Top-Down Design, Bottom-Up Implementation

Rose-Hulman Institute of Technology
Computer Science and Software Engineering

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Early Project kickoff

- Because you could benefit from an extra weekend, we want your team to begin thinking about this project.
- Details are on Project kickoff slides.

Plan for Today

- Design, implement, and test Blackjack together
  - Lots of whiteboard work
  - I'll share code after class

Designing/Implementing a Larger Program

- One common strategy: *top-down design*
  - Break the problem into a few big pieces
    - One function for each piece
  - Break each piece into smaller pieces
  - Continue until the pieces are “bite size”

Recall: Top-level Algorithm

- Create initial card deck
- Deal initial cards
- Player plays until busted or chooses to stop
- Dealer plays until required to stop
- Report who wins

Top-level Functions Called by main

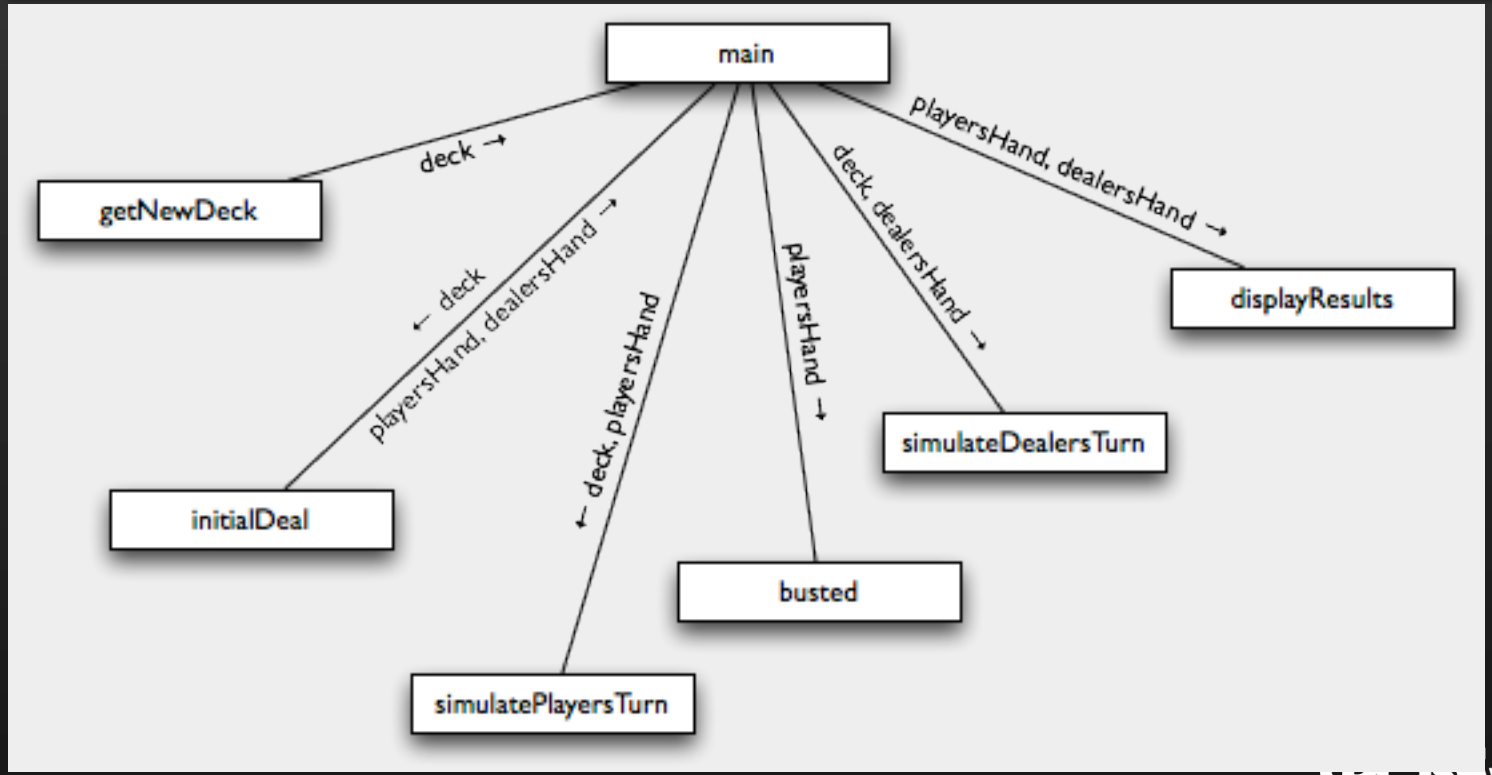
- **getNewDeck()**—Creates and returns a complete deck of cards
- **initialDeal(deck)**—Deals cards from the deck to each player, returns the hands
- **simulatePlayersTurn(deck, playersHand)**—Allows player to choose hit or stay
- **busted(playersHand)**—Checks whether the given hand is over 21
- **simulateDealersTurn(deck, dealersHand)**—Dealer hits or stays, based on the rules
- **displayResults(playersHand, dealersHand)**—Determines and displays who wins.

