Parameter Passing

Connecting Caller and Callee

- When you call a method, how are the ***arguments*** connected to the ***formal parameters***?
- When the called method body ***returns***, how are results communicated back to the code that called the method?

Example: GCD

- Suppose we have a static method `gcd` that computes and returns the ***greatest common divisor (GCD)*** of two **`int`**s:

```
public static int gcd(int i, int j) {
   ...
}
```

- For example:
  - *GCD(24,80) = 8*
  - *GCD(24,24) = 24*

How Calls Work In Java

```
public static int gcd(int i, int j) {
 int k = 1;
 ...
 return k;
}


...
int a, b;
...
int c = gcd(a, b);
```

How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}


...
int a, b;
...
int c = gcd(a, b);
```

This is the method `gcd` that is being called; `i` and `j` are its ***formal parameters***.

How Calls Work In Java

```
public static int gcd(int i, int j) {
 int k = 1;
 ...
 return k;
}


...
int a, b;
...
int c = gcd(a, b);
```

This is a fragment of the calling program; `a` and `b` are the ***arguments*** to this call of `gcd`.

How Calls Work In Java

```
public static int gcd(int i, int j) {
 int k = 1;
 ...
 return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

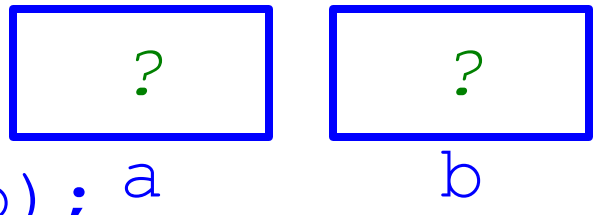
Suppose the solid red arrow indicates where program flow-of-control has taken us so far.

How Calls Work In Java

```
public static int gcd(int i, int j) {
 int k = 1;
 ...
 return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

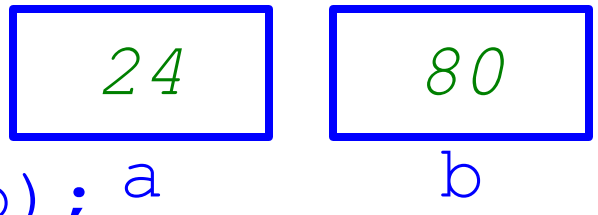
How Calls Work In Java

```
public static int gcd(int i, int j) {
 int k = 1;
 ...
 return k;
}


...
int a, b;
...
int c = gcd(a, b);
```



How Calls Work In Java

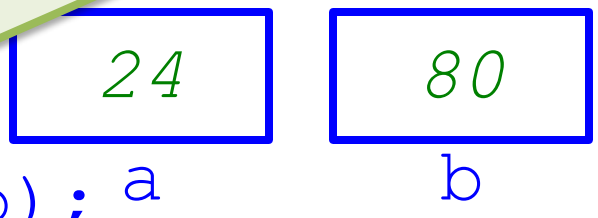
```
public static int gcd(int i, int j) {
 int k = 1;
 ...
 return k;
}


...
int a, b;
...
int c = gcd(a, b);
```



How Calls Work In Java

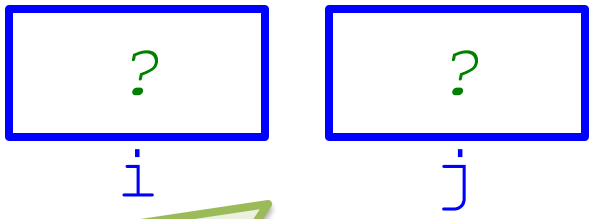
```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

The call to `gcd` begins ...

