# *conditionals and flow control (week 2)*

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## *Lists and indexing (PP chapter 8)*

*reference*: Python intro section 3.1.3

### *Lists*

- Use square brackets `[]` to set up a **list**
- Lists can contain anything but usually homogeneous
- Put other variables into lists
- `range()` makes a **range** but you can turn it into a list with `list()`
  - *Set up a list that runs from 101 to 200*
- Indexing and slicing lists works almost the same way as indexing and slicing . . .
- Put lists into lists! ("yo dawg . . . ")
  - difference between an *item from a list* (indexing, `x[0]`) and a *one-element list* (slicing, `x[0:1]`)

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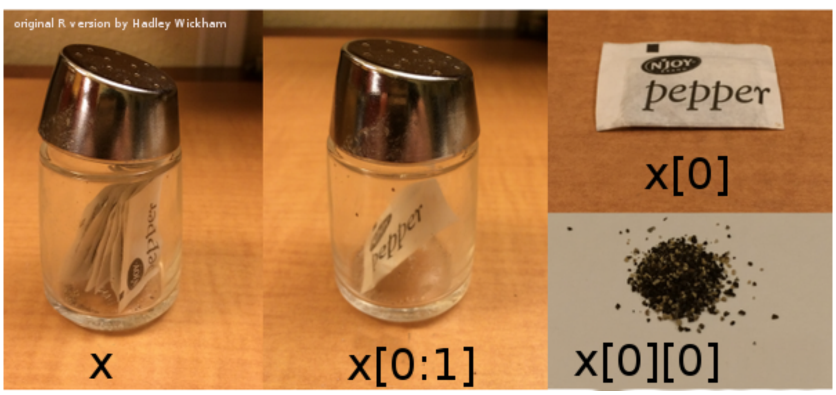



### *Other list operations*

- Lots of things you can do with lists!
- Lists are **mutable**

```
x = [1,2,3]
y = x
```

```
y[2] = 17
print(x)
```

```
## [1, 2, 17]
```

Check it out at Python Tutor

- *operators* vs. *functions* vs. *methods* `x+y` vs. `foo(x,y)` vs. `x.foo(y)`
  - list *methods*
  - appending and extending:

```
x = [1,2,3]
y = [4,5]
x.append(y)
print(x)
```

```
## [1, 2, 3, [4, 5]]
```

```
x = [1,2,3] # reset x
y = [4,5]
x.extend(y)
print(x)
```

```
## [1, 2, 3, 4, 5]
```

Can use + and += as shortcut for extending:

```
x = [1,2,3]
y = [4,5]
z = x+y
print(z)
```

```
## [1, 2, 3, 4, 5]
```

### *list methods*

- `x.insert(position,value)`: inserts (or `x=x[0:position]+[value]+x[position+1:len(x)]`)
- `x.remove(value)`: removes *first* value
- `x.pop(position)` (or `del x[position]` or `x=x[0:position]+x[position+1:len(x)]`)
- `x.reverse()` (or `x[::-1]`)
- `x.sort()`: what it says
- `x.count(value)`: number of occurrences of `value`
- `x.index(value)`: first occurrence of `value`
- `value in x`: does `value` occur in `x`? (or `logical(x.count(value)==0)`)
- `len(x)`: length

**Note**: pythonicity vs. TMTOWTDI

## *Conditionals and flow control*

- **Conditionals**: Do something *if* something else is true
- **Flow control**: Go to different places in the code: especially, repeat calculations
- Everything we need for interesting programs ("the rest is commentary")
- Technically we can compute *anything*: Turing machines (xkcd)

### *Conditionals*

- Do something *if* something is true
- `if` statement (reference)

```
if False:
    print("no")
```

- else-if (`elif`) and `else` clauses

```
if (x<=0):
    print("what??")
elif(x==1):
    print("one")
elif(x==2):
    print("two")
else:
    print("many")
```

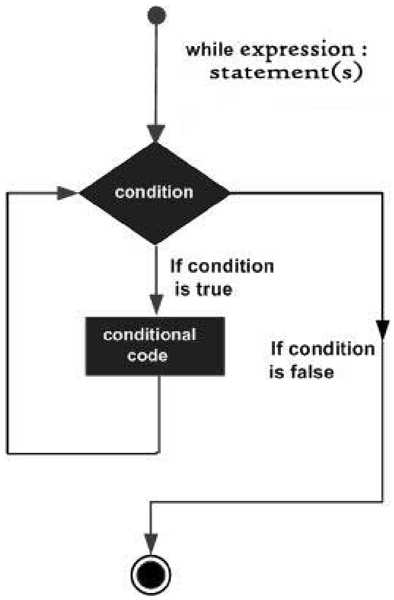
- not too much else to say
- we can do more than one thing; use a *code block*
- indentation is crucial