A couple of function names may be different than what we produced "on the fly" yesterday, but the functionality is the same.

Implementation of main

```
def main():
    deck = getNewDeck()
    playersHand, dealersHand = initialDeal(deck)
    simulatePlayersTurn(deck, playersHand)
    if(not busted(playersHand)):
        simulateDealersTurn(deck, dealersHand)
    else:
        print("Busted!!!")
    displayResults(playersHand, dealersHand)
```

Initial Blackjack Structure Diagram



Some Preliminary Data Values

```
# Define some constants used by many functions
suits = ['Clubs', 'Diamonds', 'Hearts', 'Spades']

cardNames = ['Ace', 'Deuce', '3', '4', '5',
             '6', '7', '8', '9', '10',
             'Jack', 'Queen', 'King']

winningScore = 21

dealerMustHoldScore = 16


# Card is represented by a list: [cardName, suit]
# Examples: ['Ace','Clubs'] or ['7','Diamonds']
# A hand or a deck is a list of cards.
```

Bottom-up Testing

- Implement and test as we go
- Small changes, well tested make debugging easy

Class Exercise

Design, Implement, and Test

Q3-4

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Designing newDeck()

- Write steps of **newDeck()** in English
- Write the code
- Refer to:
  - Data values on handout
  - Structure diagram on handout

newDeck() – returns complete deck

- start with an empty list
- for each cardName/ suit pair
  - generate a card with that name and suit
  - add card to list
- Return the list

```
# Create an entire deck of cards
def newDeck():
    deckList = []
    for s in suits:
        for c in cardNames:
            deckList.append([c, s])
    return deckList
```

Designing initialDeal(deck)

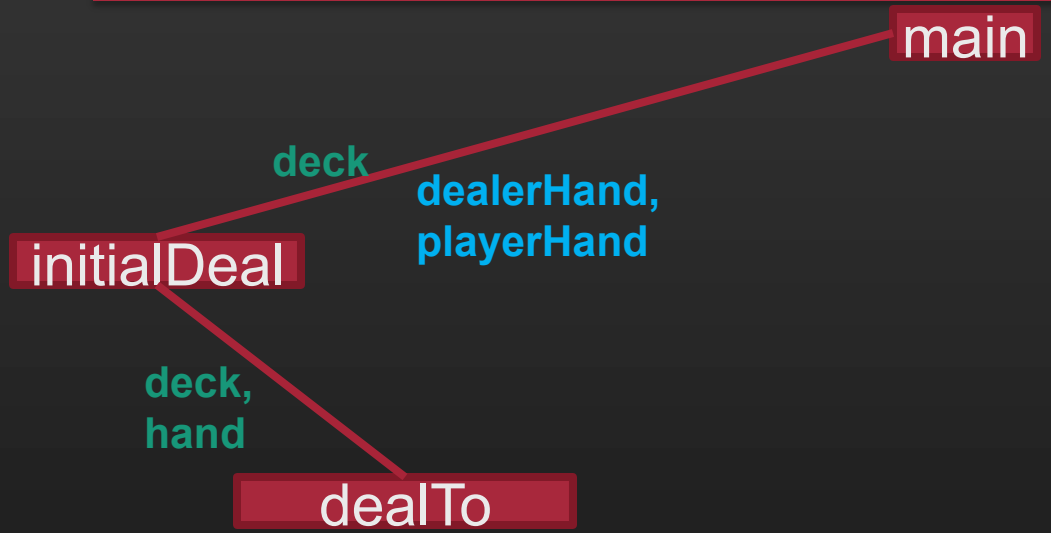
- Work in groups of 4 at a whiteboard
- Write steps for initialDeal(deck) function in English
- Write the code
- Take about 10 minutes
- Refer to:
  - Data values on handout
  - Structure diagram on handout
  - Do you need new functions? Add them to your structure chart

