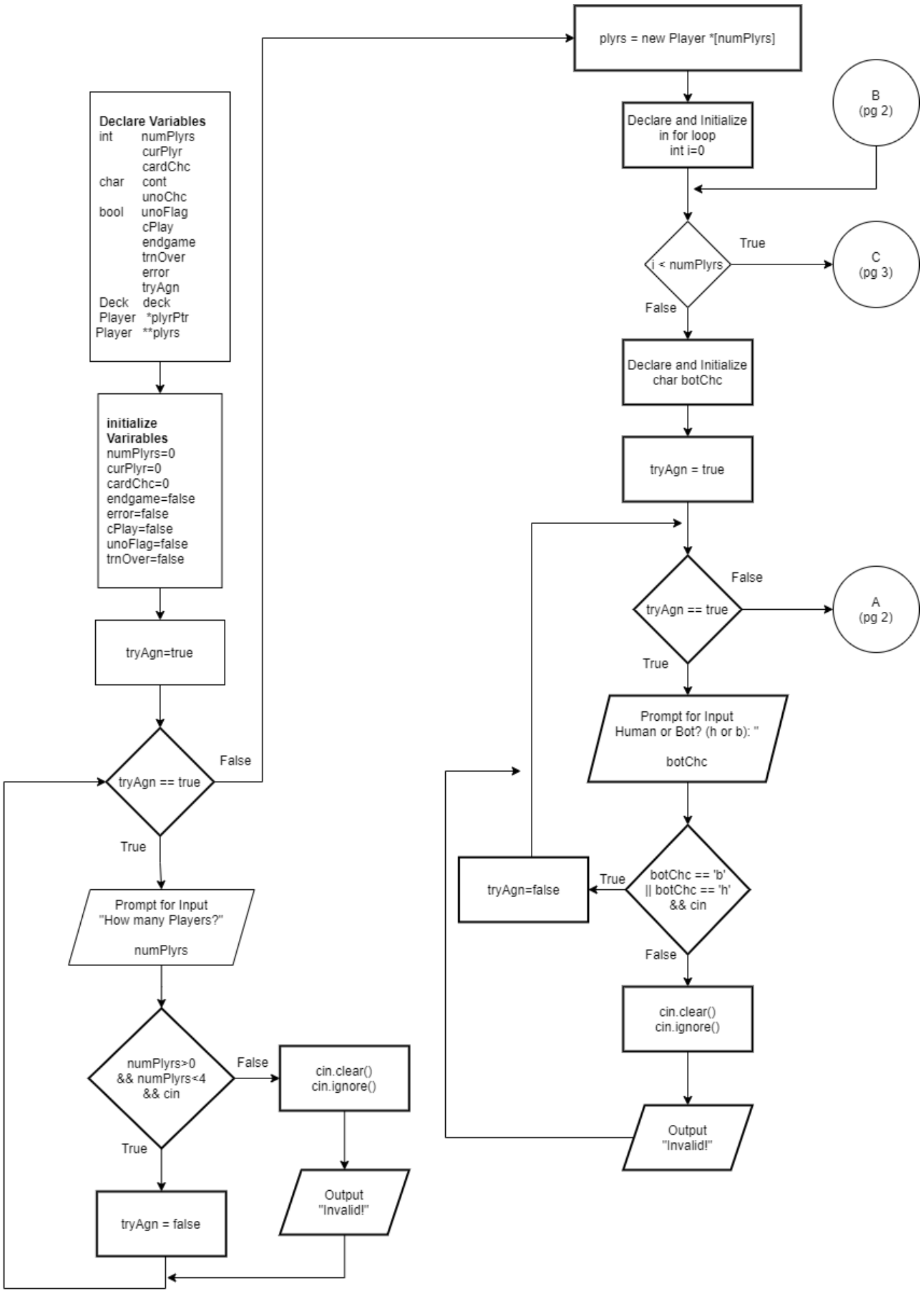
plyGame is the main game function which mediates between the Deck object and Player objects.

