

Parameters

We have discussed different classes of variables so far:

- Global/static variables
- Function local or automatic variables
- Dynamic, heap allocated variables

Chap 18

However, one important class of variables is still missing $\Rightarrow$ parameters

Terminology: Example: Java, C, C++

Function Definition	{	int plus (int a, int b)	← <u>Formal</u> Parameters
		{ return a + b; }	Function Body
Function Call	{	int x = plus(1,2);	← <u>Actual</u> Parameters
		...	

Observation: in function definitions formal parameters act as placeholders for the values of actual parameters.

Two Fundamental Questions

- How is the correspondence between actual and formal parameters established?
- How is the value of an actual parameter transmitted to a formal parameter?

Correspondence

Most programming languages use positional parameters; the first actual parameter is assigned to the first formal parameter, the second actual parameter is assigned to the second formal parameters, *etc.*

```
      1 2  
int x = plus(1,2);  
           ↓ ↓  
      1 2  
int plus (int a, int b)  
{  
    return a + b;  
}
```

The diagram shows the correspondence between the arguments in the function call `plus(1,2)` and the parameters in the function definition `plus(int a, int b)`. The arguments `1` and `2` are labeled with `1` and `2` above them. The parameters `int a` and `int b` are labeled with `1` and `2` above them. Red circles highlight the arguments `1` and `2` in the call, and the parameters `int a` and `int b` in the definition. Arrows point from the argument `1` to the parameter `int a`, and from the argument `2` to the parameter `int b`, demonstrating positional correspondence.

Correspondence

Some languages such as Ada provide keyword parameters.

Example: Ada

```
FUNCTION Divide(Dividend:Float, Divisor:Float) RETURN Float IS  
BEGIN  
    RETURN Dividend/Divisor;  
END
```

```
...  
Foo = Divide(Divisor => 2.0, Dividend => 4.0);  
...
```

2nd formal
parameter
becomes 2.0

1st formal
Parameter
Becomes 4.0

Parameter Value Transmission

- We look at three different techniques
 - By value
 - By value-result
 - By reference

I. By Value

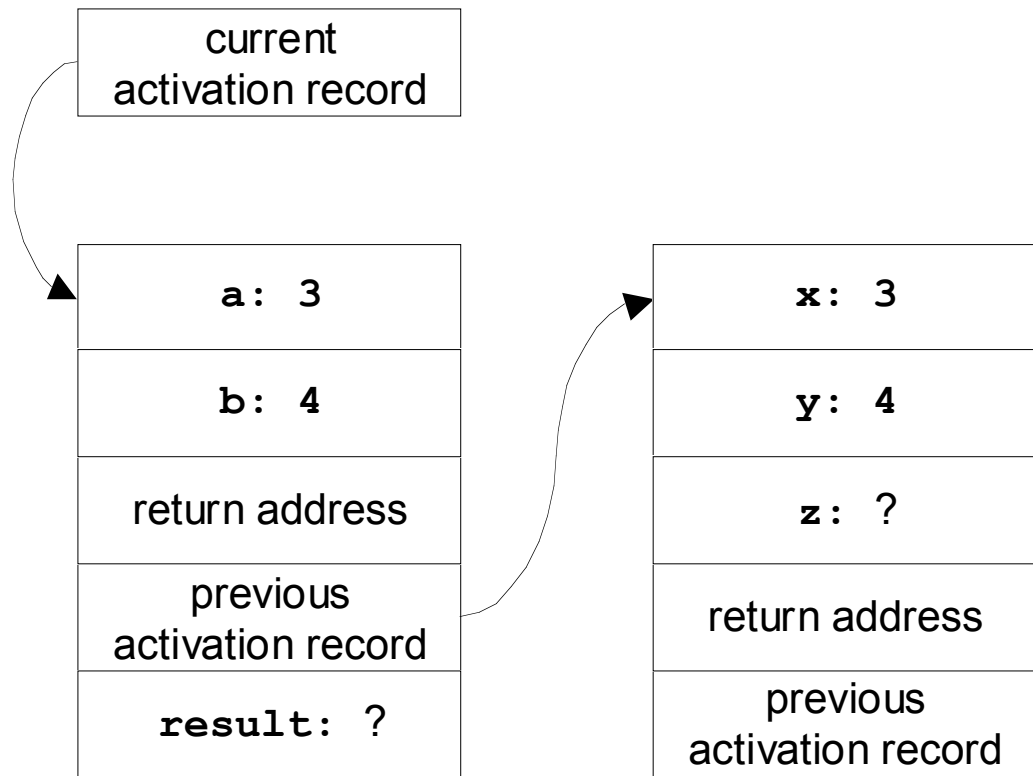
For by-value parameter passing, the formal parameter is just like a local variable in the activation record of the called method, with one important difference: it is initialized using the value of the corresponding actual parameter, before the called method begins executing.

