CSI31 Lecture 4

Topics:

2.6 Definite Loops

2.7 Future Value

2.6 Definite Loops

recall chaotic function (from lecture 2):

```
for i in range(10):
    x = 3.9 * x * (1-x)
    print(x)
```

loop body - body of the loop

- we use loops to execute a sequence of statements several times in succession.

iteration is one execution of that sequence of statements

definite loop - is a simplest kind of loop. At the point in the program when the loop begins, Python knows how many times to *iterate* the body of the loop.

The example given above is the example of the definite loop, and is called *counted loop*.

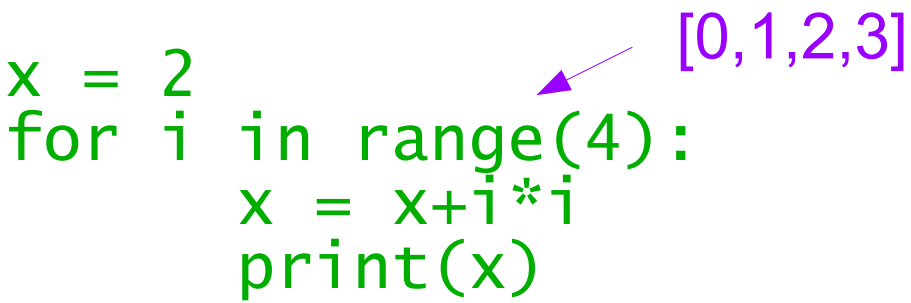
2.6 Definite Loops

Example:

```
x = 2
for i in range(4):
      x = x+i*i
      print(x)
```

2.6 Definite Loops

Example:



2.6 Definite Loops

Example:

x 2

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    print(x)
```

2.6 Definite Loops

Example:

x 2

[0,1,2,3]

```
x = 2
for i in range(4):
    x = x+i*i
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```

2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
for i in range(4):
    x = x+i*i
    print(x)
```

1st iteration

x	2
i	0

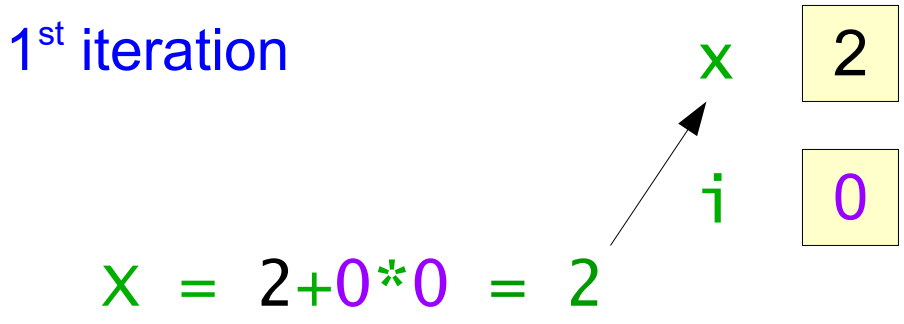
2.6 Definite Loops

Example:

```
x = 2
for i in range(4):
    x = x+i*i
    print(x)
```

[0,1,2,3]

1st iteration



2.6 Definite Loops

Example:

```
x = 2
for i in range(4):
    x = x+i*i
print(x)
```

[0,1,2,3]

1st iteration

x 2

i 0

x = 2+0*0 = 2

2

2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
for i in range(4):
    x = x+i*i
    print(x)
```

2nd iteration

x	2
i	1

2

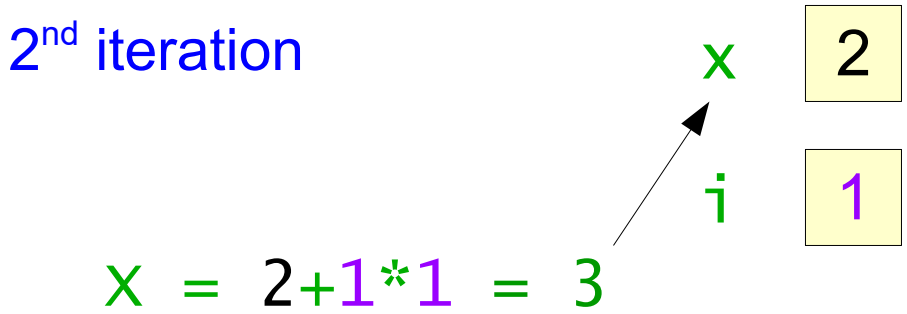
2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
for i in range(4):
    x = x+i*i
    print(x)
```

2nd iteration



2

2.6 Definite Loops

Example:

```
x = 2
for i in range(4):
    x = x+i*i
print(x)
```

[0,1,2,3]

2nd iteration

x = 2+1*1 = 3

x	3
i	1

```
2
3
```

2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
for i in range(4):
    x = x+i*i
    print(x)
```

3rd iteration

x	3
i	2

```
2
3
```

2.6 Definite Loops

Example:

```
x = 2
for i in range(4):
    x = x+i*i
    print(x)
```

[0,1,2,3]

