

Concepts of Programming Languages, Spring Term 2023
Project 2: Public Test Cases

Note that some tests have visualization provided above the test cases in order to help in understanding the test.

1 visualizeBoard

```
> visualizeBoard (Black,
[N ('d',6), B ('e',6), B ('f',4), N ('f',3), P ('h',2),P ('g',2), Q ('e',2),
P ('c',2), P ('b',2), P ('a',2), K ('c',1), R ('d',1),R ('h',1)],
[Q ('a',8), B ('e',8), R ('f',8), K ('g',8), P ('e',7), B ('g',7), P ('h',7),
P ('g',6), N ('h',6), P ('c',5), P ('f',5), P ('a',4), P ('b',4)])
```

	a	b	c	d	e	f	g	h
8	QB				BB	RB	KB	
7					PB		BB	PB
6				NW	BW		PB	NB
5			PB			PB		
4	PB	PB				BW		
3						NW		
2	PW	PW	PW		QW		PW	PW
1			KW	RW				RW

Turn: Black

```
> visualizeBoard (White,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),K ('e',7),P ('d',7),P ('c',7),P ('b',5),P ('a',3)])
```

	a	b	c	d	e	f	g	h
8								
7			PB	PB	KB			
6								
5		PB				NB		
4				NW		PW		
3	PB	PW						
2								
1	KW							

Turn: White

```
> visualizeBoard (Black,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),B ('e',7),P ('d',6),K ('c',7),P ('b',5),P ('a',3)])
```

	a	b	c	d	e	f	g	h
8								
7			KB		BB			
6				PB				
5		PB				NB		
4				NW		PW		
3	PB	PW						
2								
1	KW							

Turn: Black

2 isLegal

2.1 General

A piece cannot be placed in the place of a piece of same player

```
> isLegal (N ('e',7)) (White,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),N ('e',7),P ('d',7),K ('c',7),P ('b',5),P ('a',3)])
('f',5)
False
```

2.2 Pawn

A pawn cannot make a straight forward move if there is a piece in front of it regardless of the piece

```
> isLegal (P ('f',4)) (White,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),K ('e',7),P ('d',7),P ('c',7),P ('b',5),P ('a',3)])
('f',5)
False
```

A pawn can move 2 steps ahead only if it is in the starting position and if the path ahead of it is clear.

```
> isLegal (P ('h',2)) (White,[P ('h',2),K ('c',1)], [N ('h',3)]) ('h',4)
False
```

```
> isLegal (P ('h',2)) (White,[P ('h',2),K ('c',1)], []) ('h',4)
True
```

```
> isLegal (P ('h',2)) (White,[P ('h',2),K ('c',1), N ('h',3)],[]) ('h',4)
False
```

Pawns cannot move backwards

```
> isLegal (P ('c', 5)) (Black, [K ('a',1)] , [P ('c', 5), K ('h',7)] ('c', 6)
False
```

2.3 Knight

A legal move example for the knight

```
> isLegal (N ('e',7)) (White,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),N ('e',7),P ('d',7),K ('c',7),P ('b',5),P ('a',3)])
('d',5)
True
```

A knight can only move in L-shape

	a	b	c	d	e	f	g	h
8								
7			KB		BB			
6				PB				
5		PB				NB		
4				NW		PW		
3	PB	PW						
2								
1	KW							

Turn: Black

```
> isLegal (N ('f',5)) (Black,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),B ('e',7),P ('d',6),K ('c',7),P ('b',5),P ('a',3)]) ('g',6)
False
```

2.4 Queen

The white Queen can replace the black pawn when nothing is in between them

	a	b	c	d	e	f	g	h
8								
7			KB	PB	RB			
6								
5		PB				NB		
4				QW		PW		
3	PB	PW						
2								
1	KW							

Turn: Black

```
> isLegal (Q ('d',4)) (Black,  
[Q ('d',4),P ('f',4),P ('b',3),K ('a',1)],  
[N ('f',5),R ('e',7),P ('d',7),K ('c',7),P ('b',5),P ('a',3)])  
('d',7)  
True
```

