Functions

Defining a Function

```
def add(a, b):
    """
    adds two numbers
    """
    z = a + b
    return z
```

- general syntax:
  (1) def statement (name and parameters)
  (2) docstring
  (3) statements to compute
  (4) (optional) return statement

```
>>> x = add(10, 15)

>>> x

15
```

Functions as First Class Objects

- functions can be passed as arguments
- can be used as any other value

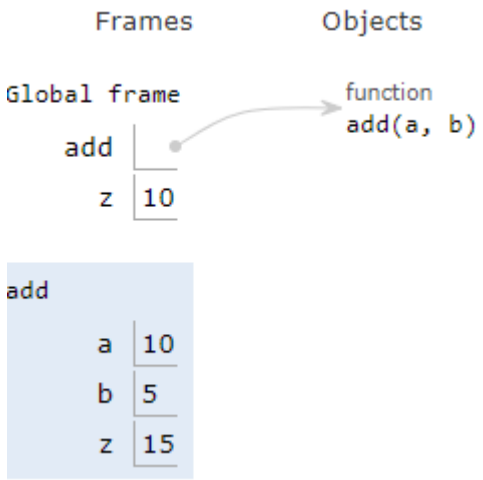
```
def add(a, b):
    return a + b
```

```
>>> print(add)
<function add at 0x7f1566d8cde8>
>>> print(add(3,5))
8
>>> print(type(add))
<type 'function'>
```

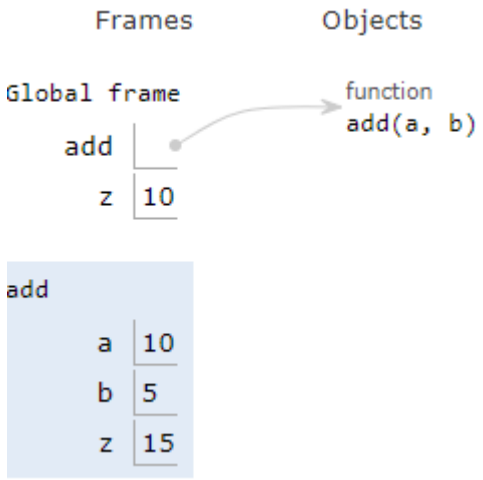
Function and Variable Scope

```
def add(a, b):
    z = a + b
    return z
```

```
>>> z = 10;  z = add(z, 5)
```




```
>>> z
```

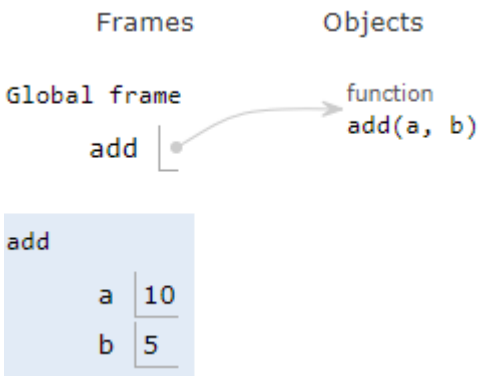


Functions With Positional Parameters

```
def add(a, b):
    z = a + b
    return z
```

```
>>> res = add(10, 5)
```

- parameters are bound by position

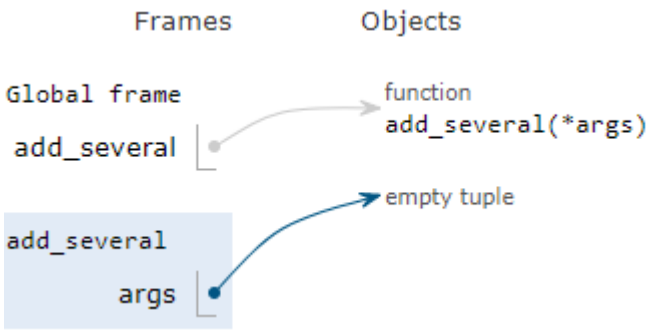



```
>>> res
15
```

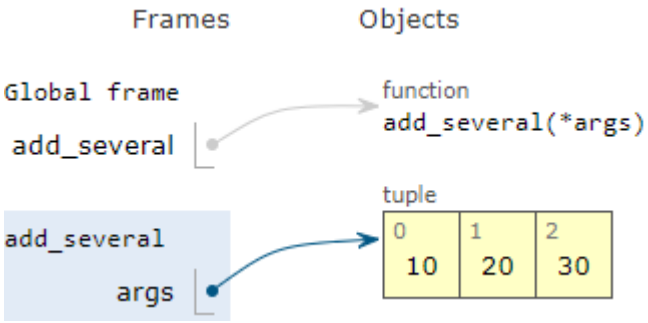
Variable Positional Args

```
def add_several(*args):
    result = 0
    for x in args:
        result = result + x
    return result
```

```
>>> add_several()
```



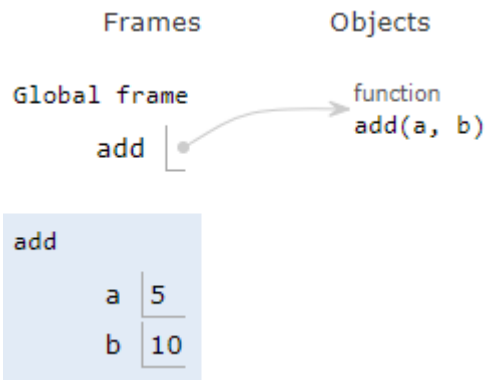

```
>>> add_several(10, 20, 40)
```



Optional Parameters

```
def add(a, b = 10):
    z = a + b
    return z
```

```
>>> add(5)
15
```



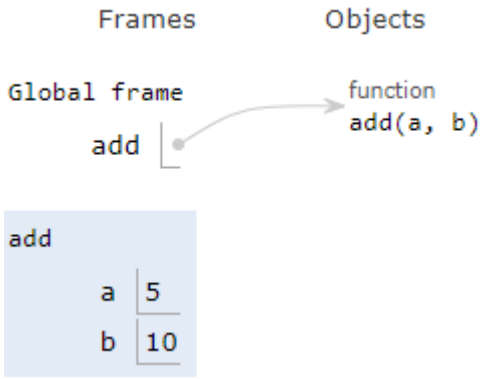
- default is bound to the function upon creation (not when it is called)

Keyword Arguments

```
def add(a, b):
    z = a + b
    return z
```

```
>>> res = add(b=10, a=5)
```

- parameters are bound by name




```
>>> res
15
```

Parameter Passing

- **call by value**:
  1. function copies values of parameters
  2. any changes to parameters are not visible to calling function

- **call by reference**:
  1. function uses address of parameters
  2. any changes to parameters are visible

- Python uses **call by assignment**

Call by Value Parameter Passing

- call by value:
  1. function copies values of parameters
  2. any changes to parameters are not visible to calling function

```
def modify(data):
    data.append('Mozzarella')
```

```
>>> x = [1, 2, 3]
>>> modify(x)
>>> print('received x = ', x)
```

- call by value should return

```
received x = [1, 2, 3']
```

Call by Reference Parameter Passing

- call by reference:
  1. function uses address of parameters
  2. any changes to parameters are visible

```
def modify(data):
    data = 'Brie’
```

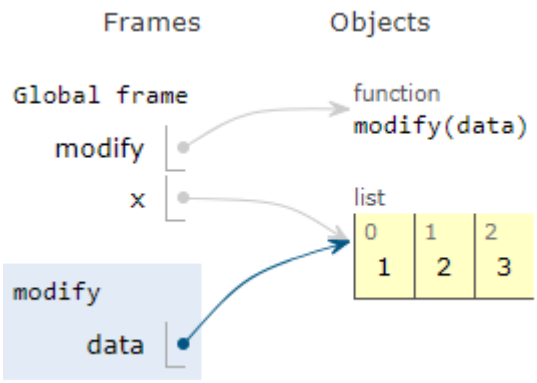
```
>>> x = 'Mozzarella’
>>> modify(x)
>>> print('received x = ', x)
```

- call by reference should return:

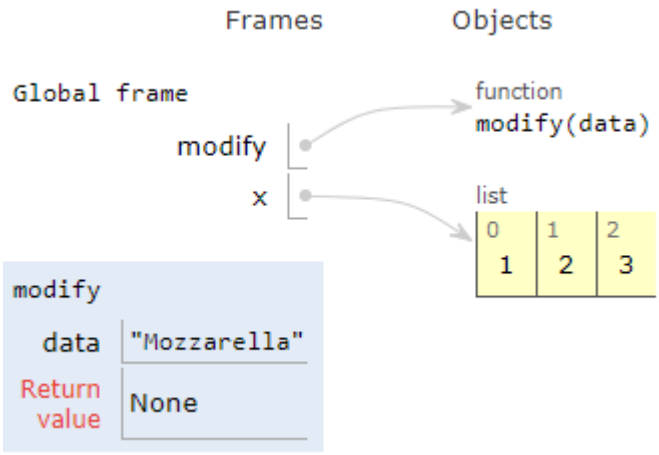
```
received x = 'Brie’
```

Mutable Objects with Rebinding (in detail)

```
>>> x = [1, 2, 3]
```




```
>>> modify(x)
```




```
>>> print('received x = ', x)
received x = [ 1, 2, 3]
```

Parameter Passing: Mutable Objects without Rebinding

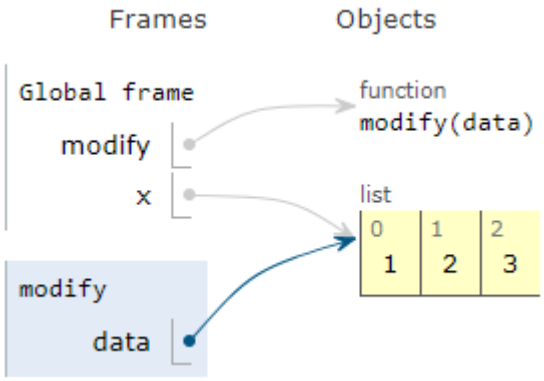
- called function gets a reference to the object and can change it
- calling function points to mutated object without rebinding − changes are visible

```
def modify(data):
    data.append('Mozzarella')
```

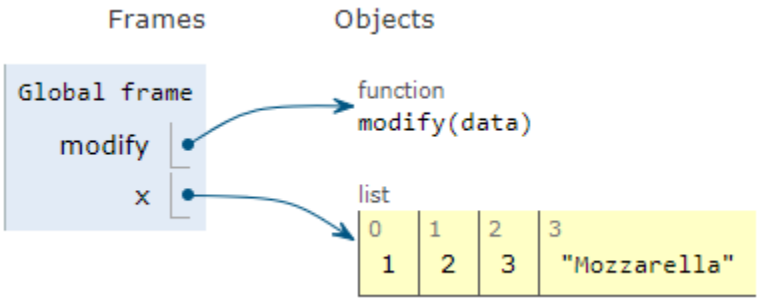
```
>>> x = [1, 2, 3]
>>> modify(x)
>>> print('received x = ', x)
received x = [1, 2, 3, 'Mozzarella']
```

Mutable Objects without Rebinding (details)

- data points to the same object



- modify object




```
>>> print('received x = ', x)
received x = [1, 2, 3, 'Mozzarella']
```

Passing Immutable Objects as Parameters

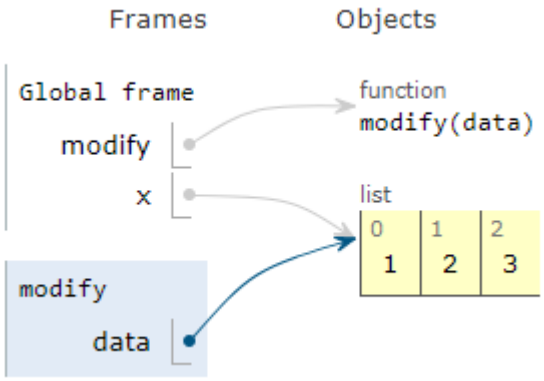
- called function gets a reference to the object and cannot change it
- calling function points to same object: no changes to the object are possible

```
def modify(data):
    data = 'Brie’
```

