

Procedural Programming: Defining Functions

Introduction to Programming in Python

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A function is a callable unit of code with a well-defined interface and behavior

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Function definition:

```
def <name>(<param1>, <param2>, ...):  
    <stmt1>  
    <stmt2>  
    ...
```

Function Definition

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A return statement is used to transfer control back to the caller, sometimes with a value

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Return statement:

```
return  
return <exp>
```

Function Definition

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Function Call Trace (`square.py`):

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```
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9 def _square(x):
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13 if __name__ == "__main__":
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```

__name__	
main::x	
main::y	
_square::x	
_square::y	

```
$ _
```

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```
$ python3 square.py 11
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$ _
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Arguments to a function are passed by value

A non-void function can only return a single value but may have multiple return statements

The scope of a function's parameters and other variables is limited to that function

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Example (computing $H_{n,r} = 1 + 1/2^r + 1/3^r + \cdots + 1/n^r$):

```
def harmonic(n, r = 1):  
    total = 0.0  
    for i in range(1, n + 1):  
        total += 1 / (i ** r)  
    return total
```

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Example (computing $H_{n,r} = 1 + 1/2^r + 1/3^r + \cdots + 1/n^r$):

```
def harmonic(n, r = 1):  
    total = 0.0  
    for i in range(1, n + 1):  
        total += 1 / (i ** r)  
    return total
```

Calling `harmonic(5)` is the same as calling `harmonic(5, 1)`

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Example:

```
import stdio

def exchange(a, i, j):
    temp = a[i]
    a[i] = a[j]
    a[j] = temp

a = [1, 2, 3, 4, 5]
exchange(a, 1, 3)
stdio.writeln(a)
```

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Example:

```
import stdio

def exchange(a, i, j):
    temp = a[i]
    a[i] = a[j]
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a = [1, 2, 3, 4, 5]
exchange(a, 1, 3)
stdio.writeln(a)
```

```
[1, 4, 3, 2, 5]
```


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- Command-line input: `n` (int)
- Standard output: the `n`th harmonic number, $H_n = 1 + \frac{1}{2} + \frac{1}{3} + \cdots + \frac{1}{n} \approx \ln(n) + 0.57721$

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$ _
```

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```
$ python3 harmonicredux.py 10
```

Examples

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```
$ python3 harmonicredux.py 10
2.9289682539682538
$ _
```

Examples

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$ python3 harmonicredux.py 10
2.9289682539682538
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```
$ python3 harmonicredux.py 10
2.9289682539682538
$ python3 harmonicredux.py 1000
7.485470860550343
$ _
```

Examples

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$ python3 harmonicredux.py 10
2.9289682539682538
$ python3 harmonicredux.py 1000
7.485470860550343
$ python3 harmonicredux.py 10000
9.787606036044348
$ _
```

Examples

Examples

```
1 import stdio
2 import sys
3
4 def main():
5     n = int(sys.argv[1])
6     stdio.writeln(_harmonic(n))
7
8 def _harmonic(n):
9     total = 0.0
10    for i in range(1, n + 1):
11        total += 1 / i
12    return total
13
14 if __name__ == "__main__":
15    main()
```

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Program (`couponcollectorredux.py`):

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- Command-line input: `n` (int)
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```
$ python3 couponcollectorredux.py 1000  
7173  
$ _
```

Examples

Program (`couponcollectorredux.py`):

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7173
$ python3 couponcollectorredux.py 10000
```

Examples

Program (`couponcollectorredux.py`):

- Command-line input: `n` (int)
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```
$ python3 couponcollectorredux.py 1000
7173
$ python3 couponcollectorredux.py 10000
94718
$ _
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Examples

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7173
$ python3 couponcollectorredux.py 10000
94718
$ python3 couponcollectorredux.py 100000
1110981
$ _
```

Examples

Examples

```
1 import stdarray
2 import stdio
3 import stdrandom
4 import sys
5
6 def main():
7     n = int(sys.argv[1])
8     stdio.writeln(_collect(n))
9
10 def _collect(n):
11     count = 0
12     collectedCount = 0
13     isCollected = stdarray.create1D(n, False)
14     while collectedCount < n:
15         value = _getCoupon(n)
16         count += 1
17         if not isCollected[value]:
18             collectedCount += 1
19             isCollected[value] = True
20     return count
21
22 def _getCoupon(n):
23     return stdrandom.uniformInt(0, n)
24
25 if __name__ == "__main__":
26     main()
```

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Program (`playthattunedeluxe.py`):

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- Standard input: sound samples, each characterized by a pitch and a duration

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$ cat data/looney.txt
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Program (`playthattunedeluxe.py`):

- Standard input: sound samples, each characterized by a pitch and a duration
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```
$ cat data/looney.txt
7 .270
5 .090
3 .180
...
10 .720
$ _
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Program (`playthattunedeluxe.py`):

- Standard input: sound samples, each characterized by a pitch and a duration
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```
$ cat data/looney.txt
7 .270
5 .090
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$ python3 playthattunedeluxe.py < data/looney.txt
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Program (`playthattunedeluxe.py`):