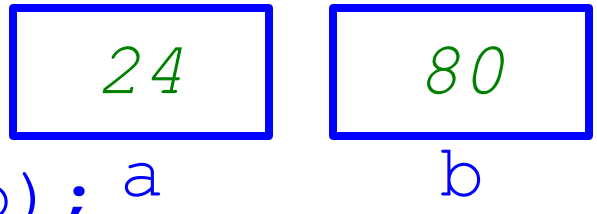


How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

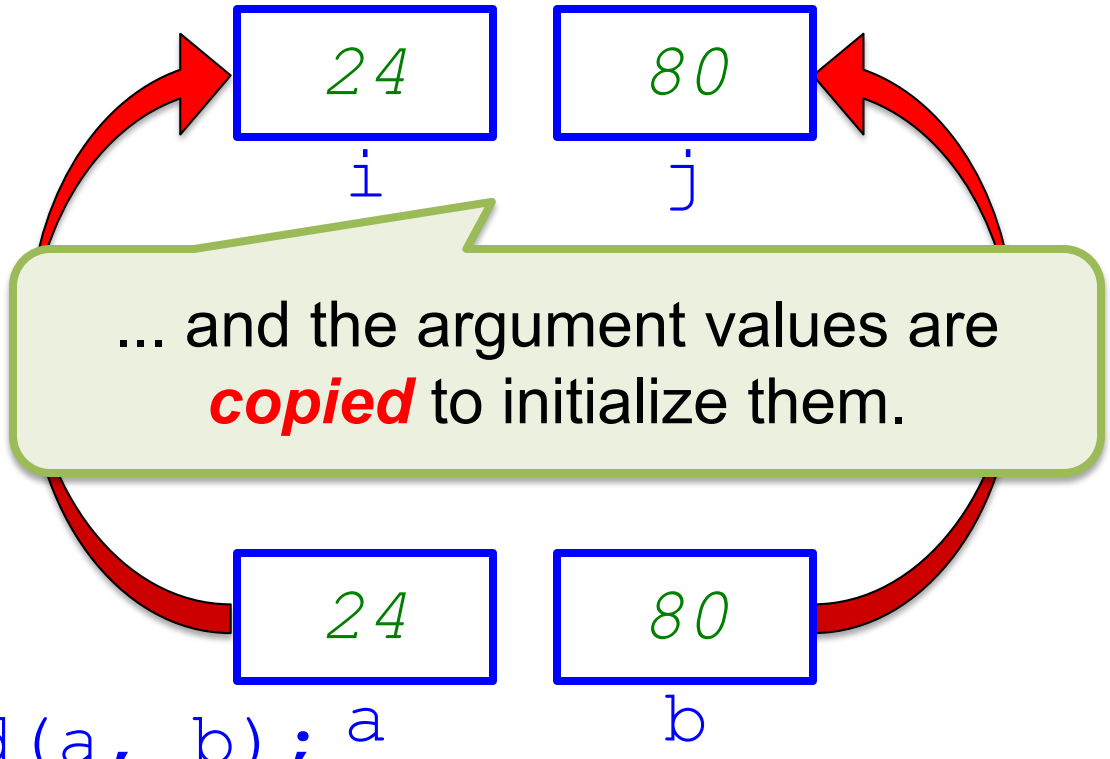


... so the formal parameters are effectively declared ...



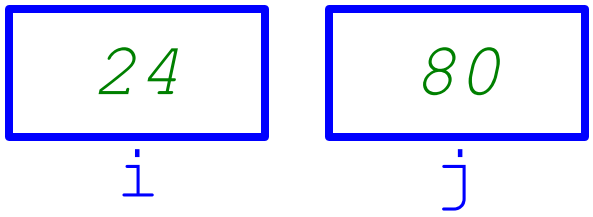
How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}


...
int a, b;
...
int c = gcd(a, b);
```

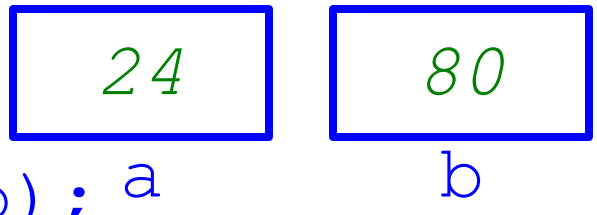


How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}


...
int a, b;
...
int c = gcd(a, b);
```