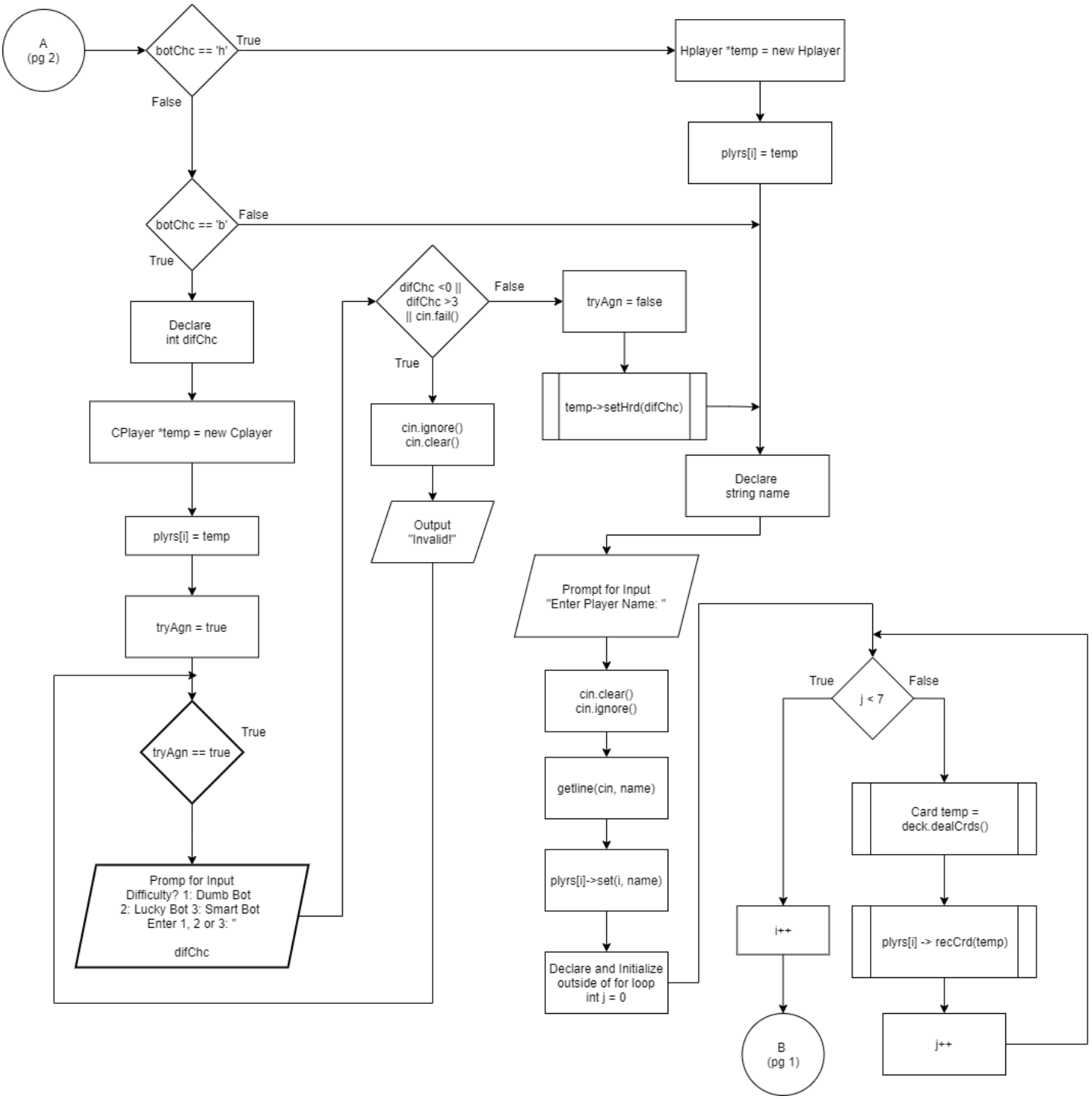
```
void plyGame()
*****************************************************************************
    int             numPlyrs,  //Number of players
                    curPlyr,   //Current player
                    cardChc;   //Card choice
    char            cont,      //User input to continue after message
                    unoChc;    //Player choice to call uno or play a card
    bool            unoFlag,   //Flag, if player called uno
                    cPlay,     //Flag, if player has a playable card
                    endgame,   //Flag, if game is running endgame=false
                    trnOver,   //Flag, if turn is over=true
                    error,     //Input Validation Error Checking
                               tryAgn;
    Deck            deck;      //Deck object
    Player         *plyrPtr;   //Pointer to individual player
    Player         **plyrs;    //Pointer to array of players
*****************************************************************************

    SET tryAgn to true
    WHILE tryAgn is true
        PRINT "How many Players? (Up to 4): "
        INPUT numPlyrs;
        IF numPlyrs less than 0 and numPlyrs greater than or equal to 4 and cin is
successful
            SET tryAgn to false
        ELSE
            clear buffer
            PRINT "Invalid!"
      end of while
    ALLOCATE memory for array of Player object pointers at plyrs
    FOR each Player pointer in plyrs [i=0 to numPlyrs]
        CREATE bot choice input variable
        SET tryAgn to true
        WHILE tryAgn is true
            PRINT "Player: Human or Bot? (h or b): "
            INPUT bot choice
            IF bot choice is b or bot choice is h and cin is successful
                SET tryAgn to false
                  end of if
            ELSE
                        clear buffer
                PRINT "Invalid!"
                  end of else
        IF bot choice is h
            ALLOCATE memory for Hplayer object
            SET pointer in plyrs array to Hplayer object
            end of if
        ELSE IF bot choice is b
            CREATE difficulty level input variable
            ALLOCATE memory for Cplayer object
            SET pointer in plyrs array to Cplayer object
            SET tryAgn to true
            WHILE tryAgn is true
                PRINT "Difficulty? 1: Dumb Bot 2: Lucky Bot 3: Smart Bot
                                  Enter 1, 2 or 3: "
                INPUT difChc
                IF tryAgn is less than 0 or tryAgn is greater than 3 or cin fails
```

