

Section 1: Use Cases

The game of Yahtzee has only a few use cases.

- Full Game
- One Game
- One Round
- Rolling
- Scoring

The full game is played with between 1 to 5 players and revolves around playing between 1 to 6 single games. Each single game consists of exactly 13 rounds. During each round, each player is given the opportunity to roll and score according to the rules of Yahtzee. No Yahtzee bonuses are permitted.

Use Case Details: Full Game

B1. For 6 games, execute use case: One Game

B2. After 6 games, Game over

Alternative 1: Users do not play a full 6 games

A1. Execute use case: One Game

A2. Assume Current Game < 6

A3. Prompt to exit

A4. User opts to exit early

A5. Game over

Use Case Details: One Game

B1. For 13 rounds, execute use case: One Round

B2. After 13 rounds, game ends

Use Case Details: One Round

B1. The first player executes use case: One Roll

B2. The second player, if present, executes use case: One Roll

B3. The third player, if present, executes use case: One Roll

B4. The fourth player, if present, executes use case: One Roll

B5. The fifth player, if present, executes use case: One Roll

B6. Round ended

Use Case Details: One Roll

- B1. Player takes roll 1, rolling all 5 dice
- B2. Player holds 0 to 4 dice of his/her choosing
- B3. Player takes roll 2, rolling all non-held dice
- B4. Player holds 0 to 4 dice of his/her choosing
- B5. Player takes roll 3, rolling all non-held dice
- B6. Rolling complete, Player must now execute use case: Scoring

Alternative 1: Player is satisfied after first roll, and goes immediately to scoring

Alternative 2: Player is satisfied after second roll, and goes immediately to scoring

Use Case Details: Scoring

- B1. Player selects an empty space on the score card
- B2. The score is calculated and entered
- B3. All subtotal scores and the grand total score are updated
- B4. The next player begins their turn, or the round ends if this was the last player

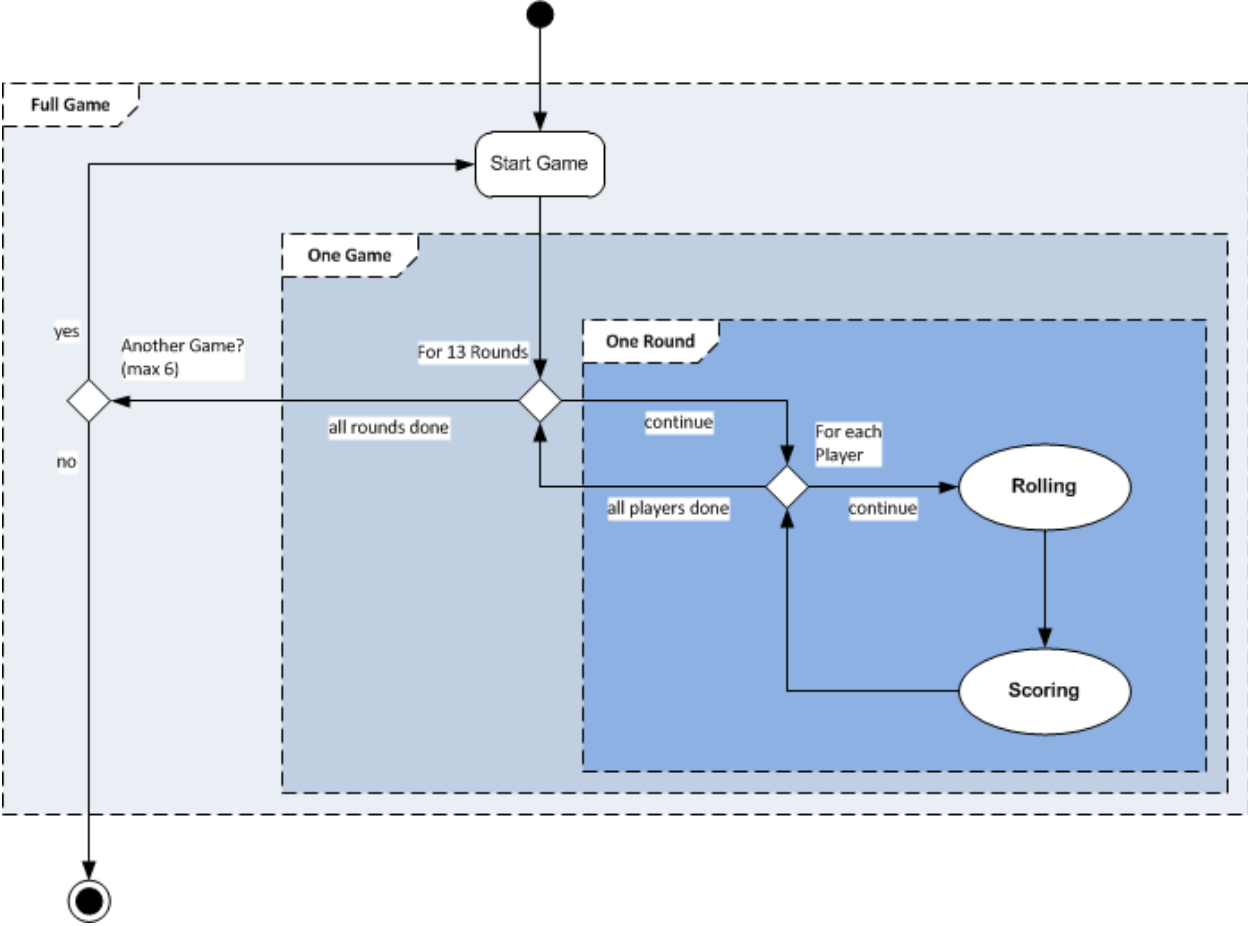
Alternative 1: The dice do not support the scoring position played

