Australian
National
University

COMP1730/COMP6730
Programming for Scientists

Strings

Announcements

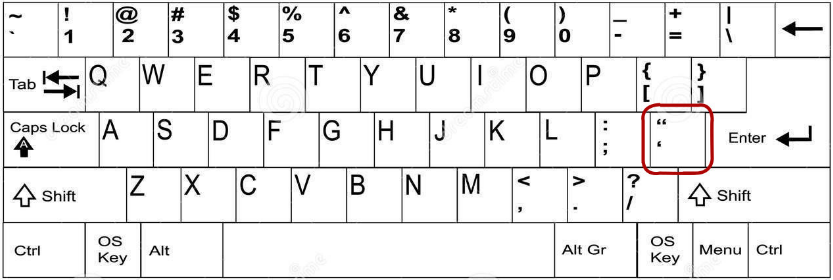
- Howework 2 assessed in labs this week. As with last week, you must attend your lab group. Any variations can only be approved in exceptional circumstances and must be submitted to comp1730@anu.edu.au by 12:00pm today.
- Homework 3 due next Monday 29 March - 9:00am Canberra time.

Lecture outline

- Character encoding & strings
- Indexing, slicing recap
- Sequence comparisons
- String methods

Strings

- Strings – values of type `str` in python – are used to store and process text.
- A string is a *sequence* of *characters*.
  - `str` is a sequence type.
- String literals can be written with
  - single quotes, as in `'hello there'`
  - double quotes, as in `"hello there"`
  - triple quotes, as in `'''hello there'''`



- Beware of copy–pasting code from slides (and other PDF files or web pages).

- Quoting characters other than those enclosing a string can be used inside it:

```
»> "it's true!"
»> '"To be,"said he, ...'
```

- Quoting characters of the same kind can be used inside a string if escaped by backslash (\):

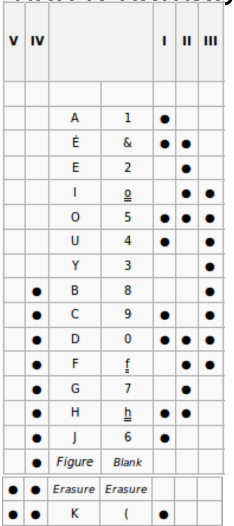
```
»> 'it\'s true'
»> "it's a \"quote\""
```

- Escapes are used also for some non-printing characters:

```
»> print("\t1m\t38s\n\t12m\t9s")
```

Character encoding

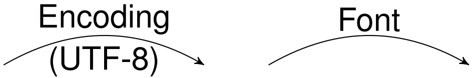
- Idea: Every character has a number.
- Baudot code (1870).
- 5-bit code, but also sequential ("letter" and "figure" mode).



V	IV			I	II	III
		A	1	●		
		É	&	●	●	
		E	2		●	
		I	º		●	●
		O	5	●	●	●
		U	4	●		●
		Y	3			●
	●	B	8			●
	●	C	9	●		●
	●	D	0	●	●	●
	●	F	f̲		●	●
	●	G	7		●	
	●	H	h̲	●	●	
	●	J	6	●		
	●	*Figure*	*Blank*			
●	●	*Erasure*	*Erasure*			
●	●	K	(	●		

Unicode, encoding and font

- *Unicode* defines numbers (“*code points*”) for $>$120,000 characters (in a space for $>$1 million).



Encoding (UTF-8)

Font

Byte(s)	Code point	Glyph
0100 0101	69	EEE$\mathcal{E}$

1110 0010
1000 0010
1010 1100
	8364	€€€€

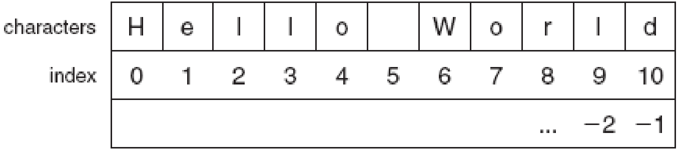
- python 3 uses the unicode character representation for all strings.
- Functions `ord` and `chr` map between the character and integer representation:

```
»> ord('A')
»> chr(65 + 4)
»> chr(32)
»> chr(8364)
»> chr(20986)+chr(21475)
»> ord('3')
```

- See `unicode.org/charts/`.

Strings are sequences

Indexing & length (reminder)



characters	H	e	l	l	o		W	o	r	l	d
index	0	1	2	3	4	5	6	7	8	9	10
									...	−2	−1

FIGURE 4.1 The index values for the string 'Hello World'.