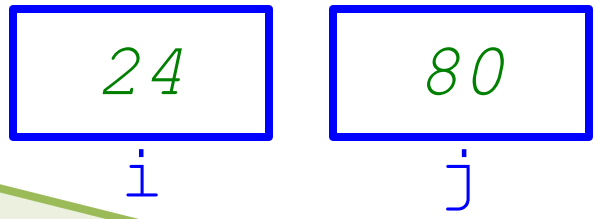


Execution of the calling program is "paused" at the point of the call…

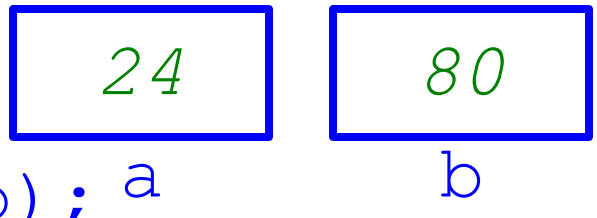


How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

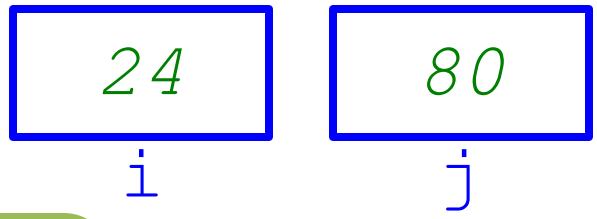


… and control is transferred to the beginning of the method body.

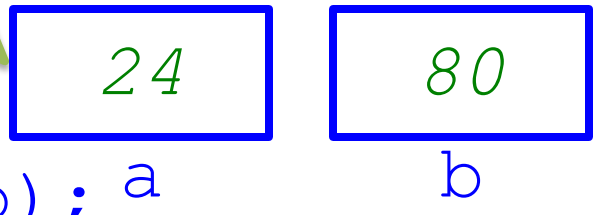


How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}
...
int a, b;
...
int c = gcd(a, b);
```

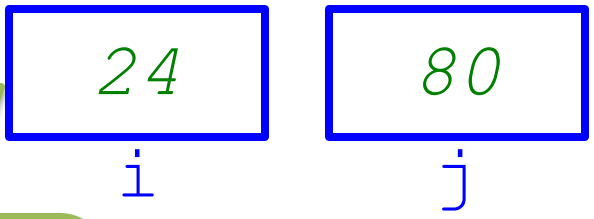


The ***scope*** of these variables is the calling program where they are declared.

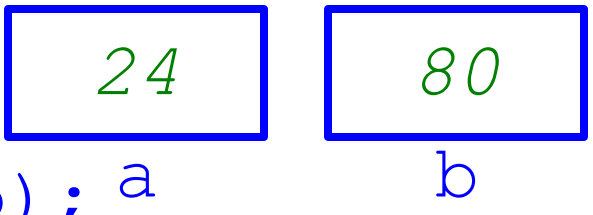


How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}
...
int a, b;
...
int c = gcd(a, b);
```

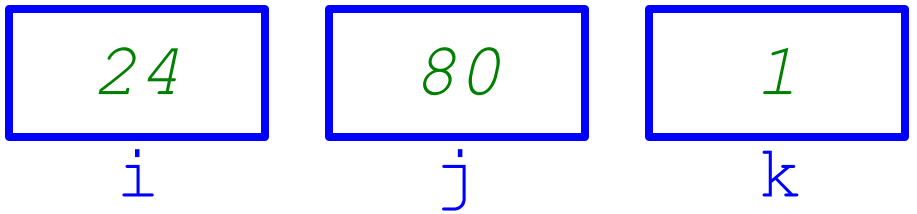


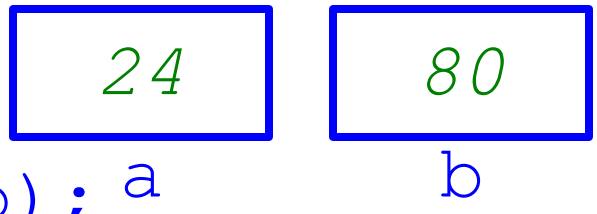
The ***scope*** of these variables is the method body where they are declared.