initialDeal(deck)

- start with two empty hands
- deal two cards to each hand
- return the two hands

```
# Deal two cards to each player.
def initialDeal(deck):
    playerHand = []
    dealerHand = []
    for i in range(2):
      dealTo(playerHand, deck)
      dealTo(dealerHand, deck)
    return playerHand, dealerHand
```

initialDeal Structure Diagram



Key:
formal parameters
return values

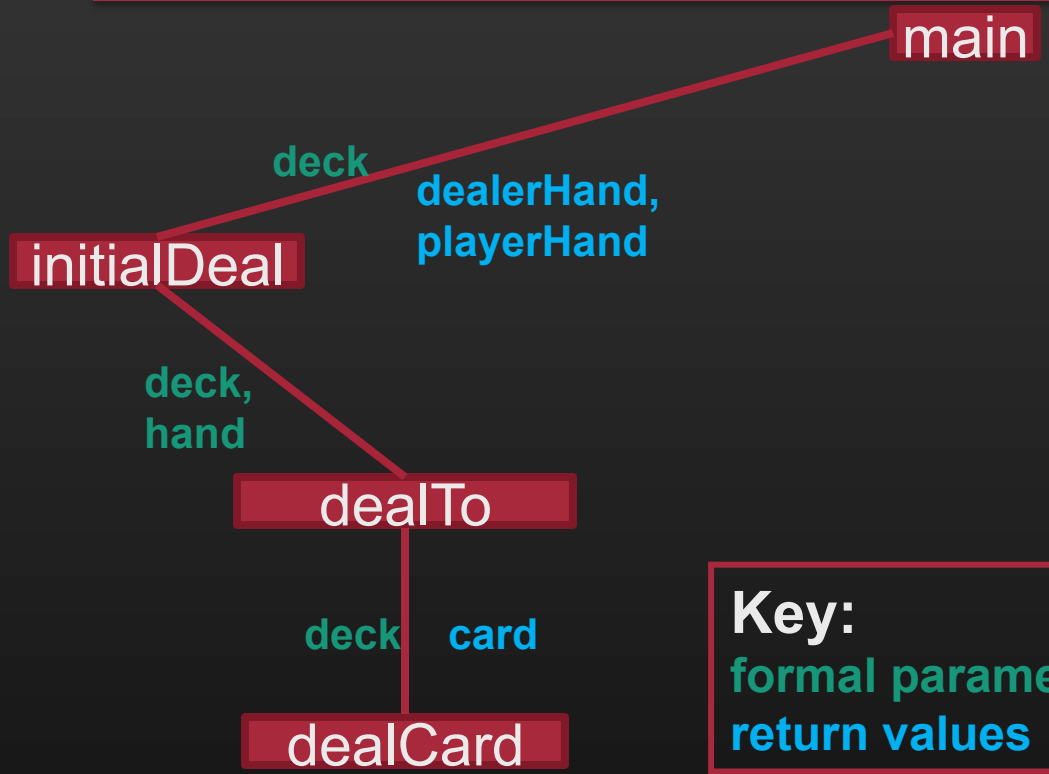
```
# Deal two cards to each player.
def initialDeal(deck):
    playerHand = []
    dealerHand = []
    for i in range(2):
      dealTo(playerHand, deck)
      dealTo(dealerHand, deck)
    return playerHand, dealerHand
```

dealTo(hand, deck)

- Pick a random card from the deck and move it to the hand

```
# deal a card from this deck and place it in this hand.
def dealTo(hand, deck):
    hand.append(dealCard(deck))
```

