16. More On Lists

Topics:
- References
- Alias
- More on Slicing
- Merging Sorted Lists

Comparing Lists

You can use == to compare two lists

```
>>> x = [10,20,30,40]
>>> y = [10,20,30,40]
>>> x==y
True
```

Comparing Lists

You can use == to compare two lists

```
x --> 0 ---> 10        y --> 0 ---> 10
      1 ---> 20              1 ---> 20
      2 ---> 30              2 ---> 30
      3 ---> 40              3 ---> 40
```

The Boolean expression x==y is True because x and y have the same length and identical values in each element

Comparing Lists

You can use == to compare two lists

```
>>> x = [1,2,3]
>>> y = [1.0,2.0,3.0]
>>> x==y
True
```

If there are ints and floats, convert everything to float then compare

Comparing Lists

Do not use <, <= , > , >= to compare two lists

```
>>> x = [10,20,30,40]
>>> y = [11,21,31,41]
>>> x<y
True
>>> y<x
True
```

Unpredictable

Aliasing

This:

```
x = [10,20,30,40]
y = x
```

Results in this:

```
x --> 0 ---> 10
      1 ---> 20
      2 ---> 30
y --> 3 ---> 40
```

Aliasing

```
x -->  0 --->  10
       1 --->  20
y -->  2 --->  30
       3 --->  40
```

Things to say:

x and y are variables that refer to the same list object.

The object is aliased because it has more than one name.

Tracking Changes

```
● x = [10,20,30,40]          x -->  0 --->  10
  y = x                             1 --->  20
  y = [1,2,3]                       2 --->  30
                                    3 --->  40
```

Tracking Changes

```
  x = [10,20,30,40]          x -->  0 --->  10
● y = x                             1 --->  20
  y = [1,2,3]                y -->  2 --->  30
                                    3 --->  40
```

Tracking Changes

```
  x = [10,20,30,40]          x -->  0 --->  10
  y = x                             1 --->  20
● y = [1,2,3]                       2 --->  30
                                    3 --->  40

                             y -->  0 --->  1
                                    1 --->  2
                                    2 --->  3
```

The is Operator

```
>>> x = [10,20,30,40]
>>> y = [10,20,30,40]
>>> x is y
False
```

```
x -->  0 --->  10        y -->  0 --->  10
       1 --->  20               1 --->  20
       2 --->  30               2 --->  30
       3 --->  40               3 --->  40
```

Even though the two lists have the same component values. x and y do not refer to the same object.

The is Operator

```
>>> x = [10,20,30,40]
>>> y = x
>>> x is y
True
```

```
x -->  0 --->  10
       1 --->  20
y -->  2 --->  30
       3 --->  40
```

x and y refer to the same object

Making a Copy of a List

```
● x = [10,20,30,40]          x -->  0 --->  10
  y = list(x)                       1 --->  20
                                    2 --->  30
                                    3 --->  40
```

Making a Copy of a List

```
  x = [10,20,30,40]          x -->  0 --->  10
● y = list(x)                       1 --->  20
                                    2 --->  30
                                    3 --->  40

                             y -->  0 --->  10
                                    1 --->  20
                                    2 --->  30
                                    3 --->  40
```

Slices Create new Objects

```
● x = [10,20,30,40]          x -->  0 --->  10
  y = x[1:]                         1 --->  20
                                    2 --->  30
                                    3 --->  40
```