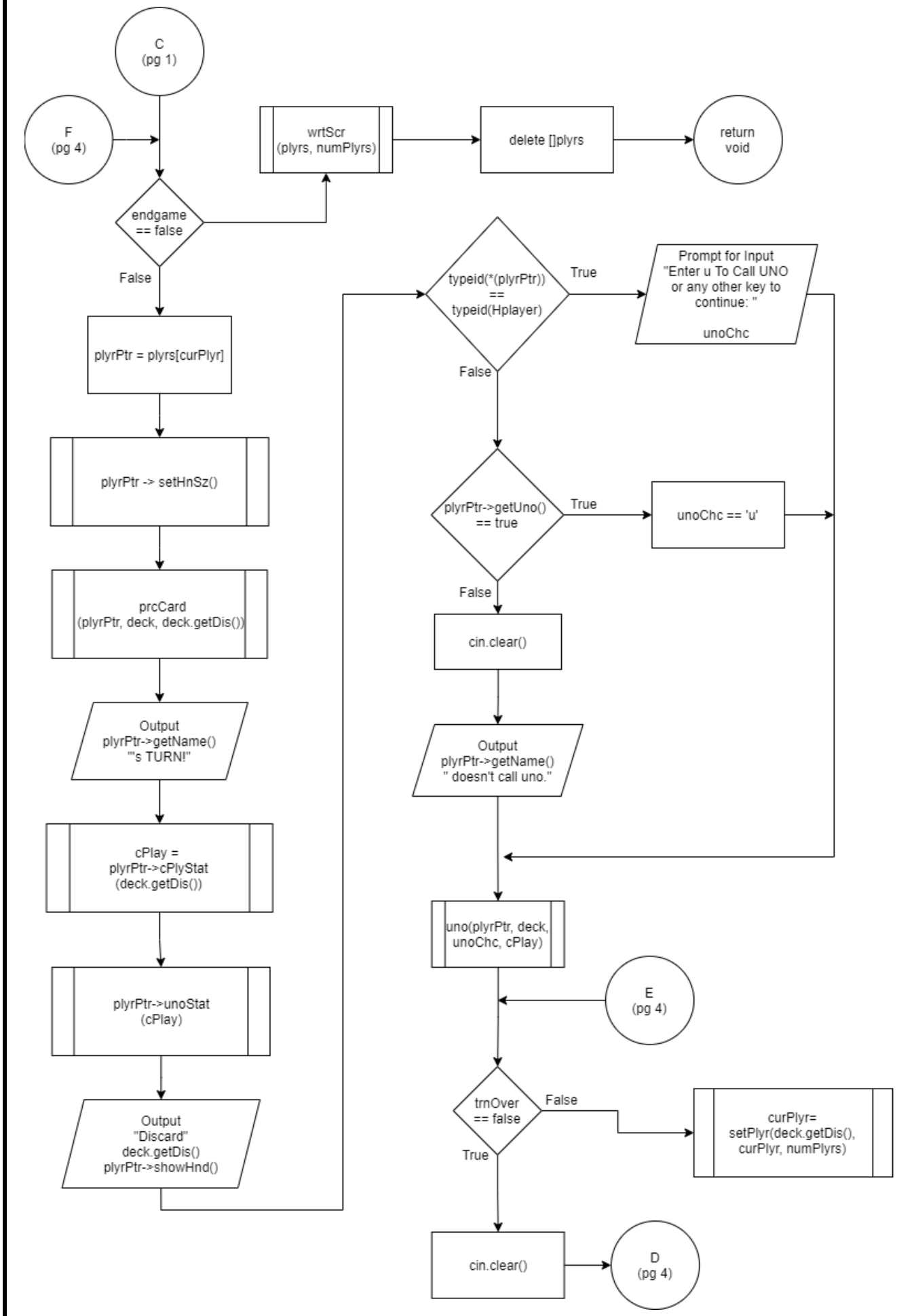
```
                        clear buffer
                PRINT "Invalid!"
                    end of if
            ELSE
                        SET tryAgn to false
                    end of else
              end of while
        SET Cplayer object difficulty level
        end of else
    CREATE name input variable
    PRINT "Enter Player Name: "
        clear buffer
    INPUT player name
    CALL plyrs[i].set(i, name)
    FOR 7 times
        CREATE Card object temp
              CALL and SET temp to deck.dealCrds()
        CALL plyrs[i]->recCrd(temp)
  end of for loop
DO WHILE endgame is false
        SET plyrPtr to plyrs array at curPlyr
        CALL plyrPtr->setHnSz()
        CALL prcCard(plyrPtr, deck, deck.getDis())
        PRINT plyrPtr->getName() "'s Turn!"
        CALL and SET cPlay to plyrPtr->cPlyStat(deck.getDis())
        CALL plyrPtr->unoStat(cPlay)
        CALL deck.getDis()
        CALL plyrPtr->showHnd()
        IF the current player is an Hplayer object
            PRINT "Enter u To Call UNO or any other key to continue: "
            INPUT unoChc;
        end of if
        ELSE
            IF player has uno
                SET unoChc to u
            end of if
            ELSE
                clear buffer
                PRINT <<plyrPtr->getName()<<" doesn't call uno."<<endl; //msg
            end of else
        end of else
        CALL uno(plyrPtr, deck, unoChc, cPlay)
        DO WHILE trnOver is false
            clear buffer
            IF cPlay is true
                CALL deck.chngDisc(plyrPtr->getPcrd(deck.getDis()))
                SET trnOver to true
            end of if
            ELSE IF cPlay is false
                DO WHILE cPlay is false
                    CREATE validate and SET to false
                    IF the current player is a Hplayer object
                        PRINT "No Valid Card to Play!"
                        PRINT Enter any key to continue"
                        INPUT cont
                    end of if
                    ELSE
                        PRINT plyrPtr->getName()
                              "has no valid card to play!"
                    end of else
                    CALL plyrPtr->recCrd(deck.dealCrds())
                    CALL and SET validate to plyrPtr->valLstCrd(deck.getDis())
                    PRINT plyrPtr->getName() " Drew: "
```