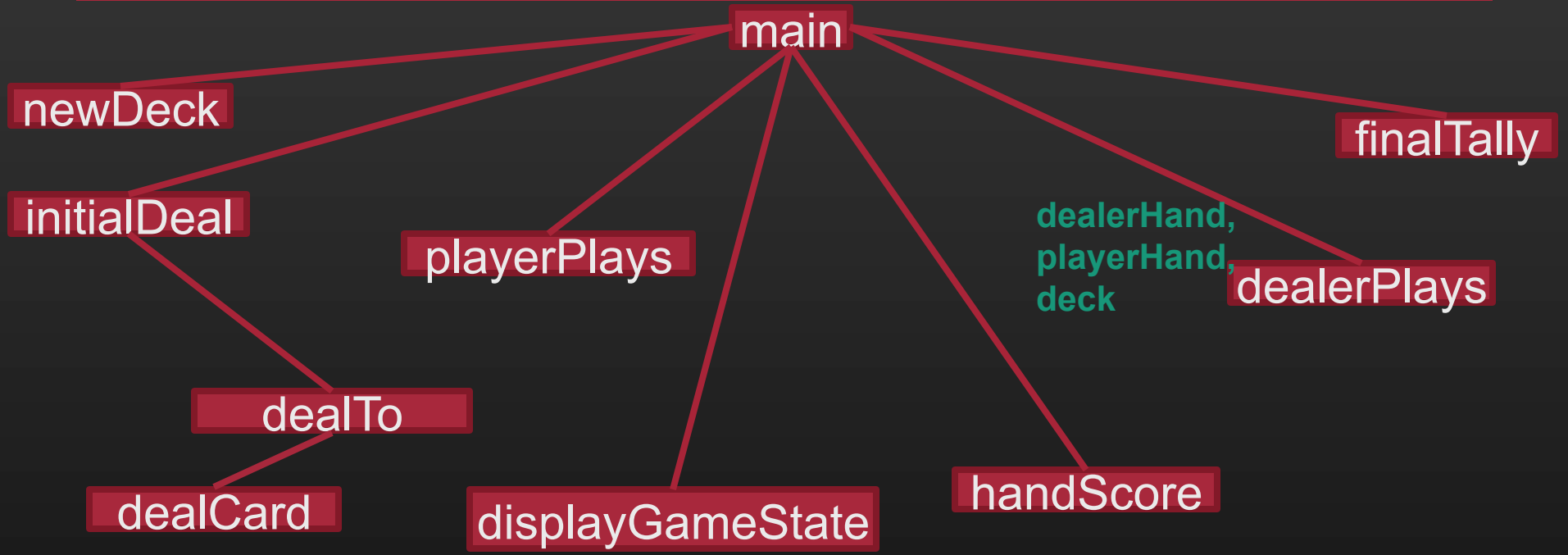
initialDeal Structure Diagram




```
# Remove  a random card from
# the deck and return it
def dealCard(deck):
    pos = randrange(len(deck))
    card = deck[pos]
    deck.remove(card)
    return card
```

Key:
formal parameters
return values

Let's skip ahead to dealerPlays( )



Designing dealerPlays()

- Work in groups of 4 at a whiteboard
- Write steps of dealerPlays() in English
- Write the code:
  - Do you need new functions? Add them to your structure chart
- Take about 10 minutes