Slices Create New Objects

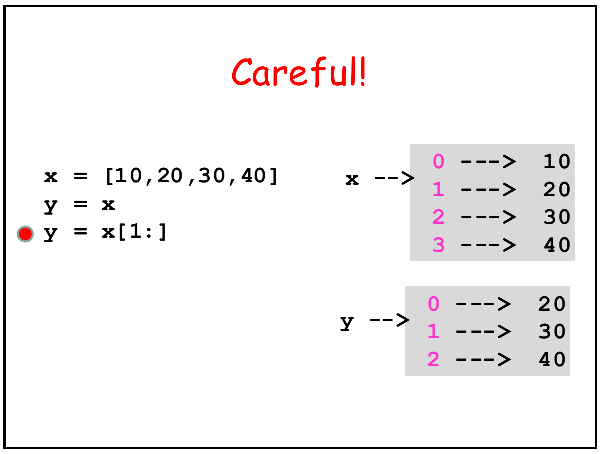
```
  x = [10,20,30,40]          x -->  0 --->  10
● y = x[1:]                         1 --->  20
                                    2 --->  30
                                    3 --->  40

                             y -->  0 --->  20
                                    1 --->  30
                                    2 --->  40
```

Careful!

```
● x = [10,20,30,40]          x -->  0 --->  10
  y = x                             1 --->  20
  y = x[1:]                         2 --->  30
                                    3 --->  40
```

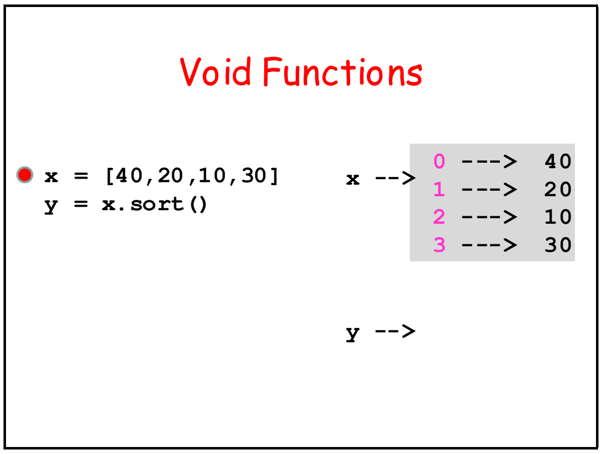
Careful!

```
  x = [10,20,30,40]          x -->  0 --->  10
● y = x                             1 --->  20
  y = x[1:]                         2 --->  30
                             y -->  3 --->  40
```



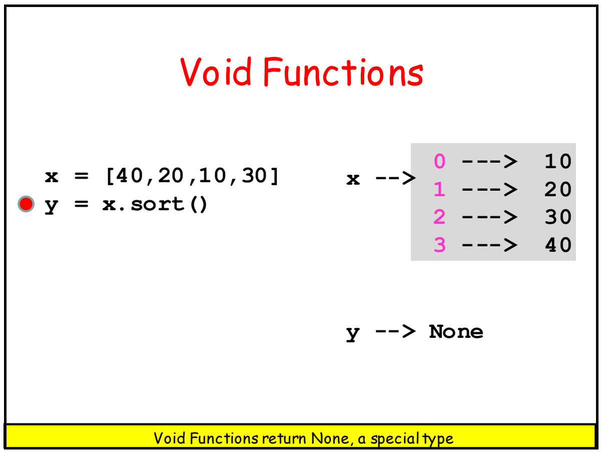
Careful!

```
  x = [10,20,30,40]        x -->  0 --->  10
  y = x                           1 --->  20
● y = x[1:]                       2 --->  30
                                  3 --->  40

                           y -->  0 --->  20
                                  1 --->  30
                                  2 --->  40
```



Void Functions

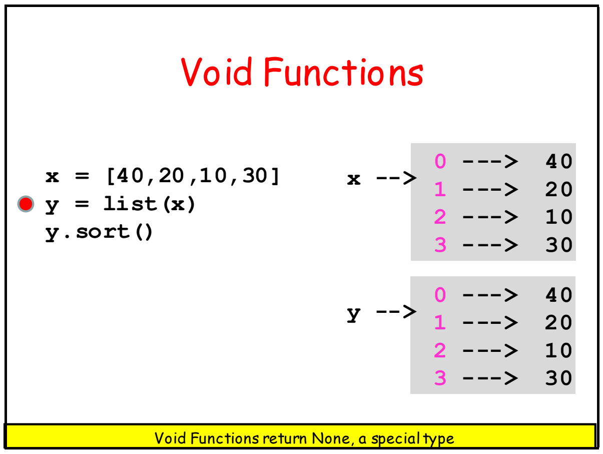
```
● x = [40,20,10,30]        x -->  0 --->  40
  y = x.sort()                    1 --->  20
                                  2 --->  10
                                  3 --->  30


                           y -->
```