A1.1 A scratch score of 0 is entered

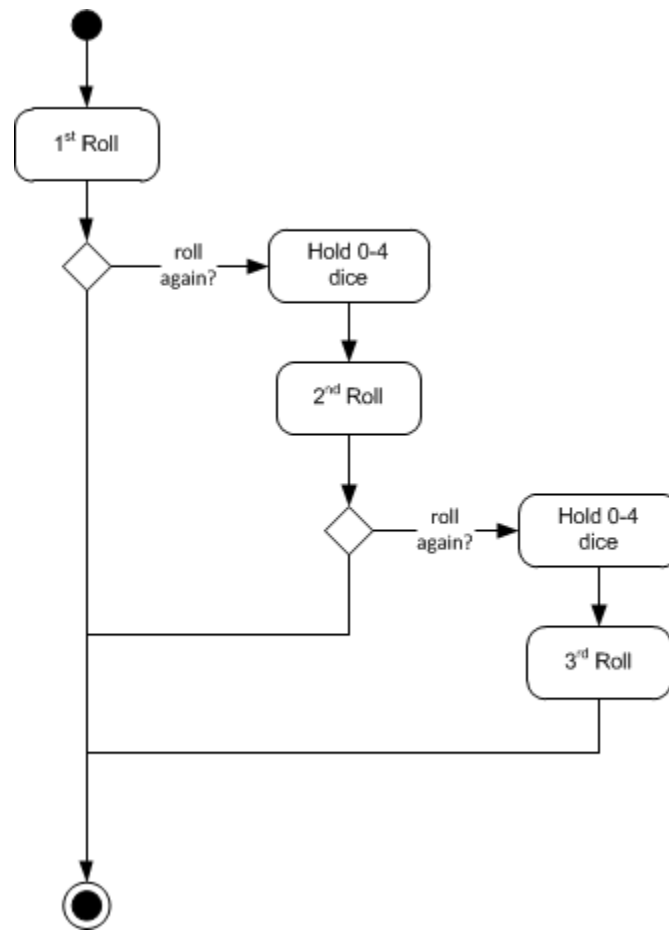
Alternative 2: The scoring position has already been played

A2.1 Nothing happens, the player may select a different scoring position.

Overall Flow of the Full Game



Flow of One Roll



Section 2: Operational Variables

Operational variables represent inputs to use cases which affect their outputs. For the Yahtzee game, operation variables include those which manage the game in progress (i.e. whose turn it is), as well as the dice values that make up the scoring.

- Current Game
 - Controls the "Another game" decision, along with user input
 - This variable should be controlled by the implementation and not the users, but it is important from a flow control point of view
- Current Round
 - Controls the "Rounds" decision
 - Every game of Yahtzee has precisely 13 rounds

- This variable should be controlled by the implementation and not the users, but it is important from a flow control point of view
- Number of players
 - Controls the "Each Player" decision, ensuring that player gets a turn
- Current Player
 - Tracks which player is currently rolling
 - This variable should be controlled by the implementation and not the users, but it is important from a flow control point of view
- Die Values
 - The value of each die
 - These values should be randomly generated by the implementation, but as they are non-deterministic, they qualify as input variables.
- Value Count
 - The count of each value
 - These variables are derived directly from the Die Values set, however this representation is easier to use when representing scoring calculations
- Die held flags
 - Indicates, for each die, whether it is held
- Scorecard
 - A compound variable per player containing information about the scoring that player has made
 - The Scorecard consists of an upper and lower section. The upper section contains 6 play fields, and the lower section contains 7, corresponding to the official Yahtzee playing combinations (i.e. sixes, 4-of-a-kind, and so on). Each section has a sub total field. Finally, the very last row of the scorecard is a grand total.
 - The Scorecard contains 6 columns of the above layout, one for each of the 6 games that an official Yahtzee scorecard supports.

