

COMP 250

INTRODUCTION TO COMPUTER SCIENCE

Assignment Project Exam Help

<https://powcoder.com>

Week 1-1: Stacks

Giulia Alberini, Fall 2020

Slides adapted from Michael Langer's

WHAT ARE WE GOING TO DO IN THIS VIDEO?



- **Stacks**

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

ABSTRACT DATA TYPE (ADT)

An ADT is a model for a data type. It defines a data type by its behavior from the user's perspective only. It describes the possible values and the set of possible operations on the data type.

<https://powcoder.com>

Add WeChat powcoder

It ignores the details of the implementation.

An ADT is more abstract than a data structure. A data structure is a concrete representation of data which includes the implementation details.

LIST ADT

<code>get(i)</code>	<code>// Returns the i-th element (but doesn't remove it)</code>
<code>set(i,e)</code>	<code>// Replaces the i-th element with e</code>
<code>add(i,e)</code>	<code>// Inserts element e into the i-th position</code>
<code>remove(i)</code>	<code>// Removes the i-th element from list</code>
<code>remove(e)</code>	<code>// Removes first occurrence of element e</code>
	<code>// from the list (if it is there)</code>
<code>clear()</code>	<code>// Empties the list.</code>
<code>isEmpty()</code>	<code>// Returns true if empty, false if not empty.</code>
<code>size()</code>	<code>// Returns number of elements in the list</code>
<code>:</code>	

These operations can be defined abstractly, without specifying the implementation details of the data structure (e.g. arraylist, or linked list)

STACK ADT

`push(element)`

`pop()`

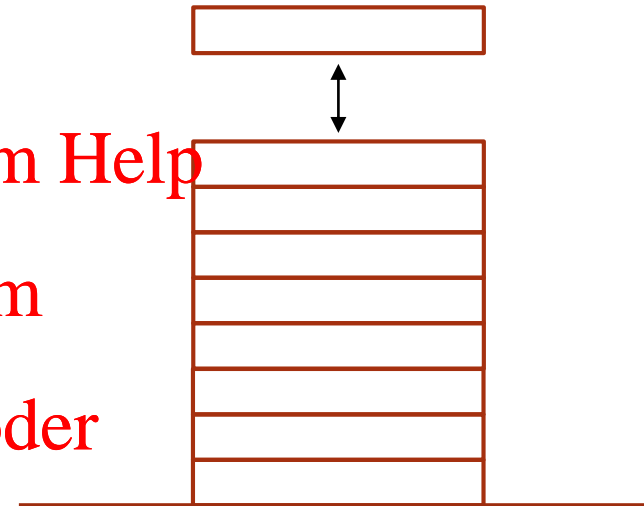
`isEmpty()`

`peek()`

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



A stack is a list. However, it typically does not have operations to access the list element i directly. Instead one accesses only the element at one end of the list.

HOW TO IMPLEMENT A STACK?

push(e)

pop ()

array list

singly linked list

doubly linked list

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

HOW TO IMPLEMENT A STACK?

push(e)

pop ()

array list

singly linked list

doubly linked list

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

addLast(e)

removeLast()

*Java ArrayList class doesn't have addLast and removeLast methods

HOW TO IMPLEMENT A STACK?

push(e)

pop ()

Assignment Project Exam Help

array list

addLast(e)

removeLast()

<https://powcoder.com>

singly linked list

Add WeChat powcoder

addFirst(e)

removeFirst()

doubly linked list

*Why not use addLast and removeLast with singly linked lists?

HOW TO IMPLEMENT A STACK?

push(e)

pop ()

array list

singly linked list

doubly linked list

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

addLast(e)

addFirst(e)

removeLast()

removeFirst()

either row above

EXAMPLE 1: STACK OF INT

push(3), push(6), push(4), push(1), pop(), push(5), pop(), pop(),...

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

time

EXAMPLE 1: STACK OF INT

push(3), push(6), push(4), push(1), pop(), push(5), pop(), pop(),...

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



EXAMPLE 1: STACK OF INT

`push(3), push(6), push(4), push(1), pop(), push(5), pop(), pop(), ...`

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



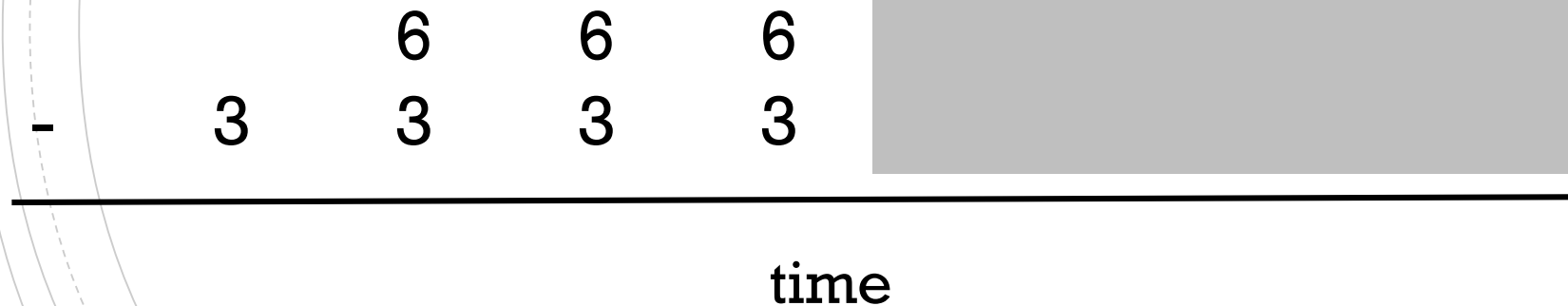
EXAMPLE 1: STACK OF INT

push(3), push(6), push(4), push(1), pop(), push(5), pop(), pop(),...

