battleship-VDM

January 2, 2017

Contents

1 Board

```
class Board
types
 public CellContent = <Empty> | <Carrier> | <Battleship> | <Cruiser> | <Submarine> | <Destroyer>
     | <Hit> | <Miss>;
 public Direction = <Up> | <Down> | <Left> | <Right>

values
 protected static shipSize: map CellContent to nat1 = {
  <Carrier> |-> 5, <Battleship> |-> 4, <Cruiser> |-> 3, <Submarine> |-> 3, <Destroyer> |-> 2
 };
 protected static colMap: map char to nat1 = {
  'A' |-> 1, 'B' |-> 2, 'C' |-> 3, 'D' |-> 4, 'E' |-> 5, 'F' |-> 6, 'G' |-> 7, 'H' |-> 8, 'I' |->
       9, 'J' |-> 10
 }; -- ndice de cada coluna

instance variables
 protected cells: seq of seq of CellContent := []; --matriz de clulas

 inv len cells = 10; -- cada tabuleiro tem 10 linhas
 inv card {i| i in set inds cells & len cells(i) = 10} = 10; -- cada linha tem 10 colunas


operations
--cria tabuleiro com todas clulas vazias
 public Board: () ==> Board
  Board() == (
   cells := [[<Empty>| x in set {1,...,10}]| x in set {1,...,10}];

   return self;
  );

--preenche a clula (line,col) com content
```

```
 public setComponent: CellContent * nat1 * nat1 ==> ()
  setComponent(content, line, col) == (

   cells(line) := cells(line) ++ {col |-> content}
  )
  pre col <= 10 and line <= 10 and content <> <Empty>;


--mapeia coluna para ndice e chama fun o para preencher c lula

 public setComponentCol: CellContent * nat1 * char ==> ()
  setComponentCol(content, line, colCh) == setComponent(content, line, colMap(colCh))
  pre colCh in set dom colMap;

-- tendo a c lula A=(line,col) e size-1 c ulas numa determinada direc o (dir)
-- todas estas c lulas est o dentro dos limites do tabuleiro e est o vazias
 pure public emptyValidCells: nat1 * nat1 * Direction * nat1 ==> bool
  emptyValidCells(line, col, dir, size) == (
   if dir = <Up> then
    for i = 0 to size - 1 do (
     if line - i <= 0 then return false;
     if cells(line - i)(col) <> <Empty> then return false;
     )
   else if dir = <Down> then
    for i = 0 to size - 1 do (
     if line + i > 10 then return false;
     if cells(line + 1)(col) <> <Empty> then return false;
     )
   else if dir = <Left> then
    for i = 0 to size - 1 do (
     if col - i <= 0 then return false;
     if cells(line)(col - i) <> <Empty> then return false;
     )

   else for i = 0 to size - 1 do (
     if col + i > 10 then return false;
     if cells(line)(col + i) <> <Empty> then return false;
     );
   return true;
  );

-- verifica o nmero de c lulas do tabuleiro preenchidas com determinada componente
 pure public countCellType: CellContent ==> nat

  countCellType(type) == (
   dcl sum : nat := 0;
   for i = 1 to len cells do
    for j = 1 to len cells(i) do
     if cells(i)(j) = type then sum := sum + 1;
   return sum;
  );

-- coloca um navio no tabuleiro dada c lula A=(line, colCh) numa determinada direc o
 public placeShip: CellContent * char * nat1 * Direction ==> ()
  placeShip(ship, colCh, line, dir) == (
   dcl col: nat1 := colMap(colCh);
   if dir = <Up> then
    for i = 0 to shipSize(ship) - 1 do
     setComponent(ship, line - i, col)
   else if dir = <Down> then
    for i = 0 to shipSize(ship) - 1 do
     setComponent(ship, line + i, col)
   else if dir = <Left> then
    for i = 0 to shipSize(ship) - 1 do
     setComponent(ship, line, col - i)
```

```
   else for i = 0 to shipSize(ship) - 1 do
     setComponent(ship, line, col + i)
  )

  pre ship in set dom shipSize