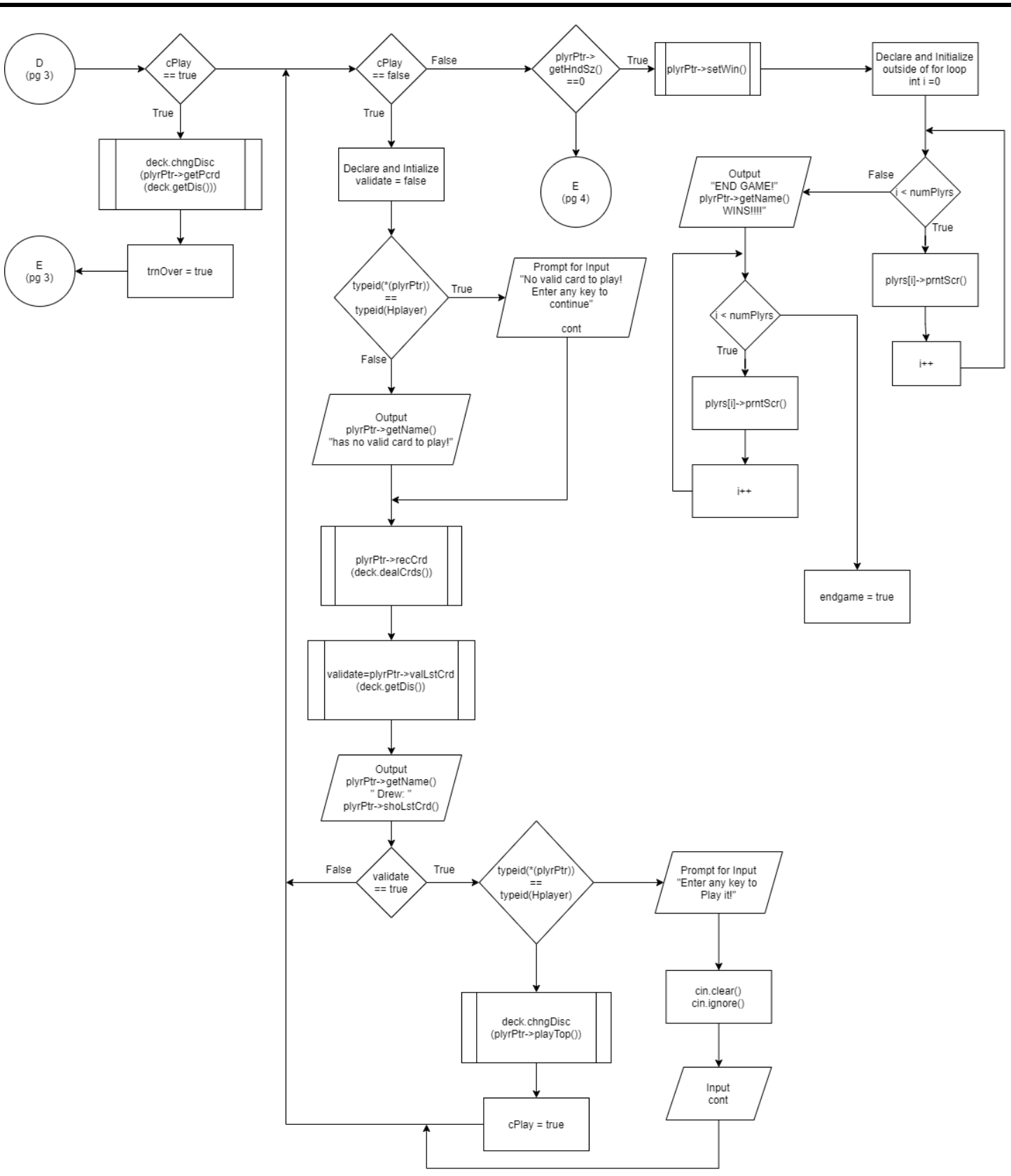
```
                    PRINT plyrPtr->shoLstCrd()
                    IF validate is true
                        IF the current player is a Hplayer object
                            PRINT "Enter any key to Play it"
                                        clear buffer
                            INPUT cont
                        end of if
                        CALL deck.chngDisc(plyrPtr->playTop())
                        SET cPlay to true
                        SET trnOver to true
                    end of if
                end of do while
            end of else
            IF hand size is 0
                CALL plyrPtr->setWin()
                FOR each player [i=0 to numPlyrs]
                    CALL plyrs[i]->setScr()
                end of for loop
                PRINT <"END GAME!!"
                PRINT plyrPtr->getName() " WINS!!!!"
                FOR each player [i=0 to numPlyrs]
                   CALL plyrs[i]->prntScr()
                end of for loop
                SET endgame to true
            end of if
        end of do while
        CALL and SET curPlyr to setPlyr(deck.getDis(), curPlyr, numPlyrs)
  end do while
CALL wrtScr(plyrs, numPlyrs)
DELETE []plyrs
```

