n! Done Recursively

Matt Bishop

MHI 289I, Fall Quarter 2024

The Recursive n! Program

```
1: def fact(n):
2:       # base case: 0! = 1 (by definition)
3:       if n == 0:
4:           return 1
5:       # recursion: n! = n * (n-1)!
6:       return n * fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```

Initial call to fact: fact(n ← 4)

```
1: def fact(n):
2:     # base case: 0! = 1 (by definition)
3:     if n == 0:
4:         return 1
5:     # recursion: n! = n * (n-1)!
6:     return n * fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```

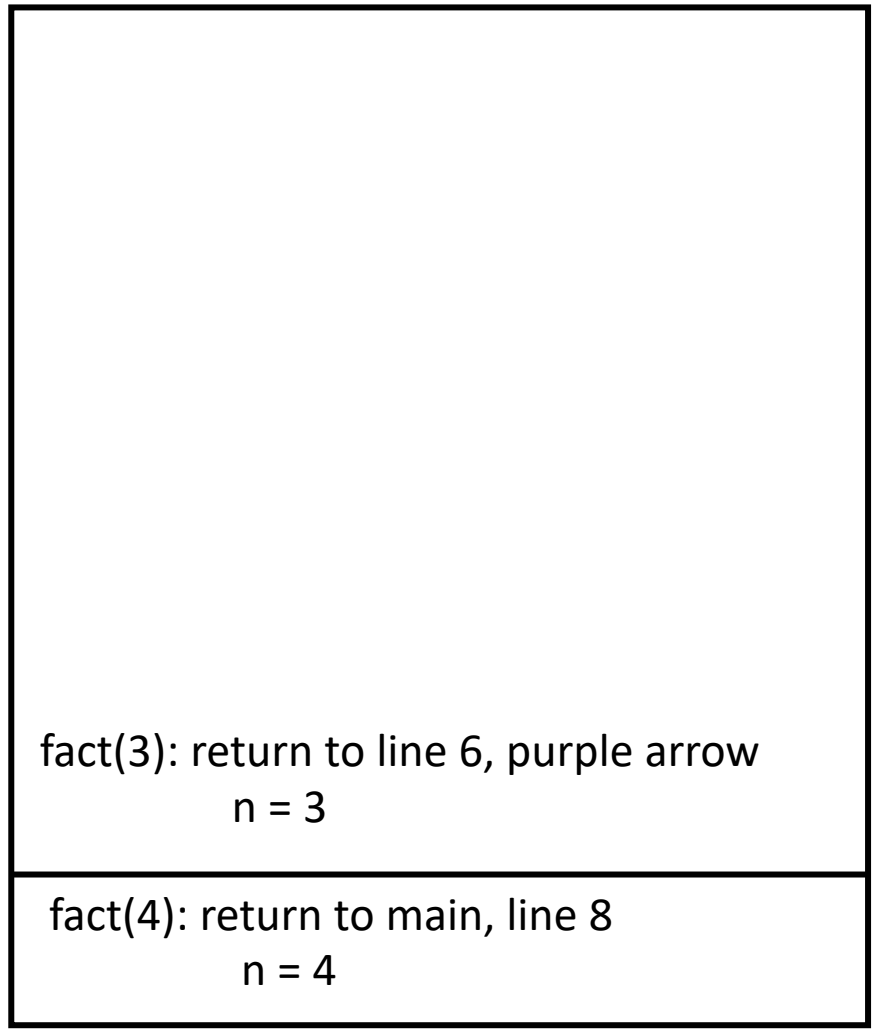
fact(4): return to main, line 8
n = 4

fact(n ← 4):

3: condition false, so skip

6: call fact(4–1), or fact(3)

```
1: def fact(n):
 2:     # base case: 0! = 1 (by definition)
 3:     if n == 0:
 4:         return 1
 5:     # recursion: n! = n * (n-1)!
 6:     return n * fact(n-1)
 7:
 8: n = fact(4)
 9: print("4! is", n)
```



fact(n ← 3):

3: condition false, so skip

6: call fact(3–1), or fact(2)

```
1: def fact(n):
2:     # base case: 0! = 1 (by definition)
3:     if n == 0:
4:         return 1
5:     # recursion: n! = n * (n-1)!
6:     return n *  fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```

fact(3): return to line 6, red arrow
n = 2

fact(3): return to line 6, purple arrow
n = 3

fact(4): return to main, line 8
n = 4

fact(n ← 2):

3: condition false, so skip

6: call fact(2–1), or fact(1)

```
1: def fact(n):
2:     # base case: 0! = 1 (by definition)
3:     if n == 0:
4:         return 1
5:     # recursion: n! = n * (n-1)!
6:     return n *    fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```

fact(1): return to line 6, blue arrow n = 1
fact(2): return to line 6, red arrow n = 2
fact(3): return to line 6, purple arrow n = 3
fact(4): return to main, line 8 n = 4

fact(n ← 1):

3: condition false, so skip

6: call fact(1–1), or fact(0)

```
1: def fact(n):
2:     # base case: 0! = 1 (by definition)
3:     if n == 0:
4:         return 1
5:     # recursion: n! = n * (n-1)!
6:     return n *     fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```

fact(0): return to line 6, green arrow n = 0
fact(1): return to line 6, blue arrow n = 1
fact(2): return to line 6, red arrow n = 2
fact(3): return to line 6, purple arrow n = 3
fact(4): return to main, line 8 n = 4

fact(n ← 0):

6: condition true, so return 1