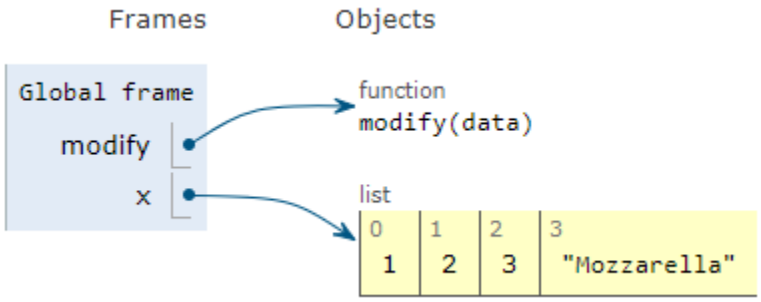
```
>>> x = 'Mozzarella’
>>> modify(x)
>>> print('received x = ', x)
received x = 'Mozzarella'
```

Mutable Objects without Rebinding (details)

- data points to the same object



- modify object




```
>>> print('received x = ', x)
received x = [1, 2, 3, 'Mozzarella']
```

Parameter Passing: Mutable Objects with Rebinding

- called function gets a reference to the object and can change it
- calling function points to mutated object with rebinding − changes are invisible

```
def modify(data):
    data = ['Mozzarella']
```

```
>>> x = [1, 2, 3]
>>> modify(x)
>>> print('received x = ', x)
received x = [1, 2, 3, 'Mozzarella']
```

Parameter Passing Summary

- arguments in functions are objects
- all variables reference an Object
- arguments are passed by reference
- mutable arguments can be changed in a function – changes are visible outside
- changes to immutable arguments result in new object(s) creation – changes are not visible outside

yield Statement

- suspends function execution
- produces a sequence of values to caller
- retains enough state to resume
- use yield to iterate over a sequence
- if function body contains yield, function becomes a generator

yield Example

```
def compute_next_cube():
    x = 1
    while True:
        yield x**3
        x = x + 1
```

- code to test

```
for result in compute_next_cube():
    if result > 1000:
        break
    print result
```

- prints

1, 8, 27 ,64, 125, 216, 343, 512, 729, 1000

Review Problems

Interview Problem

- why are functions considered first class objects in Python?

Interview Problem

- how do you create a Python function?

Interview Problem

- how does a function return values?

Interview Problem

- what happens when a function does not have a return statement?
- is this valid?

Interview Problem

- what will be the output of the following?

```
def func(x,*y,**z):
    print z
```

```
>>> func(1,2,3)
```

Interview Problem

- what does this code output?

```
def f(x, l=[]):
    for i in range(x):
        l.append(i*i)
print(l)
```

Interview Problem

- what does *args and **kwargs mean?

Interview Problem

- are function parameters passed by value or by reference?

Interview Problem

- differentiate local and global variables

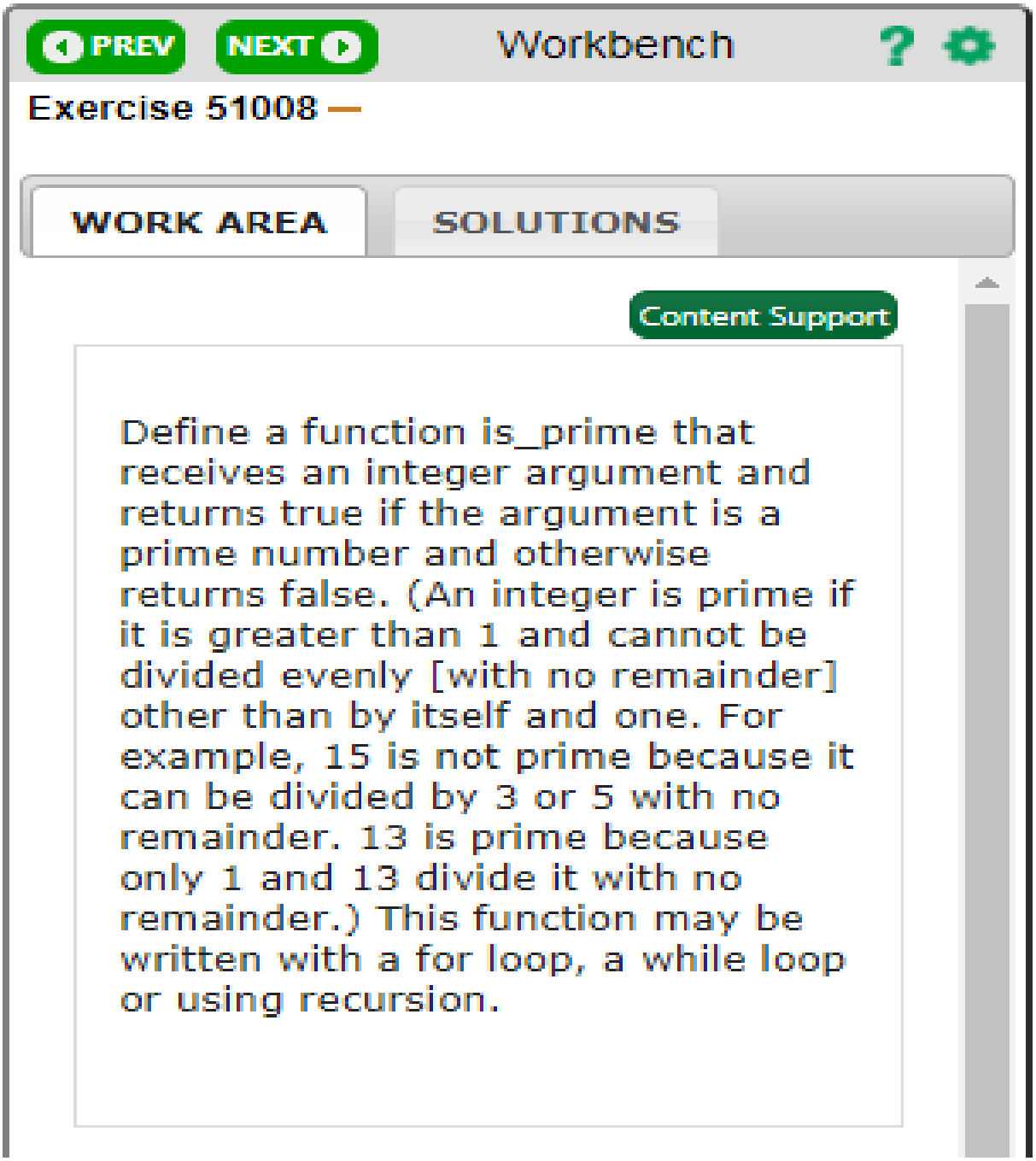
Interview Problem

- what are decorators?

Interview Problem

- what does the *yield* keyword do?

Programming Exercise



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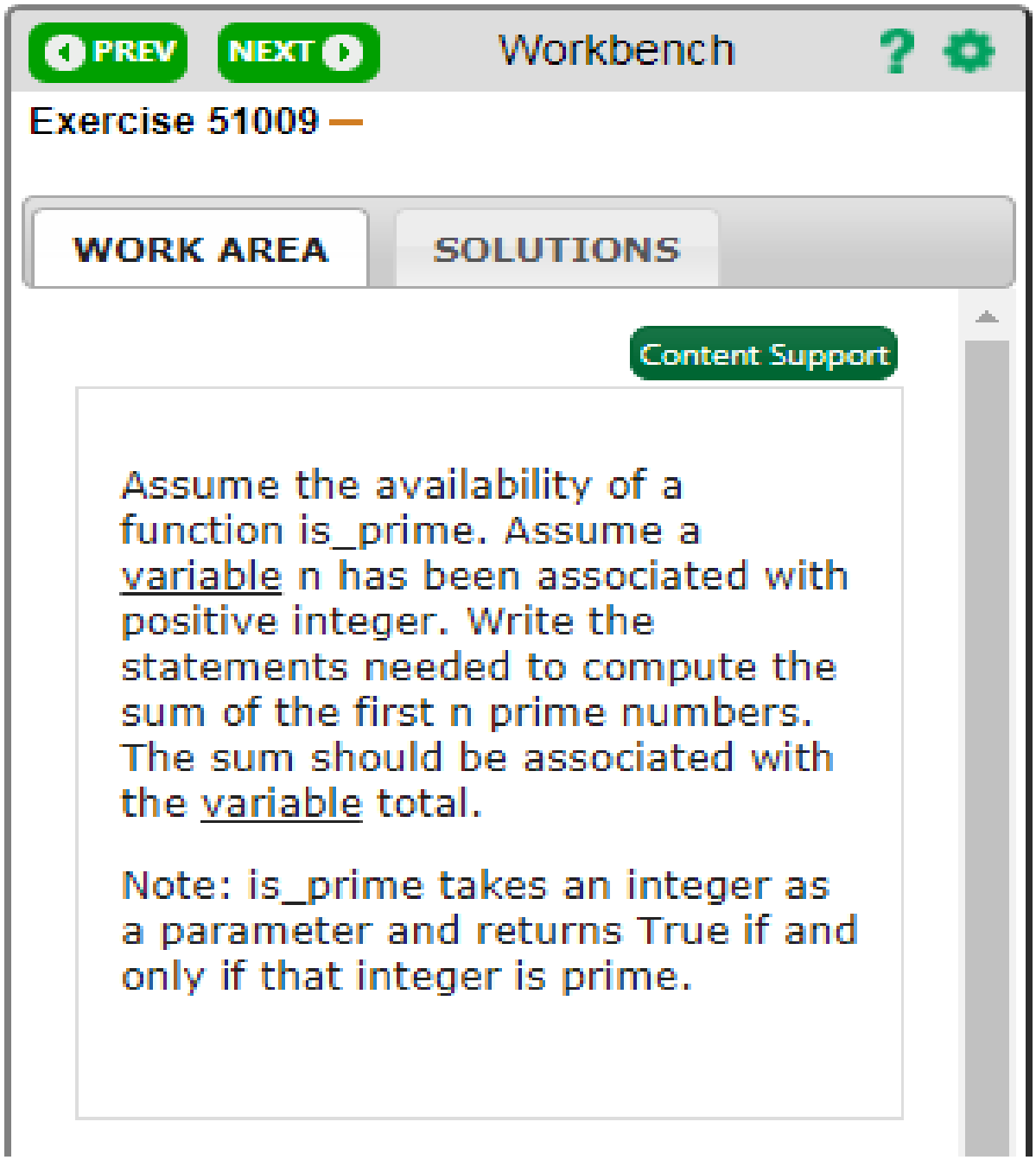