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat ¹/₄ powcoder



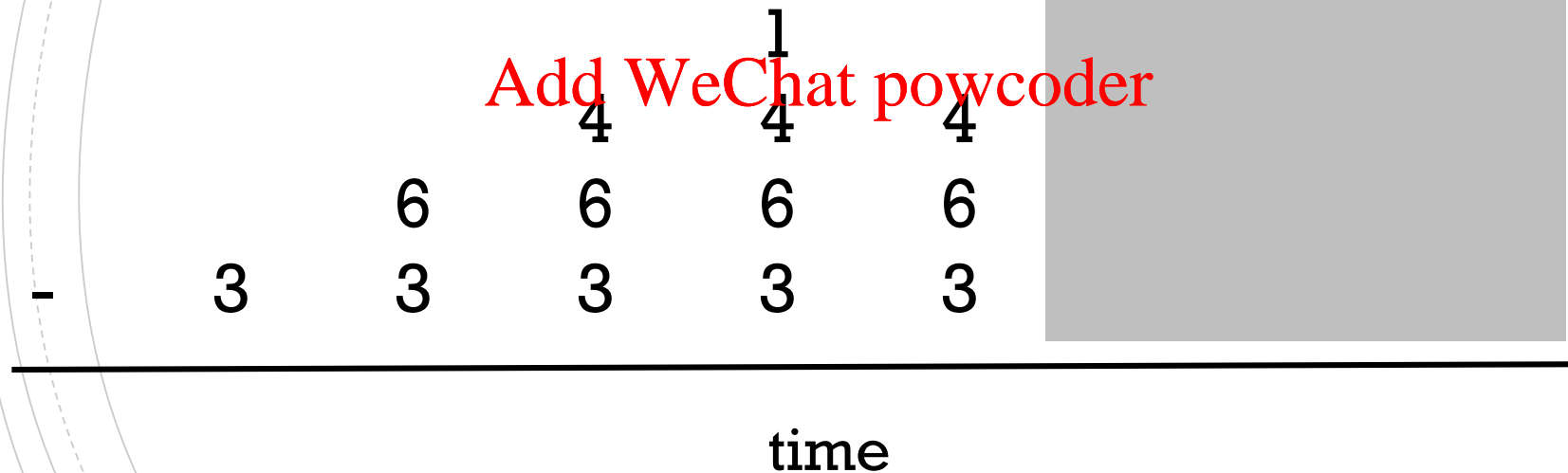
EXAMPLE 1: STACK OF INT

push(3), push(6), push(4), push(1), pop(), push(5), pop(), pop(), ...

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



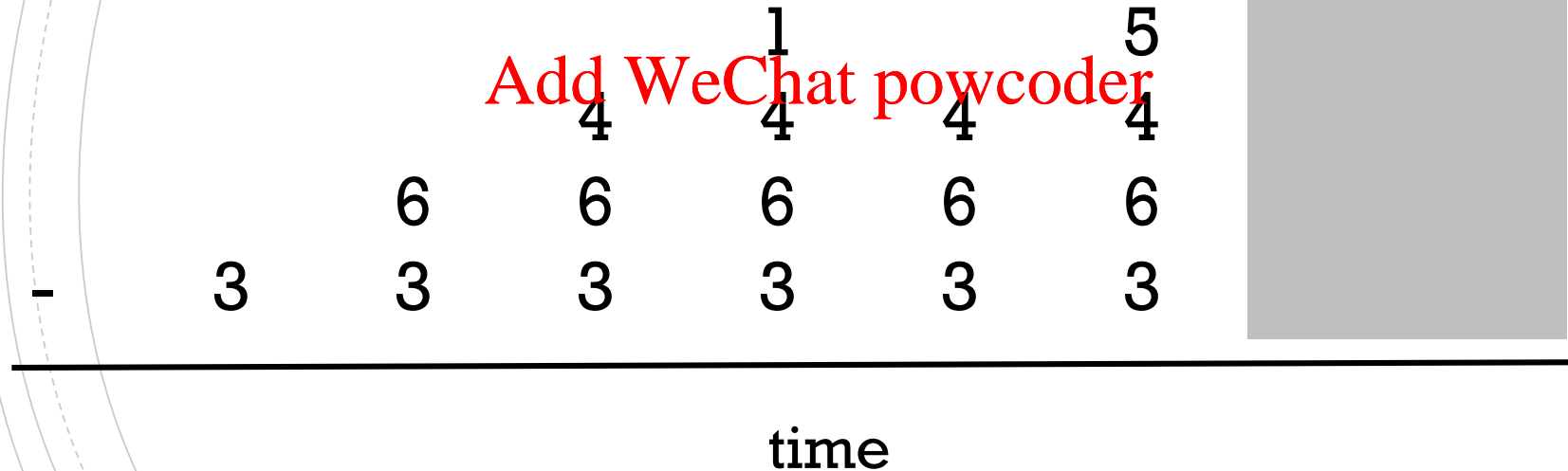
EXAMPLE 1: STACK OF INT

push(3), push(6), push(4), push(1), pop(), push(5), pop(), pop(),...

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



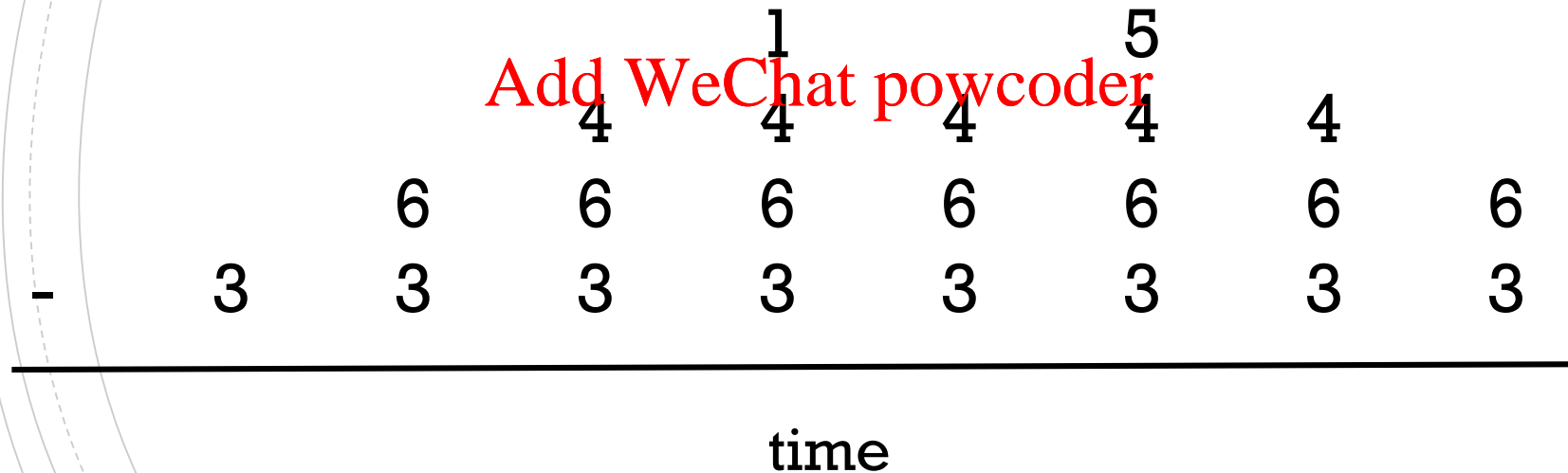
EXAMPLE 1: STACK OF INT

push(3), push(6), push(4), push(1), pop(), push(5), pop(), pop(),...