  and colCh in set dom colMap
  and countCellType(ship) = 0

  and emptyValidCells(line, colMap(colCh), dir, shipSize(ship)) --check if cells that a ship
      takes are empty and if ship fits in the board
  post countCellType(ship) = shipSize(ship);

-- retorna a lista de navios numa frota
 public getShips : () ==> set of CellContent
  getShips() == return dom shipSize;

-- retorna o nmero de navios numa frota
 public getShipsCount : () ==> nat1
  getShipsCount() == return card dom shipSize;

-- verifica se numa clula existe um navio e regista com <Hit> ou <Miss>
 public registerMove: char * nat1 ==> CellContent

  registerMove(colCh, line) == (
   dcl col: nat1 := colMap(colCh);
   dcl oldValue: CellContent := cells(line)(col);
   if oldValue = <Empty> then cells(line)(col) := <Miss>
   else cells(line)(col) := <Hit>;
   return oldValue;
  )
  pre colCh in set dom colMap and cells(line)(colMap(colCh)) not in set {<Hit>,<Miss>}
  post cells(line)(colMap(colCh)) in set {<Hit>,<Miss>};

--- print to console

 -- retorna o navio em string
 public shipToString : CellContent ==> Player`String
  shipToString(type) == (

   cases type:
   <Empty> -> return "Empty",
   <Carrier> -> return "Carrier",
   <Battleship> -> return "Battleship",
   <Cruiser> -> return "Cruiser",
   <Submarine> -> return "Submarine",

   <Destroyer> -> return "Destroyer",
   <Hit> -> return "Hit",
   <Miss> -> return "Miss"
   end;
   return "Unknow"
  );

  -- retorna a representao de um navio no tabuleiro
 public cellToString : CellContent ==> Player`String
  cellToString(type) == (
   dcl fullStr: Player`String := shipToString(type);

   return [fullStr(i)| i in set inds fullStr & i < 4];
  );

  -- imprime um tabuleiro e peas l inseridas
 public printBoard : () ==> Player`String
  printBoard() == (
```

```
  dcl board: Player`String := [];
  for i = 1 to len cells do (
   if i < 10 then board := board ^ "0";
   board := board ^ VDMUtil`val2seq_of_char[nat](i) ^ "    ";
   for j = 1 to len cells(i) do board:= board ^ cellToString(cells(i)(j)) ^ "    ";
   board := board ^ "\n";
  );
  return "      A      B      C      D      E      F      G      H      I      J    \n\n" ^
      board);

 -- imprime dois tabuleiros lado a lado
 public printParallelBoards : Board  ==> Player`String
  printParallelBoards(enemyBoard) == (
   dcl pBoard: Player`String := [];

   for i = 1 to len cells do (
    if i < 10 then pBoard := pBoard ^ "0";
    pBoard := pBoard ^ VDMUtil`val2seq_of_char[nat](i) ^ "    ";
    for j = 1 to len cells(i) do pBoard:= pBoard ^ cellToString(cells(i)(j)) ^ "    ";

    pBoard := pBoard ^ "\t\t\t";
    if i < 10 then pBoard := pBoard ^ "0";
    pBoard := pBoard ^ VDMUtil`val2seq_of_char[nat](i) ^ "    ";
    for j = 1 to len enemyBoard.cells(i) do pBoard:= pBoard ^ cellToString(enemyBoard.cells(i)(j)
        ) ^ "    ";

    pBoard := pBoard ^ "\n";
   );
   return "      A      B      C      D      E      F      G      H      I      J    " ^
   "\t\t\t" ^ "      A      B      C      D      E      F      G      H      I      J    \n\n" ^
       pBoard);

 -- imprime os navios de uma lista em formato string
 public printRemainShips: set of CellContent ==> Player`String
  printRemainShips(ships) == (
   dcl res: Player`String := [];
   for all ship in set ships do res := res ^ shipToString(ship) ^ ": " ^ VDMUtil`val2seq_of_char[
       nat](shipSize(ship)) ^ "    ";
   return res;
  )

end Board
```