How Calls Work In Java

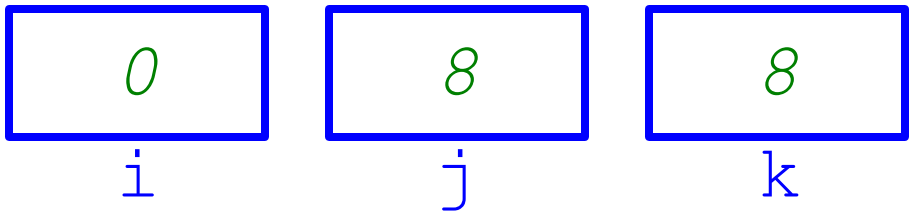
```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

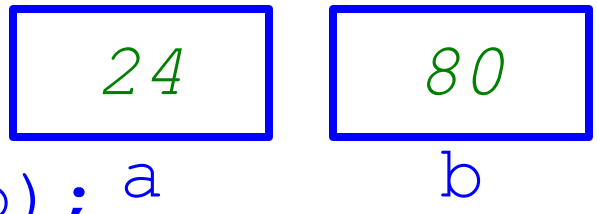




How Calls Work In Java

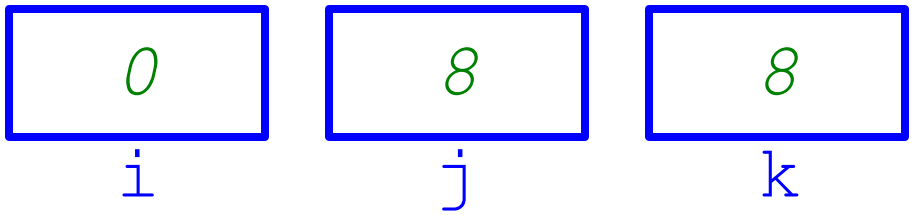
```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```