```
1: def fact(n):
2:     # base case: 0! = 1 (by definition)
3:     if n == 0:
4:         return 1
5:     # recursion: n! = n * (n-1)!
6:     return n * fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```

fact(0): return to line 6, green arrow n = 0; return 1
fact(1): return to line 6, blue arrow n = 1
fact(2): return to line 6, red arrow n = 2
fact(3): return to line 6, purple arrow n = 3
fact(4): return to main, line 8 n = 4

fact(n ← 1):

6: fact(0) = 1, so return 1 × 1 = 1

```
1: def fact(n):
2:     # base case: 0! = 1 (by definition)
3:     if n == 0:
4:         return 1
5:     # recursion: n! = n * (n-1)!
6:     return n * fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```

fact(0): return to line, green arrow n = 0; return 1
fact(1): return to line 6, blue arrow n = 1
fact(2): return to line 6, red arrow n = 2
fact(3): return to line 6, purple arrow n = 3
fact(4): return to main, line 8 n = 4

fact(n ← 2):

6: fact(1) = 1, so return 2 × 1 = 2

```
1: def fact(n):
2:     # base case: 0! = 1 (by definition)
3:     if n == 0:
4:         return 1
5:     # recursion: n! = n * (n-1)!
6:     return n * fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```

fact(0): return to line 6, green arrow
n = 0; return 1

fact(1): return to line 6, blue arrow
n = 1; fact(0) = 1; return 1

fact(2): return to line 6, red arrow
n = 2; fact(1) = 1; return 2

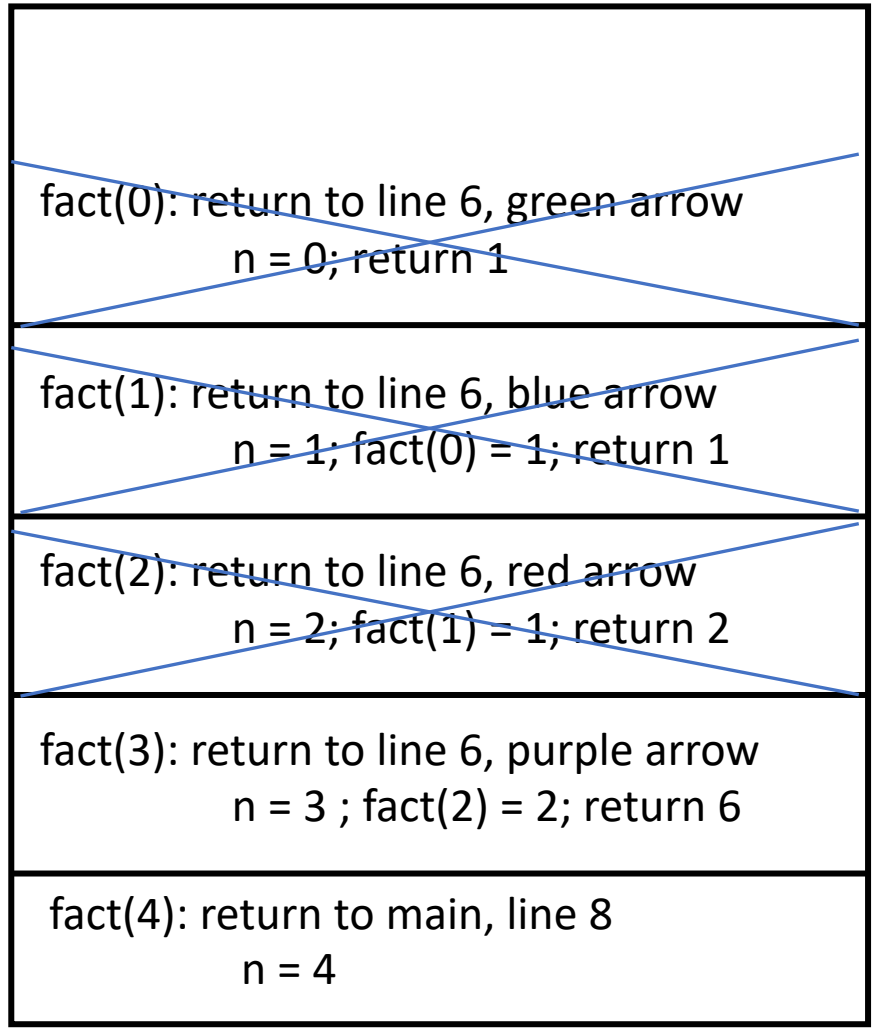
fact(3): return to line 6, purple arrow
n = 3 ; fact(2) = 2

fact(4): return to main, line 8
n = 4

fact(n ← 3):

6: fact(2) = 2, so return 3 × 2 = 6

```
1: def fact(n):
2:     # base case: 0! = 1 (by definition)
3:     if n == 0:
4:         return 1
5:     # recursion: n! = n * (n-1)!
6:     return n * fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```



fact(n ← 4):

6: nfact(3) = 6, so return 4 × 6 = 24

```
1: def fact(n):
2:     # base case: 0! = 1 (by definition)
3:     if n == 0:
4:         return 1
5:     # recursion: n! = n * (n-1)!
6:     return n * fact(n-1)
7:
8: n = fact(4)
9: print("4! is", n)
```