



# Python

## Lists



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# Loops let us do things many times

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*Collections* let us store many values together

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*Collections* let us store many values together

Most popular collection is a *list*

Create using [value, value, ...]

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Get/set values using var[index]

Create using [value, value, ...]

Get/set values using var[index]

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases
```

```
['He', 'Ne', 'Ar', 'Kr']
```

Create using [value, value, ...]

Get/set values using var[index]

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases
```

```
['He', 'Ne', 'Ar', 'Kr']
```

```
print gases[1]
```

```
Ne
```



Index from 0, not 1

Index from 0, not 1

Reasons made sense for C in 1970...

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It's an error to try to access out of range

Index from 0, not 1

Reasons made sense for C in 1970...

It's an error to try to access out of range

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases[4]
```

***IndexError: list index out of range***

Use `len(list)` to get length of list

Use `len(list)` to get length of list

```
gases = ['He', 'Ne', 'Ar', 'Kr']  
print len(gases)
```

4

Use `len(list)` to get length of list

```
gases = ['He', 'Ne', 'Ar', 'Kr']  
print len(gases)
```

4

Returns 0 for the *empty list*

```
etheric = []  
print len(etheric)
```

0

Some negative indices work



Some negative indices work

`values[-1]` is last element, `values[-2]` next-to-last, ...

Some negative indices work

values[-1] is last element, values[-2] next-to-last, ...

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

Some negative indices work

values[-1] is last element, values[-2] next-to-last, ...

```
gases = ['He', 'Ne', 'Ar', 'Kr']  
print gases[-1], gases[-4]  
Kr He
```

Some negative indices work

values[-1] is last element, values[-2] next-to-last, ...

```
gases = ['He', 'Ne', 'Ar', 'Kr']  
print gases[-1], gases[-4]  
Kr He
```

values[-1] is much nicer than values[len(values)-1]

Some negative indices work

values[-1] is last element, values[-2] next-to-last, ...

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases[-1], gases[-4]
```

```
Kr He
```

values[-1] is much nicer ~~than~~ values[len(values)-1]

less error prone

*Mutable* : can change it after it is created

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```
gases = ['He', 'Ne', 'Ar', 'K'] # last entry misspelled
```

*Mutable* : can change it after it is created

```
gases = ['He', 'Ne', 'Ar', 'K'] # last entry misspelled  
gases[3] = 'Kr'
```



*Mutable* : can change it after it is created

```
gases = ['He', 'Ne', 'Ar', 'K'] # last entry misspelled
gases[3] = 'Kr'
print gases
['He', 'Ne', 'Ar', 'Kr']
```

*Mutable* : can change it after it is created

```
gases = ['He', 'Ne', 'Ar', 'K'] # last entry misspelled
gases[3] = 'Kr'
print gases
['He', 'Ne', 'Ar', 'Kr']
```

Location must exist before assignment

*Mutable* : can change it after it is created

```
gases = ['He', 'Ne', 'Ar', 'K'] # last entry misspelled
gases[3] = 'Kr'
print gases
['He', 'Ne', 'Ar', 'Kr']
```

Location must exist before assignment

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

*Mutable* : can change it after it is created

```
gases = ['He', 'Ne', 'Ar', 'K'] # last entry misspelled
gases[3] = 'Kr'
print gases
['He', 'Ne', 'Ar', 'Kr']
```

Location must exist before assignment

```
gases = ['He', 'Ne', 'Ar', 'Kr']
gases[4] = 'Xe'
IndexError: list assignment index out of range
```

*Heterogeneous* : can store values of many kinds

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```
helium = ['He', 2]
```

```
neon = ['Ne', 8]
```

*Heterogeneous* : can store values of many kinds

```
helium = ['He', 2]
```

```
neon = ['Ne', 8]
```