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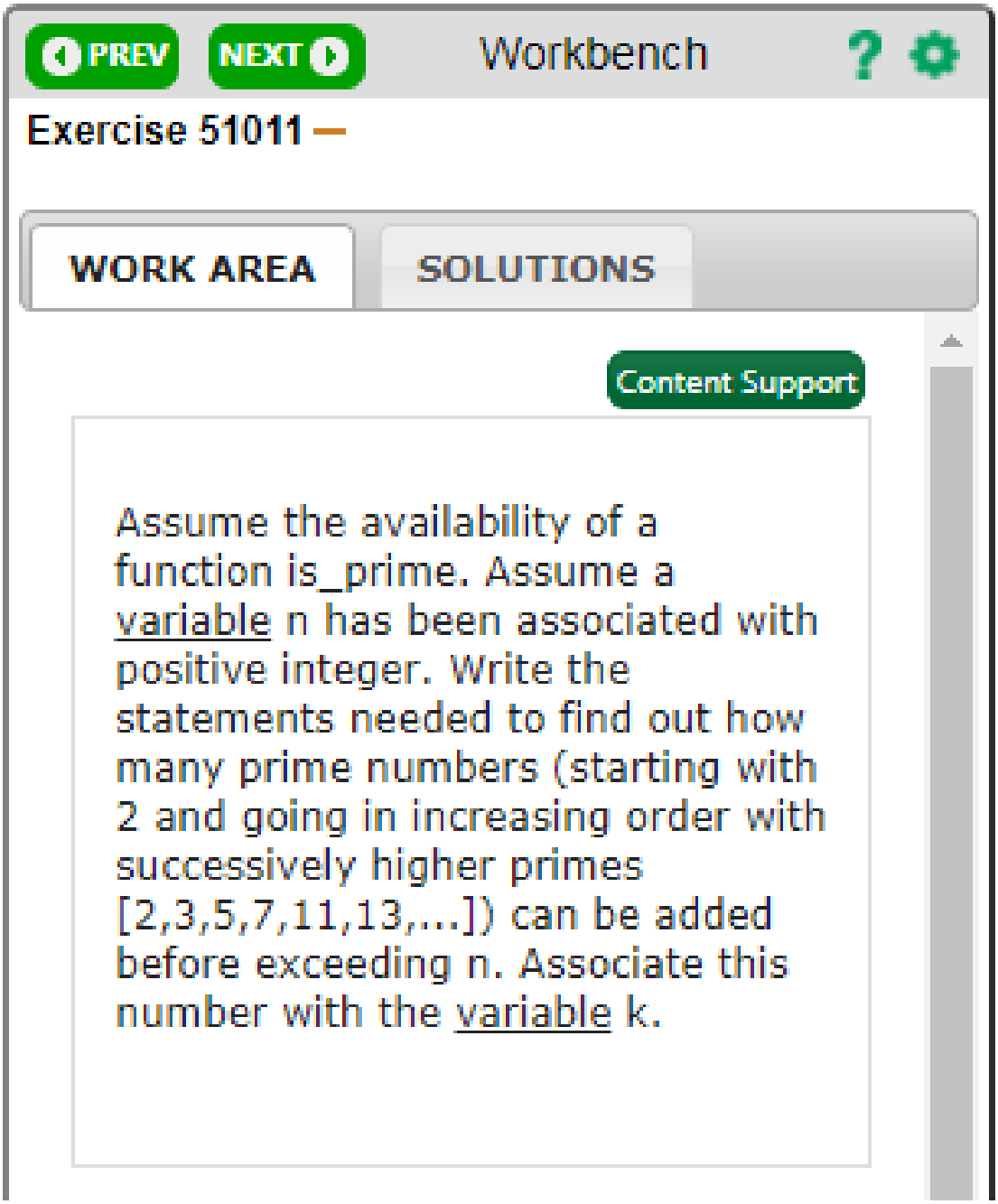

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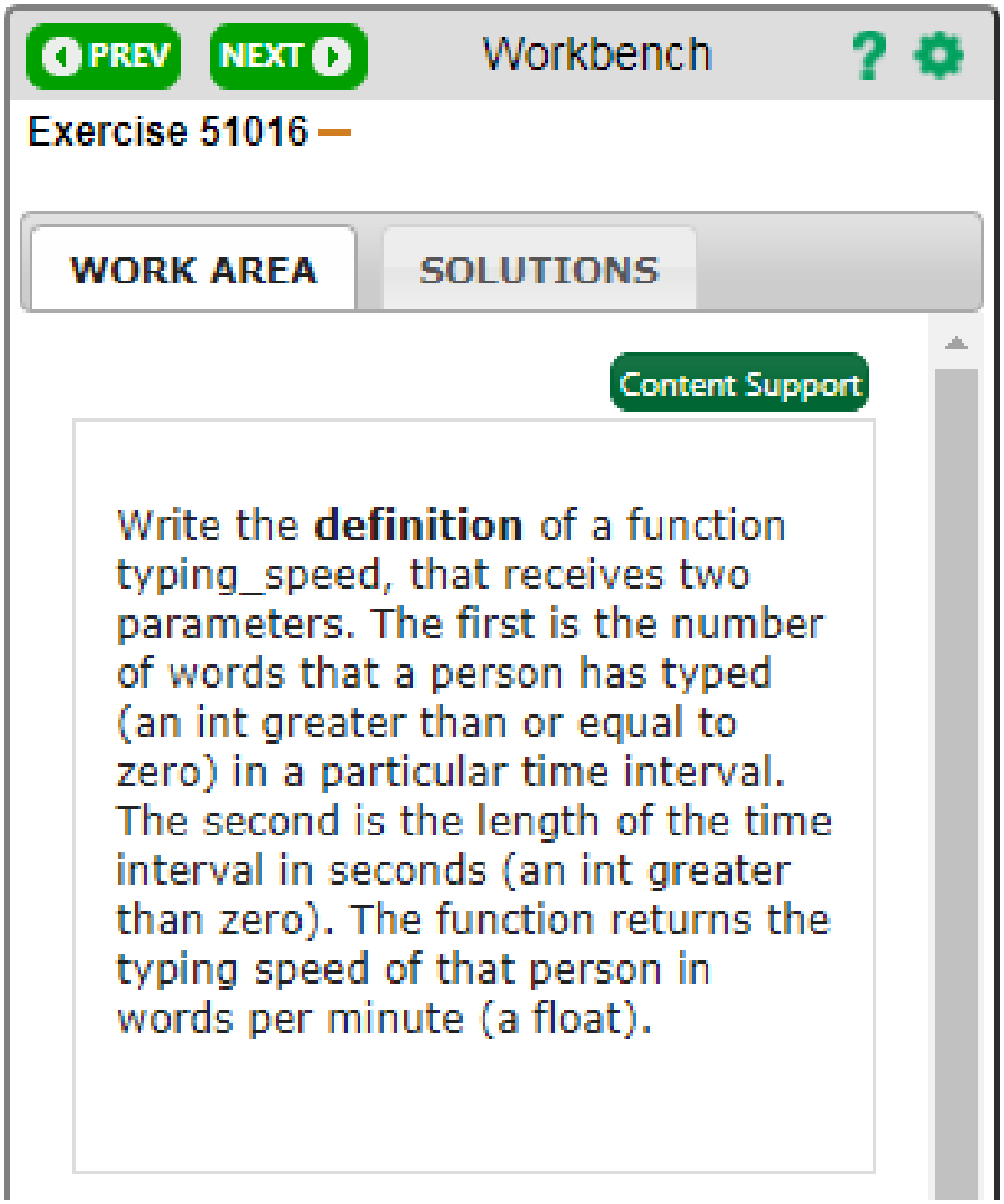

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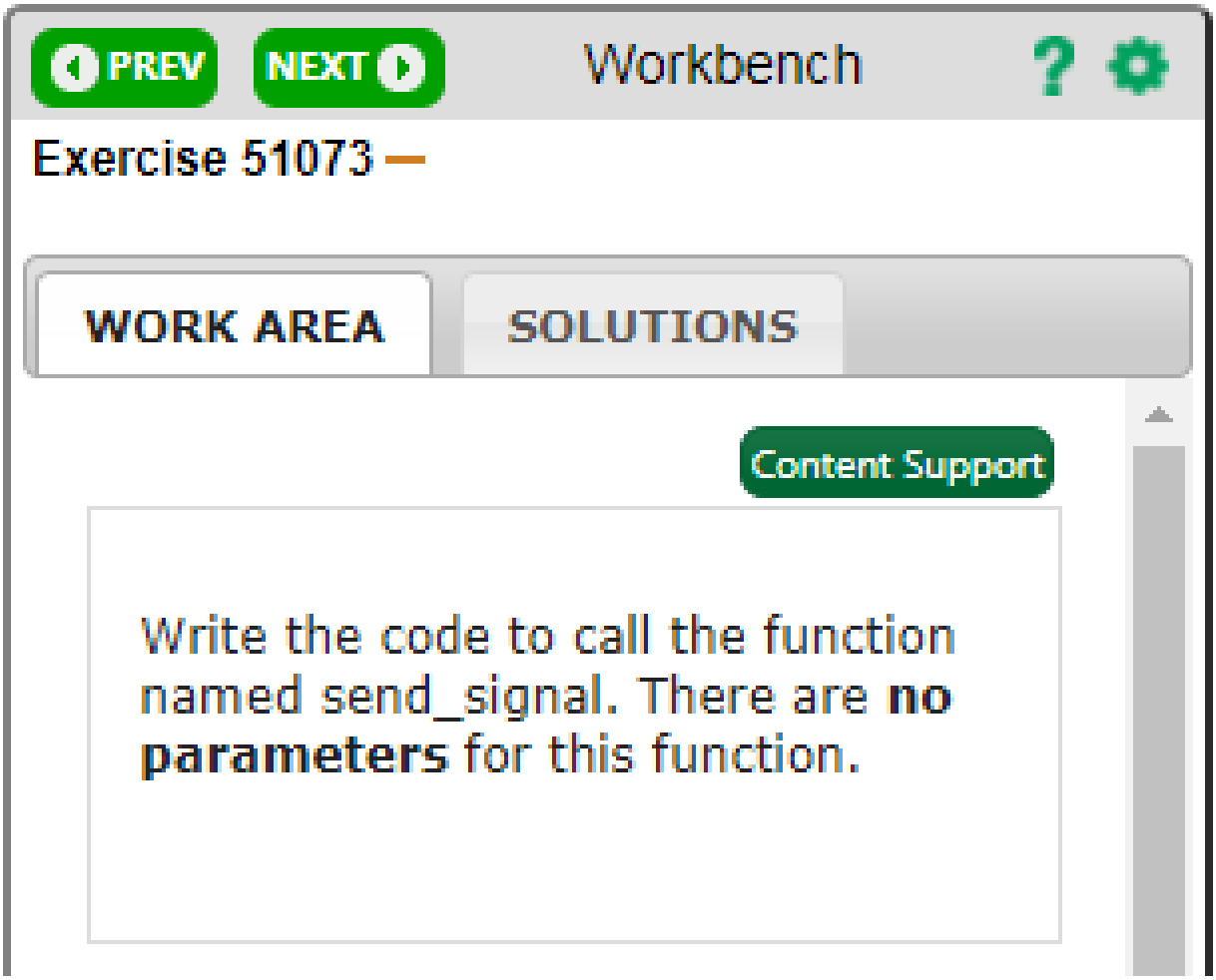