Image from Punch & Enbody

- In python, all sequences are indexed from 0.
- ...or from end, starting with -1.
- The index must be an integer.
- 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 placing the index in square brackets, `[]`.

```
»> s = "Hello World"
»> s[1]
'e'
»> s[-1]
'd'
»> len(s)
11
»> s[11]
IndexError: string index out of range
```

Slicing - Recap

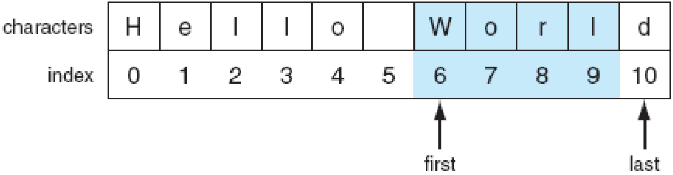
- Slicing returns a subsequence:

  `s[start:end]`

  - *`start`* is the index of the first element in the subsequence.
  - *`end`* is the index of the first element after the end of the subsequence.
- Slicing works on all built-in sequence types (`list`, `str`, `tuple`) and returns the same type.
- If *`start`* or *`end`* are left out, they default to the beginning and end (i.e., after the last element).

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

```
»> s = "Hello World"
»> s[6:10]
’Worl’
```



characters	H	e	l	l	o		W	o	r	l	d
index	0	1	2	3	4	5	6	7	8	9	10

FIGURE 4.2 Indexing subsequences with slicing.

Image from Punch & Enbody

- The end index defaults to the end of the sequence.

```
»> s = "Hello World"
»> s[6:]
’World’
```

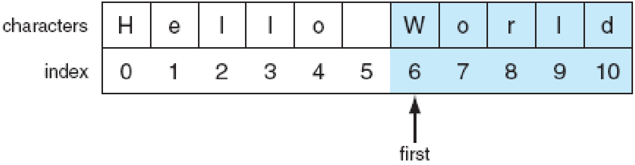
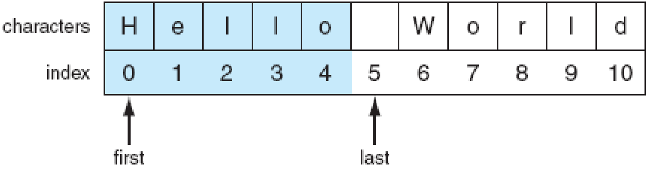


Image from Punch & Enbody

- The start index defaults to the beginning of the sequence.

```
»> s = "Hello World"
»> s[:5]
’Hello’
```



characters	H	e	l	l	o		W	o	r	l	d
index	0	1	2	3	4	5	6	7	8	9	10

Image from Punch & Enbody

```
»> s = "Hello World"
»> s[9:1]
''
»> s[−100:5]
'Hello'
```

- An empty slice (index range) returns an empty sequence
- Slice indices can go past the start/end of the sequence without raising an error.

Sequence comparisons

- Two sequences are equal if they have the same length and equal elements in every position.
- `seq1 < seq2` if
  - `seq1[i] < seq2[i]` for some index `i` and the elements in each position before `i` are equal; or
  - `seq1` is a prefix of `seq2`.
- *Note*: Comparison of NumPy arrays is *element-wise* and returns an array of `bool`.

String comparisons

- Each character corresponds to an integer.
  - ord('') == 32
  - ord('A') == 65, ..., ord('Z') == 90
  - ord('a') == 97, ..., ord('z') == 122
- Character comparisons are based on this.

```
»> "the ANU" < "The anu"
»> "the ANU" < "the anu"
»> "nontrivial" < "non trivial"
```

String methods

Methods

- Methods are only functions with a slightly different call syntax:

  ```
  "Hello World".find("o")
  ```

  instead of

  ```
  str.find("Hello World", "o")
  ```

- python’s built-in types, like `str`, have many useful methods.
  - `help(str)`
  - `docs.python.org`

Programming problem

- Find a longest repeated substring in a word:
  - `'backpack'` → `'ack'`
  - `'singing'` → `'ing'`
  - `'independent'` → `'nde'`
  - `'philosophically'` → `'phi'`
  - `'monotone'` → `'on'`
  - `'wherever'` → `'er'`
  - `'repeated'` → `'e'`
  - `'programming'` → `'r'` (or `'g'`, `'m'`)
  - `'problem'` → `''`