Another legal move for the queen in the same board

```
> isLegal (Q ('d',4)) (Black,  
[Q ('d',4),P ('f',4),P ('b',3),K ('a',1)],  
[N ('f',5),R ('e',7),P ('d',7),K ('c',7),P ('b',5),P ('a',3)])  
('h',8)  
True
```

An illegal move because of a piece in between for the same board

```
isLegal (Q ('d',4)) (Black,  
[Q ('d',4),P ('f',4),P ('b',3),K ('a',1)],  
[N ('f',5),R ('e',7),P ('d',7),K ('c',7),P ('b',5),P ('a',3)])  
('h',4)  
False
```

2.5 Rook

Visualization of the board is given to visualize the movement of a rook

	a	b	c	d	e	f	g	h
8								
7			KB	PB	RB			
6								
5		PB				NB		
4				NW		PW		
3	PB	PW						
2								
1	KW							

Turn: White

In between the old position and new position other pieces. It cannot move beyond an occupied piece of either players (cannot jump over pieces like a knight can)

```
> isLegal (R ('e',7)) (White,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),R ('e',7),P ('d',7),K ('c',7),P ('b',5),P ('a',3)])
('a',7)
False
```

A legal move for a rook

```
> isLegal (R ('e',7)) (White,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),R ('e',7),P ('d',7),K ('c',7),P ('b',5),P ('a',3)])
('e',2)
True
```

2.6 Bishop

The bishop at E7 cannot go to C5 because there is a Pawn in D6 (a piece in between).

	a	b	c	d	e	f	g	h
8								
7			KB		BB			
6				PB				
5		PB				NB		
4				NW		PW		
3	PB	PW						
2								
1	KW							

Turn: Black

```
> isLegal (B ('e',7)) (Black,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),B ('e',7),P ('d',6),K ('c',7),P ('b',5),P ('a',3)])
('c',5)
False
```

A legal move for a bishop

```
> isLegal (B ('e',7)) (White,
[N ('d',4),P ('f',4),P ('b',3),K ('a',1)],
[N ('f',5),B ('e',7),P ('d',6),K ('c',7),P ('b',5),P ('a',3)])
('g',5)
True
```

2.7 King

A legal move for a king

	a	b	c	d	e	f	g	h
8	QB				BB	RB	KB	
7					PB		BB	PB
6				NW	BW		PB	NB
5			PB			PB		
4	PB	PB				BW		
3						NW		
2	PW	PW	PW		QW		PW	PW
1			KW	RW				RW

```
> isLegal (K ('g',8)) (Black,
[N ('d',6), B ('e',6), B ('f',4), N ('f',3), P ('h',2),P ('g',2),
Q ('e',2), P ('c',2), P ('b',2), P ('a',2), K ('c',1), R ('d',1),
R ('h',1)],
[Q ('a',8), B ('e',8), R ('f',8), K ('g',8), P ('e',7), B ('g',7),
P ('h',7), P ('g',6), N ('h',6), P ('c',5), P ('f',5),
P ('a',4), P ('b',4)])
('h',8)
True
```

For the same board, a king can only move one step away from it's position

```
> isLegal (K ('c',1)) (Black,
[N ('d',6), B ('e',6), B ('f',4), N ('f',3), P ('h',2),P ('g',2),
Q ('e',2), P ('c',2), P ('b',2), P ('a',2), K ('c',1), R ('d',1),
R ('h',1)],
[Q ('a',8), B ('e',8), R ('f',8), K ('g',8), P ('e',7), B ('g',7),
P ('h',7), P ('g',6), N ('h',6), P ('c',5), P ('f',5),
P ('a',4), P ('b',4)])
('e',3)
False
```

