Python

Control Flow

Real power of programs comes from:

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repetition

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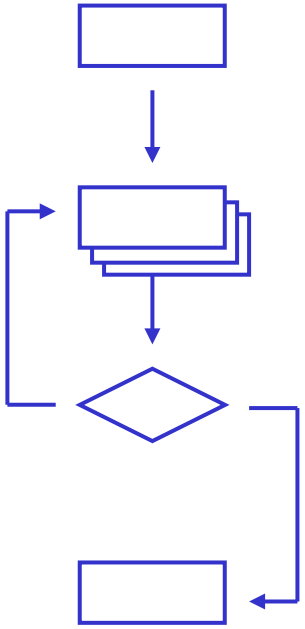
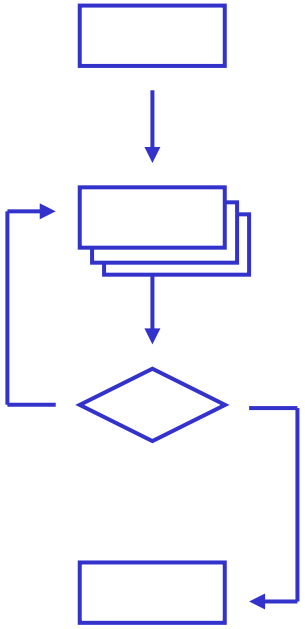
repetition



Real power of programs comes from:

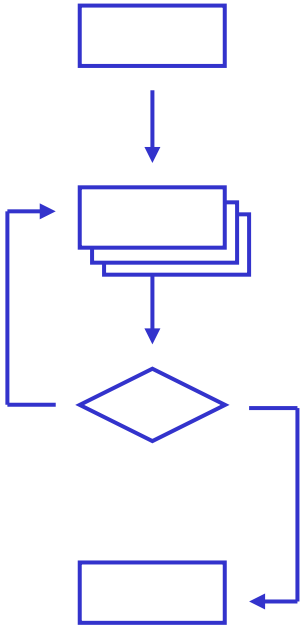
repetition



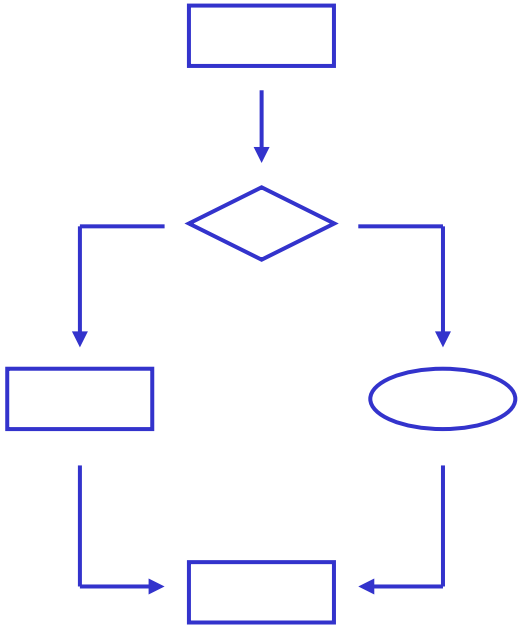
selection

Real power of programs comes from:

repetition



selection



Simplest form of repetition is *while loop*

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```
num_moons = 3
while num_moons > 0:
    print num_moons
    num_moons -= 1
```

Simplest form of repetition is *while loop*

```
num_moons = 3
while num_moons > 0:
    print num_moons
    num_moons -= 1
```

← test

Simplest form of repetition is *while loop*

```
num_moons = 3
while num_moons > 0:
    print num_moons
    num_moons -= 1
```

do

Simplest form of repetition is *while loop*

```
num_moons = 3
while num_moons > 0:
    print num_moons
    num_moons -= 1
```

do

3

Simplest form of repetition is *while loop*

```
num_moons = 3
while num_moons > 0:
    print num_moons
    num_moons -= 1
```

← test again

3

Simplest form of repetition is *while loop*

```
num_moons = 3
while num_moons > 0:
    print num_moons
    num_moons -= 1
```

3

2

Simplest form of repetition is *while loop*

```
num_moons = 3
while num_moons > 0:
    print num_moons
    num_moons -= 1
```

3
2
1

While loop may execute zero times

While loop may execute zero times