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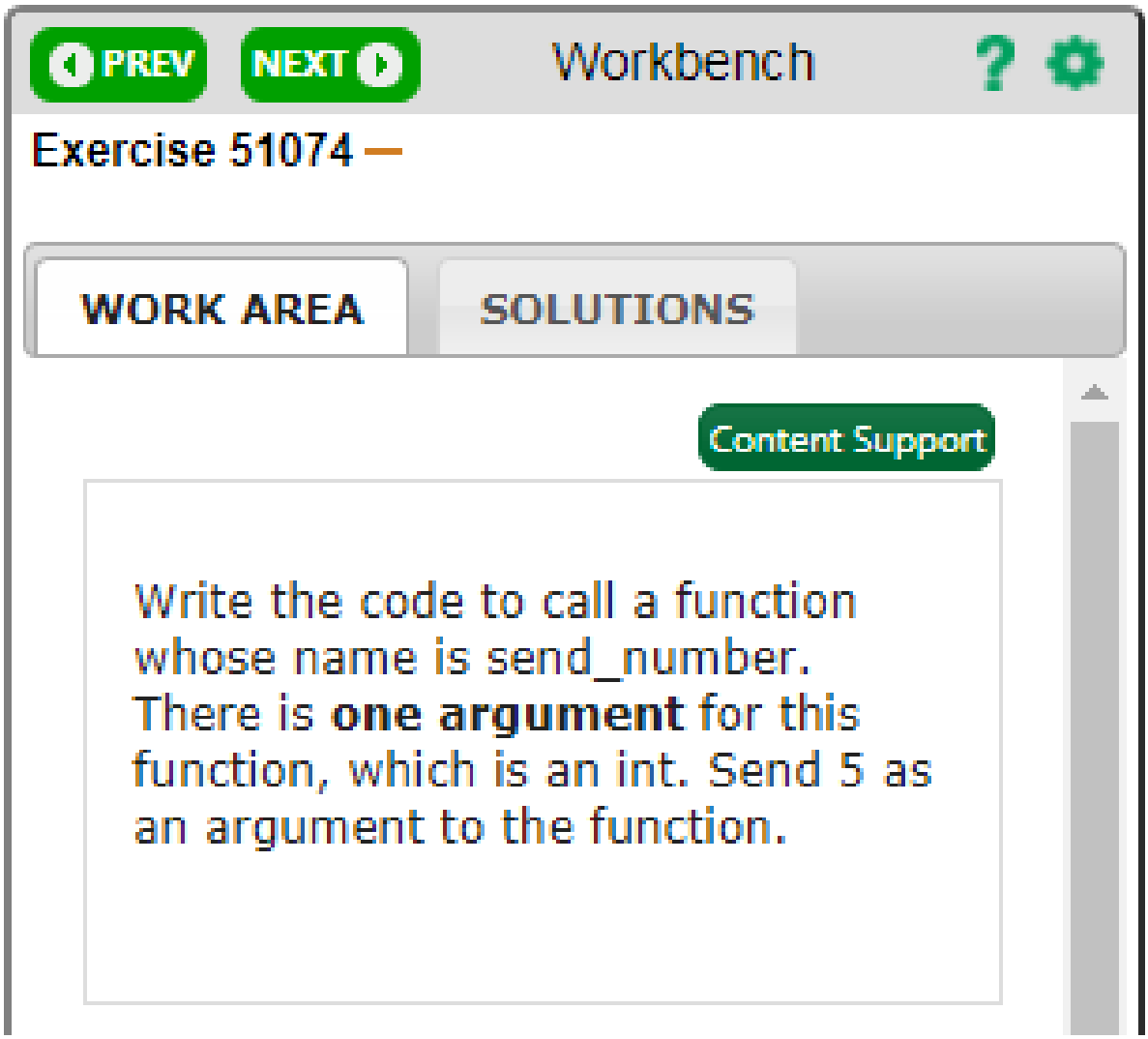

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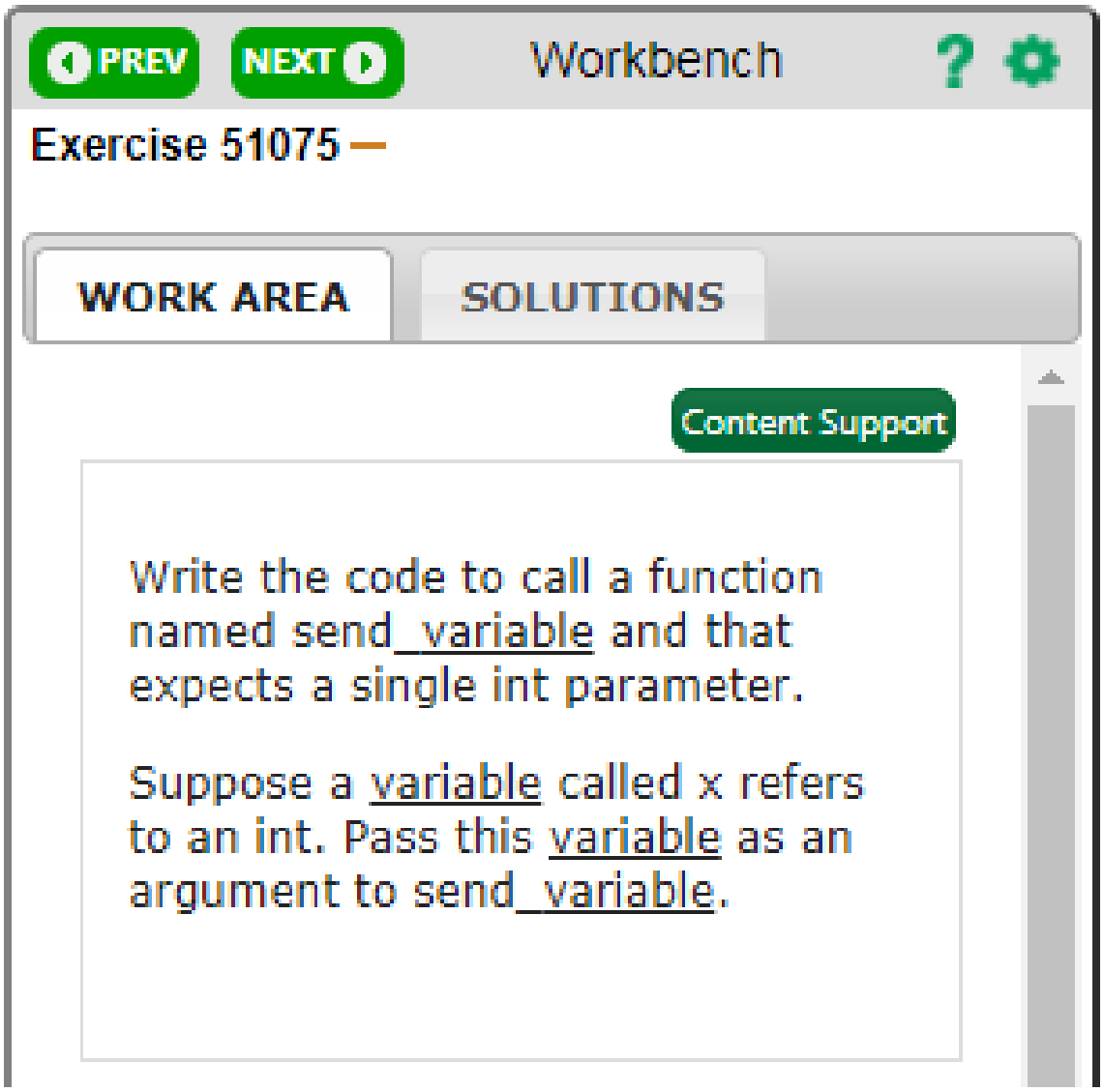

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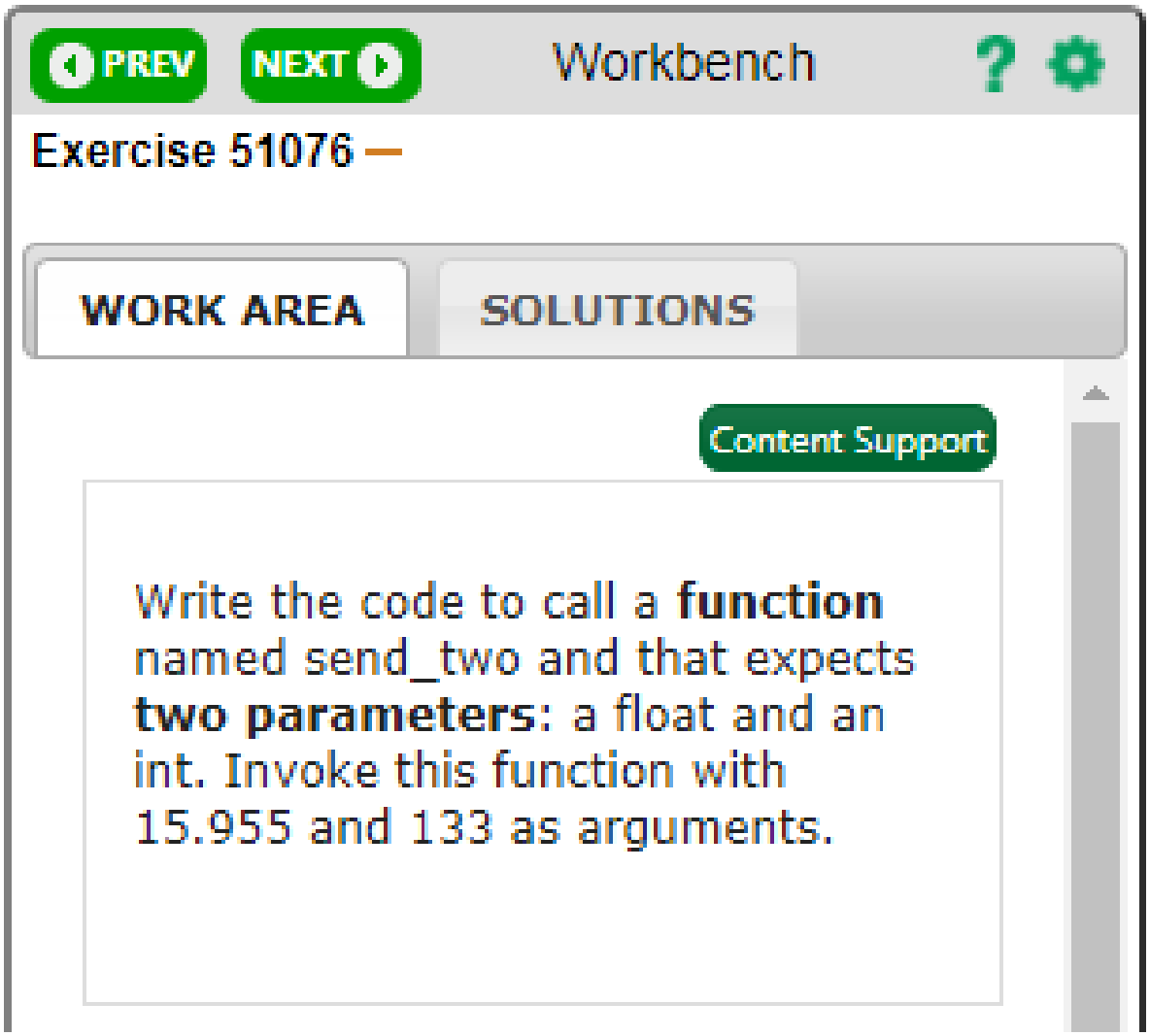