3 suggestMove

suggestMove for a rook: The Black Rook can move to any clear location or a location occupied by a piece from the opposite team as long as it is within a straight line

```
suggestMove (R ('h',8)) (Black, [P ('h', 6), K ('a', 1)] , [R ('h',8), K ('f', 4)])
[('a',8),('b',8),('c',8),('d',8),('e',8),('f',8),('g',8),('h',6),('h',7)]
```

suggestMove for a knight

	a	b	c	d	e	f	g	h
8	RB	NB	BB	QB	KB	BB		RB
7	PB	PB		PB	PB	PB	PB	PB
6			PB					
5								
4				NB				
3		PW				PW		
2	PW		PW	PW	PW		PW	PW
1	RW	NW	BW	QW	KW	BW	NW	RW

Turn: White

```
> suggestMove (N ('d',4)) (White,
[R ('h',1),N ('g',1),B ('f',1),K ('e',1),Q ('d',1),B ('c',1),N ('b',1),R ('a',1),
P ('h',2),P ('g',2),P ('f',3),P ('e',2),P ('d',2),P ('c',2),P ('b',3),P ('a',2)],
[R ('h',8),N ('d',4),B ('f',8),K ('e',8),Q ('d',8),B ('c',8),N ('b',8),R ('a',8),
P ('h',7),P ('g',7),P ('f',7),P ('e',7),P ('d',7),P ('c',6),P ('b',7),P ('a',7)])

[('b',3),('b',5),('c',2),('e',2),('e',6),('f',3),('f',5)]
```

Same board for bishop

```
> suggestMove (B ('c',1)) (White,
[R ('h',1),N ('g',1),B ('f',1),K ('e',1),Q ('d',1),B ('c',1),N ('b',1),R ('a',1),
P ('h',2),P ('g',2),P ('f',3),P ('e',2),P ('d',2),P ('c',2),P ('b',3),P ('a',2)],
[R ('h',8),N ('d',4),B ('f',8),K ('e',8),Q ('d',8),B ('c',8),N ('b',8),R ('a',8),
P ('h',7),P ('g',7),P ('f',7),P ('e',7),P ('d',7),P ('c',6),P ('b',7),P ('a',7)])

[('a',3),('b',2)]
```

suggestMove for pawn

	a	b	c	d	e	f	g	h
8	RB	NB	BB	QB	KB	BB		RB
7	PB	PB		PB	PB	PB		PB
6			PB					
5							PB	
4				NB		PW		
3		PW						
2	PW		PW	PW	PW		PW	PW
1	RW	NW	BW	QW	KW	BW	NW	RW

Turn: White

```
> suggestMove (P ('f',4)) (White,
  [R ('h',1),N ('g',1),B ('f',1),K ('e',1),Q ('d',1),B ('c',1),N ('b',1),R ('a',1),
   P ('h',2),P ('g',2),P ('f',4),P ('e',2),P ('d',2),P ('c',2),P ('b',3),P ('a',2)],
  [R ('h',8),N ('d',4),B ('f',8),K ('e',8),Q ('d',8),B ('c',8),N ('b',8),R ('a',8),
   P ('h',7),P ('g',5),P ('f',7),P ('e',7),P ('d',7),P ('c',6),P ('b',7),P ('a',7)])
[('f',5),('g',5)]
```

suggestMove for king

	a	b	c	d	e	f	g	h
8								
7								
6								
5						KB		
4								
3								
2								
1				KW				

Turn: White

```
> suggestMove (K ('d',1)) (White,[K ('d',1)],[K ('f',5)])
[('c',1),('c',2),('d',2),('e',1),('e',2)]
```


suggestMove for queen

	a	b	c	d	e	f	g	h
8	QB				BB	RB	KB	
7					PB		BB	PB
6				NW	BW		PB	NB
5			PB			PB		
4	PB	PB				BW		
3						NW		
2	PW	PW	PW		QW		PW	PW
1			KW	RW				RW

