



# PAC

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# Summary

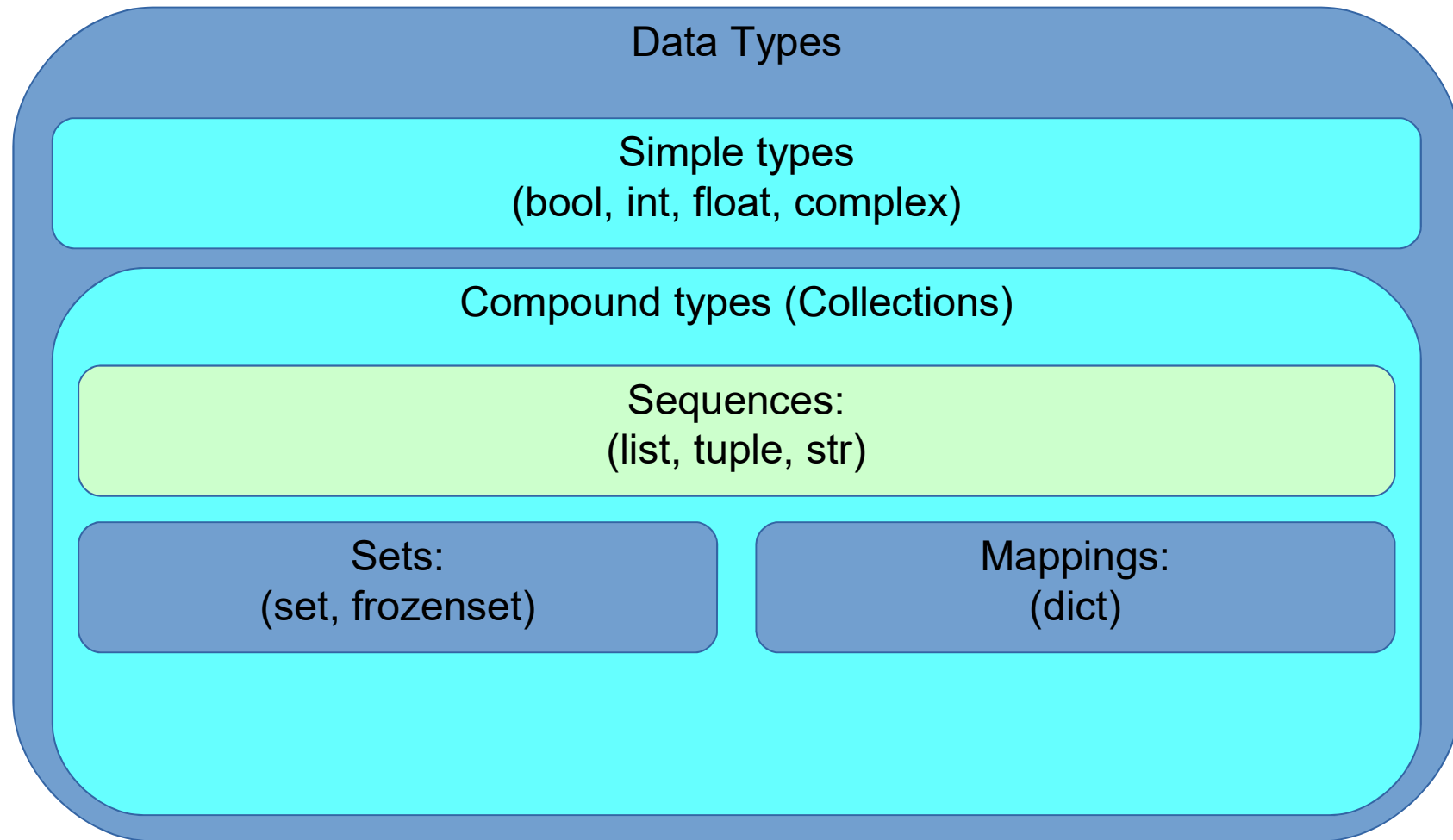
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- Sequence types
  - Lists
  - Tuples
  - Strings