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



EXAMPLE 2 - BALANCING PARENTHESES

e.g. `(([]))[]{}[]`

Assignment Project Exam Help

To ensure proper nesting, we traverse the list and use a stack.

<https://powcoder.com>

How?

Add WeChat powcoder

EXAMPLE 2 - BALANCING PARENTHESES

e.g. `(([]))[]{}[]`

Assignment Project Exam Help

To ensure proper nesting, we traverse the list and use a stack.

<https://powcoder.com>

How? When we reach a *left* parenthesis, we *push* it onto the stack.

Add WeChat powcoder

When we reach a *right* parenthesis, we compare it to top of the stack. If it matches, then we *pop*, otherwise we found an error.

EXAMPLE 2 - BALANCING PARENTHESES

e.g. (([])) [] { [] }

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

((([

EXAMPLE 2 - BALANCING PARENTHESES

e.g. `(([]))[]{}[]`

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

`(((([`

EXAMPLE 2 - BALANCING PARENTHESES

e.g. $(([])) [] \{ [] \}$

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



EXAMPLE 2 - BALANCING PARENTHESES

e.g. $(([]))[]\{\ []\}$

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

Add WeChat power



EXAMPLE 2 - BALANCING PARENTHESES

e.g. $(([]))[]\{\}\{\}$

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

etc

Add WeChat powcoder

EXAMPLE 2 - BALANCING PARENTHESES

e.g. (([)) [] { [] }

Assignment Project Exam Help

Does not match left bracket on top of stack.
<https://powcoder.com>

Add WeChat powcoder

(
(
(
[
(
(
(

BALANCING PARENTHESES - PSEUDOCODE

Algorithm: decide if parentheses are matched.

```
while (there are more tokens) { // We refer to brackets as "tokens". This is the
    token = get next token      // more general term using in string parsing.
    if token is a left parenthesis
        push(token)
    else {
        if stack is empty
            return false
        else {
            pop left parenthesis from stack
            if popped left parenthesis doesn't match the right parenthesis
                return false
        }
    }
}
return stack.empty
```

// true if stack is empty, false if not.

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

EXAMPLE 3: HTML TAGS

Supposed you'd like to write the following sentence:

I am bold. *I am italic.* <https://powcoder.com>

In html, you would write: Add WeChat powcoder

` I am bold. < i > I am italic. < /i >`

HTML ELEMENTS

An HTML *element* starts with a start tag.

An HTML *element* ends with an end tag.

HTML documents consist of nested HTML elements.

```
<html>
```

```
<body>
```

```
<b> I am bold </b>
```

```
<i> I am italic </i>
```

```
</body>
```

```
</html>
```

<https://powcoder.com>

Add WeChat powcoder

These tags can be thought of as brackets.

EXAMPLE 3: HTML TAGS

Suppose you want:

I am bold. *I am bold and italic.* *I am italic.*

What if you were to write the following?

` I am bold. <i> I am bold and italic. I am italic. </i>`

<https://powcoder.com>
Add WeChat powcoder

EXAMPLE 3: HTML TAGS

Suppose you want:

I am bold. *I am bold and italic.* *I am italic.*

What if you were to write the following?

` I am bold. <i> I am bold and italic. I am italic. </i>`

This is *officially* incorrect, because elements are not nested.

`< i >` **Error: mismatch** between `<i>` ``

`` ``

Most web browsers will interpret it correctly, however.

EXAMPLE 3: HTML TAGS

Suppose you want:

I am bold. *I am bold and italic.* *I am italic.*

Assignment Project Exam Help

The correct way to write it is:

<https://powcoder.com>

` I am bold. <i> I am bold and italic. </i> <i> I am italic. </i>`

Add WeChat powcoder

 < b > < i > < b > < b > < i >

EXAMPLE 3: HTML TAGS

What problems can arise if you write it incorrectly?

Suppose you are editing a html document that contains the following:

Assignment Project Exam Help

<https://powcoder.com>

... Hello. I am bold.

<i> I am bold and italic. I am italic. </i>

Bla bla bla

Q: What happens if you delete the middle line?

EXAMPLE 3: HTML TAGS

What problems can arise if you write it incorrectly?

Suppose you are editing a html document that contains the following:

Assignment Project Exam Help

<https://powcoder.com>

... Hello. I am bold.

<i> I am bold and italic. I am italic. </i>

Bla bla bla

Q: What happens if you delete the middle line?

A: ... Hello. **I am bold. Bla bla bla**

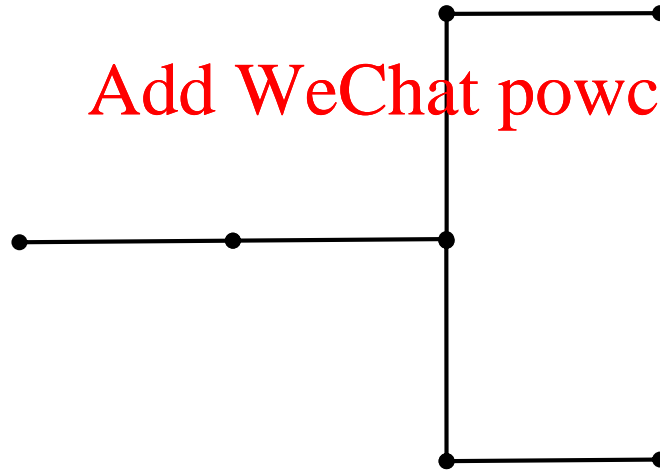
EXAMPLE 4: STACKS IN GRAPHICS

Define a 'programming language' for drawing simple figures like this:

Assignment Project Exam Help

<https://powcoder.com>

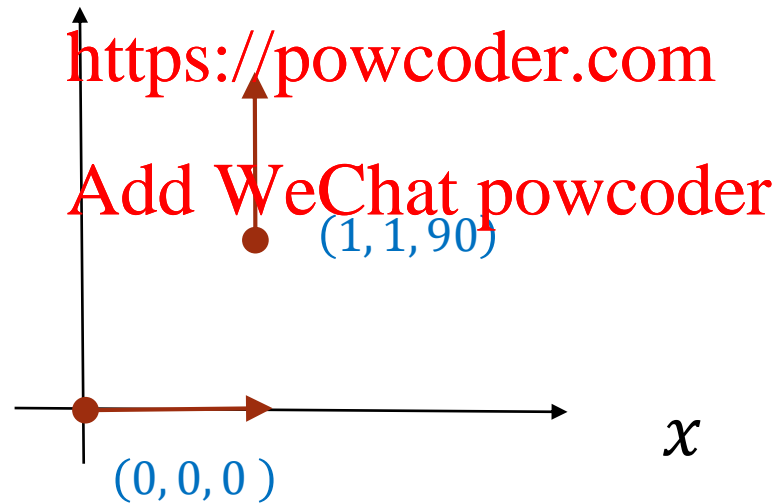
Add WeChat powcoder



EXAMPLE 4: STACKS IN GRAPHICS

Define a pen position and direction (x, y, θ) where θ is clockwise degrees from x axis.

Assignment Project Exam Help



The initial state of the pen is $(0, 0, 0)$.

EXAMPLE 4: STACKS IN GRAPHICS

Let instructions be symbols :

Assignment Project Exam Help

D - draw unit length line in direction θ (changes (x, y))

<https://powcoder.com>

R - turn right 90 degrees (changes θ)

Add WeChat powcoder

L - turn left 90 degrees (changes θ)

[- push state (x, y, θ)

] - pop state, and go to that state

EXAMPLE 4: STACKS IN GRAPHICS

D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.

Assignment Project Exam Help

D D R D L D

$(0, 0)$ <https://powcoder.com>

- Add WeChat powcoder

EXAMPLE 4: STACKS IN GRAPHICS

D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.

Assignment Project Exam Help

D D R D L D

$(0, 0)$ <https://powcoder.com>
Add WeChat powcoder $(2, 0)$

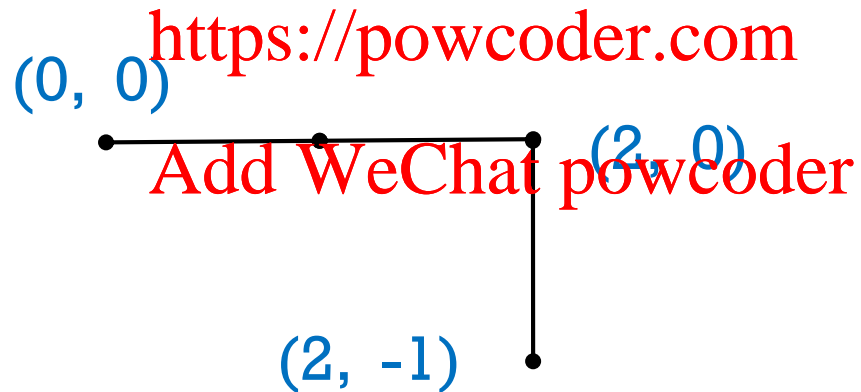
EXAMPLE 4: STACKS IN GRAPHICS

D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.

Assignment Project Exam Help

D D R D L D



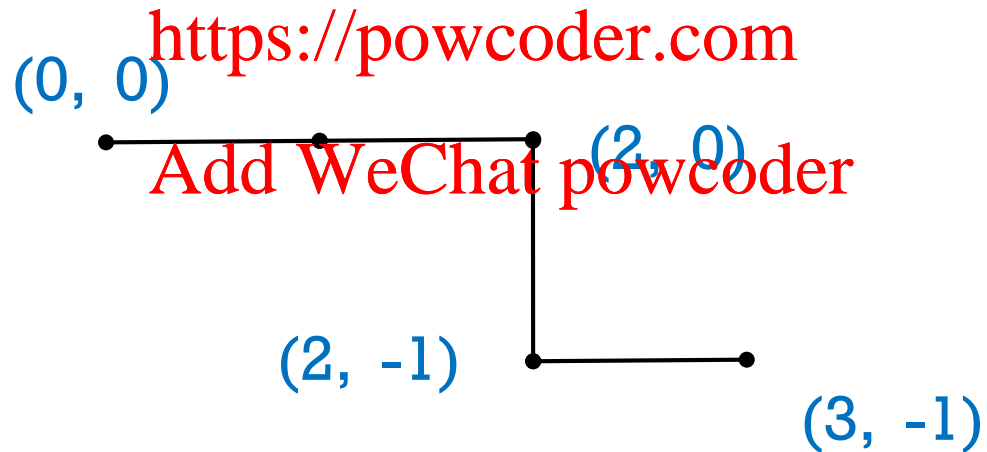
EXAMPLE 4: STACKS IN GRAPHICS

D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.

Assignment Project Exam Help

D D R D L D



The final pen state is $(3, -1, 0)$.