Turn: Black

```
> suggestMove (Q ('e',2)) (Black,
  [N ('d',6), B ('e',6), B ('f',4), N ('f',3), P ('h',2),P ('g',2), Q ('e',2),
   P ('c',2), P ('b',2), P ('a',2), K ('c',1), R ('d',1),R ('h',1)],
  [Q ('a',8), B ('e',8), R ('f',8), K ('g',8), P ('e',7), B ('g',7), P ('h',7),
   P ('g',6), N ('h',6), P ('c',5), P ('f',5), P ('a',4), P ('b',4)])

[('a',6),('b',5),('c',4),('e',1),('e',3),('e',4),
 ('e',5),('f',1),('f',2),('d',2),('d',3)]
```

4 move

	a	b	c	d	e	f	g	h
8	QB				BB	RB	KB	
7					PB		BB	PB
6				NW	BW		PB	NB
5			PB			PB		
4	PB	PB				BW		
3						NW		
2	PW	PW	PW		QW		PW	PW
1			KW	RW				RW

Turn: Black

```
> move (N ('h',6)) ('f',7) (Black,
  [N ('d',6), B ('e',6), B ('f',4), N ('f',3), P ('h',2),P ('g',2), Q ('e',2),
   P ('c',2), P ('b',2), P ('a',2), K ('c',1), R ('d',1),R ('h',1)],
  [Q ('a',8), B ('e',8), R ('f',8), K ('g',8), P ('e',7), B ('g',7), P ('h',7),
   P ('g',6), N ('h',6), P ('c',5), P ('f',5), P ('a',4), P ('b',4)])

(White,[N ('d',6),B ('e',6),B ('f',4),N ('f',3),P ('h',2),P ('g',2),
Q ('e',2),P ('c',2),P ('b',2),P ('a',2),K ('c',1),R ('d',1),R ('h',1)],
 [Q ('a',8),B ('e',8),R ('f',8),K ('g',8),P ('e',7),B ('g',7),P ('h',7),
 P ('g',6),N ('f',7),P ('c',5),P ('f',5),P ('a',4),P ('b',4)])
```

```

> move (K ('g',8)) ('h',8) (Black,
[N ('d',6), B ('e',6), B ('f',4), N ('f',3), P ('h',2),P ('g',2),
Q ('e',2), P ('c',2), P ('b',2), P ('a',2), K ('c',1), R ('d',1),
R ('h',1)],
[Q ('a',8), B ('e',8), R ('f',8), K ('g',8), P ('e',7), B ('g',7),
P ('h',7), P ('g',6), N ('h',6), P ('c',5), P ('f',5),
P ('a',4), P ('b',4)])

(White,[N ('d',6),B ('e',6),B ('f',4),N ('f',3),P ('h',2),P ('g',2),
Q ('e',2),P ('c',2),P ('b',2),P ('a',2),K ('c',1),R ('d',1),R ('h',1)],
[Q ('a',8),B ('e',8),R ('f',8),K ('h',8),P ('e',7),B ('g',7),P ('h',7),
P ('g',6),N ('h',6),P ('c',5),P ('f',5),P ('a',4),P ('b',4)])

> move (P ('f',5)) ('h',8) (Black,
[N ('d',6), B ('e',6), B ('f',4), N ('f',3), P ('h',2),P ('g',2),
Q ('e',2), P ('c',2), P ('b',2), P ('a',2), K ('c',1), R ('d',1),
R ('h',1)],
[Q ('a',8), B ('e',8), R ('f',8), K ('g',8), P ('e',7), B ('g',7),
P ('h',7), P ('g',6), N ('h',6), P ('c',5), P ('f',5),
P ('a',4), P ('b',4)])

```

Program error: Illegal move for piece P ('f',5)

	a	b	c	d	e	f	g	h
8	QB				BB	RB	KB	
7					PB	NB	BB	PB
6				NW	BW		PB	
5			PB			PB		
4	PB	PB				BW		
3						NW		
2	PW	PW	PW		QW		PW	PW
1			KW	RW				RW