Function or operation	Line	Coverage	Calls
Board	19	100.0%	52
cellToString	123	100.0%	6
countCellType	59	100.0%	101
emptyValidCells	35	100.0%	102
getComponent	36	100.0%	102
getShips	89	100.0%	6
getShipsCount	92	100.0%	6
placeShip	68	100.0%	30
printBoard	129	0.0%	0
printParallelBoards	140	0.0%	0
printRemainShips	159	0.0%	0
registerMove	95	100.0%	18
setComponent	25	100.0%	122

setComponentCol	31	100.0%	16
shipToString	108	24.1%	12
Board.vdmpp		70.1%	573

2 Game

```
class Game
types
 private State = <Off> | <Start> | <Placed> | <Round>

instance variables
 private inGame: bool := false;
 private playerA: Player;
 private playerB: Player;
 private currPlayer: Player;
 private players: set of Player := {};
 private currState: State := <Off>;

 inv currPlayer in set {playerA, playerB};
 inv playerA in set players;
 inv playerB in set players;
 inv forall p1, p2 in set players & p1 <> p2 => p1.getName() <> p2.getName();

operations


 public Game: Player`String * Player`String ==> Game
  Game(name1, name2) == (
   playerA := new Player(name1);
   playerB := new Player(name2);
   currPlayer := playerA;
   players := {playerA, playerB};
   return self
  )
  pre currState= <Off> and name1 <> name2 and card players = 0
  post card players = 2;


 public createPlayer: (Player`String) ==> Player
  createPlayer(name) == (
   dcl player: Player := new Player(name);
   players := players union {player};
   return player
  )
  pre not exists p in set players & p.getName() = name;


 public changePlayers: Player`String * Player`String ==> ()
  changePlayers(name1, name2) == (
   dcl tmpPlayer: Player := iota p in set players & p.getName() = name1;
   atomic(playerA := tmpPlayer;
   playerB := iota p in set players & p.getName() = name2;
   currPlayer := tmpPlayer;
   );
  )
  pre currState = <Off> and exists p1, p2 in set players & p1.getName() = name1 and p2.getName()
      = name2;


 public switchTurns: () ==> ()
```

```
 switchTurns() == (
  if currPlayer = playerA then currPlayer := playerB
  else currPlayer := playerA
 )
 pre currState <> <Off>;


public getOtherPlayer: () ==> Player
 getOtherPlayer() == (
  if currPlayer = playerA then return playerB
  else return playerA;
 );


public startGame: () ==> Player`String
 startGame() == (
  inGame := true;
  playerA.addBoards();
  playerB.addBoards();
  currState := <Start>;
  return "Game started with following players:\n"
  ^ playerA.printInfo()
  ^ playerB.printInfo() ^ "\n\n\n\n"
  ^ currPlayer.printPlacementStatus();
 )
 pre currState = <Off>;


public shipPlacement: Board`CellContent * char * nat1 * Board`Direction ==> Player`String
 shipPlacement(ship, colCh, line, dir) == (
  dcl ret: Player`String;
  currPlayer.shipPlacement(ship, colCh, line, dir);
  ret := currPlayer.printPlacementStatus();
  if currPlayer.allShipsPlaced() then(
   switchTurns();
   ret := ret ^ "\n\n\n\n\n";
   if currPlayer.allShipsPlaced() then (
    currState := <Placed>;
    ret := ret ^ "All ships placed\n";
   )
  else ret := ret ^ currPlayer.printPlacementStatus();
  );
  return ret;
 )
 pre currState = <Start>;


public startRounds: () ==> Player`String
 startRounds() == (
  playerA.startRounds();
  playerB.startRounds();
  currState := <Round>;
  return currPlayer.printGameStatus();
 )
 pre currState = <Placed>;


public guessShipPosition: char * nat1 ==> Player`String
 guessShipPosition(colCh, line) == (
  dcl othPlayer: Player := getOtherPlayer();
  dcl code: Board`CellContent := othPlayer.registerAttack(colCh, line);
  dcl ret: Player`String := [];
  dcl final: bool := currPlayer.registerResult(code, colCh, line);
  if code = <Miss> then (
   ret := ret ^ "\n\nSplash!! You missed!\n";
```

```
     switchTurns();
    )
   else if code = <Hit> then ret := ret ^ "\n\nGreat strike\n"
   else ret := ret ^ currPlayer.printTakeDown(code);
   if final then(
    ret := ret ^ currPlayer.printVictory();
    currState := <Off>;
    playerA.clearData();
    playerB.clearData();
    return ret;
   );
   ret := ret ^ "\n\n\n\n\n" ^ currPlayer.printGameStatus();
   return ret;
  )
  pre currState = <Round>;

end Game
```