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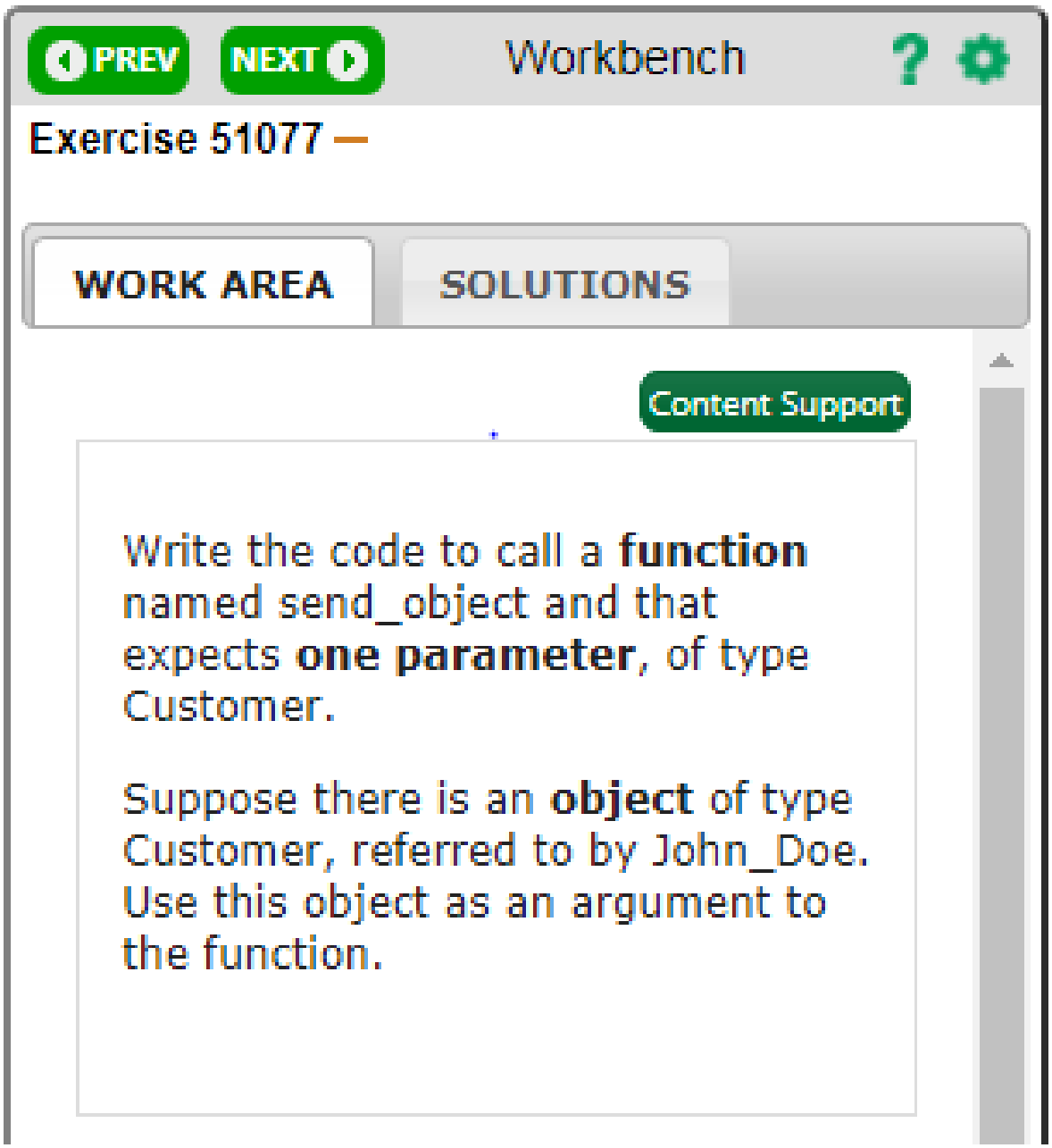

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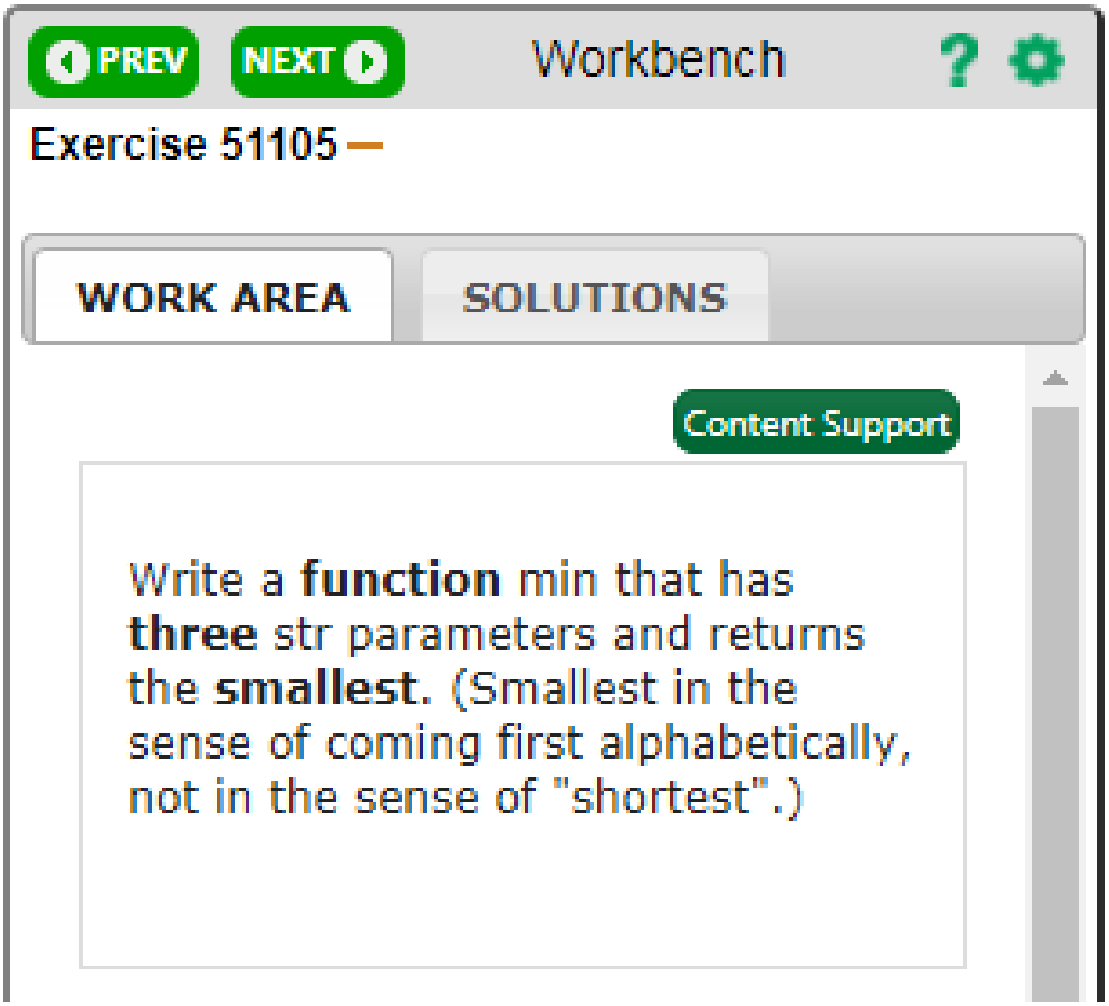

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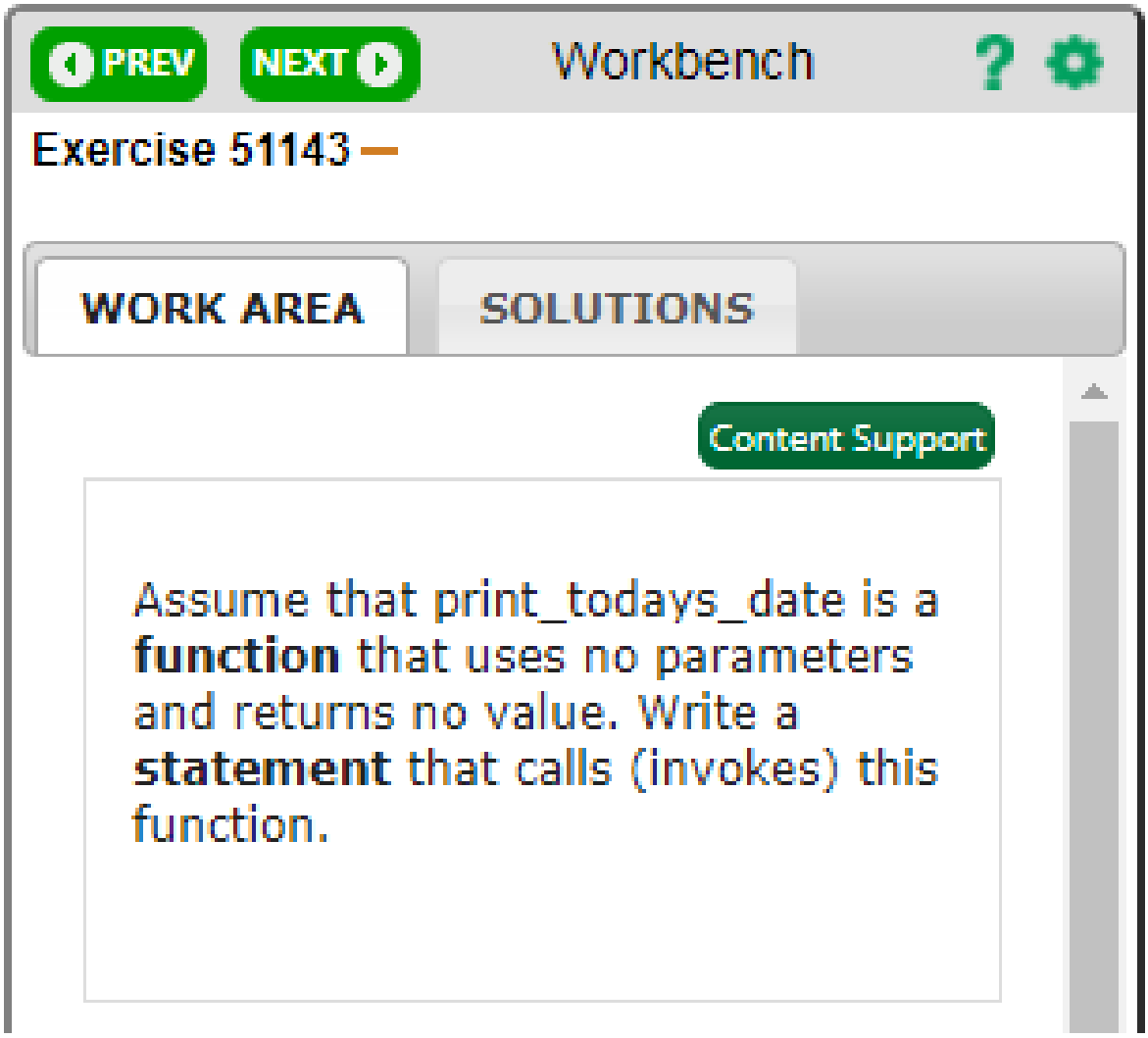

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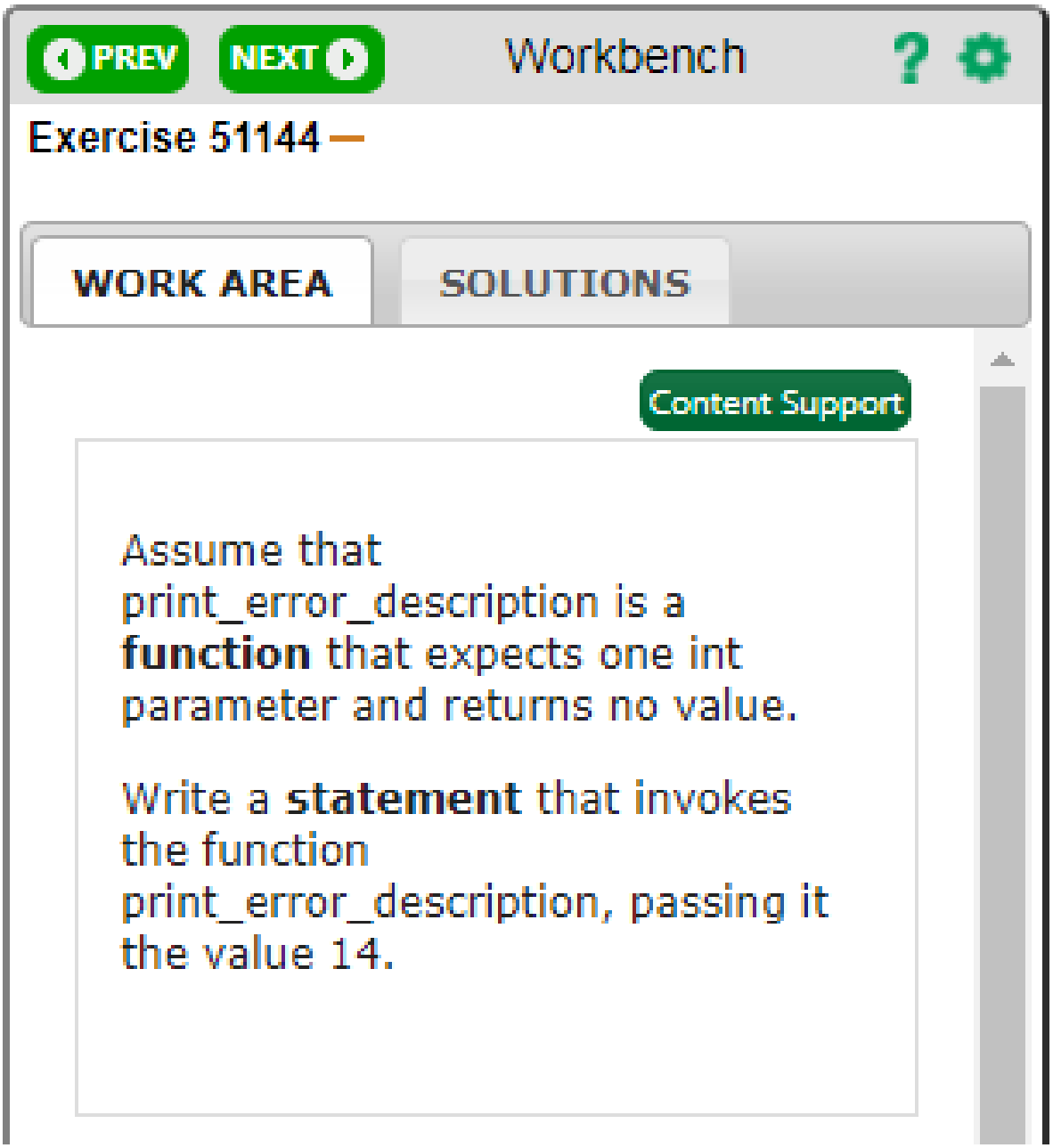