Void Functions

```
  x = [40,20,10,30]        x -->  0 --->  10
● y = x.sort()                    1 --->  20
                                  2 --->  30
                                  3 --->  40


                           y --> None
```

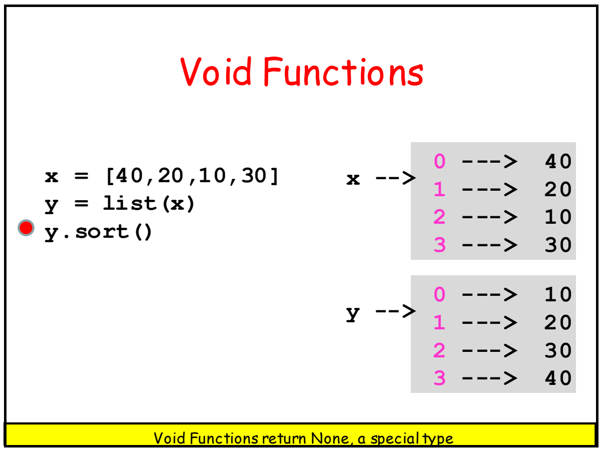
Void Functions return None, a special type



Void Functions

```
  x = [40,20,10,30]        x -->  0 --->  40
● y = list(x)                     1 --->  20
  y.sort()                        2 --->  10
                                  3 --->  30

                           y -->  0 --->  40
                                  1 --->  20
                                  2 --->  10
                                  3 --->  30
```

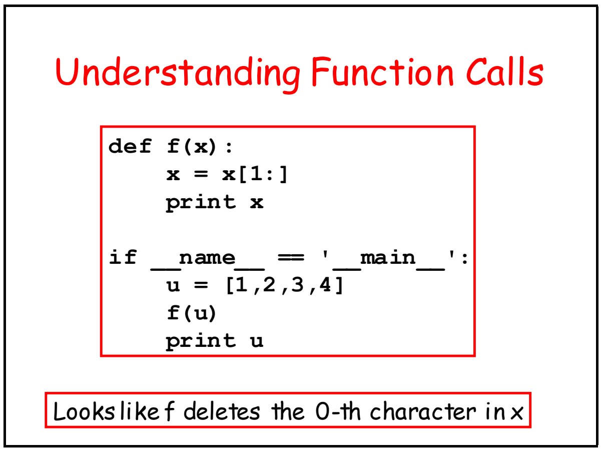
Void Functions return None, a special type



Void Functions

```
  x = [40,20,10,30]        x -->  0 --->  40
  y = list(x)                     1 --->  20
● y.sort()                        2 --->  10
                                  3 --->  30

                           y -->  0 --->  10
                                  1 --->  20
                                  2 --->  30
                                  3 --->  40
```

Void Functions return None, a special type



Understanding Function Calls

```
def f(x):
    x = x[1:]
    print x

if __name__ == '__main__':
    u = [1,2,3,4]
    f(u)
    print u
```

Looks like f deletes the 0-th character in x

Understanding Function Calls

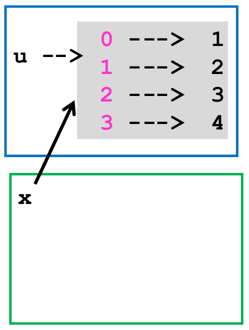
```
def f(x):
    x = x[1:]
    print x

if __name__ blabla
  ● u = [1,2,3,4]
    f(u)
    print u
```

```
u -->  0 ---> 1
       1 ---> 2
       2 ---> 3
       3 ---> 4
```

Follow the red dot and watch for impact...