Function or operation	Line	Coverage	Calls
Game	20	0.0%	0
changePlayers	39	0.0%	0
createPlayer	31	0.0%	0
getOtherPlayer	56	0.0%	0
guessShipPosition	102	0.0%	0
shipPlacement	75	0.0%	0
startGame	62	0.0%	0
startRounds	93	0.0%	0
switchTurns	49	0.0%	0
Game.vdmpp		0.0%	0

3 Player

```
class Player
types
 public String = seq of char;

instance variables
 private name: String;
 private wins: nat;
 private losses: nat;
 private ownBoard: [Board] := nil;
 private enemyBoard: [Board] := nil;
 private myShips: set of Board`CellContent := {}; -- ships placed and my ships during game (
     decrease)
 private enemiesShips: set of Board`CellContent := {}; -- enemies ships destroyed (increase)

 inv len name < 256;

operations

 public Player: String ==> Player
  Player(nameArg) == (
   name := nameArg;
   wins := 0;
```

```
   losses := 0;
   return self
  );


 pure public getName : () ==> String
  getName() == return name;


 public addBoards : () ==> ()
  addBoards() == (
   ownBoard := new Board();
   enemyBoard := new Board();
   myShips := ownBoard.getShips();
  )
  pre ownBoard = nil and enemyBoard = nil;


 public shipPlacement: Board`CellContent * char * nat1 * Board`Direction ==> ()
  shipPlacement(ship, colCh, line, dir) == (
   ownBoard.placeShip(ship, colCh, line, dir);
   myShips := myShips \ {ship}
  )
  pre ship in set myShips;


 public allShipsPlaced: () ==> bool
  allShipsPlaced() == return card myShips = 0;


 public startRounds: () ==> ()
  startRounds () == (
   myShips := ownBoard.getShips();
   enemiesShips := {};
  );


 public clearData: () ==> ()
  clearData() == (
   ownBoard := nil;
   enemyBoard := nil;
   myShips := {};
   enemiesShips := {};
  );


 public registerAttack: char * nat1 ==> Board`CellContent
  registerAttack(colCh, line) == (
   dcl shipHit : Board`CellContent := ownBoard.registerMove(colCh, line);
   if ownBoard.countCellType(shipHit) = 0 then (
    myShips := myShips \ {shipHit};
    if card myShips = 0 then losses := losses + 1;
    return shipHit;
   )
   else if shipHit <> <Empty> then return <Hit>
   else return <Miss>;
  );


 public registerResult: Board`CellContent * char * nat1 ==> bool
  registerResult(code,colCh, line) == (
  if code = <Miss> then enemyBoard.setComponentCol(<Miss>,line,colCh)
  else(
   enemyBoard.setComponentCol(<Hit>,line,colCh);
    if code <> <Hit> then enemiesShips := enemiesShips union {code};
```

```
    if card enemiesShips = enemyBoard.getShipsCount() then(
     wins := wins + 1;
     return true;
    );
   );
   return false;
 );

--- print to console


 public printInfo : () ==> String
  printInfo() == return name ^ " (" ^
   VDMUtil`val2seq_of_char[nat](wins) ^ "-" ^
   VDMUtil`val2seq_of_char[nat](losses) ^ ")\n";


 public printPlacementStatus: () ==> String
  printPlacementStatus() == return "Fleet placement\nPlayer turn: " ^ name ^ "\n" ^
  "Ships to be placed: " ^ ownBoard.printRemainShips(myShips) ^ "\n\n" ^
  ownBoard.printBoard();


 public printGameStatus : () ==> String
  printGameStatus() == (
   dcl ret: String := "Player turn: " ^ name ^ "\nMy active ships: ";
   for all ship in set myShips do ret := ret ^ ownBoard.shipToString(ship) ^ "   ";
   ret := ret ^ "\nDestroyed enemies ships: ";
   for all ship in set enemiesShips do ret := ret ^ enemyBoard.shipToString(ship) ^ "   ";
   ret := ret ^ "\n\n                                    My ships \t\t\t\t\t\t\t\t\t
       Enemy ships\n\n\n";
   ret := ret ^ ownBoard.printParallelBoards(enemyBoard);
   return ret;
  );


 public printTakeDown : Board`CellContent ==> String
  printTakeDown(shipDown) == return "\n\n" ^ enemyBoard.shipToString(shipDown) ^ " is sinking\n";


 public printVictory : () ==> String
  printVictory() == return "\nEnemy fleet destroyed. Victory!\n";

end Player
```