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```

Examples

Examples

```
1 import math
2 import stdarray
3 import stdaudio
4 import stdio
5
6 def main():
7     while not stdio.isEmpty():
8         pitch = stdio.readInt()
9         duration = stdio.readFloat()
10        stdaudio.playSamples(_createRichNote(pitch, duration))
11    stdaudio.wait()
12
13 def _createRichNote(pitch, duration):
14     NOTES_ON_SCALE = 12
15     CONCERT_A = 440.0
16     hz = CONCERT_A * pow(2, pitch / NOTES_ON_SCALE)
17     mid = _createNote(hz, duration)
18     hi = _createNote(2 * hz, duration)
19     lo = _createNote(hz / 2, duration)
20     hiAndLo = _superpose(hi, lo, 0.5, 0.5)
21     return _superpose(mid, hiAndLo, 0.5, 0.5)
22
23 def _createNote(hz, duration):
24     SPS = 44100
25     n = int(SPS * duration)
26     note = stdarray.create1D(n + 1, 0.0)
```

Examples

Examples

```
27     for i in range(n + 1):
28         note[i] = math.sin(2 * math.pi * i * hz / SPS)
29     return note
30
31 def _superpose(a, b, aWeight, bWeight):
32     c = stdarray.create1D(len(a), 0.0)
33     for i in range(len(a)):
34         c[i] = a[i] * aWeight + b[i] * bWeight
35     return c
36
37 if __name__ == "__main__":
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```


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- They can receive functions as arguments
- They can return functions as results

Special Functions

Special Functions ► `filter()` Function

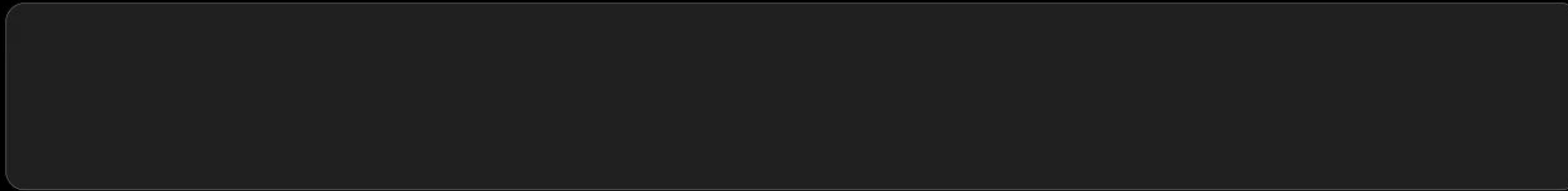
Special Functions ► `filter()` Function

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>>> _
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```
>>> primes = filter(isPrime, range(11))
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Example:

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Special Functions ► `filter()` Function

`filter(f, seq)` returns those items of `seq` for which `f(item)` is `True`

Example:

```
>>> primes = filter(isPrime, range(11))
>>> list(primes)
[2, 3, 5, 7]
>>> _
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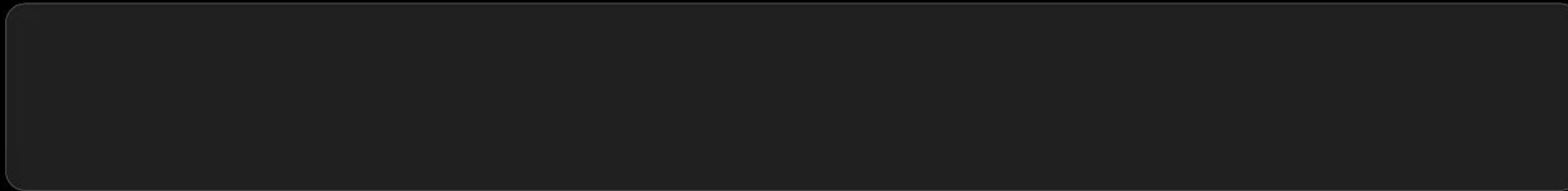
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Special Functions ► Lambda Function

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>>> odds = filter(lambda x: x % 2 != 0, range(11))
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>>> list(odds)
```

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>>> list(odds)
[1, 3, 5, 7, 9]
>>> _
```

Special Functions

Special Functions ► `map()` Function

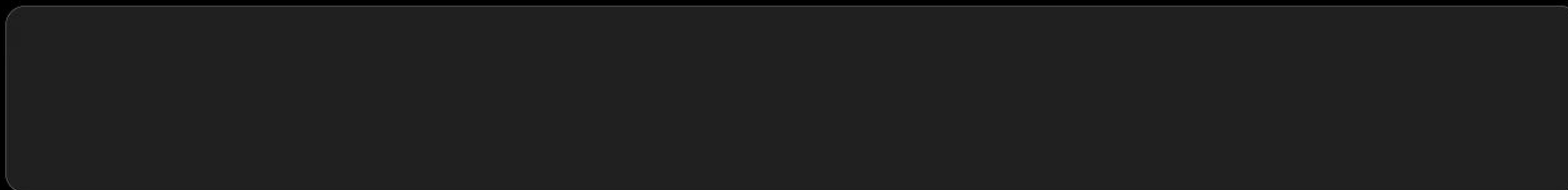
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Example:

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>>> squares = map(lambda x: x ** 2, range(11))
>>> list(squares)
[0, 1, 4, 9, 16, 25, 36, 49, 64, 81, 100]
>>> _
```