dealerPlays

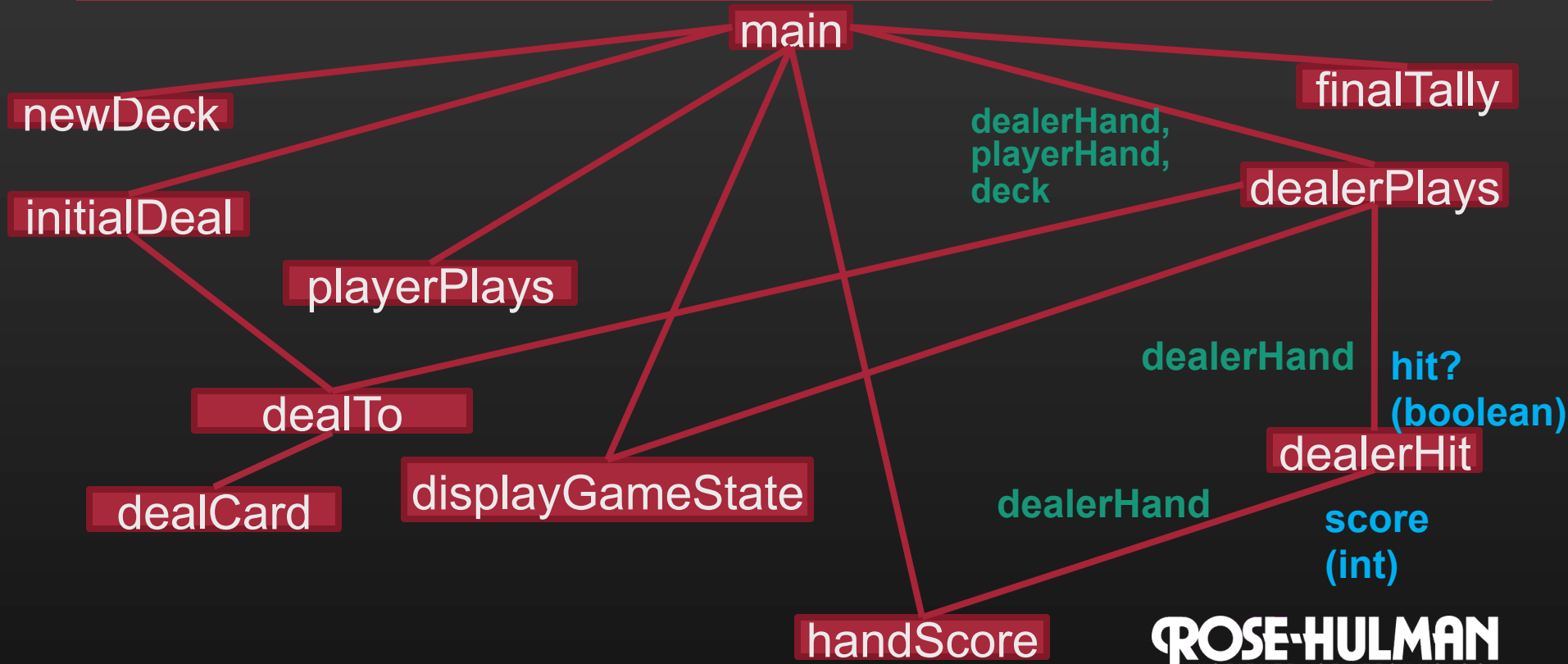
- while dealerMustTakeaHit
  - deal a card to Dealer's hand

```
# Dealer takes hits until no more hits allowed.
def dealerPlays(player, dealer, deck):
    displayGameState(player, dealer, True)
    while dealerHit(dealer):
        sleep(3)
        print("Dealer takes a hit")
        dealTo(dealer, deck)
        displayGameState (player, dealer, True)
```

```
# Determine whether dealer
# "takes a hit" (gets another card).
def dealerHit(dealerHand):
    dealerScore = handScore(dealerHand)
    return dealerScore < dealerMustHoldScore
```

Design so far

Key:
formal parameters
return values



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Code for handScore( )