Section 3: Operation Variable Relationships

Yahtzee uses a standard 6 sided die. All die values must always be between 1 and 6. For simplicity, all die values will be show in non-decreasing sorted order.

The *Die Value* and *Value Count* operational variables are bound to each other. That is, they are two different representations of the same variables, so we assume correctness in the translation from one format to another.

Upper Section Scoring

The following tables show the scoring value that should be assigned if:

- The player chooses to play the indicated scorecard space.
- The scorecard space is not already played this game.

In all cases, attempts to play a scorecard space that has already been played should be disallowed.

Ones

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	0	DC	DC	DC	DC	DC	0	Scratch
2	1	DC	DC	DC	DC	DC	1	
3	2	DC	DC	DC	DC	DC	2	
4	3	DC	DC	DC	DC	DC	3	
5	4	DC	DC	DC	DC	DC	4	
6	5	DC	DC	DC	DC	DC	5	

Twos

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	DC	0	DC	DC	DC	DC	0	Scratch
2	DC	1	DC	DC	DC	DC	2	
3	DC	2	DC	DC	DC	DC	4	
4	DC	3	DC	DC	DC	DC	6	
5	DC	4	DC	DC	DC	DC	8	
6	DC	5	DC	DC	DC	DC	10	

Threes

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	DC	DC	0	DC	DC	DC	0	Scratch
2	DC	DC	1	DC	DC	DC	3	
3	DC	DC	2	DC	DC	DC	6	
4	DC	DC	3	DC	DC	DC	9	
5	DC	DC	4	DC	DC	DC	12	
6	DC	DC	5	DC	DC	DC	15	

Fours

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	DC	DC	DC	0	DC	DC	0	Scratch
2	DC	DC	DC	1	DC	DC	4	
3	DC	DC	DC	2	DC	DC	8	
4	DC	DC	DC	3	DC	DC	12	
5	DC	DC	DC	4	DC	DC	16	
6	DC	DC	DC	5	DC	DC	20	

Fives

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	DC	DC	DC	DC	0	DC	0	Scratch
2	DC	DC	DC	DC	1	DC	5	
3	DC	DC	DC	DC	2	DC	10	
4	DC	DC	DC	DC	3	DC	15	
5	DC	DC	DC	DC	4	DC	20	
6	DC	DC	DC	DC	5	DC	25	

Sixes

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	DC	DC	DC	DC	DC	0	0	Scratch
2	DC	DC	DC	DC	DC	1	6	
3	DC	DC	DC	DC	DC	2	12	
4	DC	DC	DC	DC	DC	3	18	
5	DC	DC	DC	DC	DC	4	24	
6	DC	DC	DC	DC	DC	5	30	

Lower Section Scoring

The following tables show the scoring value that should be assigned if:

- The player chooses to play the indicated scorecard space.
- The scorecard space is not already played this game.

In all cases, attempts to play a scorecard space that has already been played should be disallowed.

3-of-a-kind

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	< 3	< 3	< 3	< 3	< 3	< 3	0	Scratch
2	>= 3	DC	DC	DC	DC	DC	Sum of all dice	
3	DC	>= 3	DC	DC	DC	DC	Sum of all dice	
4	DC	DC	>= 3	DC	DC	DC	Sum of all dice	
5	DC	DC	DC	>= 3	DC	DC	Sum of all dice	
6	DC	DC	DC	DC	>= 3	DC	Sum of all dice	
7	DC	DC	DC	DC	DC	>= 3	Sum of all dice	

4-of-a-kind

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	< 4	< 4	< 4	< 4	< 4	< 4	0	Scratch

Variant	Operational Variables (Value Count)						Expected Result
	1's	2's	3's	4's	5's	6's	Score
2	>= 4	DC	DC	DC	DC	DC	Sum of all dice
3	DC	>= 4	DC	DC	DC	DC	Sum of all dice
4	DC	DC	>= 4	DC	DC	DC	Sum of all dice
5	DC	DC	DC	>= 4	DC	DC	Sum of all dice
6	DC	DC	DC	DC	>= 4	DC	Sum of all dice
7	DC	DC	DC	DC	DC	>= 4	Sum of all dice