3.2.1 plyGame() flowchart




A
(pg 2)
botChc == 'h'
True
False
Hplayer *temp = new Hplayer
plyrs[i] = temp
botChc == 'b'
False
True
Declare
int difChc
CPlayer *temp = new Cplayer
plyrs[i] = temp
tryAgn = true
tryAgn == true
True
Promp for Input
Difficulty? 1: Dumb Bot
2: Lucky Bot 3: Smart Bot
Enter 1, 2 or 3: "
difChc
difChc <0 ||
difChc >3
|| cin.fail()
True
False
cin.ignore()
cin.clear()
Output
"Invalid!"
tryAgn = false
temp->setHrd(difChc)
Declare
string name
Prompt for Input
"Enter Player Name: "
cin.clear()
cin.ignore()
getline(cin, name)
plyrs[i]->set(i, name)
Declare and Initialize
outside of for loop
int j = 0
True
j < 7
False
i++
B
(pg 1)
Card temp =
deck.dealCrds()
plyrs[i] -> recCrd(temp)
j++


C
(pg 1)
F
(pg 4)
endgame
== false
False
wrtScr
(plyrs, numPlyrs)
delete []plyrs
return
void
plyrPtr = plyrs[curPlyr]
plyrPtr -> setHnSz()
prcCard
(plyrPtr, deck, deck.getDis())
Output
plyrPtr->getName()
"'s TURN!"
cPlay =
plyrPtr->cPlyStat
(deck.getDis())
plyrPtr->unoStat
(cPlay)
Output
"Discard"
deck.getDis()
plyrPtr->showHnd()
typeid(*(plyrPtr))
==
typeid(Hplayer)
True
Prompt for Input
"Enter u To Call UNO
or any other key to
continue: "
unoChc
False
plyrPtr->getUno()
== true
True
unoChc == 'u'
False
cin.clear()
Output
plyrPtr->getName()
" doesn't call uno."
uno(plyrPtr, deck,
unoChc, cPlay)
E
(pg 4)
trnOver
== false
False
curPlyr=
setPlyr(deck.getDis(),
curPlyr, numPlyrs)
True
cin.clear()
D
(pg 4)


D
(pg 3)
cPlay
== true
True
deck.chngDisc
(plyrPtr->getPcrd
(deck.getDis()))
trnOver = true
E
(pg 3)
cPlay
== false
False
True
Declare and Intialize
validate = false
typeid(*(plyrPtr))
==
typeid(Hplayer)
True
Prompt for Input
"No valid card to play!
Enter any key to
continue"
cont
False
Output
plyrPtr->getName()
"has no valid card to play!"
plyrPtr->recCrd
(deck.dealCrds())
validate=plyrPtr->valLstCrd
(deck.getDis())
Output
plyrPtr->getName()
" Drew: "
plyrPtr->shoLstCrd()
validate
== true
False
True
typeid(*(plyrPtr))
==
typeid(Hplayer)
Prompt for Input
"Enter any key to
Play it!"
cin.clear()
cin.ignore()
Input
cont
deck.chngDisc
(plyrPtr->playTop())
cPlay = true
plyrPtr->
getHndSz()
==0
True
E
(pg 4)
plyrPtr->setWin()
Declare and Initialize
outside of for loop
int i =0
i < numPlyrs
False
True
plyrs[i]->prntScr()
i++
Output
"END GAME!"
plyrPtr->getName()
WINS!!!!"
i < numPlyrs
True
plyrs[i]->prntScr()
i++
endgame = true

3.3 getPcrd Function

Polymorphic behavior is only possible when objects are passed by reference to the abstract function.
By using a pointer to the player objects in the main game function, Cplayer and Hplayer objects can call different versions of the getPcrd function.