Understanding Function Calls

```
●def f(x):
    x = x[1:]
    print x

if __name__ blabla
    u = [1,2,3,4]
    f(u)
    print u
```



Parameter x initially refers to the same object as u

Understanding Function Calls

```
def f(x):
  ● x = x[1:]
    print x

if __name__ blabla
    u = [1,2,3,4]
    f(u)
    print u
```

```
u -->  0 ---> 1
       1 ---> 2
       2 ---> 3
       3 ---> 4

x -->  0 ---> 2
       1 ---> 3
       2 ---> 4
```

x[1:] creates a new object and x will refer to it

Understanding Function Calls

```
def f(x):
    x = x[1:]
  ● print x

if __name__ blabla
    u = [1,2,3,4]
    f(u)
    print u
```

```
u -->  0 ---> 1
       1 ---> 2
       2 ---> 3
       3 ---> 4

x -->  0 ---> 2
       1 ---> 3
       2 ---> 4
```

2 3 4 is printed

Understanding Function Calls

```
def f(x):
    x = x[1:]
    print x

if __name__ blabla
    u = [1,2,3,4]
    f(u)
   ●print u
```

```
u -->  0 ---> 1
       1 ---> 2
       2 ---> 3
       3 ---> 4

x -->  0 ---> 2
       1 ---> 3
       2 ---> 4
```

1 2 3 4 is printed

Some Inadvertent Errors

```
>>> x = [10,20,30]
>>> y = [11,21,31]
>>> z = x+y
>>> print z
[10,20,30,11,21,31]
```

Some Inadvertent Errors

```
>>> x = [10,20,30]
>>> y = 3*x
>>>Print y
[10,20,30,10,20,30,10,20,3]
```

List Comprehensions

A short cut for setting up “simple” lists

```
>>> x = [i for i in range(5)]
>>> print x
[0,1,2,3,4]
```

List Comprehensions

A short cut for setting up “simple” lists

```
>>> x = [1 for i in range(5)]
>>> print x
[1,1,1,1,1]
```

List Comprehensions

A short cut for setting up “simple” lists

```
>>> x = [math.sqrt(i) for i in range(5)]
>>> print x
[0,1,1.414,1.732,2.0]
```

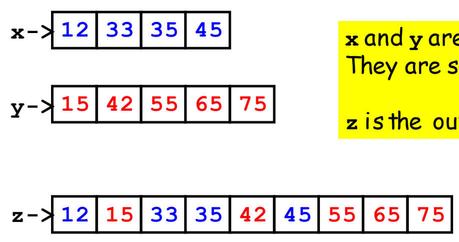
Quickly: Lists of Strings

```
>>> x = [‘Maine’,’Vermont’,’New York’]
>>> a = x[1]
>>> print a
‘Vermont’
>>> c = a[2]
>>> print c
‘r’
>>> x[1][2]
‘r’
```