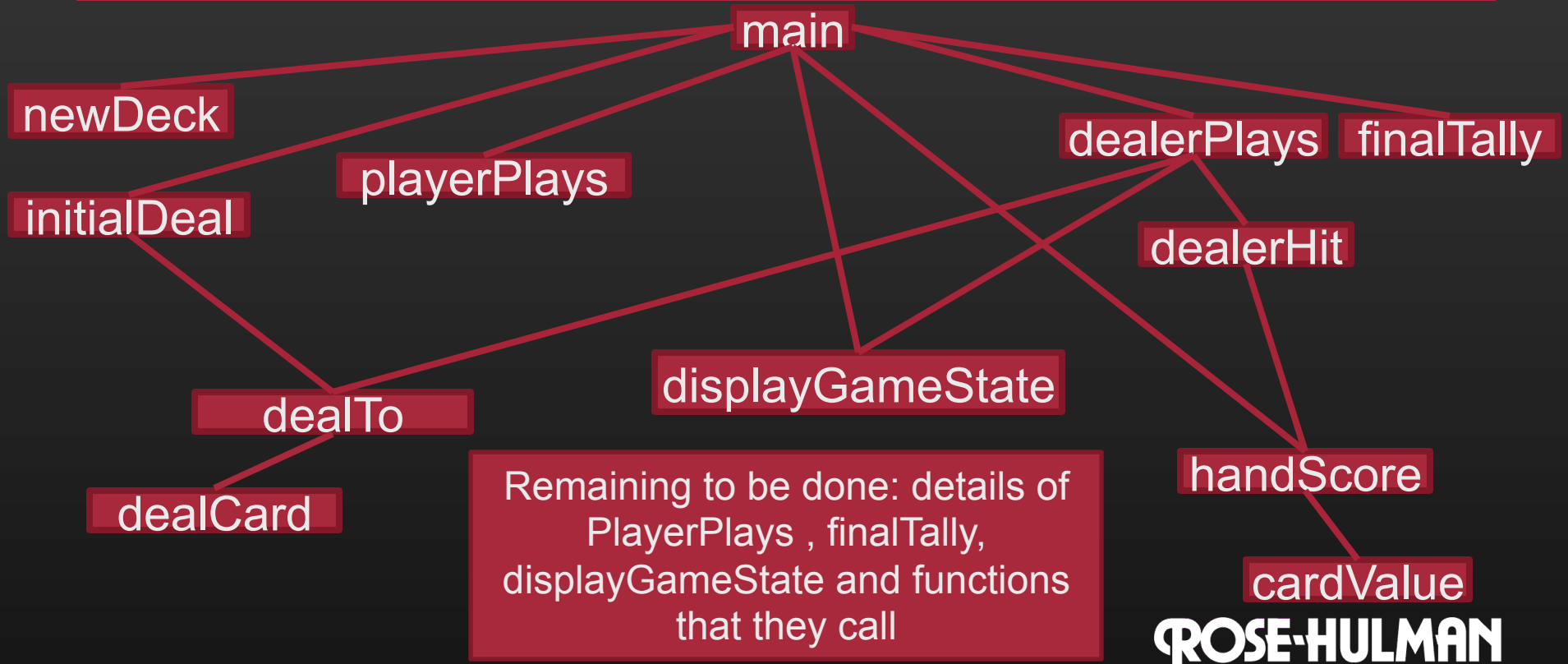
```
# Calculate the score for the whole hand.
def handScore(hand):
    score = 0
    hasAce = False
    for card in hand:
        val = cardValue(card)
        score += val
        if val == 1:
            hasAce = True
    if score <= winningScore - 10 and hasAce:
        score = score + 10
    return score
```

What if they have two or more aces?

Code for cardValue( )

```
# calculate how many points this card is worth.
# Face cards count 10.
# Ace Counts 1 (or 11, but that adjustment is
#             made at the handScore level).
def cardValue(card):
    name = card[0]
    pos = cardNames.index(name)
    if pos < 10:  # if not a face card.
        return pos + 1
    return 10
```