3rd iteration

x = 3+2*2 = 7

x 3

i 2

2
3

2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
for i in range(4):
    x = x+i*i
print(x)
```

3rd iteration

x 7

i 2

x = 3+2*2 = 7

```
2
3
7
```

2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
for i in range(4):
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    print(x)
```

4th iteration

x 7

i 3

2
3
7

2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
for i in range(4):
    x = x+i*i
    print(x)
```

4th iteration

x 7

i 3

x = 7+3*3 = 16

```
2
3
7
```

2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
for i in range(4):
    x = x+i*i
print(x)
```

4th iteration

x 16

i 3

x = 7+3*3 = 16

2
3
7
16

2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
for i in range(4):
    x = x+i*i
    print(x)
```

4th iteration

x	16
i	3

```
2
3
7
16
```

2.6 Definite Loops

Example:

[0,1,2,3]

```
x = 2
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    print(x)
```

4th iteration

x 16

i 3

2
3
7
16

2.6 Definite Loops

A Python `for` loop has this general form:

```
for <var> in <sequence>:
    <body>
```

loop heading

`<body>` is any sequence of Python statements

`<var>` is the *loop index* (it takes on each successive value in the `sequence`, and the statements in the `body` are exectuted once for each value.)

`sequence` portion often consists of a *list* of values.

example:

the length the list determines the number of times the loop will execute

```
y = 1
for counter in [1,2,3,4]:
    y = y + counter
    print(''counter = '', counter, '', y = '', y)
```

2.6 Definite Loops

example:

```
y = 1
for counter in [1,2,3,4]:
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```

counter = 1, y = 2
counter = 2, y = 4
counter = 3, y = 7
counter = 4, y = 11

2.6 Definite Loops

Compare two *counted loops*:

```
for i in range(10):
      x = 3.9 * x * (1-x)
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```

```
for counter in [1,2,3,4]:
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```

`range(10)` is a sequence of 10 numbers (from 0 till 9)

Try to input in the *interactive window*:

```
>>> range(10)
```

range(0,10) - you will get a sequence of values from 0 to 9

2.6 Definite Loops

The `range` function is a built-in Python function (command)

General form of the range function:

```
range(<expr>)
```

- will produce a sequence of numbers starting from 0 and going up to, but not including, the value of `<expr>`

If you begin to type in `range(` in the interactive window - you'll see a hint:

```
range([start,] stop[, step]) -> list of integers
```

Try to input the following statements in the *Python shell*:

```
>>> list(range(4,13))
>>> list(range(4, 16, 2))
```

and see the result.

2.6 Definite Loops

Statements like *for loops* are called *control structures* because they control the execution of other parts of the program.

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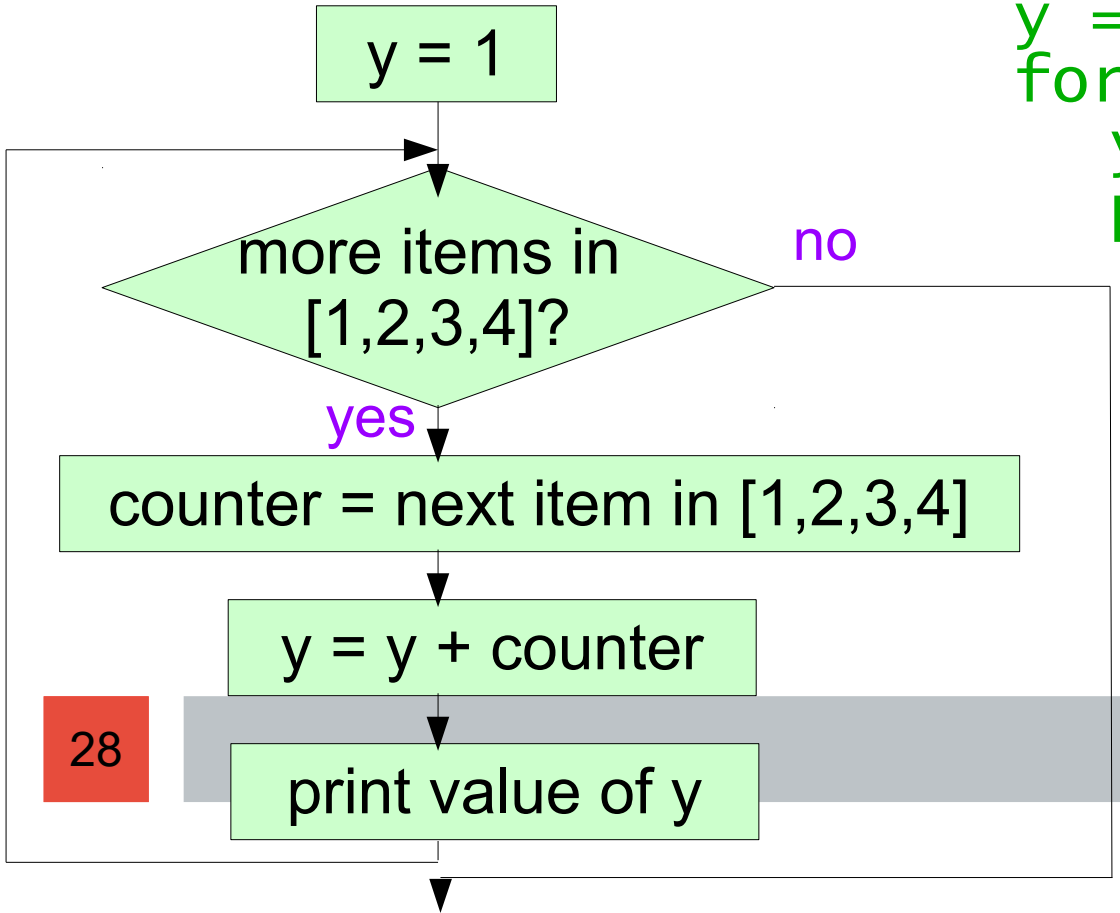