3.3.1 Cplayer getPcrd pseudo code

This version of the getPcrd function calculates a "value" for each card in the players hand based on the frequency of colors and symbols (number and type) in the hand.
After running a few tests, I determined that all three bot levels won more often when they prioritized DRAW2, REVERSE, and SKIP types, and de-prioritized WILD and WILD4 types.

```
Card Cplayer::getPcrd(Card &disCrd)
*******************************************************************************
    Card temp;              //Card object to return
    vector<int> valCrds;    //Valid card indexes
    int vecSz=0;            //Size of valid card vector
*******************************************************************************

    FOR i=0 to hand.size()
        IF valPlay(disCrd,hand[i])) returns true
            CALL valCrds.push_back(i)
            increment vector size
        end of if
    end of for loop
    SWITCH on hardNum
        case 1
            CREATE index
            SET index to random element in valCrds
            SET temp to hand[valCrds[index]]
            CALL hand.erase(hand.begin()+valCrds[index])
            end of case 1
        case 2
            CREATE coin
            SET coin to random number 1 or 2
            IF coin is 1
                CREATE sScrs[14] and initalize all elements to 0
                CALL scoreSym(sScrs) calculate valid card values based on symbol
                CREATE smax variable to hold index of card with highest value
                        CALL and SET smax to scrCrdsN(valCrds, sScrs, vecSz)
                CREATE index
                        SET index to valCrds[smax]
                SET temp to hand[index]
                CREATE and SET erase to valCrds[smax]
                CALL hand.erase(hand.begin()+erase)
            end of if
            ELSE
                CREATE cScrs[4] and initalize all elements to 0
                CALL scoreClr(cScrs) calculate valid card values based on color
                CREATE cmax variable to hold index of card with highest value
                        CALL and SET cmax to scrCrdsC(valCrds, cScrs, vecSz)
                        CREATE index
                        SET index to valCrds[cmax]
                SET temp to hand[index]
                CREATE AND SET erase to valCrds[cmax]
                CALL hand.erase(hand.begin()+erase)
            end of case 2
```

```
        case 3
            CREATE sScrs[14] and initalize all elements to 0
                  CALL scoreSym(sScrs) calculate valid card values based on symbol
            CREATE cScrs[4] and initalize all elements to 0
            CALL scoreClr(cScrs) calculate valid card values based on color
            CREATE amax variable to hold index of card with highest value
                  CALL and SET amax to sCrdsA(sScrs, cScrs, valCrds, vecSz)
            SET index to valCrds[amax]
            SET temp to hand[index]
            CREATE AND SET erase to valCrds[amax]
            CALL hand.erase(hand.begin()+erase)
            end of case 3
    end of switch
    IF temp.getType() is WILD or temp.getType() is WILD4)
        CREATE wCol
        CALL and SET wCol to chsWild()
            RETURN wCol
        CALL temp.setColor(wCol)
    end of if
    PRINT name " plays "
    PRINT temp
    RETURN temp
```

3.3.1.1 Supporting Functions for Cplayer::getPcrd

3.3.1.2 scoreClr

```
void Cplayer::scoreClr(int cScrs[])
    FOR each Card in hand
        CREATE and SET color to hand[i].getColor()
        SWITCH on color
            case r : increment cScrs[0]
            case g : increment cScrs[1]
            case b : increment cScrs[2]
            case y : increment cScrs[3]
           end of switch
```