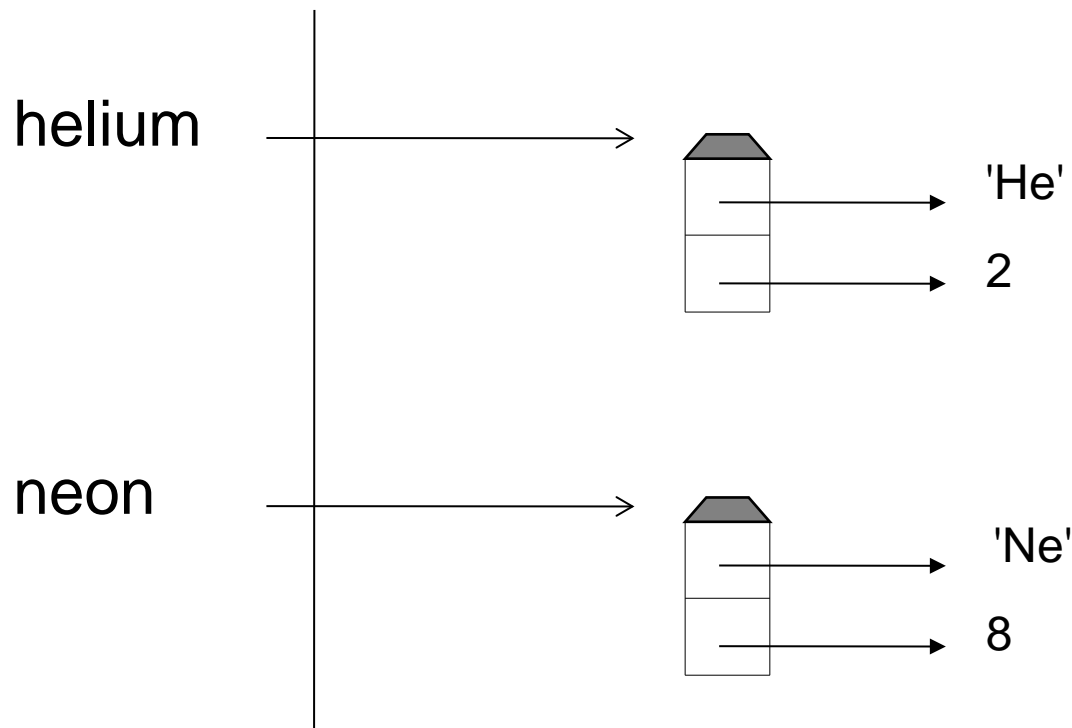


[string, int]

*Heterogeneous* : can store values of many kinds

```
helium = ['He', 2]
```

```
neon = ['Ne', 8]
```





*Heterogeneous* : can store values of many kinds

```
helium = ['He', 2]
```

```
neon = ['Ne', 8]
```

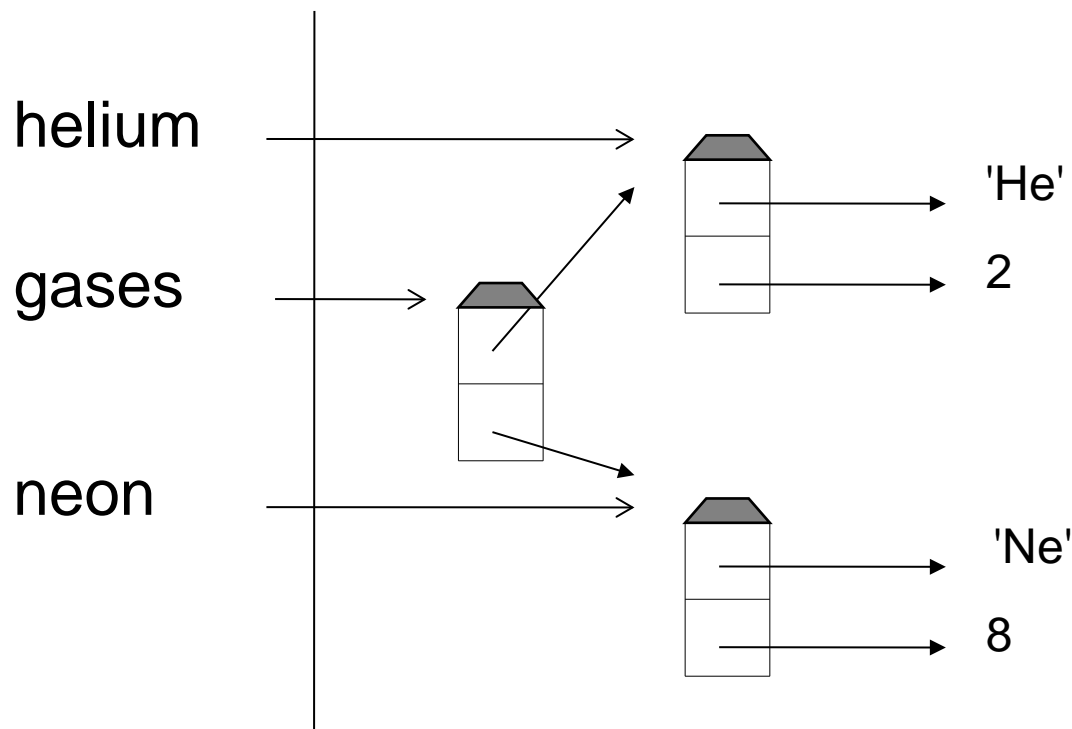
```
gases = [helium, neon]
```

*Heterogeneous* : can store values of many kinds

```
helium = ['He', 2]
```

```
neon = ['Ne', 8]
```

```
gases = [helium, neon]
```

