Lecture 21

While Loops

Announcements for This Lecture

Assignments

- A5 due next Tuesday
  - Should be done with Part I
  - Do Part II this weekend
- Fill out the Progress Survey
  - Tell us how far you got
  - Tell us hours worked
  - Submit by Wed. night
  - Will use to adjust Part II
- A6 will be posted next week

Prelim 2

- Thursday, 7:30-9pm
  - A–G (Olin 155)
  - H–K (Olin 165)
  - L–R (Olin 255)
  - S–Z (Upson B17)
  - Extra-time (Upson 5130)
- **Make-up** is Friday
  - 6:30-8pm in Upson 5130
  - Only if submitted conflict

Recall: For Loops

```
# Print contents of seq
x = seq[0]
print x
x = seq[1]
print x
...
x = seq[len(seq)-1]
print x
```

The for-loop:

```
for x in seq:
    print x
```

- Key Concepts
  - **loop sequence:** seq
  - **loop variable**: x
  - **body**: print x
  - Also called **repetend**

for-loops: Beyond Sequences

- Work on *iterable* objects
  - Object with an *ordered collection* of data
  - This includes sequences
  - But also much more
- **Examples**:
  - Text Files (built-in)
  - Web pages (urllib2)
- **2110**: learn to design custom iterable objects

```
def blanklines(fname):
    """Return: # blank lines in file fname
    Precondition: fname is a string"""
    # open makes a file object
    file = open('myfile.txt')

    # Accumulator
    count = 0
    for line in file:        # line is a string
        if len(line) == 0: # line is blank
            count = count+1

    f.close() # close file when done
    return count
```

Important Concept in CS: Doing Things Repeatedly

1. Process each item in a sequence
   - Compute aggregate statistics fo
     such as the mean, median, stan
   - Send everyone in a Facebook group an appointment time

```
for x in sequence:
    process x
```

2. Perform *n* trials or get *n* samples.
   - A4: draw a triangle six times to m
   - Run a protein-folding simulati

```
for x in range(n):
    do next thing
```

3. Do something an unknown number of times
   - CUAUV team, vehicle keeps moving until reached its goal

????

Beyond Sequences: The while-loop

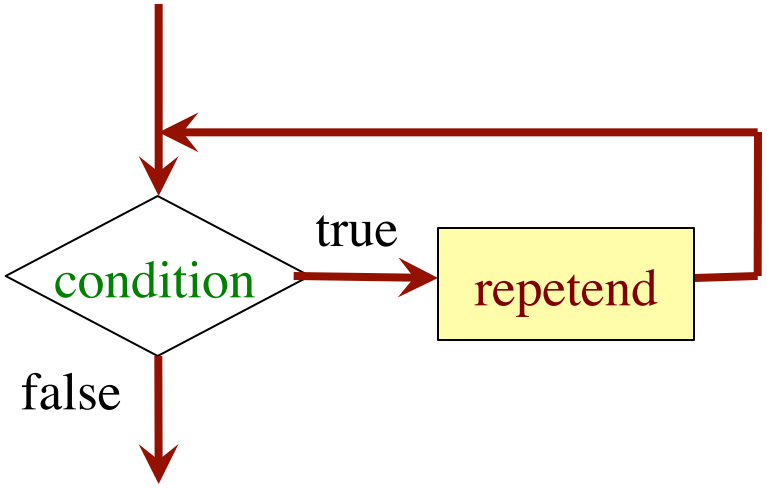
while <*condition*>:

    statement 1

    ...

    statement n

repetend or **body**



- Relationship to for-loop
  - Broader notion of "still stuff to do"
  - Must explicitly ensure condition becomes false
  - *You* explicitly manage what changes per iteration

While-Loops and Flow

```
print 'Before while'
count = 0
i = 0
while i < 3:
    print 'Start loop '+str(i)
    count = count + i
    i = i + 1
    print 'End loop '
print 'After while'
```

Output:

```
Before while
Start loop 0
End loop
Start loop 1
End loop
Start loop 2
End loop
After while
```

while Versus for

```
# process range b..c-1
for k in range(b,c)
    process k
```

```
# process range b..c-1
k = b
while k < c:
    process k
    k = k+1
```

Must remember to increment

```
# process range b..c
for k in range(b,c+1)
    process k
```

```
# process range b..c
k = b
while k <= c:
    process k
    k = k+1
```

Note on Ranges

- m..n is a range containing n+1-m values
  - 2..5 contains 2, 3, 4, 5. Contains 5+1 – 2 = 4 values
  - 2..4 contains 2, 3, 4. Contains 4+1 – 2 = 3 values
  - 2..3 contains 2, 3. Contains 3+1 – 2 = 2 values
  - 2..2 contains 2. Contains 2+1 – 2 = 1 values
  - 2..1 contains ???