What we have developed so far



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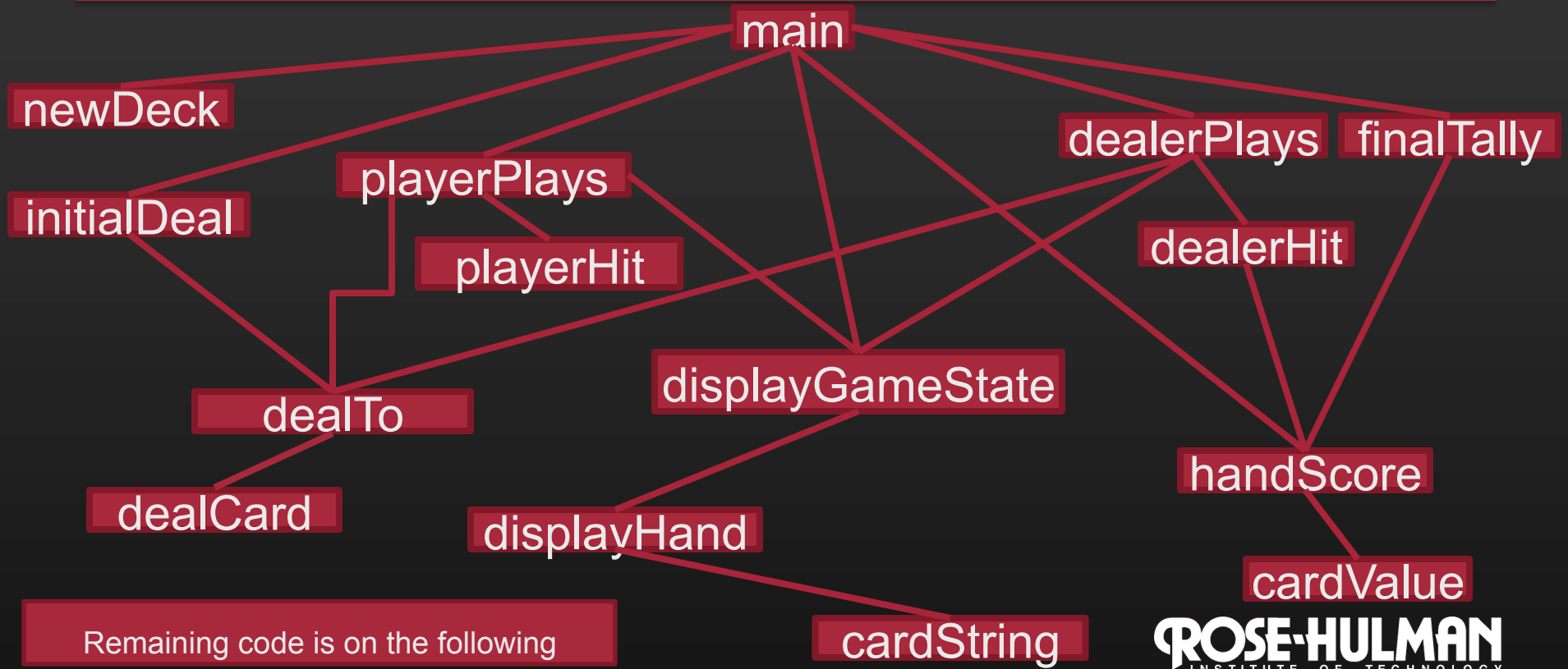
Complete Structure Diagram



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Display Functions

```
# Show the contents of both players' hands.
def displayGameState(playerHand, dealerHand, gameOver):
    displayHand('Dealer', dealerHand, gameOver)
    displayHand('Player', playerHand, True)
# print the contents of the hand. showAll false implies not showing dealer's hole card
def displayHand(name, hand, showAll):
    print(name + "'s hand:",)
    if showAll:
        print("(score is %d)" % (handScore(hand)))
        print cardString(hand[0])
    else:
        print()
        print('  Face Down' )
   # print the rest of the hand.
    for i in range(1, len(hand)):
        print(cardString(hand[i]))
```

```
# return a string that represents the given card.
def cardString(card):
    return '  ' + card[0] + " of " + card[1]
```

playerPlays and PlayerHit

```
# Player takes hits until Busted or stops requesting hits.
def playerPlays(player, dealer, deck):
    while playerHit(handScore(player)):
        dealTo(player, deck)
        displayGameState(player, dealer, False)
# Ask player whether she wants another card.
def playerHit(playerScore):
    if playerScore > winningScore:
        return False
    answer = win_raw_input("Hit? (Y/N) ")
    firstChar = answer[0]
    return firstChar == 'y' or firstChar == 'Y'
```

finalTally function

```
# Figure out who won.
def finalTally(player, dealer):
    playerScore = handScore(player)
    dealerScore = handScore(dealer)
    if dealerScore > winningScore:
        print("DEALER IS BUSTED, YOU WIN“)
    elif dealerScore > playerScore:
        print("DEALER WINS" )
    else:
        print("YOU WIN!" )
```