```
print 'before'
num_moons = -3
while num_moons > 0:
    print num_moons
    num_moons -= 1
print 'after'
```

While loop may execute zero times

```
print 'before'
num_moons = -3
while num_moons > 0:
    print num_moons
    num_moons -= 1
print 'after'
```

← not true when first tested…

While loop may execute zero times

```
print 'before'
num_moons = -3
while num_moons > 0:
    print num_moons
    num_moons -= 1
print 'after'
```

…so this is never executed

While loop may execute zero times

```
print 'before'
num_moons = -3
while num_moons > 0:
    print num_moons
    num_moons -= 1
print 'after'
```

before
after

While loop may execute zero times

```
print 'before'
num_moons = -3
while num_moons > 0:
    print num_moons
    num_moons -= 1
print 'after'
```

before
after

Important to consider this case when designing and testing code

While loop may also execute forever

While loop may also execute forever

```
print 'before'
num_moons = 3
while num_moons > 0:
    print num_moons
print 'after'
```

While loop may also execute forever

```
print 'before'
num_moons = 3
while num_moons > 0:
    print num_moons
print 'after'
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before

While loop may also execute forever

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while num_moons > 0:
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3

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before
3
3

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while num_moons > 0:
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print 'after'
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before
3
3
3

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print 'before'
num_moons = 3
while num_moons > 0:
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print 'after'
```

before
3
3
3
⋮

While loop may also execute forever

```
print 'before'
num_moons = 3
while num_moons > 0:
    print num_moons
print 'after'
```

before
3
3
3
⋮

Nothing in here changes the loop control condition

While loop may also execute forever

```
print 'before'
num_moons = 3
while num_moons > 0:
    print num_moons
print 'after'
```

before
3
3
3
⋮

Usually not the desired behavior…

While loop may also execute forever

```
print 'before'
num_moons = 3
while num_moons > 0:
    print num_moons
print 'after'
```

```
before
3
3
3
⋮
```

Usually not the desired behavior…

…but there *are* cases where it's useful

Why indentation?

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Studies show that's what people actually pay attention to

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- Every textbook on C or Java has examples where indentation and braces don't match

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Python Style Guide (PEP 8) recommends 4 spaces

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Doesn't matter how much you use, but whole block must be consistent

Python Style Guide (PEP 8) recommends 4 spaces

And no tab characters

Use if, elif, and else to make choices

Use if, elif, and else to make choices

```
moons = 3
if moons < 0:
    print 'less'
elif moons == 0:
    print 'equal'
else:
    print 'greater'
```

Use if, elif, and else to make choices

```
moons = 3
if moons < 0:
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```

← not true when first tested…

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```
moons = 3
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```

← …so this is *not* executed

Use if, elif, and else to make choices

```
moons = 3
if moons < 0:
    print 'less'
elif moons == 0:
    print 'equal'
else:
    print 'greater'
```

← this isn't true either…

Use if, elif, and else to make choices

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moons = 3
if moons < 0:
    print 'less'
elif moons == 0:
    print 'equal'
else:
    print 'greater'
```

← …so this isn't executed

Use if, elif, and else to make choices

```
moons = 3
if moons < 0:
    print 'less'
elif moons == 0:
    print 'equal'
else:
    print 'greater'
```

← nothing else has executed…

Use if, elif, and else to make choices

```
moons = 3
if moons < 0:
    print 'less'
elif moons == 0:
    print 'equal'
else:
    print 'greater'
```

← …so this *is* executed

Use if, elif, and else to make choices

```
moons = 3
if moons < 0:
    print 'less'
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    print 'equal'
else:
    print 'greater'
```

greater

Use if, elif, and else to make choices

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moons = 3
if moons < 0:
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else:
    print 'greater'
```

greater

Always start with **if**

Use if, elif, and else to make choices

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moons = 3
if moons < 0:
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greater

Always start with **if**

Can have any number of **elif** clauses (including none)

Use if, elif, and else to make choices

```
moons = 3
if moons < 0:
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```

greater

Always start with **if**

Can have any number of **elif** clauses (including none)

And the **else** clause is optional

Use if, elif, and else to make choices

```
moons = 3
if moons < 0:
    print 'less'
elif moons == 0:
    print 'equal'
else:
    print 'greater'
```

greater

Always start with **if**

Can have any number of **elif** clauses (including none)

And the **else** clause is optional

Always tested in order

Blocks may contain blocks

Blocks may contain blocks