Next Problem

Merging Two Sorted Arrays
Into a
Single Sorted Array

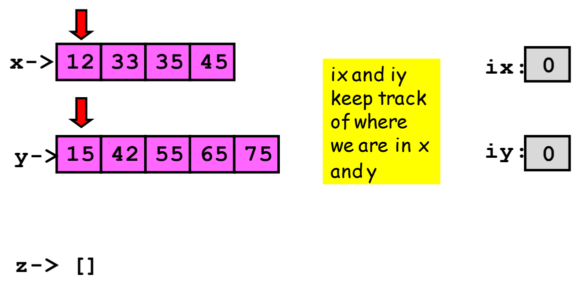
Example



x and **y** are input
They are sorted

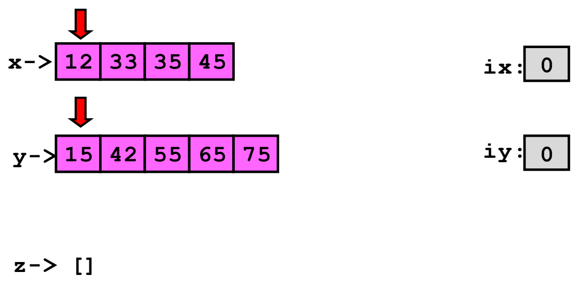
z is the output

Merging Two Sorted Lists



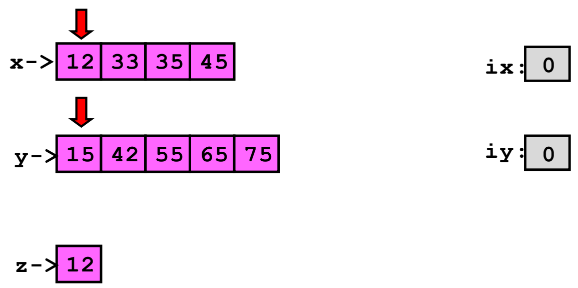
ix and iy keep track of where we are in x and y

Merging Two Sorted Lists



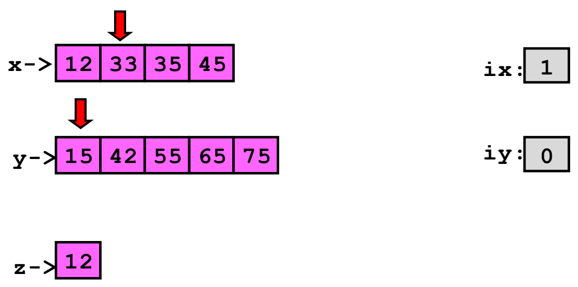
Do we pick from x ? `x[ix] <= y[iy]` ???

Merge



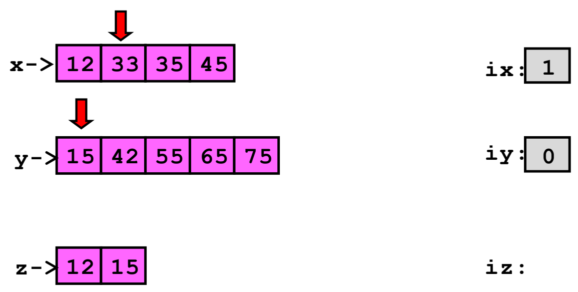
Yes. So update ix

Merge



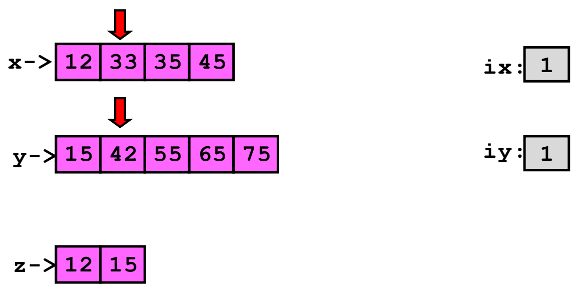
Do we pick from x ? `x[ix] <= y[iy]` ???

Merge



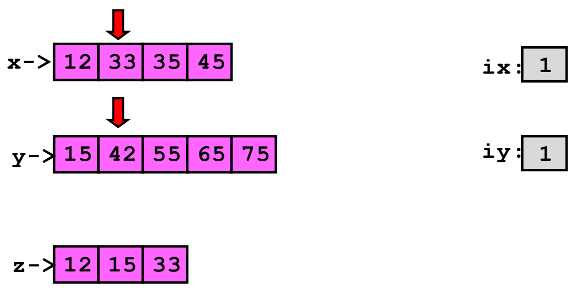
No. So update iy

Merge



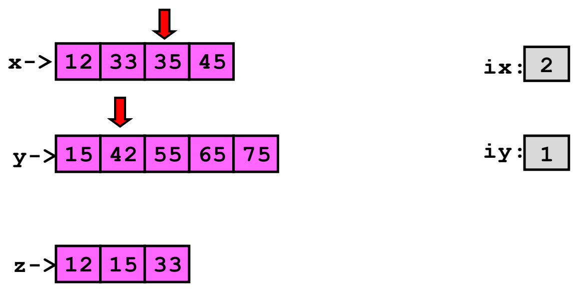
Do we pick from x ? `x[ix] <= y[iy]` ???