# Sequences

- Python data types





# Lists

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- A **list** is a mutable sequence of values of any type.
- The values in a list are called *elements* or *items*.
- List literals are written in brackets.

```
numbers = [10, 20, 30, 40]
fruits = ['banana', 'pear', 'orange']
empty = [] # an empty list
things = ['spam', 2.0, [1, 2]] # a list inside a list!
```

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- Function `len` returns the *length* of a collection.

```
len(numbers)    #-> 4
len(empty)      #-> 0
len(things)     #-> 3
```

# Indexing

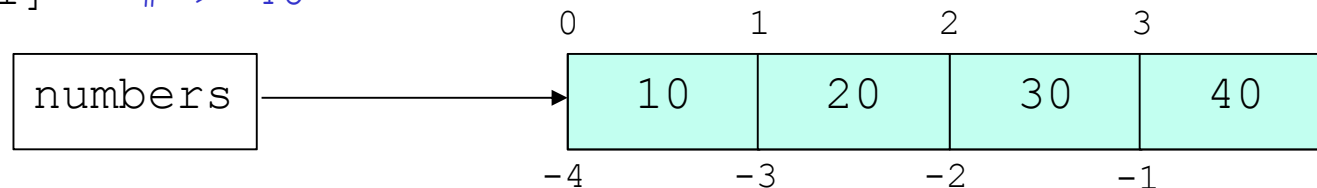
- We can access each element of a sequence using the bracket operator and a value – the *index*.

```
numbers[0]    #-> 10          (index starts at 0)
fruits[2]     #-> 'orange'
```

[Play ▶](#)

- A negative index counts backward from the end.

```
numbers[-1]   #-> 40
```



- Any integer expression may be used as an index.

```
numbers[(9+1)%4]  #-> 30
```

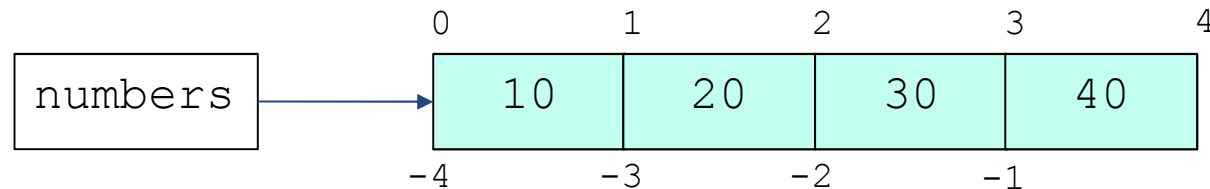
- Using an index outside the list bounds is an error.

```
numbers[4]        #-> IndexError
numbers[-5]       #-> IndexError
```

# Slicing

- We can extract a *subsequence* using **slicing**.

```
numbers[1:3]    #-> [20, 30]
numbers[0:4:2]  #-> [10, 30] (step = 2)
numbers[2:2]    #-> []
```

[Play ▶](#)

- Negative indices may be used too.

```
numbers[-4:-2]  #-> [10, 20]
numbers[1:-1]   #-> [20, 30]
```

- Indices may be omitted for the start or end.

```
numbers[:2]     #-> [10, 20]
numbers[3:]     #-> [40]
numbers[:]      # a full copy of numbers
```

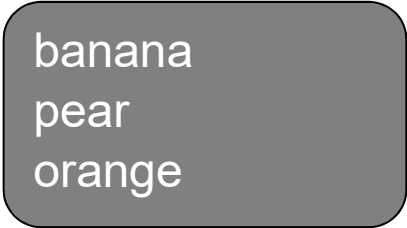


# Traversing

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- The most common way to traverse the elements of a sequence is with a **for** loop.

```
for f in fruits:  
    print(f)
```



banana  
pear  
orange

[Play ▶](#)

- We may also traverse a sequence using the indexes.

```
for i in range(len(fruits)):  
    print(i, fruits[i])
```

- In this case, we may use a **while** loop instead.

```
i = 0  
while i < len(fruits):  
    print(i, fruits[i])  
    i += 1
```

- Or traverse the indexes and items simultaneously.

```
for i, f in enumerate(fruits):  
    print(i, f)
```



