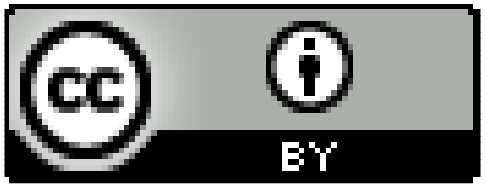
Python

Control Flow



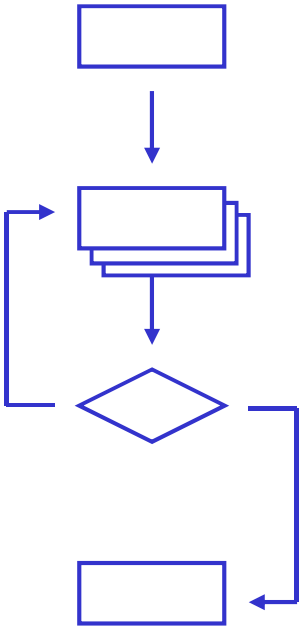
Real power of programs comes from:

Real power of programs comes from:

repetition

Real power of programs comes from:

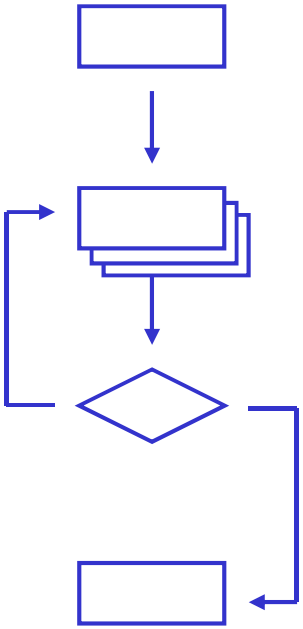
repetition



Real power of programs comes from:

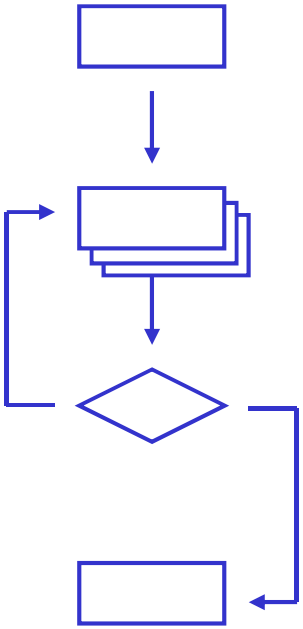
repetition

selection

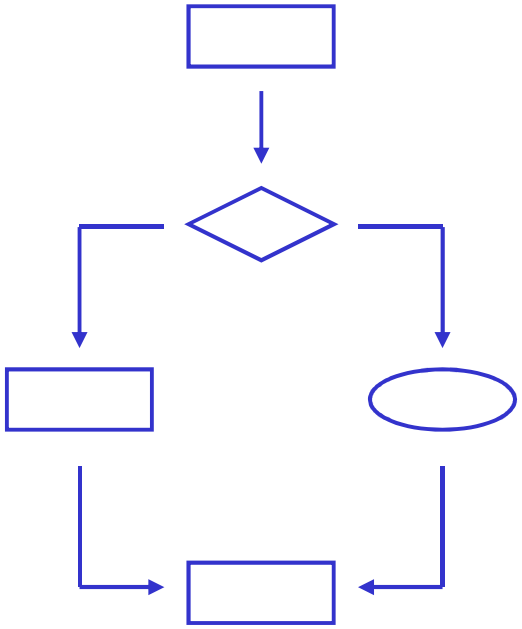


Real power of programs comes from:

repetition



selection



Simplest form of repetition is *while loop*

Simplest form of repetition is *while loop*

```
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
```

Simplest form of repetition is *while loop*

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


```
3
```

Simplest form of repetition is *while loop*

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

3

test again

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'
```

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'
```

before

While loop may also execute forever

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

```
before
3
```

While loop may also execute forever

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

```
before
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
```

While loop may also execute forever

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

Why indentation?

Studies show that's what people actually pay attention to

Why indentation?

Studies show that's what people actually pay attention to

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

Why indentation?

Studies show that's what people actually pay attention to

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

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

Why indentation?

Studies show that's what people actually pay attention to

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

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

Python Style Guide (PEP 8) recommends 4 spaces

Why indentation?

Studies show that's what people actually pay attention to

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

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

← not true when first tested...

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 *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

```
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'
elif moons == 0:
    print 'equal'
else:
    print 'greater'
```

```
greater
```

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`

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)

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

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

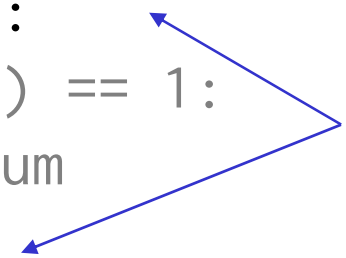
Blocks may contain blocks

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
```

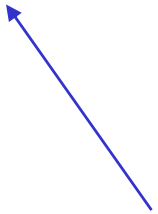
Print primes less than 1000

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
```

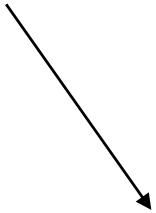


Cannot be evenly divided

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

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
```

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:
            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:
            is_prime = False
        trial += 1
    if is_prime:
        print num
    num += 1
```

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

Where's the bug?

Failures occur for perfect squares

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
```

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.

created by

Greg Wilson

September 2010