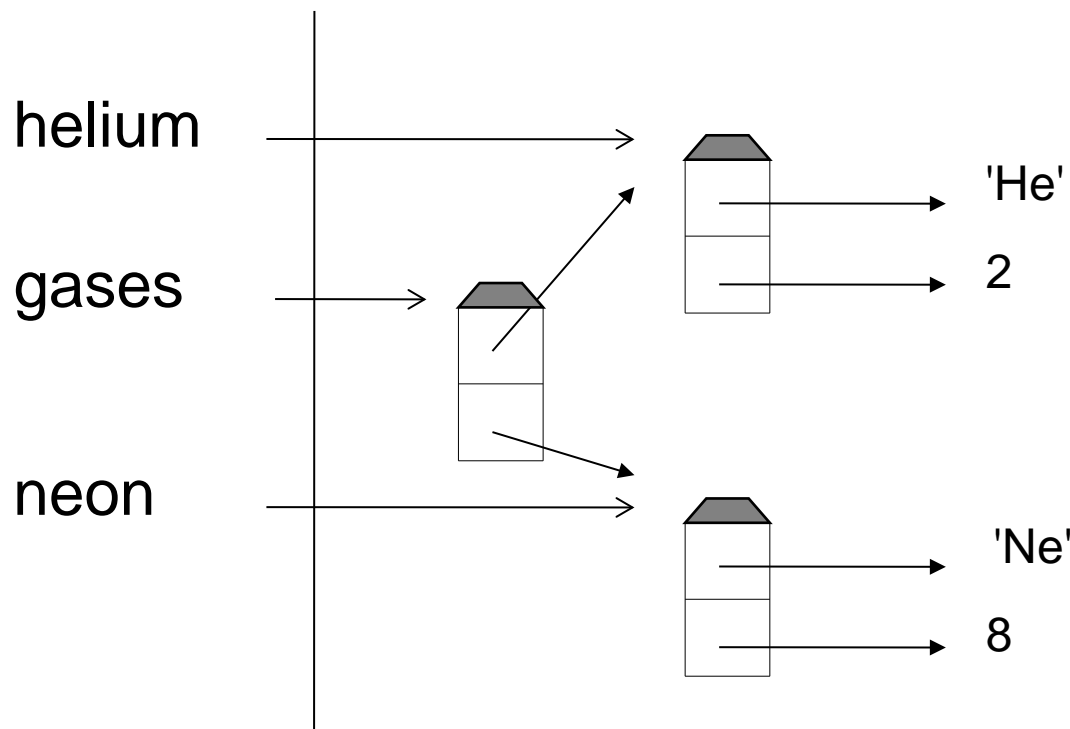


*Heterogeneous* : can store values of many kinds

```
helium = ['He', 2]
```

```
neon = ['Ne', 8]
```

```
gases = [helium, neon]
```



Devote a whole episode to this

# Loop over elements to "do all"

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Use while to step through all possible indices

Loop over elements to "do all"

Use while to step through all possible indices

```
gases = ['He', 'Ne', 'Ar', 'Kr']  
i = 0  
while i < len(gases):  
    print gases[i]  
    i += 1
```

Loop over elements to "do all"

Use while to step through all possible indices

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
i = 0
```



First legal index

```
while i < len(gases):
```

```
    print gases[i]
```

```
    i += 1
```

Loop over elements to "do all"

Use while to step through all possible indices

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
i = 0
```

```
while i < len(gases):
```

```
    print gases[i]
```

```
    i += 1
```

← Next index



Loop over elements to "do all"

Use while to step through all possible indices

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
i = 0
```

```
while i < len(gases):
```

```
    print gases[i]
```

```
    i += 1
```

← Defines set of legal indices

Loop over elements to "do all"

Use while to step through all possible indices

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
i = 0
```

```
while i < len(gases):
```

```
    print gases[i]
```

```
    i += 1
```

*He*

*Ne*

*Ar*

*Kr*

Loop over elements to "do all"

Use while to step through all possible indices

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
i = 0
```

```
while i < len(gases):
```

```
    print gases[i]
```

```
    i += 1
```

*He*

*Ne*

*Ar*

*Kr*

Tedious to type in over and over again

Loop over elements to "do all"

Use while to step through all possible indices

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
i = 0
```

```
while i < len(gases):
```

```
    print gases[i]
```

```
    i += 1
```

```
He
```

```
Ne
```

```
Ar
```

```
Kr
```

