COMP1730/COMP6730
Programming for Scientists

Sequence types

Lecture outline

* Sequence data types
* Indexing, length & slicing

Sequences

* A *sequence* contains zero or more values.
* Each value in a sequence has a *position*, or *index*, ranging from 0 to $n - 1$.
* The *indexing operator* can be applied to all sequence types, and returns the value at a specified position in the sequence.
  - Indexing is done by writing the index in square brackets after the sequence value, like so:

    `sequence[pos]`

Sequence data types

* python has three important built-in sequence types:
  - strings (`str`) contain only text;
  - lists (`list`) can contain a mix of value types;
  - tuples (`tuple`) are like lists, but immutable.
* Sequence types provided by other modules (but not covered here):
  - NumPy arrays (`numpy.ndarray`).

Indexing & length

sequence:	3.0	1.5	0.0	-1.5	-3.0
index:	0	1	2	3	4
	-5	-4	-3	-2	-1

* In python, all sequences are indexed from 0.
* The index must be an integer.
* python also allows indexing from the sequence end using negative indices, starting with -1.
* The length of a sequence is the number of elements, *not* the index of the last element.

* `len(`*`sequence`*`)` returns sequence length.
* Sequence elements are accessed by writing the index in square brackets, `[]`.

```
>>> x = [3, 1.5, 0, -1.5, -3]
>>> x[1]
1.5
>> x[-1]
-3.0
>>> len(x)
5
>>> x[5]
IndexError: index 5 is out of bounds
            for axis 0 with size 5
```

Functions on sequences

There are many built-in functions that operate on sequences:

* `min` and `max` return the smallest and largest elements in the sequence.
* `sum` returns the sum of the elements in the sequence.
* `len` returns the number of elements in the sequence.
* `sorted` returns a list with the elements of the sequence arranged in ascending order.
* `x in sequence` returns `True` iff `x` is an element of the `sequence`.

Generalised indexing

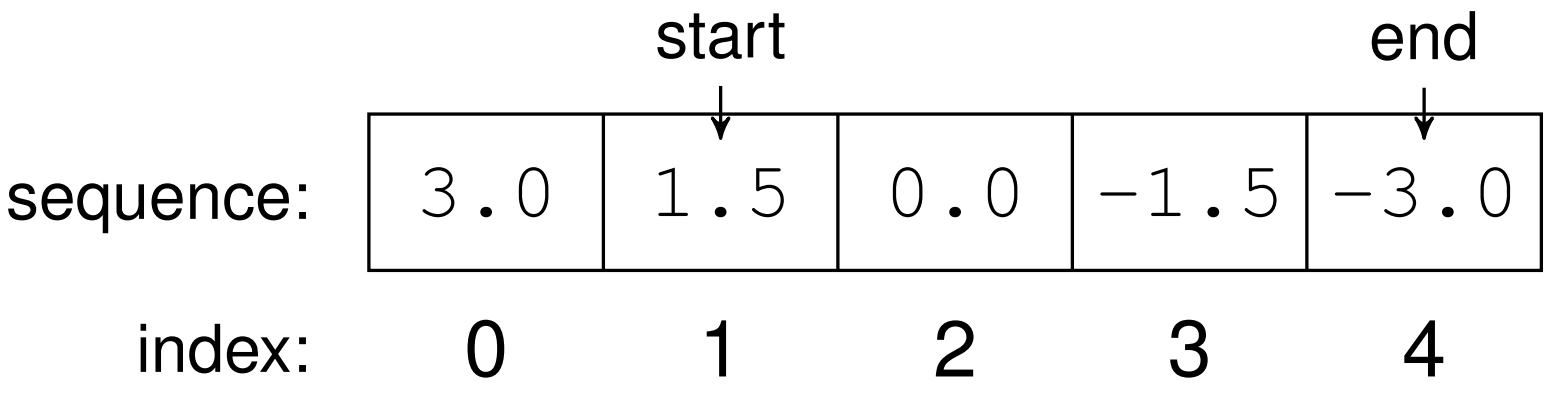
* Most python sequence types support *slicing* – accessing a subsequence by indexing a range of positions:

```
sequence[start:end]
sequence[start:end:step-size]
```

Slicing

* The slice range is “half-open”: start index is included, end index is one after last included element.

```
>>> x = [3, 1.5, 0, -1.5, -3]
>>> x[1:4]
 [ 1.5, 0, -1.5]
```



Slicing is an operator

* The slicing operator returns a sequence, which can be indexed (or sliced):

```
>>> x[1:4][1]
0.0
```

* Slicing associates to the left.

Indexing vs. Slicing

* Indexing a sequence returns an element: The index must be valid (i.e., between `0` and `length-1` or `-1` and `-length`).
* Slicing returns a subsequence of the same type: Indexes in a slice do not have to be valid. And a slice may contain 0 or more elements.

Tuples

* Commonly used as simple representation of x,y coordinates.
* A one-element tuple must be written with a comma after the single element.

```
>>> ('TGAC','UCAG') # two element tuple
('TGAC','UCAG')
>>> ('TGAC',) # a one element tuple
('TGAC',)
>>>() # an empty tuple
()
>>>('TGAC') # not a tuple- a string!
'TGAC'
```

Tuples

```
>>> tuple('TGAC') # a string is a sequence
('T','C','A','G') # of one-character strings (characters)

>>>tuple(range(5,10)
(5, 6, 7, 8, 9)

>>> a = (1,2)
>>> a[0] = 3 # tuples are not mutable
TypeError:  'tuple' object does not support item assignment
```

Take home message

* `list` data type to store an (ordered) sequence of values.
* Sequence index starts from 0, not 1!
* Indexing operator returns an element, whereas slicing operator returns a sequence.