Turn: White

```

> move (B ('e',6)) ('f',7) (White,
[N ('d',6),B ('e',6),B ('f',4),N ('f',3),P ('h',2),
P ('g',2), Q ('e',2),P ('c',2),P ('b',2),P ('a',2),
K ('c',1),R ('d',1),R ('h',1)],
[Q ('a',8),B ('e',8),R ('f',8),K ('g',8),P ('e',7),
B ('g',7),P ('h',7), P ('g',6),N ('f',7),P ('c',5),
P ('f',5),P ('a',4),P ('b',4)])

```

```
(Black,[N ('d',6),B ('f',7),B ('f',4),N ('f',3),P ('h',2),P ('g',2),Q ('e',2),
P ('c',2),P ('b',2), P ('a',2),K ('c',1),R ('d',1),
R ('h',1)],[Q ('a',8),
B ('e',8),R ('f',8),K ('g',8),P ('e',7),B ('g',7),
P ('h',7),P ('g',6),P ('c',5),P ('f',5),P ('a',4),
P ('b',4)])
```

Same board, move rook

```
> move (R ('d',1)) ('d',5) (White,
[N ('d',6),B ('e',6),B ('f',4),N ('f',3),P ('h',2),
P ('g',2), Q ('e',2),P ('c',2),P ('b',2),P ('a',2),
K ('c',1),R ('d',1),R ('h',1)],
[Q ('a',8),B ('e',8),R ('f',8),K ('g',8),P ('e',7),
B ('g',7),P ('h',7), P ('g',6),N ('f',7),P ('c',5),
P ('f',5),P ('a',4),P ('b',4)])
```

```
(Black,[N ('d',6),B ('e',6),B ('f',4),N ('f',3),P ('h',2),P ('g',2),Q ('e',2),
P ('c',2),P ('b',2),P ('a',2),K ('c',1),R ('d',5),R ('h',1)],
[Q ('a',8),B ('e',8),R ('f',8),K ('g',8),P ('e',7),B ('g',7),P ('h',7),P ('g',6),
N ('f',7),P ('c',5),P ('f',5),P ('a',4),P ('b',4)])
```

Same board, move queen

```
> move (Q ('e',2)) ('a',6) (White,
[N ('d',6),B ('e',6),B ('f',4),N ('f',3),P ('h',2),
P ('g',2), Q ('e',2),P ('c',2),P ('b',2),P ('a',2),
K ('c',1),R ('d',1),R ('h',1)],
[Q ('a',8),B ('e',8),R ('f',8),K ('g',8),P ('e',7),
B ('g',7),P ('h',7), P ('g',6),N ('f',7),P ('c',5),
P ('f',5),P ('a',4),P ('b',4)])
```

```
(Black,[N ('d',6),B ('e',6),B ('f',4),N ('f',3),P ('h',2),P ('g',2),Q ('a',6),
P ('c',2),P ('b',2),P ('a',2),K ('c',1),R ('d',1),R ('h',1)],
[Q ('a',8),B ('e',8),R ('f',8),K ('g',8),P ('e',7),B ('g',7),P ('h',7),P ('g',6),
N ('f',7),P ('c',5),P ('f',5),P ('a',4),P ('b',4)])
```

Same board, move pawn

```
> move (P ('c',2)) ('c',4) (White,
[N ('d',6),B ('e',6),B ('f',4),N ('f',3),P ('h',2),
P ('g',2), Q ('e',2),P ('c',2),P ('b',2),P ('a',2),
K ('c',1),R ('d',1),R ('h',1)],
[Q ('a',8),B ('e',8),R ('f',8),K ('g',8),P ('e',7),
B ('g',7),P ('h',7), P ('g',6),N ('f',7),P ('c',5),
P ('f',5),P ('a',4),P ('b',4)])
```

(Black, [N ('d',6),B ('e',6),B ('f',4),N ('f',3),P ('h',2),P ('g',2),Q ('e',2),
P ('c',4),P ('b',2),P ('a',2),K ('c',1),R ('d',1),R ('h',1)],
[Q ('a',8),B ('e',8),R ('f',8),K ('g',8),P ('e',7),B ('g',7),P ('h',7),P ('g',6),
N ('f',7),P ('c',5),P ('f',5),P ('a',4),P ('b',4)])