- Also called ‘copy-in’
- Simplest method
- Widely used
- The only method in Java

By Value - Example

```
int plus(int a, int b) {  
    a += b;  
    return a;  
}  
  
void f() {  
    int x = 3;  
    int y = 4;  
    int z = plus(x, y);  
}
```

When **plus**
is starting



II. By Value-Result

For passing parameters by value-result, the formal parameter is just like a local variable in the activation record of the called method. It is initialized using the value of the corresponding actual parameter, before the called method begins executing. Then, after the called method finishes executing, the final value of the formal parameter is assigned to the actual parameter.

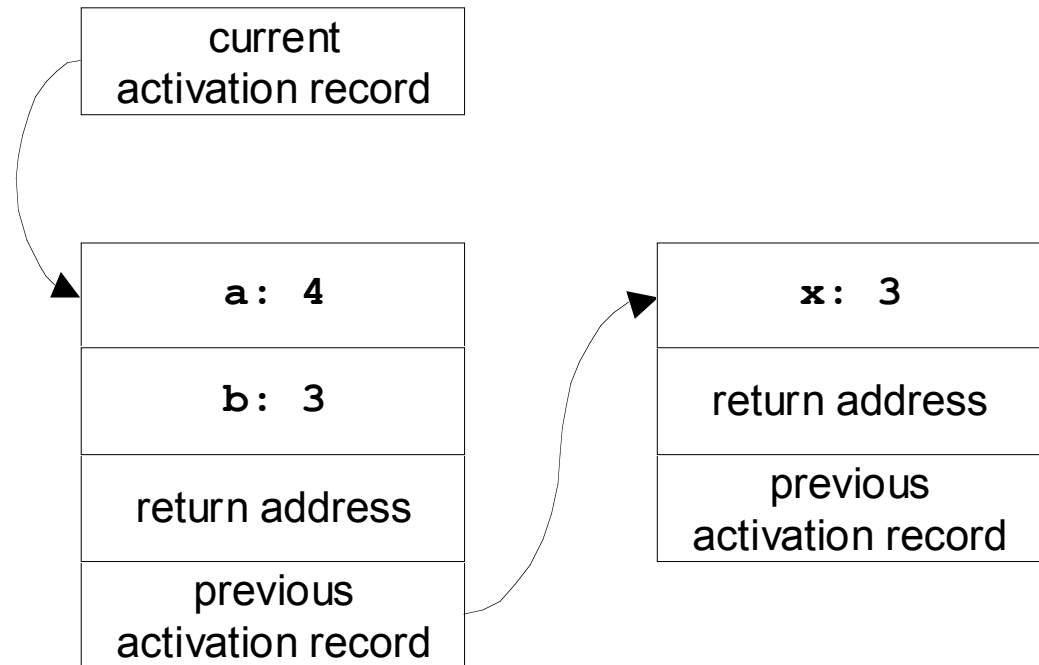
- Also called ‘copy-in/copy-out’
- Actual must have an lvalue

Lvalues are values that have addresses, meaning they are variables or dereferenced references to a certain place.

By Value-Result - Example

```
void plus(int a, by-value-result int b) {  
    b += a;  
}  
void f() {  
    int x = 3;  
    plus(4, x);  
}
```

