Simple Stack Frame Examples

CS21 at Swarthmore College
At the beginning of the program, `main` is called. We create a new stack frame. Since `main` has no parameters, the stack frame is empty.
Basic Example

```python
1  def f(x,y):
2      x += y
3      print x
4      return x
5
6  def main():
7      n = 4
8      out = f(n,2)
9      print out
10
11  main()
```

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When line 7 of `main` is executed, the variable `n` is set to the value 4. We signify this by drawing a box in the stack frame and labeling it with the variable name. We put the contents of the variable in the box.
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def f(x,y):
    x += y
    print x
    return x

def main():
    n = 4
    out = f(n,2)
    print out

main()

When line 8 is executed, we will call f. To do so, we must first determine the value of each of its arguments. In this case, the first parameter is n, whose value is currently 4. The second parameter is just 2.
Basic Example

```python
def f(x, y):
    x += y
    print x
    return x

def main():
    n = 4
    out = f(n, 2)
    print out

main()
```

Once we’ve established the value of the arguments on line 8 (4 and 2, respectively), the `f` function is called. We create a new stack frame. Since `f` has two parameters, we create variables for them in the stack frame. They contain the values of their corresponding arguments.
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```python
def f(x,y):
    x += y
    print x
    return x

def main():
    n = 4
    out = f(n,2)
    print out

main()
```

Note that the stack frame for main is keeping track of where we were in that function. When we are done with \( f \), we will return to that line.
When we run line 2 in $f$, we will update the variable $x$ by adding the contents of the variable $y$ to it. We change the stack diagram accordingly.
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    return x

def main():
    n = 4
    out = f(n, 2)
    print out

main()
```

Line 3 will print the contents of the `x` variable: in this case, 6.
Basic Example

```python
def f(x, y):
    x += y
    print x
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def main():
    n = 4
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def f(x,y):
    x += y
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def main():
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Line 4 will return the value of `x` to the place where `f` was called. As a result, the variable `out` in `main` is given the value 6.
**Basic Example**

```python
1 def f(x,y):
    x += y
    print x
    return x

2 def main():
    n = 4
    out = f(n,2)
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3 main()
```

Line 4 will return the value of \( x \) to the place where \( f \) was called. As a result, the variable \( out \) in \( \text{main} \) is given the value 6.
Basic Example

```python
1 def f(x, y):
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Line 4 will return the value of `x` to the place where `f` was called. As a result, the variable `out` in `main` is given the value 6.
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3     print x
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6 def main():
7     n = 4
8     out = f(n,2)
9     print out
10 main()
```

Line 9 prints the contents of the `out` variable (here, 6). After it runs, the `main` function is complete and the program is finished.
def f(x, y):
    x += y
    print x
    return x

def main():
    n = 4
    out = f(n, 2)
    print out

main()

Line 9 prints the contents of the out variable (here, 6). After it runs, the main function is complete and the program is finished.
As before, `main` is called at the start of this program. We create a new stack frame for it.
Lists Example

```python
def add_twice(lst, x):
    lst.append(x)
    lst.append(x)

def main():
    data = [1]
    add_twice(data, 2)
    print(data)
    add_twice(data, 3)
    print(data)

main()
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def main():
    data = [1]
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    print(data)
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main()
```

Line 6 of `main` creates a new list containing just the value 1. A reference to that list is stored in the `data` variable. We represent the list by using a rounded box; we represent the reference as an arrow.
def add_twice(lst, x):
    lst.append(x)
    lst.append(x)

def main():
    data = [1]
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    print data
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    lst.append(x)
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def main():
    data = [1]
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    print data
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main()

Line 7 of main is a function call. Just as before, we create a new stack frame and copy each argument into its corresponding parameter. Here, we copy the value 2 into the variable x and we copy the reference from data into the variable lst.
Line 7 of `main` is a function call. Just as before, we create a new stack frame and copy each argument into its corresponding parameter. Here, we copy the value 2 into the variable `x` and we copy the *reference* from `data` into the variable `lst`. 
def add_twice(lst, x):
    lst.append(x)
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def main():
    data = [1]
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    print(data)
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    print(data)

main()

Line 2 of add_twice appends a copy of the value in x to the end of the list. Here, that value is 2. We change the list object in our diagram to reflect this.
def add_twice(lst, x):
    lst.append(x)
    lst.append(x)

def main():
    data = [1]
    add_twice(data, 2)
    print data
    add_twice(data, 3)
    print data

main()

Line 2 of add_twice appends a copy of the value in x to the end of the list. Here, that value is 2. We change the list object in our diagram to reflect this.
Of course, line 3 does the same thing; this adds another 2 to our list. Note that this function doesn’t return anything; it just adds to the list.
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def add_twice(lst, x):
    lst.append(x)
    lst.append(x)

def main():
    data = [1]
    add_twice(data, 2)
    print data
    add_twice(data, 3)
    print data

main()
```

Once we're finished with the add_twice function, we destroy its stack frame and return to executing main.
Lists Example

```python
def add_twice(lst, x):
    lst.append(x)
    lst.append(x)

def main():
    data = [1]
    add_twice(data, 2)
    print data
    add_twice(data, 3)
    print data

main()
```

Line 8 of `main` prints the contents of the list to which `data` refers. Because of the call to `add_twice`, this list changed. So `main` prints "[1,2,2]".
Lists Example

```python
def add_twice(lst, x):
    lst.append(x)
    lst.append(x)

def main():
    data = [1]
    add_twice(data, 2)
    print(data)
    add_twice(data, 3)
    print(data)

main()
```

Line 9 of `main` calls `add_twice` again. Just as last time, we copy the arguments into their respective parameters. This time, `x` is set to 3; `lst` is still set to the same reference as `data`. 
```python
def add_twice(lst, x):
    lst.append(x)
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def main():
    data = [1]
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Once again, `add_twice` adds the value contained in `x` to the list referenced by `lst`; it does this twice.
def add_twice(lst, x):
    lst.append(x)
    lst.append(x)

def main():
    data = [1]
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main()

Once again, add_twice adds the value contained in x to the list referenced by lst; it does this twice.
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def add_twice(lst, x):
    lst.append(x)
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Once again, `add_twice` adds the value contained in `x` to the list referenced by `lst`; it does this twice.
def add_twice(lst,x):
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    lst.append(x)

def main():
    data = [1]
    add_twice(data,2)
    print data
    add_twice(data,3)
    print data

main()

We finish add_twice, discarding its stack frame. We return to main, where line 10 prints the contents of the list. Because it has been changed again, we print [1, 2, 2, 3, 3] this time.
Lists Example

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def add_twice(lst, x):
    lst.append(x)
    lst.append(x)

def main():
    data = [1]
    add_twice(data, 2)
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With that, the program is finished.
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