Merge



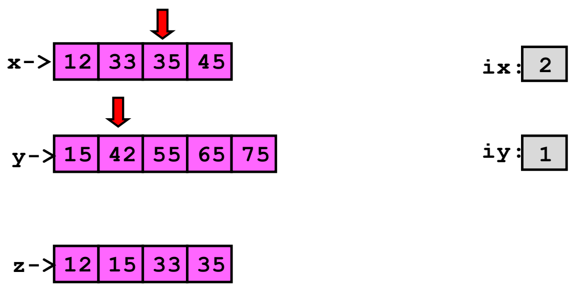
Yes. So update ix

Merge



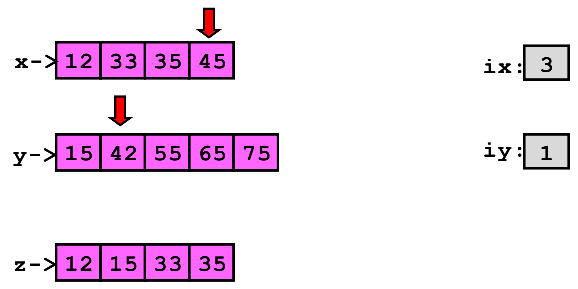
Do we pick from x ? `x[ix] <= y[iy]` ???

Merge



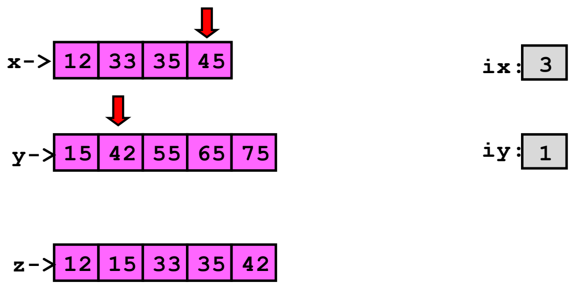
Yes. So update ix

Merge



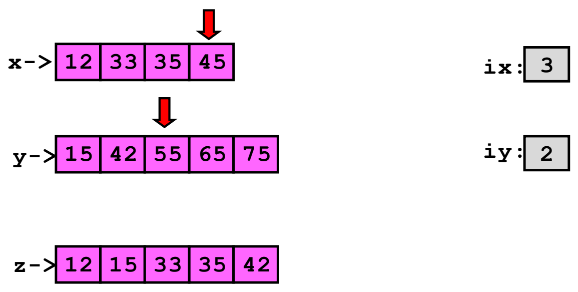
Do we pick from x ? `x[ix] <= y[iy]` ???

Merge



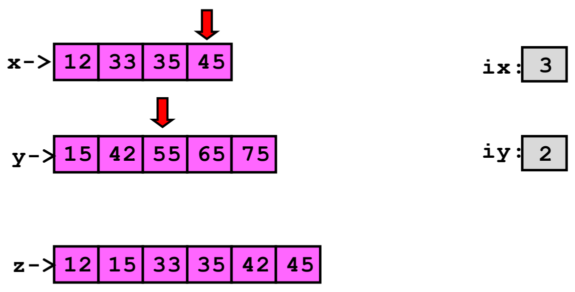
No. So update iy...