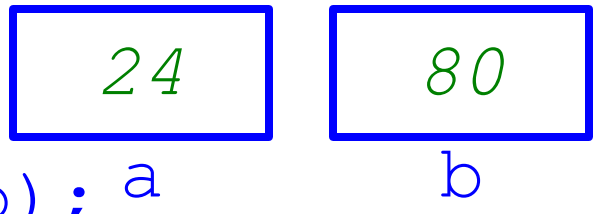


How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

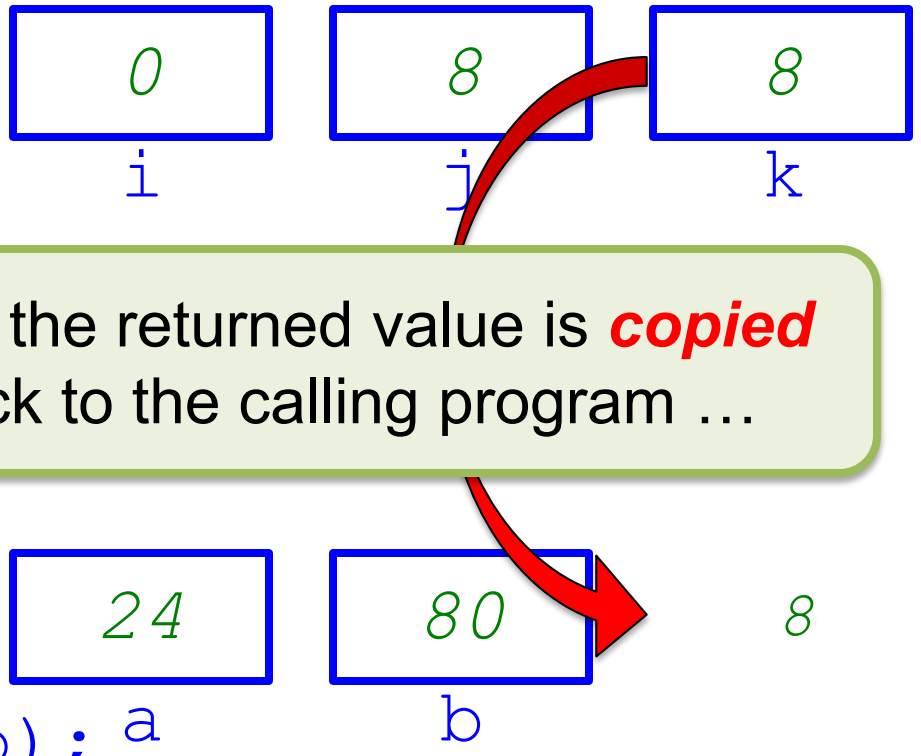


The **`return`** statement immediately ends execution of method body…



How Calls Work In Java

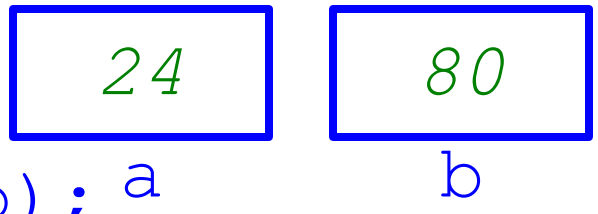
```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```



How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

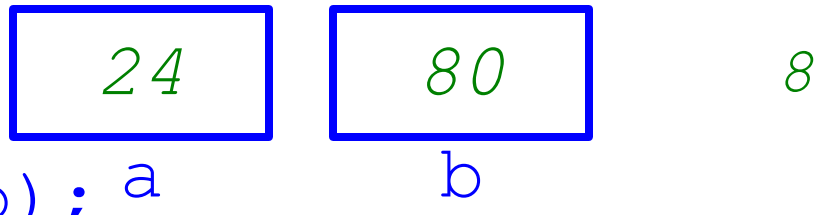
... and the method body has finished, so its variables go away.



How Calls Work In Java

```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

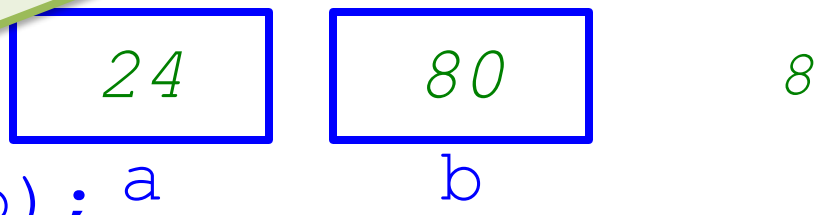
Note that the values of the formal parameters are *not copied back* to the arguments!



How Calls Work In Java

```
public static int gcd(int i, int j) {
 int k = 1;
 ...
 return k;
}


...
int a, b;
...
int c = gcd(a, b);
```

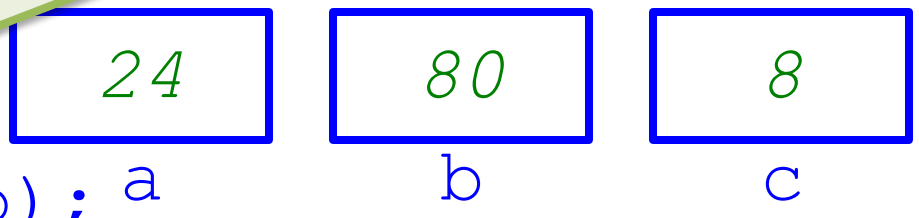
Execution of the calling program "resumes" in mid-statement ...



How Calls Work In Java

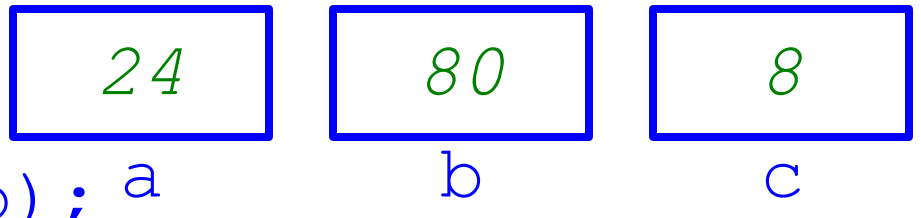
```
public static int gcd(int i, int j) {
  int k = 1;
  ...
  return k;
}

...
int a, b;
...
int c = gcd(a, b);
```

... and the value that was returned by the call is assigned to c.



How Calls Work In Java

```
public static int gcd(int i, int j) {
 int k = 1;
 ...
 return k;
}


...
int a, b;
...
int c = gcd(a, b);
```



Connecting Caller and Callee

- When you call a method, how are the ***arguments*** connected to the ***formal parameters***?
  - The argument values are ***copied*** into the formal parameters to initialize them
- When the called method body ***returns***, how are results communicated back to the code that called the method?
  - *Only* the returned value is ***copied*** back to the caller; the formal parameters are simply "lost"

Names for This?

- Parameter-passing mechanism of Java:
  - May be termed ***call-by-copying*** because argument values are *copied* into formal parameters
  - May be termed ***call-by-value*** because argument *values* are copied into formal parameters
- There are other ways it might have been done (and is done in some languages)

Tracing Over a Call

Code	State
	a = 24 *b = 80*
`int c = gcd(a, b);`	
	a = 24 *b = 80* *c = 8*