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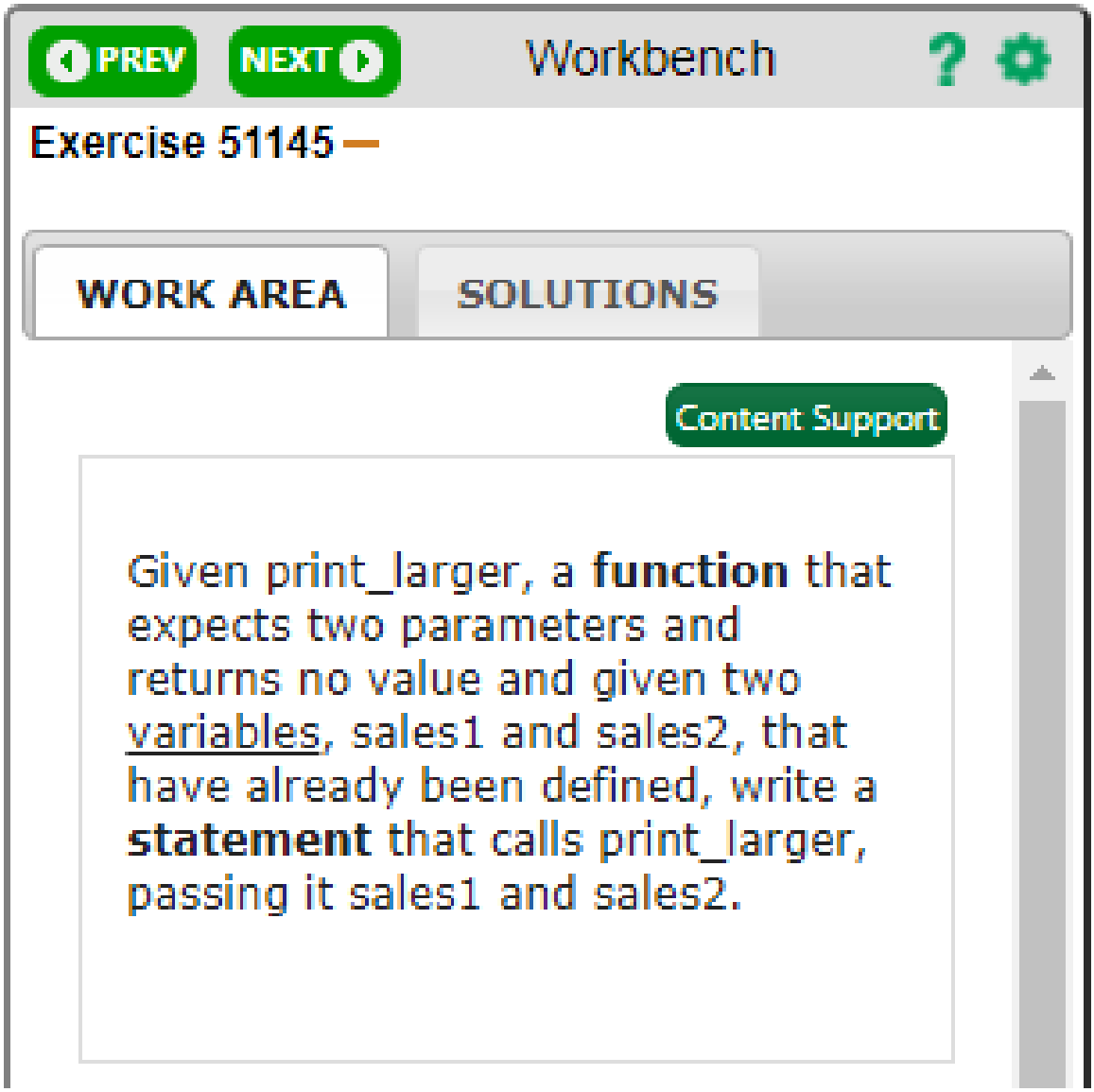

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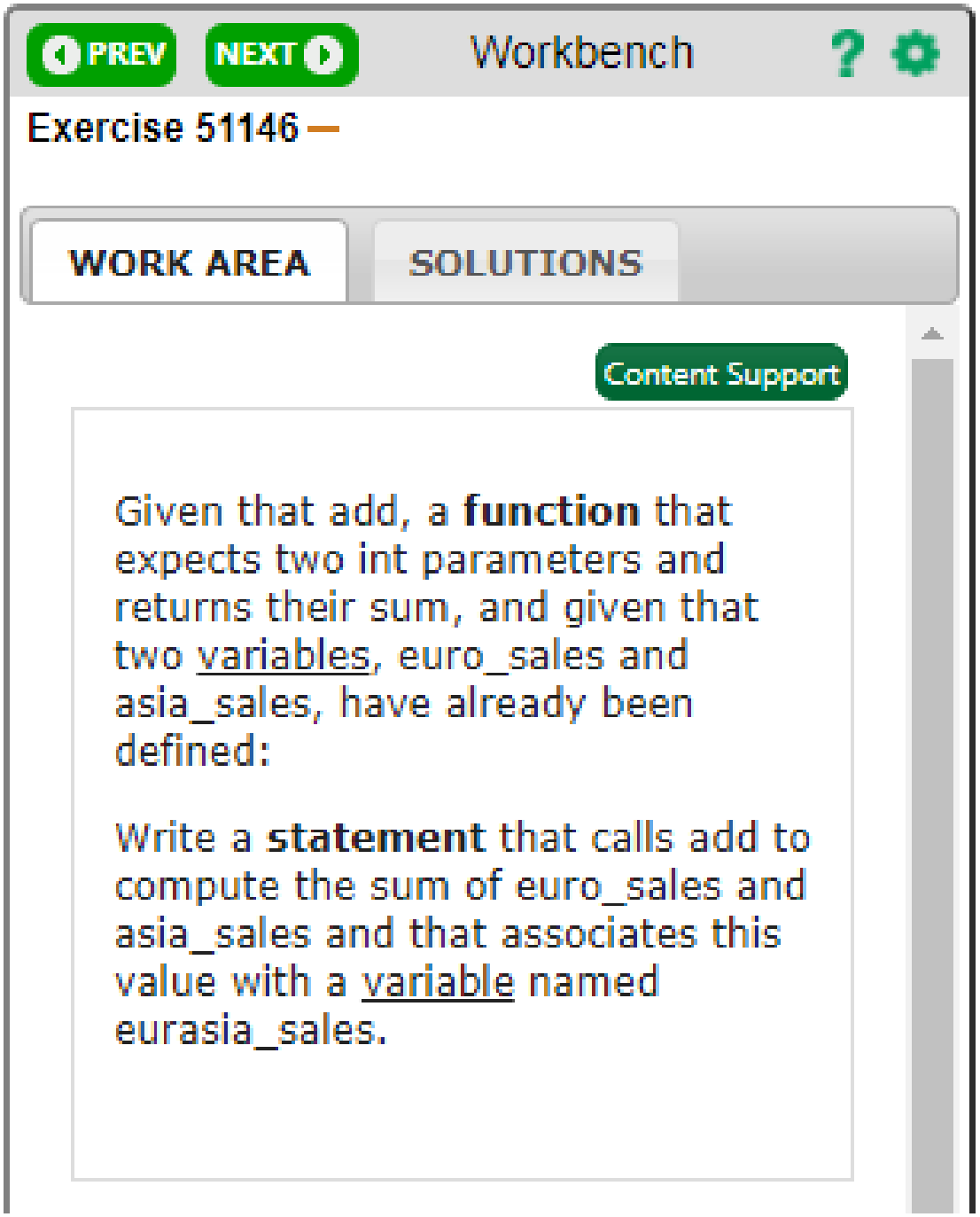

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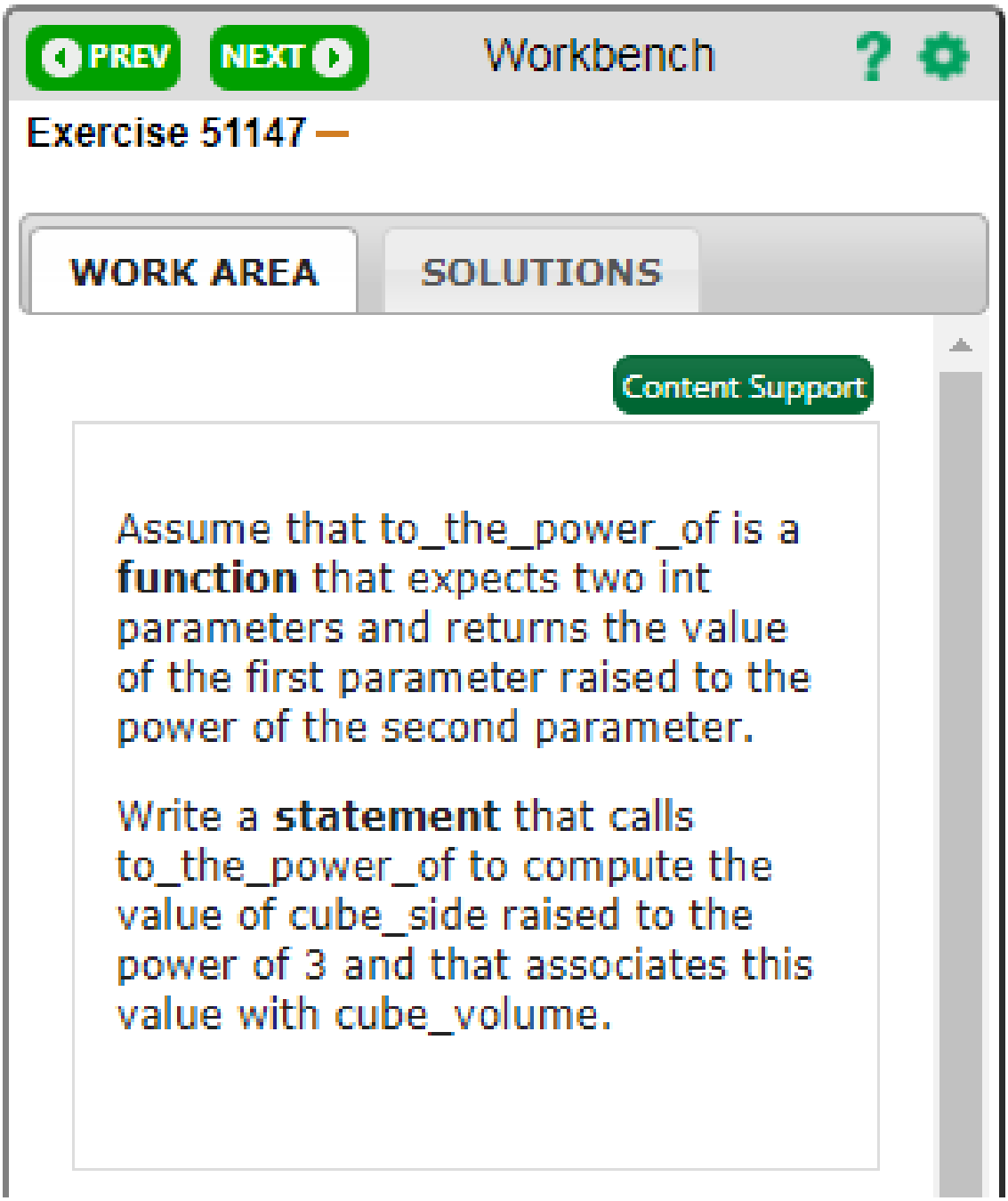