# Sequence operations

- The `+` operator concatenates and `*` repeats sequences.

```
s = [1, 2, 3] + [7, 7]    #-> [1, 2, 3, 7, 7]
s2 = [1, 2, 3]*2          #-> [1, 2, 3, 1, 2, 3]
s3 = 3*[0]                #-> [0, 0, 0]
```

[Play ▶](#)

- Operator `in` checks if an element is included in the sequence. Operator `not in` means the opposite.

```
7 in s          #-> True
4 not in s      #-> True
```

- Some built-in functions apply to sequences.

```
sum(s)          #-> 20
min(s)           #-> 1
max(s)           #-> 7
```





# Lists are mutable

- Lists are **mutable**, i.e., we can change their contents.

```
numbers[1] = 99
numbers      #-> [10, 99, 20, 40]
```

[Play ▶](#)

- We can even change a sublist.

```
numbers[2:3] = [98, 97]
numbers      #-> [10, 99, 98, 97, 40]
```

- Lists have several methods to change their contents.

```
lst = [1, 2]
lst.append(3)      # appends 3 to end of lst → [1, 2, 3]
x = lst.pop()      # lst → [1, 2], x → 3
lst.extend([4, 5]) # lst → [1, 2, 4, 5]
lst.insert(1, 6)   # lst → [1, 6, 2, 4, 5]
x = lst.pop(0)     # lst → [6, 2, 4, 5], x → 1
```

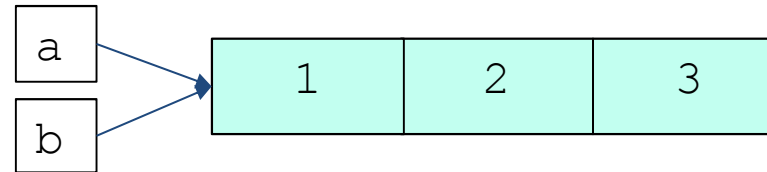
# Mutability and aliasing

- In Python, variables store **references** to objects.

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```
a = [1, 2, 3]
```

```
b = a
```



```
# a and b refer to the same object!  
# In other words, a and b are aliases.
```

- We can confirm that `a` and `b` refer to *the same* object.

```
a is b          #-> True
```

- If object is changed under one name, it is changed under all names! *This may seem strange, at first.*

```
b[0] = 9  # object referenced by b is modified  
b          #-> [9, 2, 3] of course!  
a          #-> [9, 2, 3] even though we did not change a!
```

- Aliasing = Different names referring to the same object.



# Aliasing and argument passing

---

- Aliasing occurs whenever we pass objects as arguments.
- If the object is changed inside the function, this is reflected outside, too.

```
def grow(lst):  
    lst.append(3)  
    return lst  
lst1 = [1, 2]  
lst2 = grow(lst1)  
print(lst1, lst2)  # What's the value of lst1 and lst2?
```

[Play ▶](#)

- This is memory-efficient and can be very useful.
- But if you don't want it, just make a copy before changing.

```
def grow(lst):  
    r = lst[:]  
    r.append(3)  
    return r
```

# Equality *versus* identity

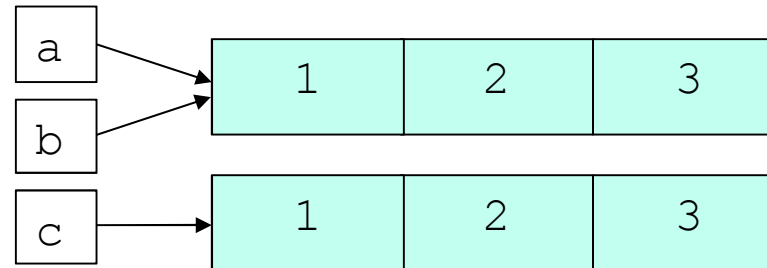
- Objects may be *equal* without being *the same*!

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```
a = [1, 2, 3]
```

```
b = a
```

```
c = a[:]
```



- We test **equality** with `==` (or `!=`).

```
a == b    #-> True
```

```
a != b    #-> False
```

```
a == c    #-> True
```

```
a != c    #-> False
```

- We test **identity** with `is` (or `is not`).

```
a is b    #-> True
```

```
a is not b    #-> False
```

```
a is c    #-> False
```

```
a is not c    #-> True
```

- Identity implies equality!
- Equality does not imply identity.