What does 2..1 contain?

A: nothing
B: 2,1
C: 1
D: 2
E: something else

Note on Ranges

- m..n is a range containing n+1-m values
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  - 2..4 contains 2, 3, 4. Contains 4+1 – 2 = 3 values
  - 2..3 contains 2, 3. Contains 3+1 – 2 = 2 values
  - 2..2 contains 2. Contains 2+1 – 2 = 1 values
  - 2..1 contains ???
- The notation m..n, always implies that m <= n+1
  - So you can assume that even if we do not say it
  - If m = n+1, the range has 0 values

while Versus for

```
# incr seq elements
for k in range(len(seq)):
    seq[k] = seq[k]+1
```

Makes a **second** list.

```
# incr seq elements
k = 0
while k < len(seq):
    seq[k] = seq[k]+1
    k = k+1
```

while is more flexible, but requires more code to use

Patterns for Processing Integers

range a..b-1

```
i = a
while i < b:
    process integer I
    i = i + 1
```

```
# store in count # of '/'s in  String s
count = 0
i = 0
while i < len(s):
    if s[i] == '/':
        count= count + 1
    i= i +1
# count is # of  '/'s in s[0..s.length()-1]
```

range c..d

```
i= c
while i <= d:
    process integer I
    i= i + 1
```

```
# Store in double var. v the sum
# 1/1   + 1/2 + ...+ 1/n
v = 0;     # call this 1/0 for today
i = 0
while i <= n:
    v = v + 1.0 / i
    i= i +1
# v= 1/1   + 1/2 + ...+ 1/n
```

while Versus for

```
# table of squares to N
seq = []
n = floor(sqrt(N)) + 1
for k in range(n):
    seq.append(k*k)
```

```
# table of squares to N
seq = []
k = 0
while k*k < N:
    seq.append(k*k)
    k = k+1
```

A for-loop requires that you know where to stop the loop **ahead of time**

A while loop can use complex expressions to check if the loop is done

while Versus for

Fibonacci numbers:

$$F_0 = 1$$
$$F_1 = 1$$
$$F_n = F_{n-1} + F_{n-2}$$

```
# Table of n Fibonacci nums
fib = [1, 1]
for k in range(2,n):
    fib.append(fib[-1] + fib[-2])
```

Sometimes you do not use the loop variable at all

```
# Table of n Fibonacci nums
fib = [1, 1]
while len(fib) < n:
    fib.append(fib[-1] + fib[-2])
```

Do not need to have a loop variable if you don't need one

Cases to Use **while**

Great for when you must **modify** the loop variable

```
# Remove all 3's from list t
i = 0
while i < len(t):
    # no 3's in t[0..i-1]
    if t[i] == 3:
        del t[i]
    else:
        i += 1
```

```
# Remove all 3's from list t
while 3 in t:
    t.remove(3)
```

Cases to Use while

Great for when you must **modify** the loop variable

```
# Remove all 3's from list t
i = 0
while i < len(t):
    # no 3's in t[0..i-1]
    if t[i] == 3:
        del t[i]
    else:
        i += 1
```

Stopping point keeps changing.

```
# Remove all 3's from list t
while 3 in t:
    t.remove(3)
```

The stopping condition is not a numerical counter this time. Simplifies code a lot.

Cases to Use while

- Want square root of c
  - Make poly $f(x) = x^2 - c$
  - Want root of the poly (x such that $f(x)$ is 0)
- Use **Newton's Method**
  - x_0 = GUESS ($c/2$??)
  - $x_{n+1} = x_n - f(x_n)/f'(x_n)$
    $= x_n - (x_n x_n - c)/(2x_n)$
    $= x_n - x_n/2 + c/2x_n$
    $= x_n/2 + c/2x_n$
  - Stop when x_n good enough

```
def sqrt(c):
    """Return: square root of c
    Uses Newton's method
    Pre: c >= 0 (int or float)"""
    x = c/2
    # Check for convergence
    while abs(x*x - c) > 1e-6:
        # Get x_{n+1} from x_n
        x = x / 2 + c / (2*x)

    return x
```

Cases to Use while

- Want square root of c
  - Make poly $f(x) = x^2 - c$
  - Want root of the poly (x such that $f(x)$ is 0)
- Use **Newton's**
  - $x_{n+1} = x_n - (x_n x_n - c)/(2x_n)$
    $= x_n - x_n/2 + c/2x_n$
    $= x_n/2 + c/2x_n$
  - Stop when x_n good enough

```
def sqrt(c):
    """Return: square root of c
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    while abs(x*x - c) > 1e-6:
        # Get x_{n+1} from x_n
        x = x / 2 + c / (2*x)

    return x
```

Part II of A5 uses a similar idea.