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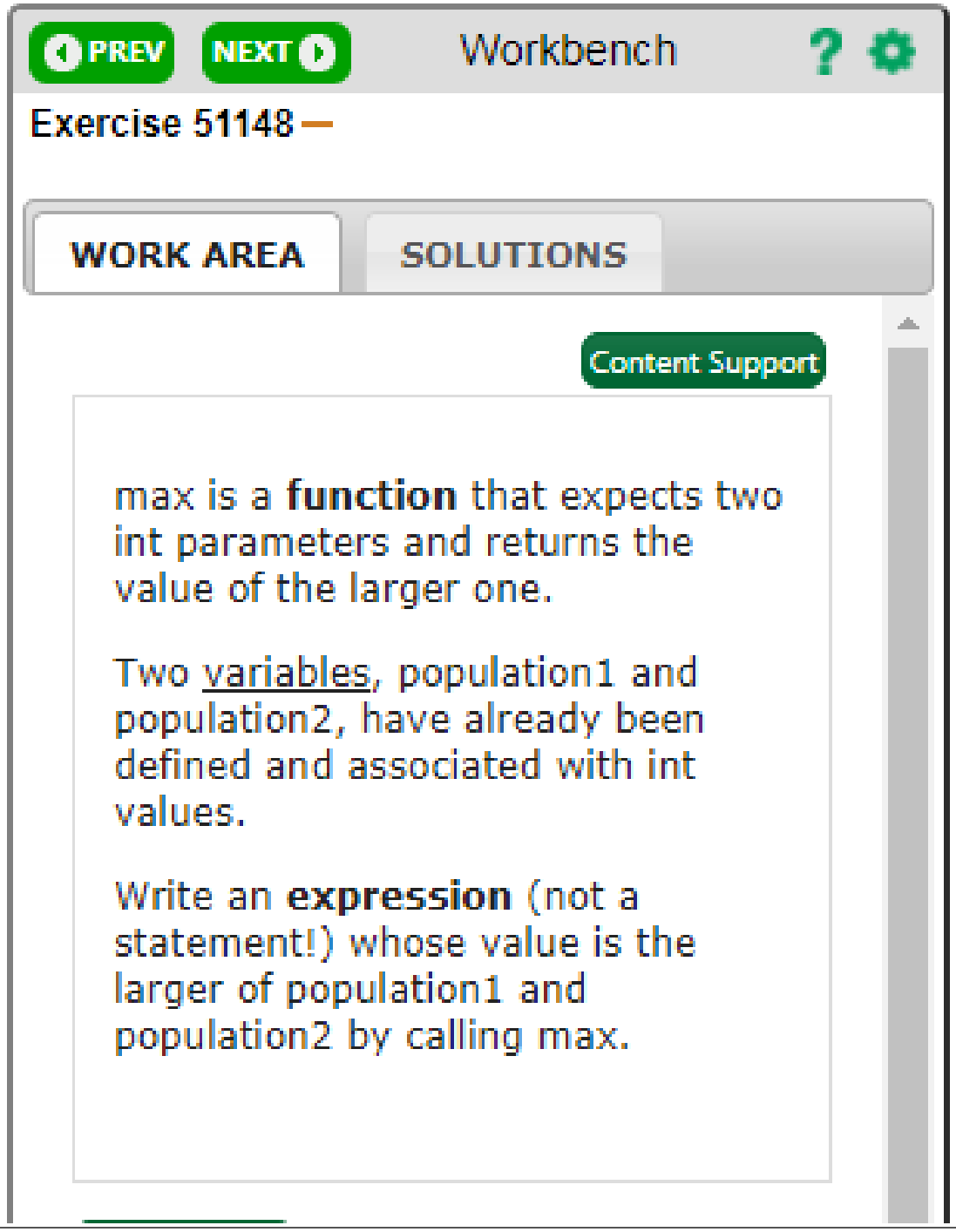

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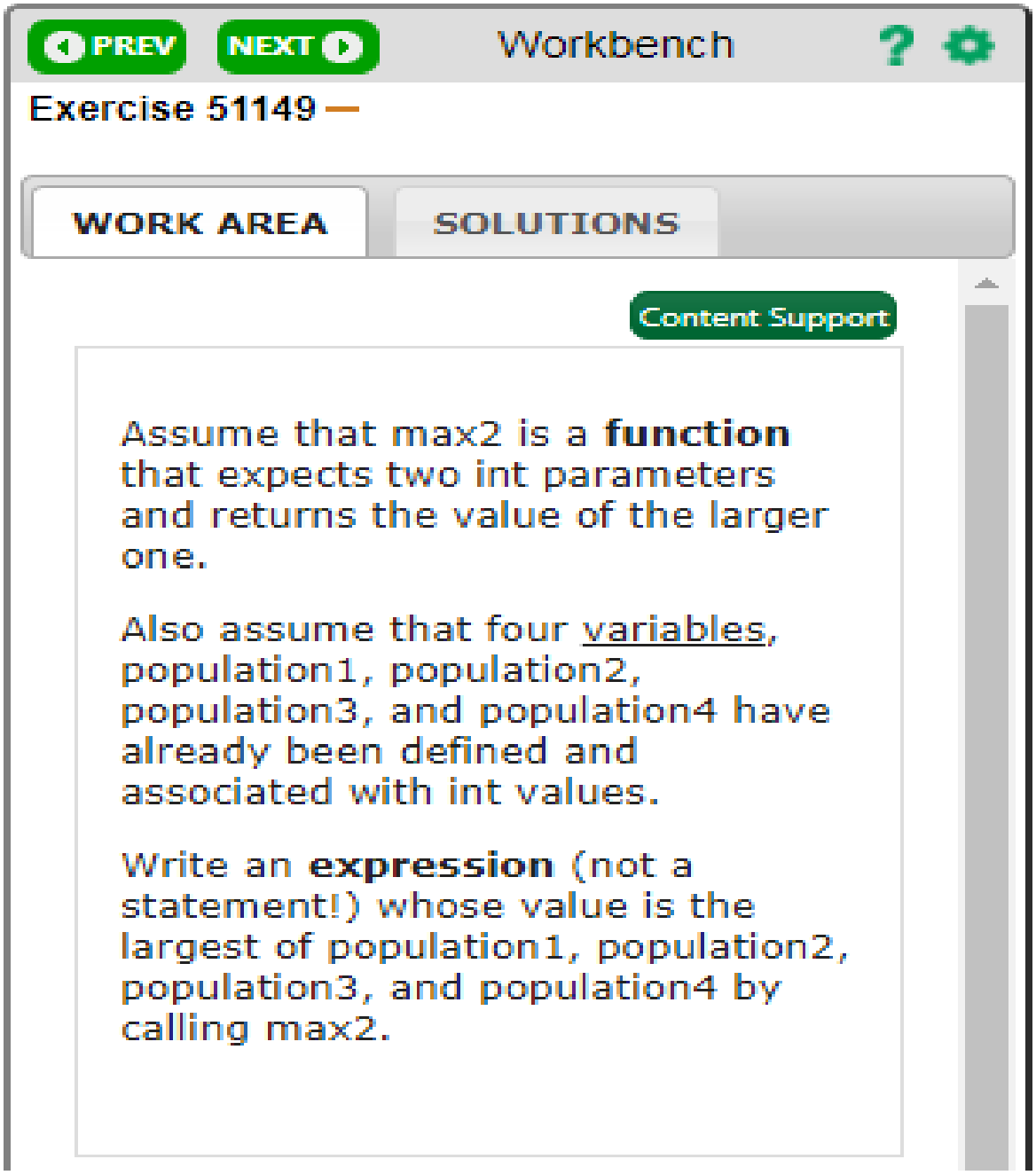

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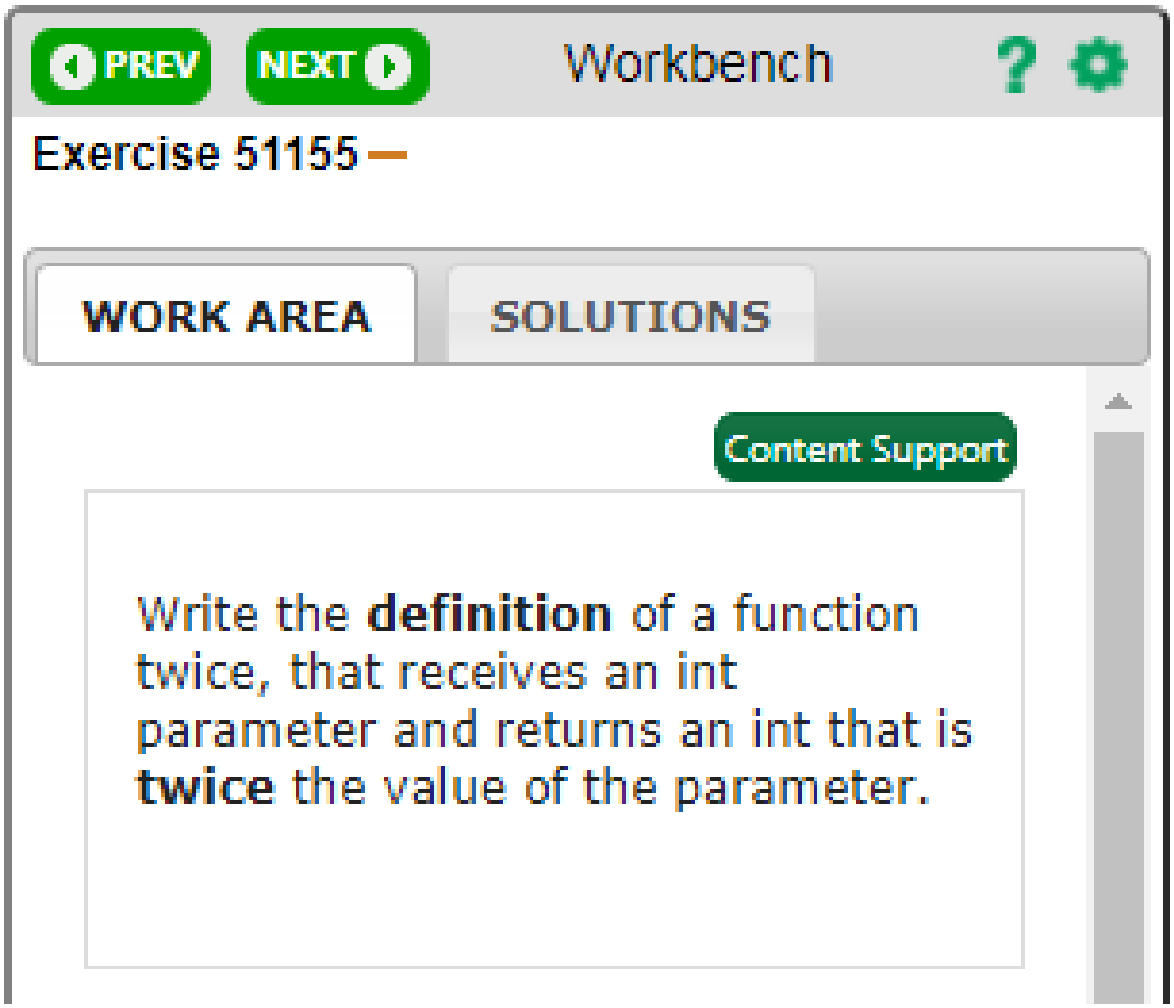