# Identity and immutable types

---

- Don't use **is** when you mean **==** !

```
[1, 2] == [1, 2]           #-> True
[1, 2] is [1, 2]           #-> False
"abx"[:2] == "ab"         #-> True
"abx"[:2] is "ab"         #-> False (probably...)
1000+1 is 1001            #-> False (probably...)
```

- For some immutable types, Python can sometimes detect equal values and share the same object to save space.

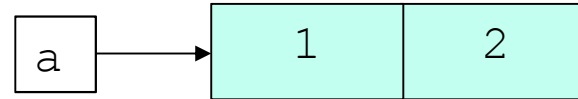
```
"ab" is "ab"              #-> probably True, but ...
10+1 is 11                 #-> probably True, but ...
```

- This is implementation-dependent, so do not rely on it!

# Cloning

- Sometimes, we need to make a copy of an object, so we can change it without changing the original.
- To clone lists, we may use the slicing operator `[ : ]`.

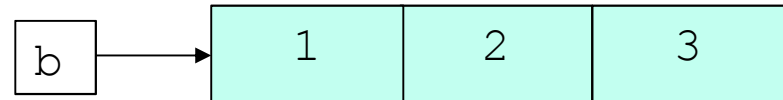
```
a = [1, 2]
```



```
b = a[:]    # slicing creates a new list
```

```
b is a      #-> False
```

```
b.append(3)
```



- We could also use the more general **copy** method.

```
b = a.copy()    # clone a
```

```
b is a          #-> False
```

- Other mutable types (such as sets and dictionaries) also have a `copy` method.
- Immutable types (tuples, strings) don't need one.



# List methods

- List objects have several useful methods.

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<code>lst.append(item)</code>	Add item to the end
<code>lst.insert(pos, item)</code>	Insert item at the given position
<code>lst.extend(collection)</code>	Add all the items in the argument
<code>lst.pop()</code>	Remove last item
<code>lst.pop(pos)</code>	Remove item in given position
<code>lst.remove(item)</code>	Remove first occurrence of given item (if any)
<code>lst.index(item)</code>	Position of first occurrence of given item
<code>lst.count(item)</code>	Number of occurrences of given item
<code>lst.sort()</code>	Sort the items in the list
<code>lst.reverse()</code>	Reverse the order of items in the list



# Strings

---

- Strings are sequences of characters.
- String literals are delimited by single or double quotes.

```
fruit = 'orange'
```

- Like other sequences, we can use indexing and slicing.

```
letter = fruit[0] #-> 'o' (1st character)
```

```
len(fruit)          #-> 6    (length of string)
```

```
fruit[1:4]          #-> 'ran'
```

```
fruit[: -1]         #-> 'orang'
```

```
fruit[::-1]         #-> 'egnaro'
```

- We can also concatenate and repeat strings.

```
name = 'tom' + 'cat'  #-> 'tomcat'
```

```
gps = 2 * 'tom'       #-> 'tomtom'
```





# Strings are immutable

---

- Unlike lists, strings in *Python* are **immutable**. Once a string is created it can't be modified.

```
fruit[0] = 'a'           #-> TypeError
```

- But we can create new strings by combining existing ones.

```
ape = fruit[:-1]+'utan'  #-> 'orangutan'
```

- Even methods that imply modification actually only return a new string object.

```
fruit.upper()           #-> 'ORANGE'
```

```
fruit.replace('a', 'A') #-> 'orAnge'
```

```
fruit                   #-> 'orange' (not changed)
```



# String - traversal

---

- One way to traverse strings is with a `for` loop:

```
fruit = 'banana'
for char in fruit:
    print(char)
```

- Another way:

```
index = 0
while index < len(fruit):
    letter = fruit[index]
    print(letter)
    index = index + 1
```

- Another example:

```
prefixes = 'JKLMNOPQ'
suffix = 'ack'
for letter in prefixes:
    print(letter + suffix)
```



# Examples

---

- The following program counts the number of times the letter 'a' appears in a string:

```
word = 'banana'; count = 0
for letter in word:
    if letter == 'a':
        count = count + 1
print(count)
```