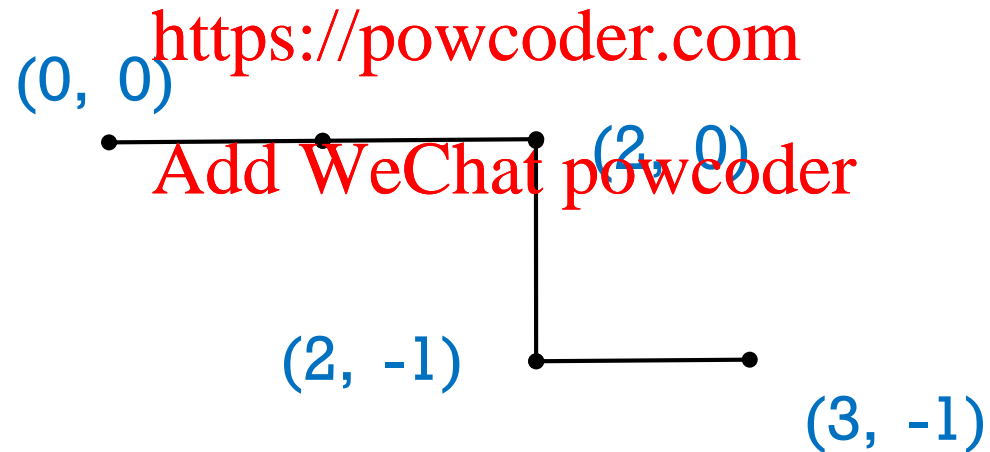
EXAMPLE 4: STACKS IN GRAPHICS

D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.

Assignment Project Exam Help

D D [R D L D]



Q: What will be the final pen state?

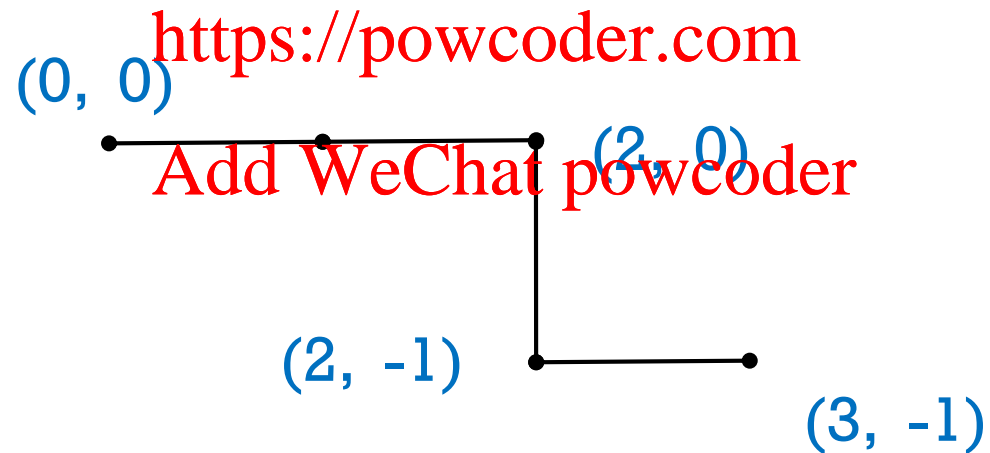
EXAMPLE 4: STACKS IN GRAPHICS

D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.

Assignment Project Exam Help

D D [R D L D]



Q: What will be the final pen state?

A: $(2, 0, 0)$

EXAMPLE 4: STACKS IN GRAPHICS

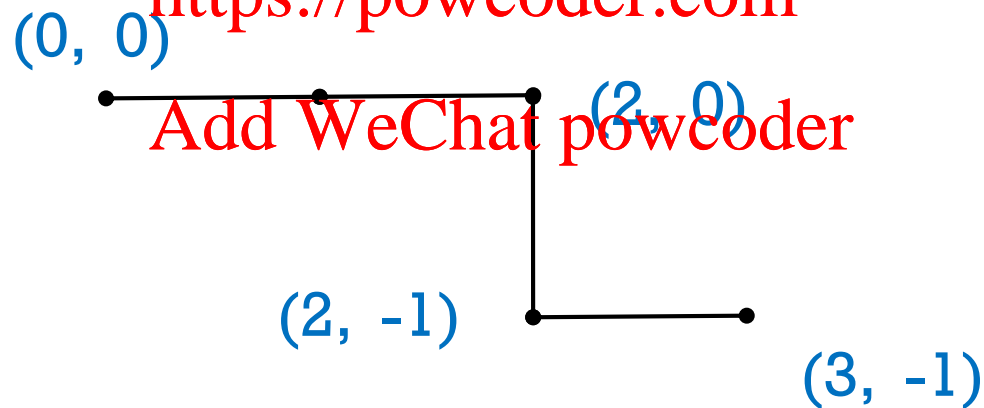
D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.