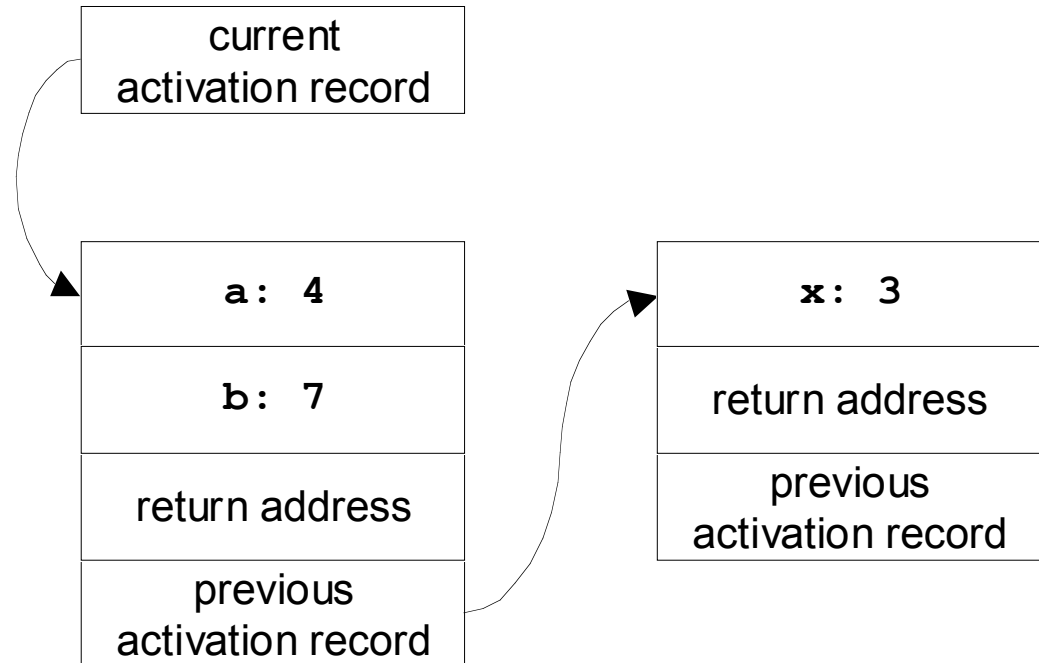
When **plus**
is starting



By Value-Result - Example

```
void plus(int a, by-value-result int b) {  
    b += a;  
}  
void f() {  
    int x = 3;  
    plus(4, x);  
}
```

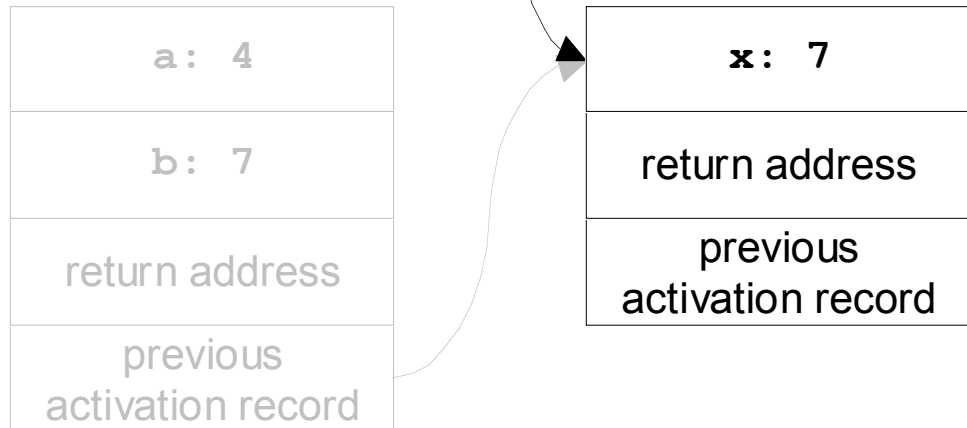
When **plus** is
ready to return



By Value-Result - Example

```
void plus(int a, by-value-result int b) {  
    b += a;  
}  
void f() {  
    int x = 3;  
    plus(4, x);  
}
```