Full House

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	3	2	0	0	0	0	25	
2	3	0	2	0	0	0	25	
3	3	0	0	2	0	0	25	
4	3	0	0	0	2	0	25	
5	3	0	0	0	0	2	25	
6	2	3	0	0	0	0	25	
7	0	3	2	0	0	0	25	
8	0	3	0	2	0	0	25	
9	0	3	0	0	2	0	25	
10	0	3	0	0	0	2	25	
11	2	0	3	0	0	0	25	
12	0	2	3	0	0	0	25	
13	0	0	3	2	0	0	25	
14	0	0	3	0	2	0	25	
15	0	0	3	0	0	2	25	
16	2	0	0	3	0	0	25	
17	0	2	0	3	0	0	25	
18	0	0	2	3	0	0	25	
19	0	0	0	3	2	0	25	
20	0	0	0	3	0	2	25	
21	2	0	0	0	3	0	25	
22	0	2	0	0	3	0	25	
23	0	0	2	0	3	0	25	
24	0	0	0	2	3	0	25	
25	0	0	0	0	3	2	25	
26	2	0	0	0	0	3	25	
27	0	2	0	0	0	3	25	
28	0	0	2	0	0	3	25	
29	0	0	0	2	0	3	25	
30	0	0	0	0	2	3	25	
31	Any other combination of values						0	Scratch

Small Straight

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	>= 1	>=1	>= 1	>= 1	DC	DC	30	
2	DC	>=1	>= 1	>= 1	>= 1	DC	30	
3	DC	DC	>= 1	>= 1	>= 1	>= 1	30	
4	Any other combination of values						0	Scratch

Large Straight

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	1	1	1	1	1	0	40	
2	0	1	1	1	1	1	40	
3	Any other combination of values						0	Scratch

Yahtzee

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	5	0	0	0	0	0	50	
2	0	5	0	0	0	0	50	
3	0	0	5	0	0	0	50	
4	0	0	0	5	0	0	50	
5	0	0	0	0	5	0	50	
6	0	0	0	0	0	5	50	
7	Any other combination of values						0	Scratch

Chance

Variant	Operational Variables (Value Count)						Expected Result	
	1's	2's	3's	4's	5's	6's	Score	
1	Any combination of values							Sum of all dice

Totals

Each of the upper and lower sections of the scorecard contains a subtotal for each game. There is also a grand total field for each game.

The following invariants should be maintained. The upper section subtotal of the Scorecard must always equal the sum of the individual upper section play fields, while the lower section subtotal must always equal the sum of its individual play fields. The grand total field must always equal the sum of the two sub totals.

Die Rolling

Yahtzee uses a standard 6 sided die. The following invariants must be maintained. All die values must always be between 1 and 6.

Die Holding

Every round of Yahtzee begins with the player rolling all 5 dice. After the first roll, the player may optionally make 1 or 2 additional rolls. On each of these additional rolls, the play may “hold”, that is, not roll, up to 4 of the dice. A die that is held on the first additional roll may later be “unheld” for the second additional roll.

Should rolling be permitted?

Variant	Operational Variables (Die Held)						Expected Result
	Roll #	D1	D2	D3	D4	D5	
1	1	Not held	Not held	Not held	Not held	Not held	Permit roll
2	1	Held	DC	DC	DC	DC	Disallow roll
3	1	DC	Held	DC	DC	DC	Disallow roll
4	1	DC	DC	Held	DC	DC	Disallow roll
5	1	DC	DC	DC	Held	DC	Disallow roll
6	1	DC	DC	DC	DC	Held	Disallow roll
7	2	Held	Held	Held	Held	Held	Disallow roll
8	2	Not Held	DC	DC	DC	DC	Permit roll
9	2	DC	Not Held	DC	DC	DC	Permit roll
10	2	DC	DC	Not Held	DC	DC	Permit roll
11	2	DC	DC	DC	Not Held	DC	Permit roll
12	2	DC	DC	DC	DC	Not Held	Permit roll
13	3	Held	Held	Held	Held	Held	Disallow roll
14	3	Not Held	DC	DC	DC	DC	Permit roll
15	3	DC	Not Held	DC	DC	DC	Permit roll
16	3	DC	DC	Not Held	DC	DC	Permit roll
17	3	DC	DC	DC	Not Held	DC	Permit roll
18	3	DC	DC	DC	DC	Not Held	Permit roll
19	> 3	DC	DC	DC	DC	DC	Disallow roll