3.3.1.3 scrCrdsC

```
int Cplayer::scrCrdsC(vector<int> valCrds, int cScrs[], int vecSz){
    CREATE colTots[vecSz] and initialize all elements to 0
    FOR each element i in valCrds
        CREATE and SET col to hand[valCrds[i]].getColor();
        SWITCH on color
            case r : SET colTots[i] to cScrs[0]
            case g : SET colTots[i] to cScrs[1]
            case b : SET colTots[i] to cScrs[2]
            case y : SET colTots[i] to cScrs[3]
            case X : SET colTots[i] to 0 de
            end of switch
    CREATE cmax and SET to 0
    FOR each element i in vecSz
        IF colTots[i] is greater than cmax)
            SET cmax to i
        end of if
    end of for loop
    RETURN cmax
```

3.2.1 Hplayer getPcrd pseudo code

The Hplayer version of getPcrd gets input from the user and utilizes an exception class to perform input validation.

```
Card Hplayer::getPcrd(Card &disCrd)
*******************************************************************************
    int chc;            //Hold card choice
    Card temp;          //Temp Card object to return
    int index;          //Index of card choice for temp card
    bool tryAgn=true;   //Input validation flag
*******************************************************************************
    clear buffer
    PRINT "What card do you want to play?"
    INPUT chc
    WHILE tryAgn is true
        TRY
            CALL and SET index to pCrd(disCrd, chc)
            SET tryAgn to false;
        end of try
        CATCH(BadChc bad)
            PRINT "Error: " bad.getChc() " is an invalid choice!"
            PRINT "Enter the number that corresponds to your card choice: "
            INPUT chc
        end of catch
    end of while
    CREATE colChc
    IF hand[index].getType() is WILD or hand[index].getType() is WILD4
            CALL and SET colChc to chsWild()
            CALL and SET colChc to tolower(colChc)
            CALL hand[index].setColor(colChc)
    end of if
    SET temp to hand[index]
    CALL hand.erase(hand.begin()+index)
    RETURN temp
```

4. Project Check Off Sheet

Chapter	Section	Topic	Where Line #"s	Pts	Notes
13		Classes			
	1 to 3	Instance of a Class	(main) 84	4	The Deck object deck is declared here. The classes Card, Deck, Player, Hplayer and Cplayer are defined in their respective .h files
	4	Private Data Members	(Player.h) 18-24	4	Never Public
	5	Specification vs. Implementation	Player: Player.h Player.cpp Cplayer: Cplayer.h Cplayer.cpp Hplayer: Hplayer.h Hplayer.cpp	4	.h vs. .cpp files
	6	Inline	(Player.h) 52	4	setHnSz() adds the current hand size to the hndSzs vector in one line within the Player.h file
	7, 8, 10	Constructors	(Card.h) 44, (Deck.cpp) 14	4	The members of Card are set in it's Constructor. When new cards are added to the deck, their member values are passed to the Constructor
	9	Destructors		4	
	12	Arrays of Objects	Declared (main) 86, Filled (main 16 & 131)	4	Array of Player pointers holds pointers to derived class Cplayer and Hplayer objects
	16	UML	(in Project 2 Folder) UML.png	4	
14		More about Classes			
	1	Static		5	
	2	Friends	(Card.h) 76	2	Overloaded << operator is a friend of ostream class
	4	Copy Constructors	(Card.h) 36-41	5	Overloads the = operator
	5	Operator Overloading	<< (Card.h) 76 = (Card.h) 35	8	Overload 3 operators
	7	Aggregation	(Deck.h) 17-19	6	The Deck class has Card class member variables
15		Inheritance			

	1	Protected members	(Player.h) 18-24	6	The protected Player members are accessed by derived classes Cplayer and Hplayer.
	2 to 5	Base Class to Derived	Player.h, Cplayer.h, and Hplayer.h	6	The Cplayer and Hplayer classes are derived from the Player class
	6	Polymorphic associations	(Player.h) 32 (Cplayer.h) 26 (Hplayer.h) 24	6	The abstract member function getPcrd is overriden in the derived classes Cplayer and Hplayer
	7	Abstract Classes		6	
16		Advanced Classes			
	1	Exceptions	(Hplayer.cpp) 27-36	6	Exception class BadChc is used for input validation
	2 to 4	Templates		6	
	5	STL	(Deck.cpp) 82-83	6	STL vector member function are used extensively throughout the program. Here, back() and pop_back() are used
		Sum		100	