Merge



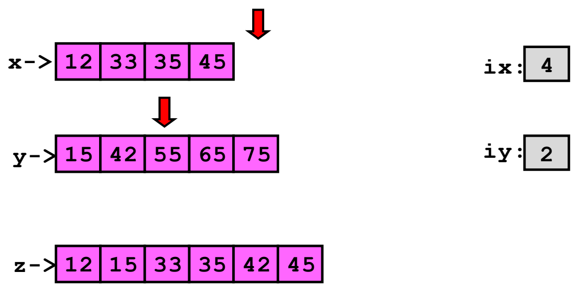
Do we pick from x ? `x[ix] <= y[iy]` ???

Merge



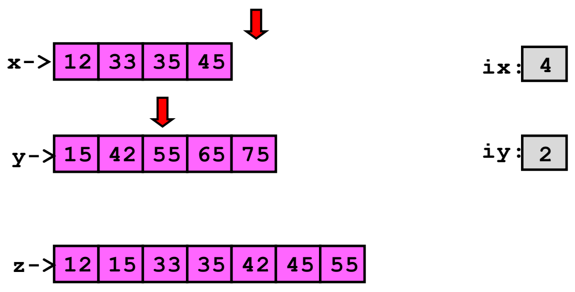
Yes. So update ix.

Merge



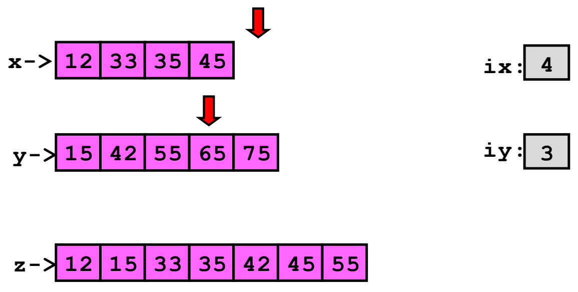
Done with x. Pick from y

Merge



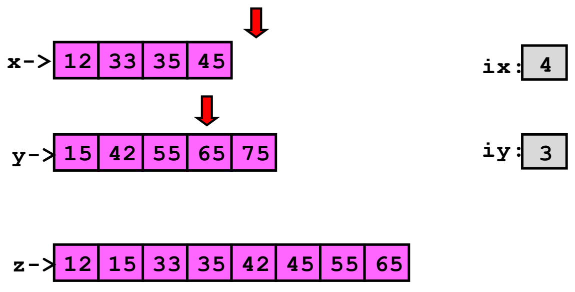
So update iy

Merge



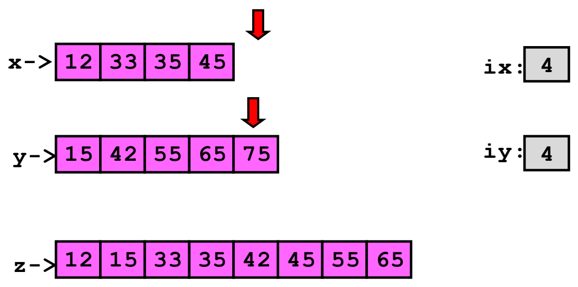
Done with x. Pick from y

Merge



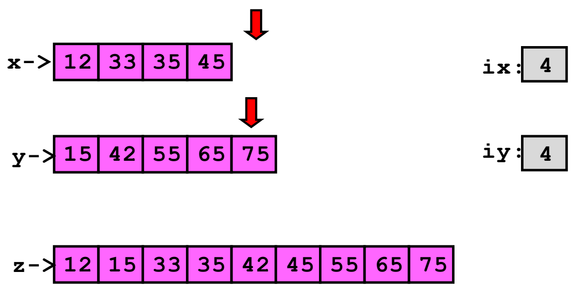
So update iy.