### *codingbat examples*

- CodingBat date_fashion problem
- CodingBat alarm clock problem

### *while*

- repeat code many times, *while* some logical statement is true (reference)




For example:

```
x = 17
while x>1:
    x = x/2
```

Maybe we want to know how many steps that took:

```
x = 17
n = 0
while x>1:
    x = x/2
    n = n+1
```

- **What is the answer?**
- Can you get the same answer using `import math` and `math.log(x,2)` (and maybe `round()` or `math.floor`)?
- We can use logical operators to combine

```
x = 17
n = 0
while x>1 and n<3:
    x = x/2
    n = n+1
```

*for loops*

- what if we want to repeat a fixed number of times? We could use something like

```
n = 0
while n<n_max:
    # do stuff
    n = n+1
```

Or we could use a `for` loop:

```
for n in range(0,n_max):
    # do stuff
```

- does this repeat `n_max` or `n_max+1` times? (hint: try it out, and/or use `list(range(...))` ...)
- more generally, we can use `for` to iterate over *any list*.

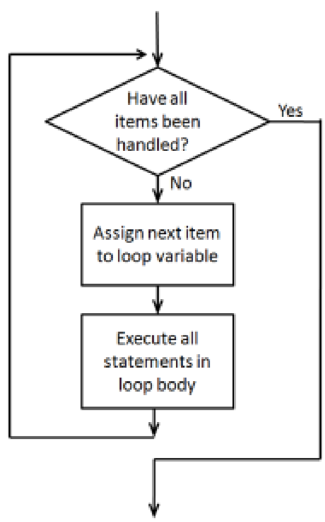



Figure 1: for loop

*`for` loop examples*

- CodingBat > string-2 > countHi
- CodingBat > string-2 > catDog
- CodingBat > Array-2 > bigDiff

Another example: a change-writing program.

*Given an amount of money, return a list of length 5 that gives the (smallest) number of coins of each unit (toonies, loonies, quarters, dimes, and nickels) required to make up that amount.*

```
total=5.73
toonies = 5.73 // 2 ## integer division
total = total - 2*toonies
```

```
total = 5.73
res = []   # empty list
denoms = list(2,1,0.25,0.1,0.05)
for d in denoms:
    # do stuff
```

- start with `total`, use `denoms` above

1. program to see how many pennies are left (how could we do this much more easily?)
2. **or** print out change as we go along
3. **or** save results as an array

*Coin counting continued*

Before coding up a solution, first describe it at a high level and then refine it:

- Initialization phase
  - initialize the variables that will be used, such as variables to hold the total amount of money, the list of coin denominations being used, and a list of the results.
- Loop. For each denomination d in our list:
  - determine how many coins of denomination d are needed.
  - update our result list with this amount.
  - update the total amount of money left.
- Print out the results

*Prime walk*

Now let's look at the prime walk program again ...

- Initialization phase
  - retrieve a list of primes
  - initialize the variables that will be used:
    - variables to hold the lists of the x and y coordinates of the points visited on the walk
    - the current direction of the walk
    - the number of steps taken on the walk so far
- Loop. For each step of the walk:
  - update the x and y coordinate lists with the coordinates of the next step
  - change the walk direction.
- display the walk.

*More CodingBat examples:*

- List-2 > count_evens
- List-2 >sum13
- List-2 > bigdiff
- reverse a list (not using slicing)?

### *break*

`break` is a way to get out of a `while` or `for` loop early:

```
for i in range(0,10):
   if i>5:
      break
```

### *nested `for` loops*

We can look at (e.g.) all the combinations of `i` and `j` via:

```
for i in range(0,3):
   for j in range(0,3):
      print([i,j])
```

### *matrix addition*

We can store matrices as a **list of lists**: represents a $2 \times 3$ matrix. We can loop over rows and columns to operate on every element, or combine the elements in some way:

```
## initialization
m = [[1,2,3], [2,7,9]]
nrows = len(m)
ncols = len(m[0])
total = 0
## loop
for i in range(nrows):
    for j in range(ncols):
        total += m[i][j]
print(total)
```

```
## 24
```

### *Loops and indices*

From Secret Weblog: all of the following are equivalent . . .

```
i = 0
while i < mylist_length:
```

```
    do_something(mylist[i])
    i += 1  ## or i=i+1
```

vs.

```
for i in range(mylist_length):
    do_something(mylist[i])
```

(this form is useful if we need to combine two lists, or otherwise index element `i` of several different things . . . )

vs.

```
for element in mylist:
    do_something(element)
```

*Criteria*

- speed
- memory use
- simplicity (code length)
- simplicity (avoid modules)
- simplicity (avoid abstractions)
- pythonicity