Assignment Project Exam Help

D D [R D L D] L D R D

<https://powcoder.com>
Add WeChat powcoder

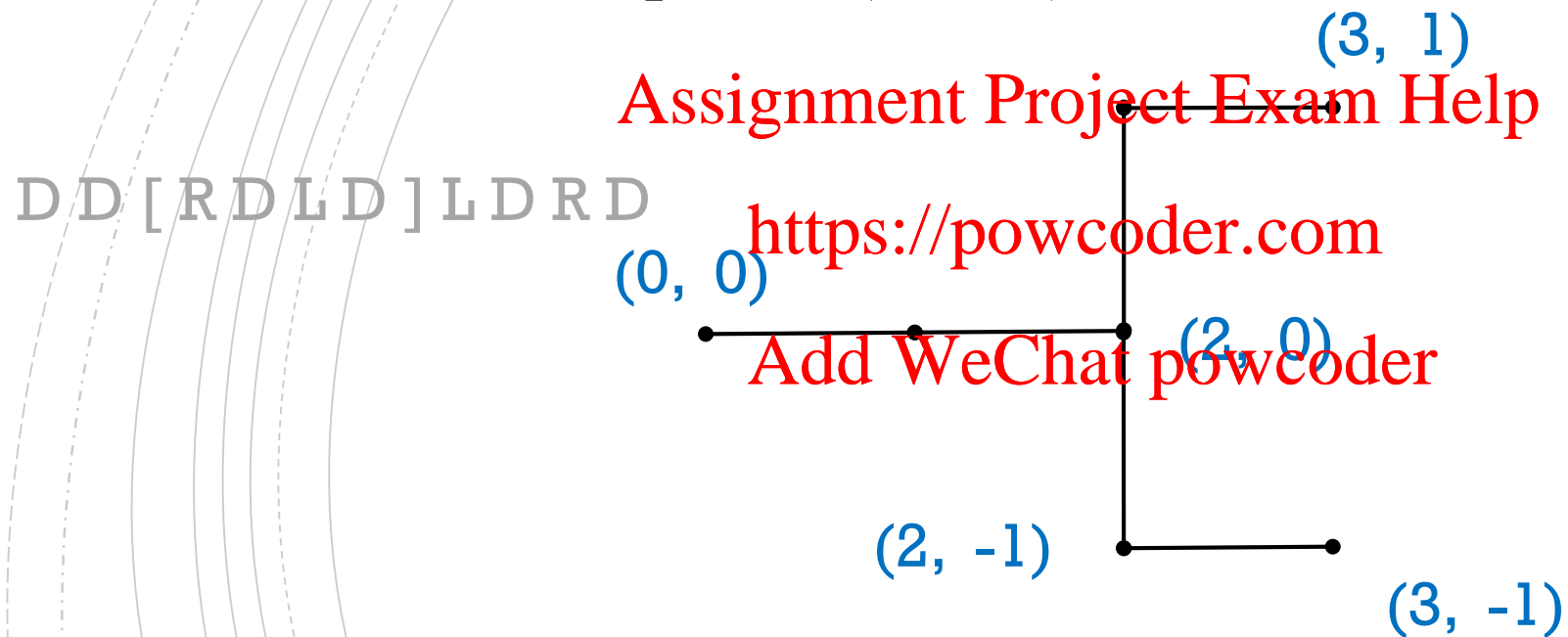


Q: What will be the final pen state?

EXAMPLE 4: STACKS IN GRAPHICS

D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.



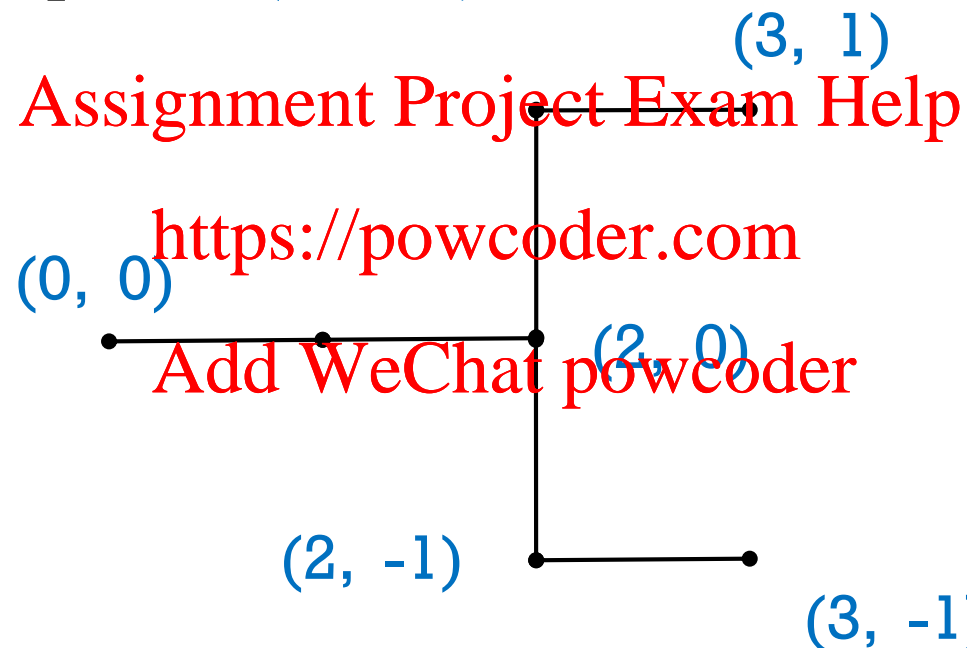
Q: What will be the final pen state?

A: $(3, 1, 0)$

EXAMPLE 4: STACKS IN GRAPHICS

D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.



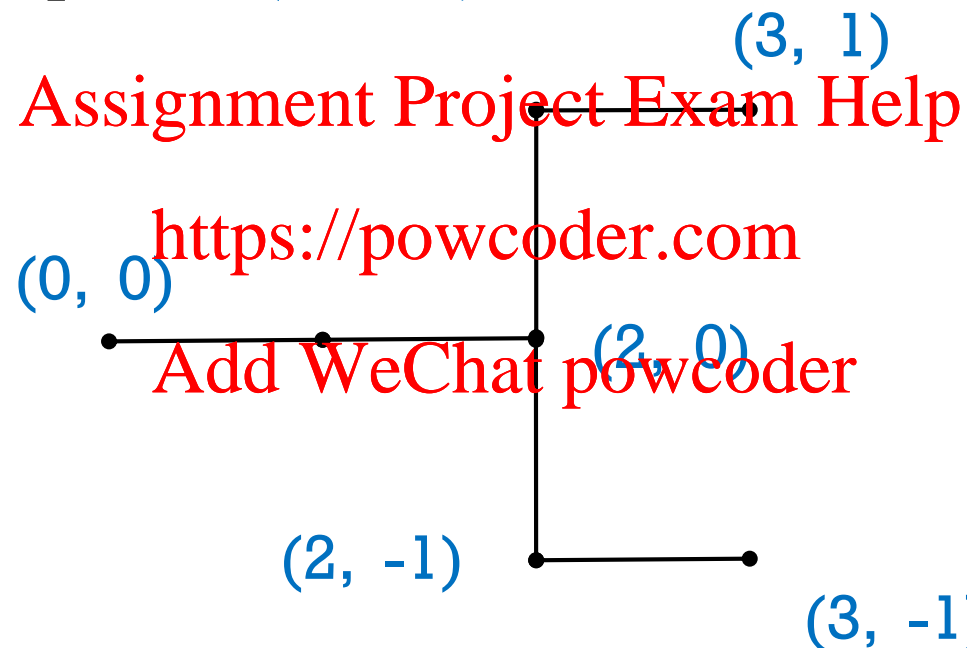
Q: What if we add brackets at the beginning and at the end?

[D D [R D L D] L D R D]

EXAMPLE 4: STACKS IN GRAPHICS

D	-	draw
R	-	turn right
L	-	turn left
[	-	push state
]	-	pop state

The initial state of the pen is $(0, 0, 0)$.



Q: What if we add brackets at the beginning and at the end?