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2.7 Example program: future value

Let's develop a program to determine the future value of an investment.

Money are deposited in a bank account (the principal).

They earn interest (APR – annual percentage rate), that might be compounded annually, quarterly, etc.

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Example: if it is compounded quarterly, then for $100 and 3$ APR, each three months we will earn ¾ %.

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Example: if it is compounded quarterly, then for $100 and 3$ APR, each three months we will earn ¾ %. Hence, in a year we will get: $100 + ¾% of $100 = $100 + $0.75 = $100.75 *in 3 months*

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$100 + ¾% of $100 = $100 + $0.75 = $100.75 *in 3 months*
$100.75 + ¾% of $100.75 ≈ $100.75 + $0.76 = $101.51 *in 6 months*

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$100.75 + ¾% of $100.75 ≈ $100.75 + $0.76 = $101.51 *in 6 months*
$101.51 + ¾% of $101.51 ≈ $101.51+ $0.76 = $102.27 *in 9 months*

2.7 Example program: future value

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$100.75 + ¾% of $100.75 ≈ $100.75 + $0.76 = $101.51 *in 6 months*
$101.51 + ¾% of $101.51 ≈ $101.51+ $0.76 = $102.27 *in 9 months*
$102.27 + ¾% of $102.27 ≈ $102.27 + $0.77 = **$103.04** *in a year*

2.7 Example program: future value

Summary: Given the principal, the interest rate and the number of compounding periods, we should be able to calculate the value of the investment ten years into the future!

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Inputs:

- the amount of money being invested (in dollars)
- the interest rate (APR – annual percentage rate) (in %)
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- The number of compounding periods

Output: The value of investment in 10 years.

Relationship: value after one year … needs to be established
This formula needs to be applied 10 times.

2.7 Example program: future value

Let's use the following denotations:
p: principal amount
apr: annual percent rate (interest)
c: number of compounding periods

If c = 1, i.e. annually, we get *p+p*apr* in a year
If c = 2, i.e. semi-annually, we get:

in 6 months

$$\underbrace{\left(p+p*\frac{apr}{2}\right)}+\underbrace{\left(p+p*\frac{apr}{2}\right)\frac{apr}{2}}=p+p*apr+p*\left(\frac{apr}{2}\right)^2=p\left(1+apr+\left(\frac{apr}{2}\right)^2\right)=$$

in 12 months

$$=p\left(1+\frac{apr}{2}\right)^2$$

2.7 Example program: future value

Let's use the following denotations:
p: principal amount
apr: annual percent rate (interest)
c: number of compounding periods

If c = 3, i.e. every 4 months, we get:

in 12 months

in 4 months

$$\left(p+p*\frac{apr}{3}\right)+\left(p+p*\frac{apr}{3}\right)\frac{apr}{3}+\left(\left(p+p*\frac{apr}{3}\right)+\left(p+p*\frac{apr}{3}\right)\frac{apr}{3}\right)\frac{apr}{3}=$$

in 8 months

$$=p+p*apr+3\,p*\left(\frac{apr}{3}\right)^2+p\left(\frac{apr}{3}\right)^3=p\left(1+apr+3\left(\frac{apr}{3}\right)^2+\left(\frac{apr}{3}\right)^3\right)=$$

$$=p\left(1+\frac{apr}{3}\right)^3$$

2.7 Example program: future value

Let's use the following denotations:
p : principal amount
apr : annual percent rate (interest)
c: number of compounding periods

If c = 1, i.e. annually, we get *p+p*apr* in a year

If c = 2, i.e. semi-annually, we get: $p\left(1+\frac{apr}{2}\right)^2$

If c = 3, i.e. every 4 months, we get: $p\left(1+\frac{apr}{3}\right)^3$

If c = n, we get $p\left(1+\frac{apr}{n}\right)^n$

See program futureValue.py