Tedious to type in over and over again

And it's easy to forget the "+= 1" at the end

Use a **for** loop to access each value in turn

Use a for loop to access each value in turn

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
for gas in gases:
```

```
    print gas
```

```
He
```

```
Ne
```

```
Ar
```

```
Kr
```

Use a for loop to access each value in turn

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
for gas in gases:
```

```
    print gas
```

```
He
```

```
Ne
```

```
Ar
```

```
Kr
```

Loop variable assigned each *value* in turn

Use a for loop to access each value in turn

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
for gas in gases:
```

```
    print gas
```

```
He
```

```
Ne
```

```
Ar
```

```
Kr
```

Loop variable assigned each *value* in turn

*Not* each index



Use a for loop to access each value in turn

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
for gas in gases:
```

```
    print gas
```

```
He
```

```
Ne
```

```
Ar
```

```
Kr
```

Loop variable assigned each *value* in turn

*Not* each index

Because that's the most common case

Can delete entries entirely (shortens the list)

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```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

Can delete entries entirely (shortens the list)

```
gases = ['He', 'Ne', 'Ar', 'Kr']  
del gases[0]
```

Can delete entries entirely (shortens the list)

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
del gases[0]
```

```
print gases
```

```
['Ne', 'Ar', 'Kr']
```

Can delete entries entirely (shortens the list)

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
del gases[0]
```

```
print gases
```

```
['Ne', 'Ar', 'Kr']
```

```
del gases[2]
```

Can delete entries entirely (shortens the list)

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
del gases[0]
```

```
print gases
```

```
['Ne', 'Ar', 'Kr']
```

```
del gases[2]
```

```
print gases
```

```
['Ne', 'Ar']
```

Can delete entries entirely (shortens the list)

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
del gases[0]
```

```
print gases
```

```
['Ne', 'Ar', 'Kr']
```

```
del gases[2]
```

```
print gases
```

```
['Ne', 'Ar']
```

Yes, deleting an index that doesn't exist is an error



# Appending values to a list lengthens it

Appending values to a list lengthens it

```
gases = []
```

## Appending values to a list lengthens it

```
gases = []  
gases.append('He')
```

## Appending values to a list lengthens it

```
gases = []  
gases.append('He')  
gases.append('Ne')
```

## Appending values to a list lengthens it

```
gases = []  
gases.append('He')  
gases.append('Ne')  
gases.append('Ar')
```

## Appending values to a list lengthens it

```
gases = []  
gases.append('He')  
gases.append('Ne')  
gases.append('Ar')  
print gases  
['He', 'Ne', 'Ar']
```

Appending values to a list lengthens it

```
gases = []  
gases.append('He')  
gases.append('Ne')  
gases.append('Ar')  
print gases  
['He', 'Ne', 'Ar']
```

Most operations on lists are *methods*

Appending values to a list lengthens it

```
gases = []  
gases.append('He')  
gases.append('Ne')  
gases.append('Ar')  
print gases  
['He', 'Ne', 'Ar']
```

Most operations on lists are *methods*

A function that belongs to (and usually operates on)  
specific data



Appending values to a list lengthens it

```
gases = []  
gases.append('He')  
gases.append('Ne')  
gases.append('Ar')  
print gases  
['He', 'Ne', 'Ar']
```

Most operations on lists are *methods*

A function that belongs to (and usually operates on)  
specific data

thing . method (args)

# Some useful list methods

## Some useful list methods

```
gases = ['He', 'He', 'Ar', 'Kr'] # 'He' is duplicated
```

## Some useful list methods

```
gases = ['He', 'He', 'Ar', 'Kr'] # 'He' is duplicated
print gases.count('He')
2
```

## Some useful list methods

```
gases = ['He', 'He', 'Ar', 'Kr'] # 'He' is duplicated
```

```
print gases.count('He')
```

```
2
```

```
print gases.index('Ar')
```

```
2
```

## Some useful list methods

```
gases = ['He', 'He', 'Ar', 'Kr'] # 'He' is duplicated
```

```
print gases.count('He')
```

```
2
```

```
print gases.index('Ar')
```

```
2
```

```
gases.insert(1, 'Ne')
```

## Some useful list methods

```
gases = ['He', 'He', 'Ar', 'Kr'] # 'He' is duplicated
```

```
print gases.count('He')
```

```
2
```

```
print gases.index('Ar')
```

```
2
```

```
gases.insert(1, 'Ne')
```

```
print gases
```

```
['He', 'Ne', 'He', 'Ar', 'Kr']
```