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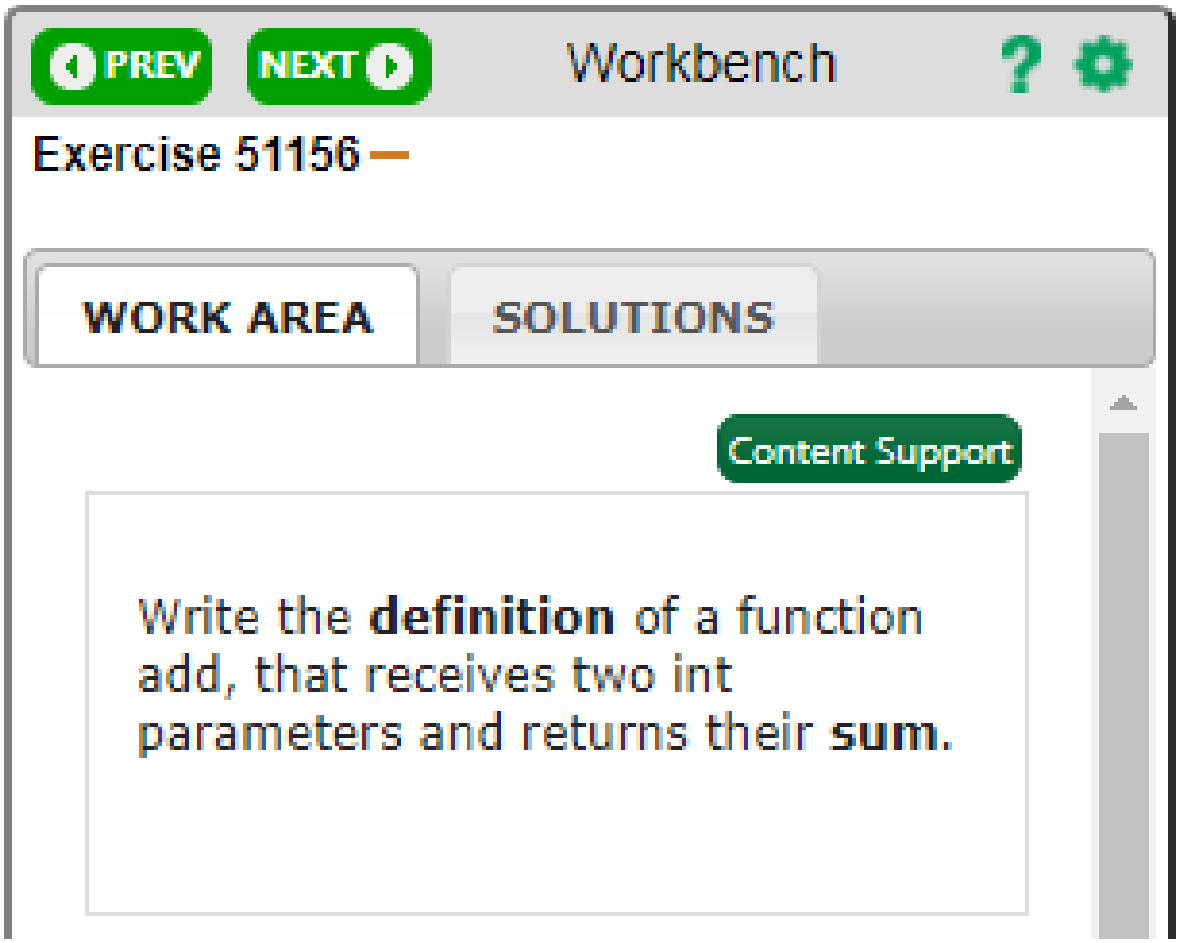

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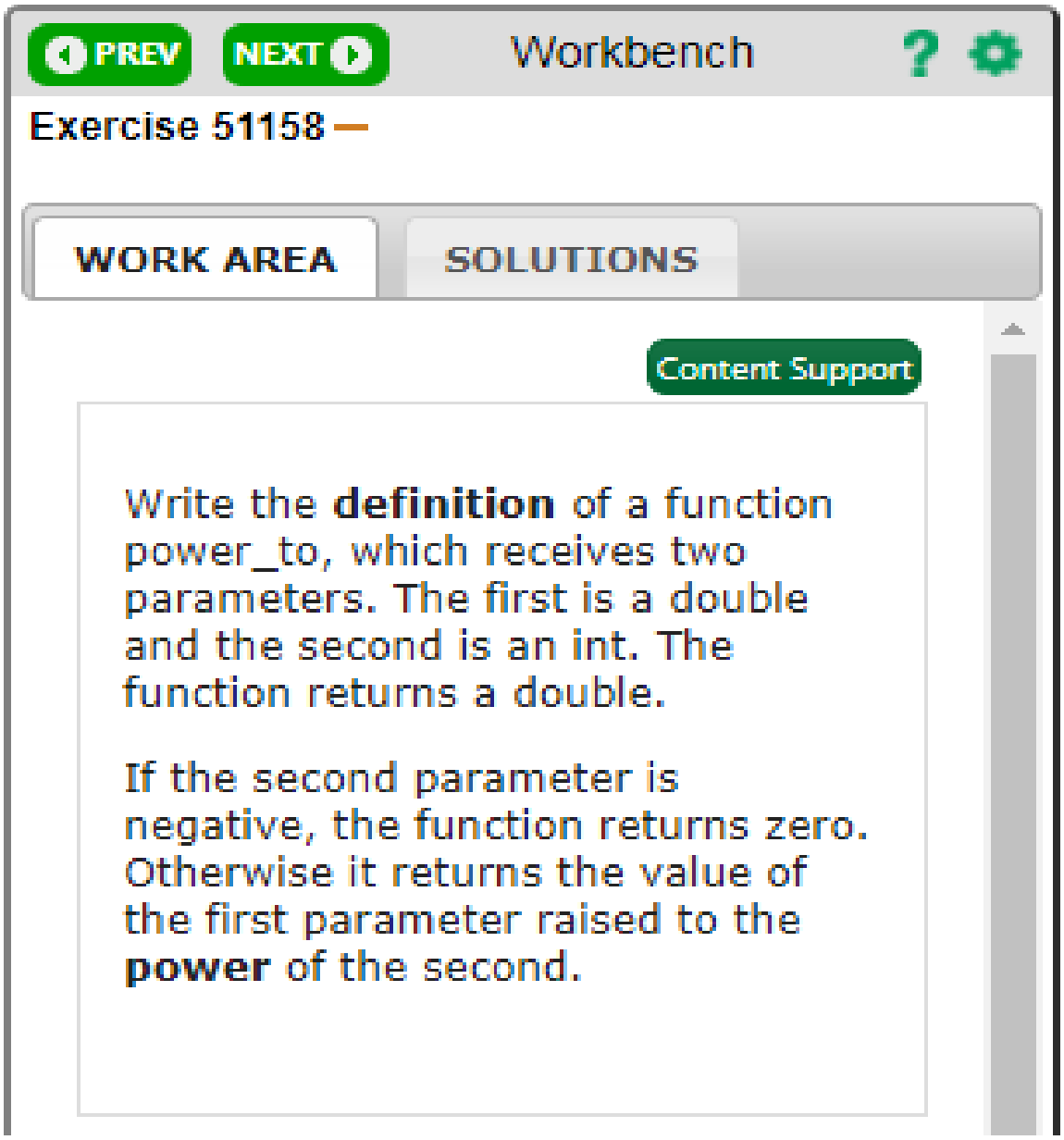

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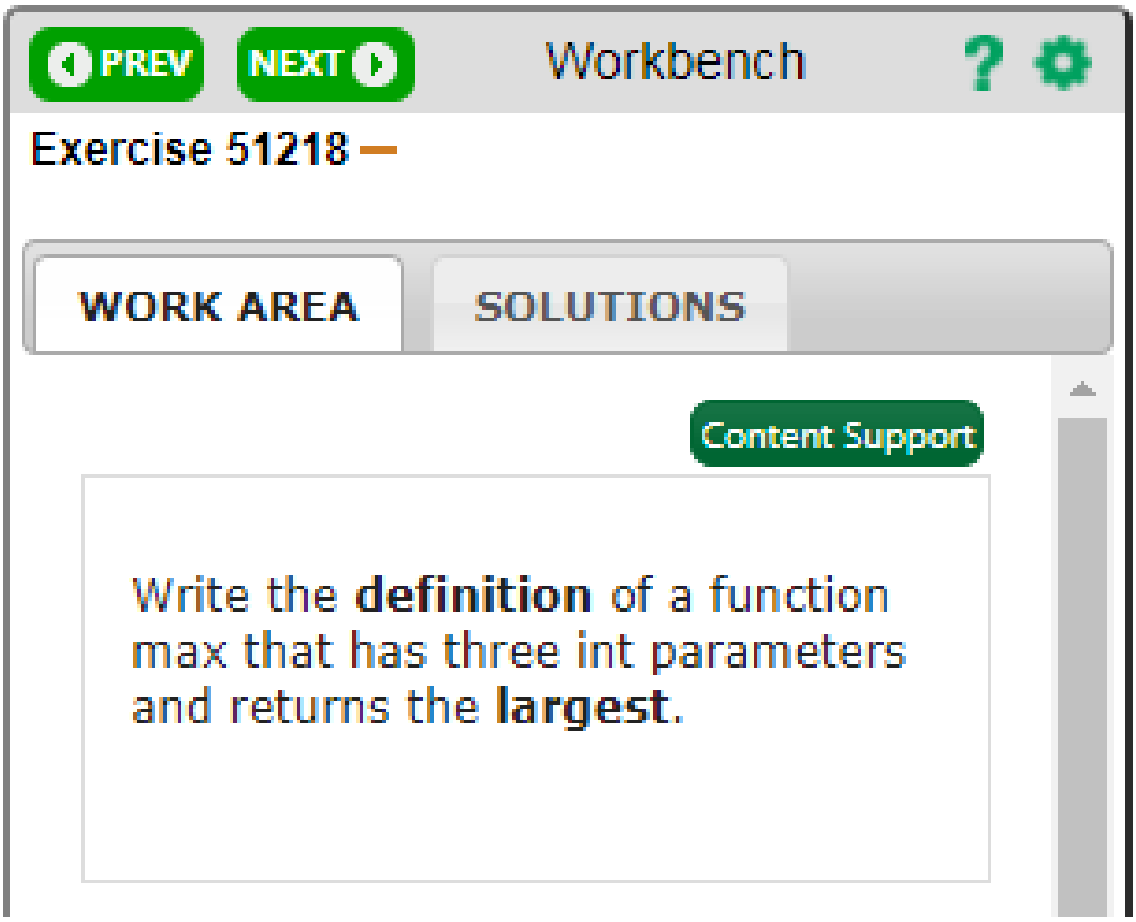

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