```
num = 0
while num <= 10:
    if (num % 2) == 1:
        print num
    num += 1
```

Blocks may contain blocks

```
num = 0
while num <= 10:
    if (num % 2) == 1:
        print num
    num += 1
```

Count from 0 to 10

Blocks may contain blocks

```
num = 0
while num <= 10:
    if (num % 2) == 1:
        print num
    num += 1
```

← Print odd numbers

Blocks may contain blocks

```
num = 0
while num <= 10:
    if (num % 2) == 1:
        print num
    num += 1
```

1
3
5
7
9

A better way to do it

A better way to do it

```
num = 1
while num <= 10:
    print num
    num += 2
```

A better way to do it

```
num = 1
while num <= 10:
    print num
    num += 2
```

1
3
5
7
9

Stop here

Print primes less than 1000

Print primes less than 1000

```
num = 2
while num <= 1000:
    ...figure out if num is prime...
    if is_prime:
        print num
    num += 1
```

Print primes less than 1000

```
num = 2
while num <= 1000:
    ...figure out if num is prime...
    if is_prime:
        print num
    num += 1
```

Cannot be evenly divided

by any other integer

Print primes less than 1000

```
num = 2
while num <= 1000:
    ...figure out if num is prime...
    if is_prime:
        print num
    num += 1
```

```
is_prime = True
trial = 2
while trial < num:
    if ...num divisible by trial...:
        is_prime = False
    trial += 1
```

Print primes less than 1000

```
num = 2
while num <= 1000:
    ...figure out if num is prime...
    if is_prime:
        print num
    num += 1
```

```
is_prime = True
trial = 2
while trial < num:
    if ...num divisible by trial...:
        is_prime = False
    trial += 1
```

Remainder is zero

Print primes less than 1000

```
num = 2
while num <= 1000:
    ...figure out if num is prime...
    if is_prime:
        print num
    num += 1
```

```
is_prime = True
trial = 2
while trial < num:
    if ...num divisible by trial...:
        is_prime = False
    trial += 1
```

(num % trial) == 0

Print primes less than 1000

```
num = 2
while num <= 1000:
    is_prime = True
    trial = 2
    while trial < num:
        if (num % trial) == 0:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
```

A more efficient way to do it

A more efficient way to do it

```
num = 2
while num <= 1000:
    is_prime = True
    trial = 2
    while trial**2 < num:
        if (num % trial) == 0:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
```

A more efficient way to do it

```
num = 2
while num <= 1000:
    is_prime = True
    trial = 2
    while trial**2 < num:
        if (num % trial) == 0:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
```

N cannot be divided evenly by any number greater than sqrt(N)

Any code that hasn't been tested is probably wrong

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```
num = 2
while num <= 10:
    is_prime = True
    trial = 2
    while trial**2 < num:
        if (num % trial) == 0:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
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Any code that hasn't been tested is probably wrong

```
num = 2
while num <= 10:
    is_prime = True
    trial = 2
    while trial**2 < num:
        if (num % trial) == 0:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
```

```
2
3
4
5
7
9
```

Any code that hasn't been tested is probably wrong

```
num = 2
while num <= 10:
    is_prime = True
    trial = 2
    while trial**2 < num:
        if (num % trial) == 0:
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        trial += 1
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2
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Any code that hasn't been tested is probably wrong

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```
2
3
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5
7
9
```

Where's the bug?

Failures occur for perfect squares

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```
num = 2
while num <= 10:
    is_prime = True
    trial = 2
    while trial**2 < num:
        if (num % trial) == 0:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
```

Failures occur for perfect squares

```
num = 2
while num <= 10:
    is_prime = True
    trial = 2
    while trial**2 < num:
        if (num % trial) == 0:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
```

2**2 == 4

Failures occur for perfect squares

```
num = 2
while num <= 10:
    is_prime = True
    trial = 2
    while trial**2 < num:
        if (num % trial) == 0:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
```

2**2 == 4

So never check to see

if 4 % 2 == 0

Failures occur for perfect squares

```
num = 2
while num <= 10:
    is_prime = True
    trial = 2
    while trial**2 < num:
        if (num % trial) == 0:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
```

2**2 == 4

So never check to see

if 4 % 2 == 0

Or if 9 % 3 == 0, etc.

software carpentry

created by

Greg Wilson

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