Merge



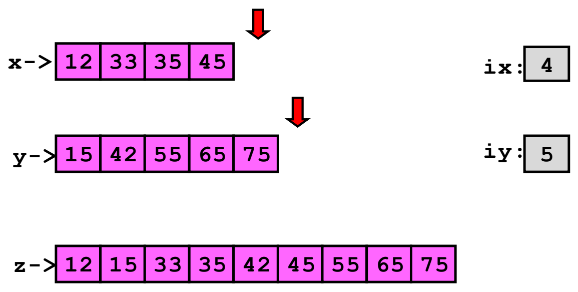
Done with x. Pick from y

Merge



Update iy

Merge



All Done

The Python Implementation…

```
def Merge(x,y):
   n = len(x); m = len(y);
   ix = 0; iy = 0; z = []
   for iz in range(n+m):
       if   ix>=n:
           z.append(y[iy]);  iy+=1
       elif iy>=m:
           z.append(x[ix]);  ix+=1
       elif x[ix] <= y[iy]:
           z.append(x[ix]);  ix+=1
       elif x[ix] > y[iy]:
           z.append(y[iy]);  iy+=1
   return z
```

Build z up via repeated appending

x-list exhausted y-list exhausted x-value smaller y-value smaller

```
def Merge(x,y):
   n = len(x); m = len(y);
   ix = 0; iy = 0; z = []
   for iz in range(n+m):
       if   ix>=n:
           z.append(y[iy]);  iy+=1
       elif iy>=m:
           z.append(x[ix]);  ix+=1
       elif x[ix] <= y[iy]:
           z.append(x[ix]);  ix+=1
       elif x[ix] > y[iy]:
           z.append(y[iy]);  iy+=1
   return z
```

len(x)+len(y) is the total length of the merged list

x-list exhausted y-list exhausted x-value smaller y-value smaller

Implementation Using Pop

```
def Merge(x,y):
    u = list(x)
    v = list(y)
    z = []
    while len(u)>0 and len(v)>0 :
        if u[0]<= v[0]:
            g = u.pop(0)
        else:
            g = v.pop(0)
        z.append(g)
    z.extend(u)
    z.extend(v)
    return z
```

Make copies of the Incoming lists

Implementation Using Pop

```
def Merge(x,y):
    u = list(x)
    v = list(y)
    z = []
    while len(u)>0 and len(v)>0 :
        if u[0]<= v[0]:
            g = u.pop(0)
        else:
            g = v.pop(0)
        z.append(g)
    z.extend(u)
    z.extend(v)
    return z
```

Build z up via repeated appending

Implementation Using Pop

```
def Merge(x,y):
    u = list(x)
    v = list(y)
    z = []
    while len(u)>0 and len(v)>0 :
        if u[0]<= v[0]:
            g = u.pop(0)
        else:
            g = v.pop(0)
        z.append(g)
    z.extend(u)
    z.extend(v)
    return z
```

Every "pop" reduces the length by 1. The loop shuts down when one of u or v is exhausted

Implementation Using Pop

```
def Merge(x,y):
    u = list(x)
    v = list(y)
    z = []
    while len(u)>0 and len(v)>0 :
        if u[0]<= v[0]:
            g = u.pop(0)
        else:
            g = v.pop(0)
        z.append(g)
    z.extend(u)
    z.extend(v)
    return z
```

g gets the popped value and it is appended to z

Implementation Using Pop

```
def Merge(x,y):
    u = list(x)
    v = list(y)
    z = []
    while len(u)>0 and len(v)>0 :
        if u[0]<= v[0]:
            g = u.pop(0)
        else:
            g = v.pop(0)
        z.append(g)
    z.extend(u)
    z.extend(v)
    return z
```

Add what is left in u. OK if u is the empty list

Implementation Using Pop

```
def Merge(x,y):
    u = list(x)
    v = list(y)
    z = []
    while len(u)>0 and len(v)>0 :
        if u[0]<= v[0]:
            g = u.pop(0)
        else:
            g = v.pop(0)
        z.append(g)
    z.extend(u)
    z.extend(v)
    return z
```

Add what is left in v. OK if v is the empty list