# Two that are often used incorrectly



Two that are often used incorrectly

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

Two that are often used incorrectly

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases.sort()
```

*None*

## Two that are often used incorrectly

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases.sort()
```

```
None
```

```
print gases
```

```
['Ar', 'He', 'Kr', 'Ne']
```

## Two that are often used incorrectly

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases.sort()
```

```
None
```

```
print gases
```

```
['Ar', 'He', 'Kr', 'Ne']
```

```
print gases.reverse()
```

```
None
```

## Two that are often used incorrectly

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases.sort()
```

```
None
```

```
print gases
```

```
['Ar', 'He', 'Kr', 'Ne']
```

```
print gases.reverse()
```

```
None
```

```
print gases
```

```
['Ne', 'Kr', 'He', 'Ar']
```

## Two that are often used incorrectly

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases.sort()
```

```
None
```

```
print gases
```

```
['Ar', 'He', 'Kr', 'Ne']
```

```
print gases.reverse()
```

```
None
```

```
print gases
```

```
['Ne', 'Kr', 'He', 'Ar']
```

A common bug

Two that are often used incorrectly

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print gases.sort()
```

*None*

```
print gases
```

*['Ar', 'He', 'Kr', 'Ne']*

```
print gases.reverse()
```

*None*

```
print gases
```

*['Ne', 'Kr', 'He', 'Ar']*

A common bug

`gases = gases.sort()` assigns `None` to `gases`

There is an alternative built-in function for sorting:

```
>>> gases = ['He', 'Ne', 'Ar', 'Kr']  
>>> s_gases = sorted(gases)  
>>> r_gases = sorted(gases, reverse=True)
```

```
>>> print gases  
['He', 'Ne', 'Ar', 'Kr']
```

```
>>> print s_gases  
['Ar', 'He', 'Kr', 'Ne']
```

```
>>> print r_gases  
['Ne', 'Kr', 'He', 'Ar']
```



Use `in` to test for membership

Use `in` to test for membership

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

Use `in` to test for membership

```
gases = ['He', 'Ne', 'Ar', 'Kr']  
print 'He' in gases  
True
```

## Use `in` to test for membership

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print 'He' in gases
```

```
True
```

```
if 'Pu' in gases:
```

```
    print 'But plutonium is not a gas!'
```

```
else:
```

```
    print 'The universe is well ordered.'
```

## Use `in` to test for membership

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print 'He' in gases
```

*True*

```
if 'Pu' in gases:
```

```
    print 'But plutonium is not a gas!'
```

```
else:
```

```
    print 'The universe is well ordered.'
```

*The universe is well ordered.*

# Use range to construct lists of numbers

# Use range to construct lists of numbers

```
print range(5)  
[0, 1, 2, 3, 4]
```

## Use range to construct lists of numbers

```
print range(5)
```

```
[0, 1, 2, 3, 4]
```

```
print range(2, 6)
```

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



## Use range to construct lists of numbers

```
print range(5)
```

```
[0, 1, 2, 3, 4]
```

```
print range(2, 6)
```

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

```
print range(0, 10, 3)
```

```
[0, 3, 6, 9]
```

## Use range to construct lists of numbers

```
print range(5)
```

```
[0, 1, 2, 3, 4]
```

```
print range(2, 6)
```

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

```
print range(0, 10, 3)
```

```
[0, 3, 6, 9]
```

```
print range(10, 0)
```

```
[]
```

So `range(len(list))` is all indices for the list

So `range(len(list))` is all indices for the list

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

So `range(len(list))` is all indices for the list

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print len(gases)
```

4

So `range(len(list))` is all indices for the list

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print len(gases)
```

```
4
```

```
print range(len(gases))
```

```
[0, 1, 2, 3]
```

So `range(len(list))` is all indices for the list

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print len(gases)
```

```
4
```

```
print range(len(gases))
```

```
[0, 1, 2, 3]
```

```
for i in range(len(gases)):
```

```
    print i, gases[i]
```

So `range(len(list))` is all indices for the list

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print len(gases)
```

```
4
```

```
print range(len(gases))
```

```
[0, 1, 2, 3]
```

```
for i in range(len(gases)):
```

```
    print i, gases[i]
```

```
0 He
```

```
1 Ne
```

```
2 Ar
```

```
3 Kr
```



So `range(len(list))` is all indices for the list

```
gases = ['He', 'Ne', 'Ar', 'Kr']
```

```
print len(gases)
```

```
4
```

```
print range(len(gases))
```

```
[0, 1, 2, 3]
```

```
for i in range(len(gases)):
```

```
    print i, gases[i]
```

```
0 He
```

```
1 Ne
```

```
2 Ar
```

```
3 Kr
```

A very common *idiom* in Python