- For strings, the **in** operator returns `True` iff the first string appears as a substring in the second.

```
for letter in word1:
    if letter in word2:
        print(letter)
```




## More on strings

---

- The relational operators work on strings and other sequences.

```
if word < 'banana':  
    print(word, 'comes before banana.')  
elif word > 'banana':  
    print(word, 'comes after banana.')  
else:  
    print('the same')
```

- Characters (letters, digits, punctuation) are stored as numeric codes (according to Unicode in Python3).
  - `ord(c)` - returns the code of the character `c`.
  - `chr(n)` - returns the character represented by code `n`.
- The `str` class has various built-in methods for checking for different classes of characters (`isalpha, ...`).



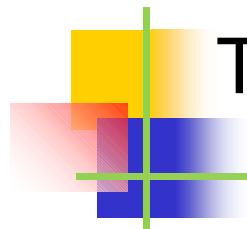
# String methods

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- Strings have a lot of useful methods.

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<code>str.isalpha()</code> <code>str.isdigit()</code> <code>str.is...</code>	True if all characters are alphabetic. True if all characters are digits. ...
<code>str.upper()</code> <code>str.lower()</code> ...	Convert to uppercase. Convert to lowercase. ...
<code>str.strip()</code> <code>str.lstrip()</code> <code>str.rstrip()</code>	Remove leading and trailing whitespace. Remove leading whitespace. Remove trailing whitespace.
<code>str.split()</code>	Split str by the whitespace characters.
<code>str.split(sep)</code>	Split str using sep as the delimiter.
<code>sep.join(lst)</code>	Join the strings in lst using delimiter sep.



# Tuples

---

- A **tuple** is an immutable sequence of values of any type.
- The values are indexed by integers, like in lists. The important difference is that **tuples are immutable**.
- Syntactically, a tuple is a comma-separated list of values.

```
t = 'a', 'b', 'c', 'd', 'e'
```

- It is common (and sometimes necessary) to enclose tuples in parentheses.

```
t = ('a', 'b', 'c', 'd', 'e')
```

- To create a tuple with a single element, you have to include a final comma:

```
t1 = ('a',)  
type(t1)      #->  <type 'tuple'>
```



## Tuples (2)

---

- Another way to create a tuple is the built-in function `tuple`. With no argument, it creates an empty tuple:

```
t = tuple()                                # t → ()
```

- If the argument is a sequence (string, list or tuple), the result is a tuple with the elements of the sequence:

```
t = tuple('ape')                           # t → ('a', 'p', 'e')
```

```
t = tuple([1, 2])                         # t → (1, 2)
```

- Most list operators also work on tuples.
- We can't modify the elements in a tuple, but we can replace one tuple with another.

```
t = t + (3, 4)                             # t → (1, 2, 3, 4)
```



# Lists and tuples

---

- The built-in function `zip` takes two or more sequences and generates a sequence of tuples, each containing one element from each sequence.

```
s = 'abc'
t = [4, 3, 2]
list(zip(s, t))  # → [('a', 4), ('b', 3), ('c', 2)]
```

- `enumerate` generates a sequence of (index, item) pairs.

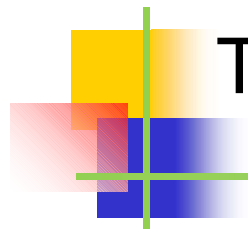
```
enumerate('abc')  # → (0, 'a'), (1, 'b'), (2, 'c')
```

- You can use tuple assignment in a **for** loop to traverse a sequence of tuples:

```
s = 'somestuff'
for i, c in enumerate(s):
    print(i, c)
```







## Tuples – Other features

---

- The **relational operators** work with tuples and other sequences:

- Python starts by comparing the first element from each sequence. If they are equal, it goes on to the next elements, and so on, until it finds elements that differ.

```
(0, 1, 2) < (0, 3, 4)      #-> True
```

- The `sorted` function and the list `sort` method work the same way. They sort primarily by first element, but in the case of a tie, they sort by second element, and so on.
- Tuples may be used as keys in dictionaries.

```
directory[last, first] = number
for last, first in directory:
    print(first, last, directory[last,first])
```