[D D [R D L D] L D R D]

A: $(0, 0, 0)$

EXAMPLE 5: "CALL STACK"

```
class Demo {  
    void mA () {  
        mB ();  
        mC ();  
    }  
    void mB () { ... }  
    void mC () { ... }  
  
    public static void main(String[] args) {  
        mA ();  
    }  
}
```

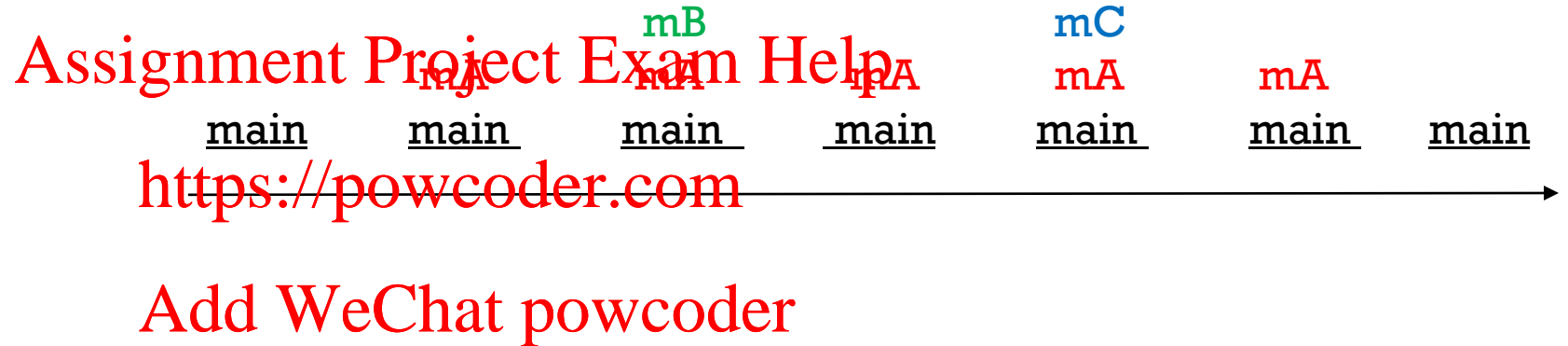
Assignment Project Exam Help

<https://powcoder.com>

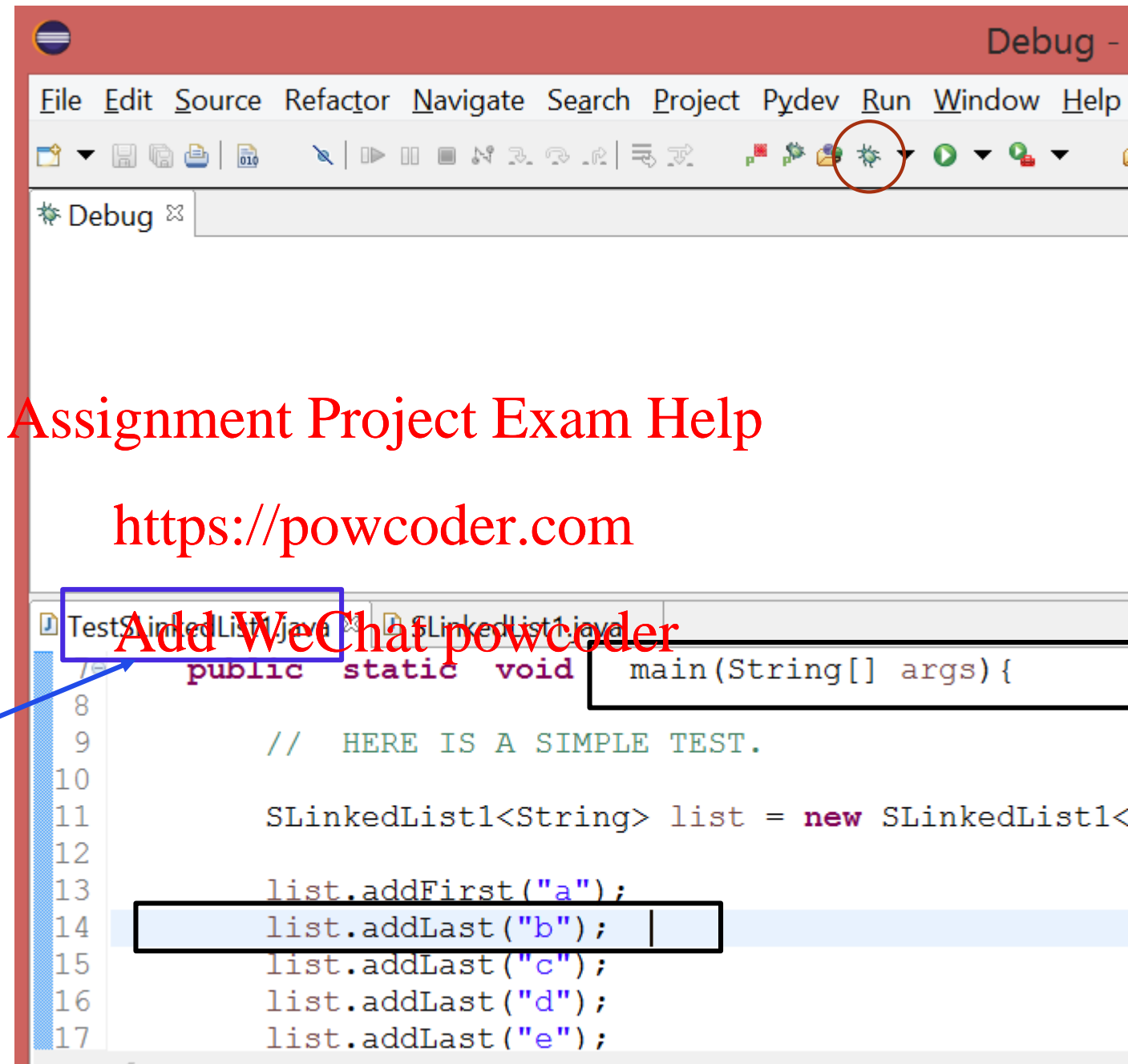
Add WeChat powcoder

EXAMPLE 5: "CALL STACK"

```
class Demo {  
    void mA () {  
        mB ();  
        mC ();  
    }  
    void mB () { ... }  
    void mC () { ... }  
  
    public static void main(String[] args) {  
        mA ();  
    }  
}
```