Function or operation	Line	Coverage	Calls
Player	17	0.0%	0
addBoards	28	0.0%	0
allShipsPlaced	43	0.0%	0
clearData	52	0.0%	0
getName	25	0.0%	0
printGameStatus	98	0.0%	0
printInfo	88	0.0%	0
printPlacementStatus	93	0.0%	0
printTakeDown	109	0.0%	0
printVictory	112	0.0%	0
registerAttack	60	0.0%	0

registerResult	72	0.0%	0
shipPlacement	36	0.0%	0
startRounds	46	0.0%	0
Player.vdmpp		0.0%	0

4 TestBase

```
class TestBase

operations



 static public assertTrue : bool ==> ()
  assertTrue(cond) == return
 pre cond;



 static public assertEqual : ? * ? ==> ()
  assertEqual(result, expected) == return
 post result = expected;

 static public runAllTests: () ==> ()
  runAllTests() == (
    dcl tb: TestBoard := new TestBoard();
    tb.run();

    );
end TestBase
```

Function or operation	Line	Coverage	Calls
AssertTrue	4	100.0%	72
assertEqual	9	100.0%	140
assertTrue	5	100.0%	72
runAllTests	9	100.0%	8
TestBase.vdmpp		100.0%	292

5 TestBoard

```
class TestBoard is subclass of Board
operations


 -- todas as clulas est o vazias ao criar o tabuleiro
 private testCreateBoard : () ==> ()
  testCreateBoard() == (
   dcl b: Board := new Board();
   TestBase`assertEqual(b.countCellType(<Empty>),100);

 );
```

```
-- testa mapeamento entre colunas char e seu ndice
private testColMap : () ==> ()
 testColMap() == (
  dcl b: Board := new Board();
  dcl c: Board := new Board();
  TestBase`assertEqual(2,colMap('B'));
  TestBase`assertEqual(2-1,colMap('A'));
  TestBase`assertEqual(2+1,colMap('C'));

  b.setComponent(<Cruiser>,1,2);
  c.setComponentCol(<Cruiser>,1,'B');
  TestBase`assertEqual(b.cells(1)(2),c.cells(1)(colMap('B')));
);


private testEmptyBeforePlacement: () ==> ()
 testEmptyBeforePlacement() == (
 dcl b: Board := new Board();
 b.setComponentCol(<Cruiser>,6,'F');
 TestBase`assertTrue(b.emptyValidCells(2,colMap('C'),<Right>,3));
 TestBase`assertTrue(not b.emptyValidCells(7,colMap('F'),<Up>,3));
 TestBase`assertTrue(not b.emptyValidCells(1,colMap('F'),<Up>,3));
 TestBase`assertTrue(not b.emptyValidCells(1,colMap('A'),<Left>,2));
 TestBase`assertTrue(not b.emptyValidCells(9,colMap('H'),<Down>,3));
 TestBase`assertTrue(not b.emptyValidCells(5,colMap('F'),<Down>,3));