When **plus**
has returned



III. By Reference

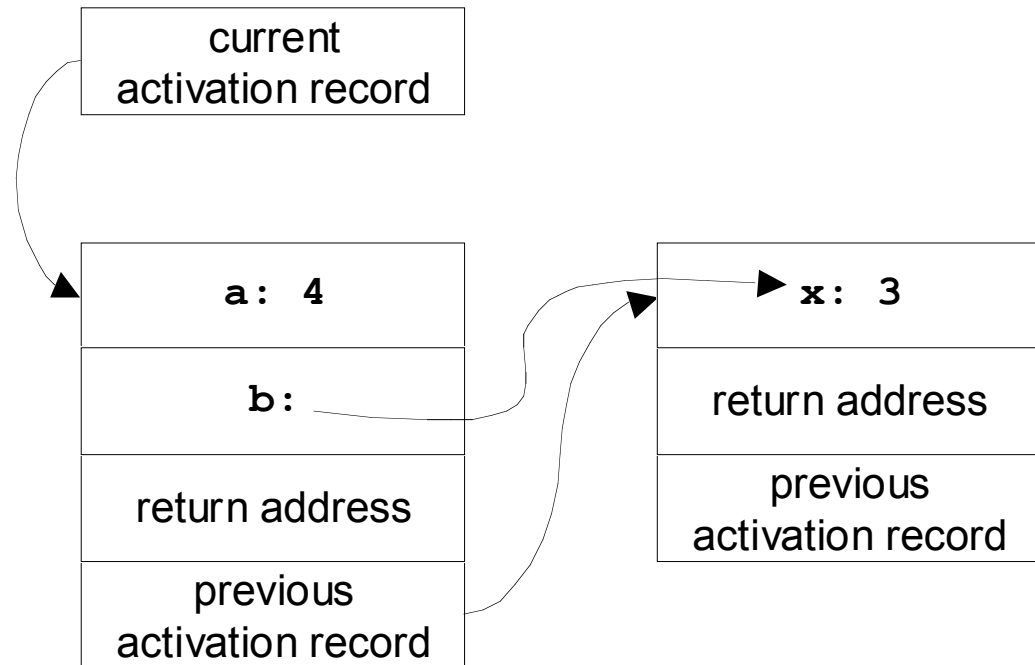
For passing parameters by reference, the lvalue of the actual parameter is computed before the called method executes. Inside the called method, that lvalue is used as the lvalue of the corresponding formal parameter. In effect, the formal parameter is an alias for the actual parameter—another name for the same memory location.

- One of the earliest methods: Fortran
- Most efficient for large objects
- Still frequently used; C++ allows you define calls by reference

By Reference - Example

```
void plus(int a, by-reference int b) {  
    b += a;  
}  
void f() {  
    int x = 3;  
    plus(4, x);  
}
```

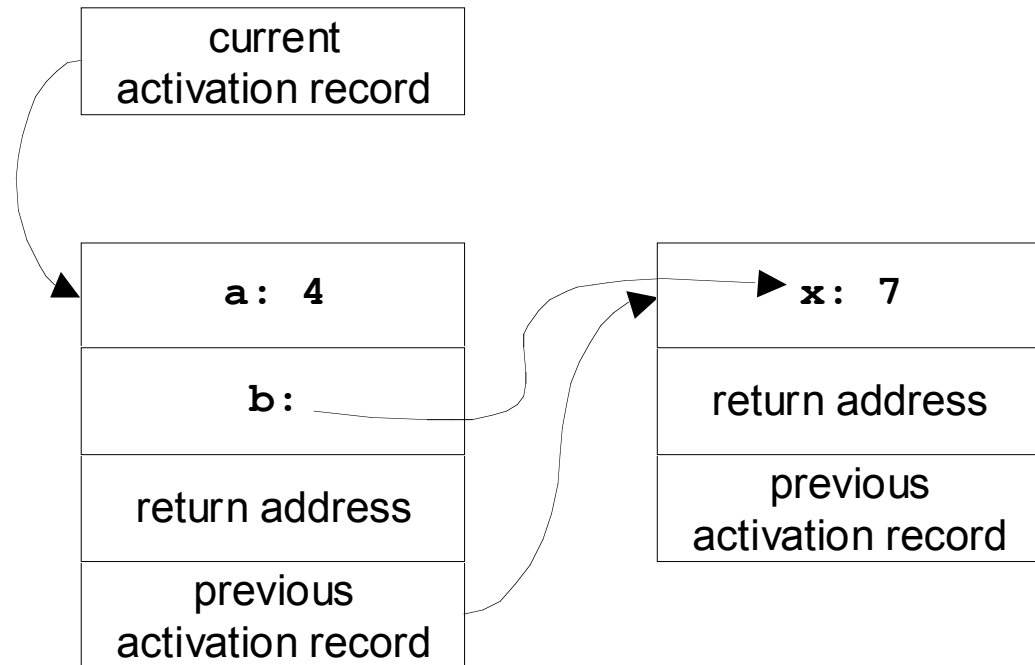
When **plus**
is starting



By Reference - Example

```
void plus(int a, by-reference int b) {  
    b += a;  
}  
void f() {  
    int x = 3;  
    plus(4, x);  
}
```

When **plus**
has made the
assignment



Homework

- HW#9 – see website