Eclipse debug mode



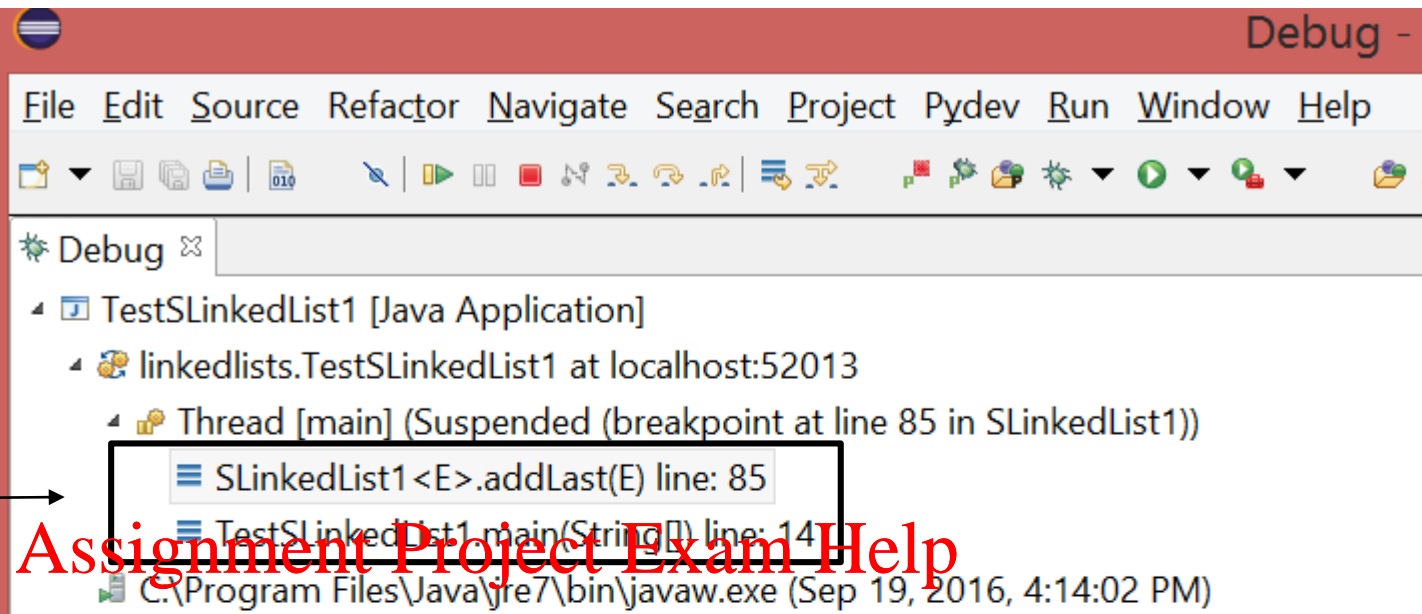
Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

TestSLinkedList1's
main() method calls
addLast() method of
SLinkedList class.

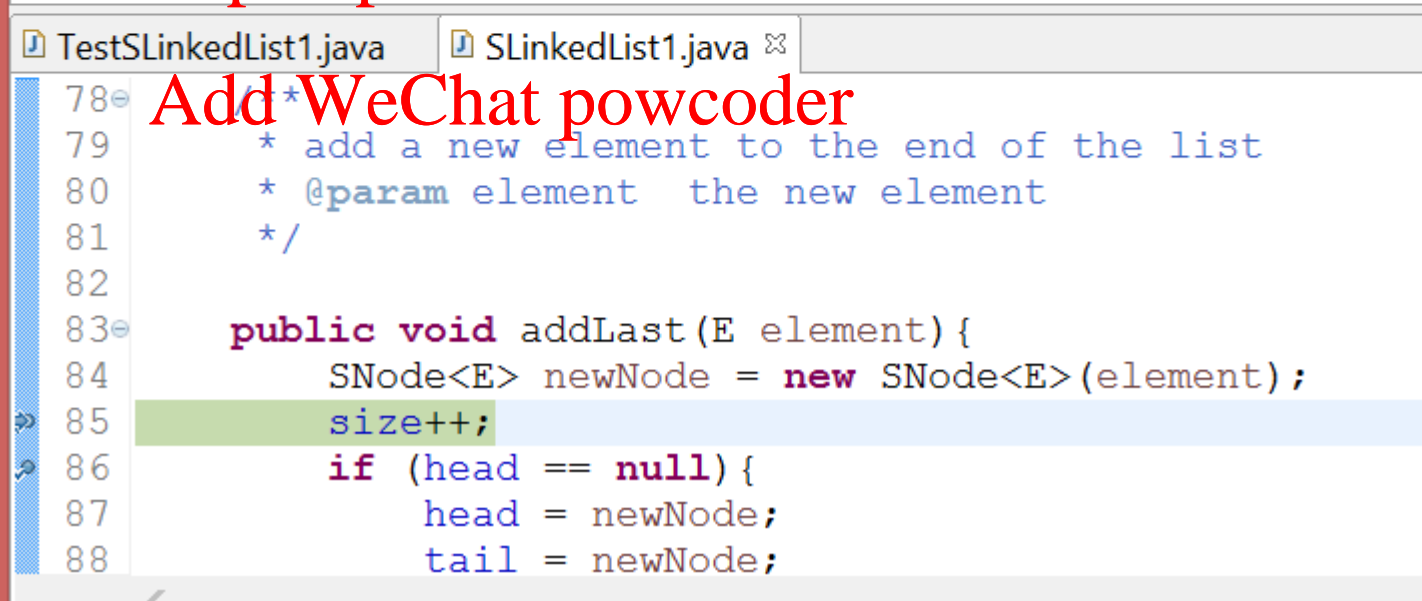
call stack



Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



breakpoint in the
SLinkedList1.addLast()
method

OVERFLOW AND UNDERFLOW

- **Stack overflow**

It happens if a stack has a finite capacity, and we attempt to push.

<https://powcoder.com>

Add WeChat powcoder

- **Stack underflow**

It happens if when a stack is empty we attempt to pop.



Coming Soon

Assignment Project Exam Help

In the next video:

■ Queues <https://powcoder.com>

Add WeChat powcoder