 TestBase`assertTrue(not b.emptyValidCells(6,colMap('C'),<Right>,5));
 TestBase`assertTrue(not b.emptyValidCells(6,colMap('H'),<Left>,4));
 TestBase`assertTrue(not b.emptyValidCells(2,colMap('H'),<Right>,5));



 TestBase`assertEqual(b.countCellType(<Submarine>),0);
 TestBase`assertEqual(shipSize(<Submarine>),3);
 b.placeShip(<Submarine>,'C',2,<Right>);
 TestBase`assertEqual(b.countCellType(<Submarine>),3);

 b.placeShip(<Carrier>,'J',1,<Down>);
 TestBase`assertEqual(b.countCellType(<Carrier>),5);


 b.placeShip(<Destroyer>,'J',9,<Left>);
 TestBase`assertEqual(b.countCellType(<Destroyer>),2);

 b.placeShip(<Battleship>,'A',7,<Up>);
 TestBase`assertEqual(b.countCellType(<Battleship>),4);
);

private testGetShips: () ==> ()
 testGetShips() == (
  dcl b: Board := new Board();
  TestBase`assertEqual(b.getShipsCount(),5);
  TestBase`assertEqual(b.getShips(),{<Carrier>, <Battleship>, <Cruiser>, <Submarine>, <Destroyer
      >});
);

private testRegisterMove: () ==> ()
 testRegisterMove() == (
  dcl b: Board := new Board();

  dcl ret: CellContent := <Empty>;
  b.placeShip(<Submarine>,'C',2,<Right>);
  ret := b.registerMove('A',3);
  TestBase`assertEqual(ret,<Empty>);
```

```
    TestBase`assertEqual(b.cells(3)(colMap('A')),<Miss>);

    ret := b.registerMove('D',2);
    TestBase`assertEqual(ret,<Submarine>);
    TestBase`assertEqual(b.cells(2)(colMap('D')),<Hit>);

    ret := b.registerMove('C',2);
    TestBase`assertEqual(ret,<Submarine>);
    TestBase`assertEqual(b.cells(2)(colMap('C')),<Hit>);
   );

  private testPrints: () ==> ()
   testPrints() == (
    TestBase`assertEqual(shipToString(<Carrier>),"Carrier");
    TestBase`assertEqual(cellToString(<Carrier>),"Car");
  );

  public run: () ==> ()
   run() == (
    testCreateBoard();
    testColMap();
    testEmptyBeforePlacement();
    testGetShips();
    testRegisterMove();
    testPrints();
  );
end TestBoard
```

Function or operation	Line	Coverage	Calls
getShips	39	100.0%	24
run	9	100.0%	8
testColMap	11	100.0%	8
testCreateBoard	4	100.0%	8
testEmptyBeforePlacement	25	100.0%	8
testGetShips	39	100.0%	6
testPrints	64	100.0%	6
testRegisterMove	46	100.0%	6
TestBoard.vdmpp		100.0%	74