61A Lecture 14

Friday, October 3

Announcements

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- Homework 4 due Tuesday 10/7 @ 11:59pm (It is small)

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- Project 2 due Thursday 10/9 @ 11:59pm (It is BIG)

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  - Project Party Monday 5pm–7pm in 271, 273, & 275 Soda
  - Extra credit point for submitting your project at least 24 hours before the deadline

Encoding Strings

(Bonus Material)

Representing Strings: the ASCII Standard

American Standard Code for Information Interchange

ASCII Code Chart

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

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8 rows: 3 bits	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
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1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
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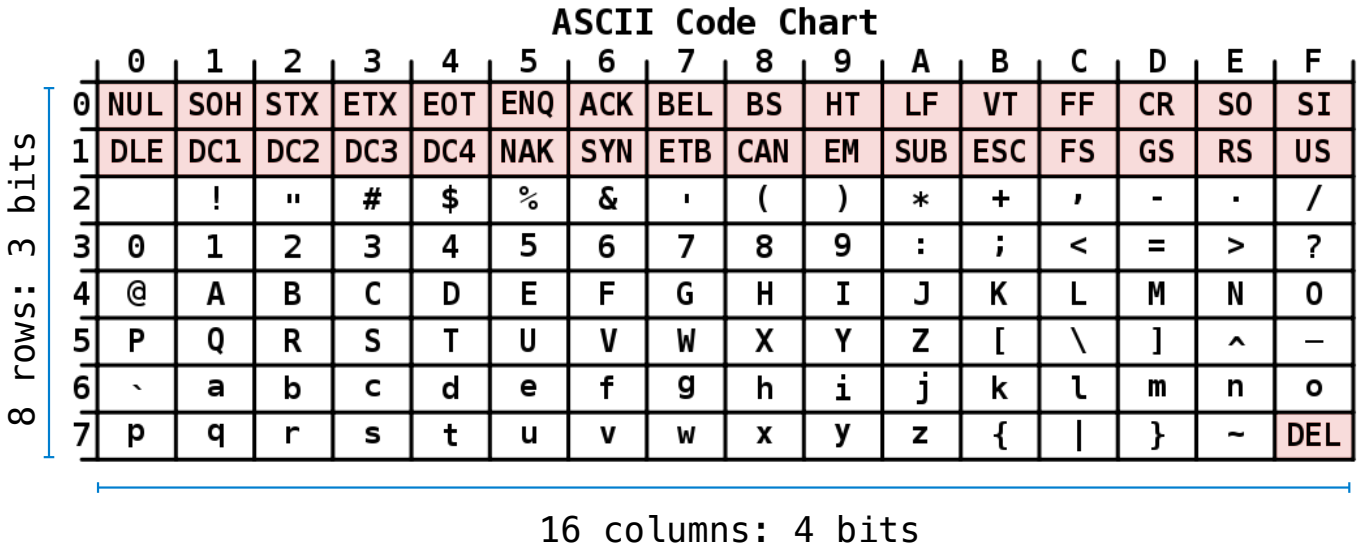

Representing Strings: the ASCII Standard

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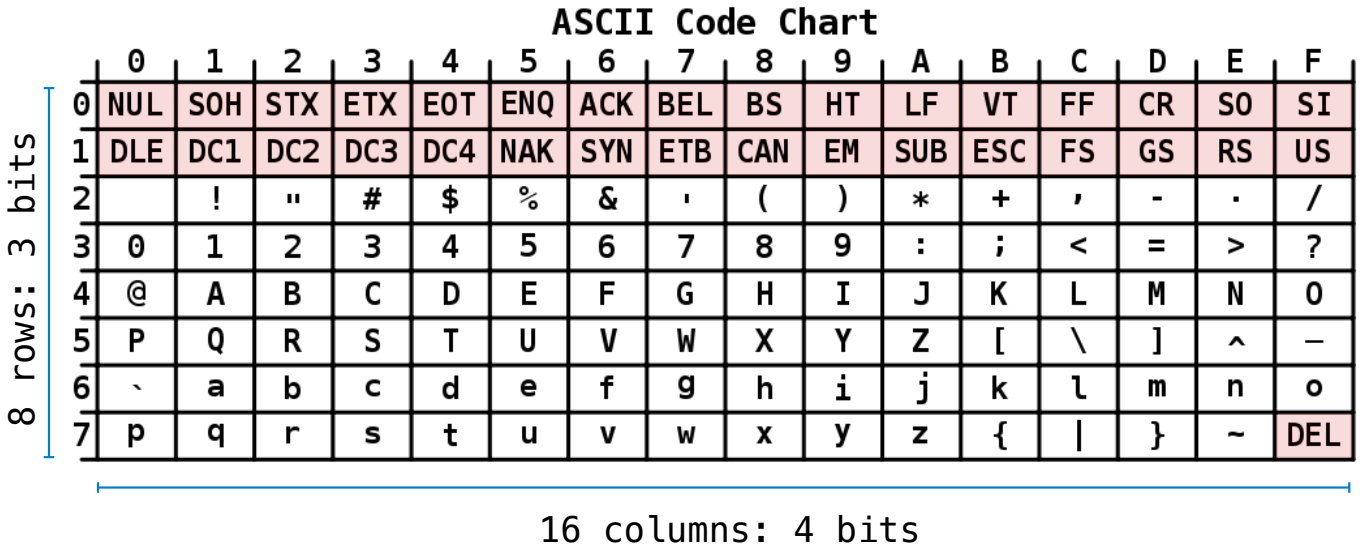

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
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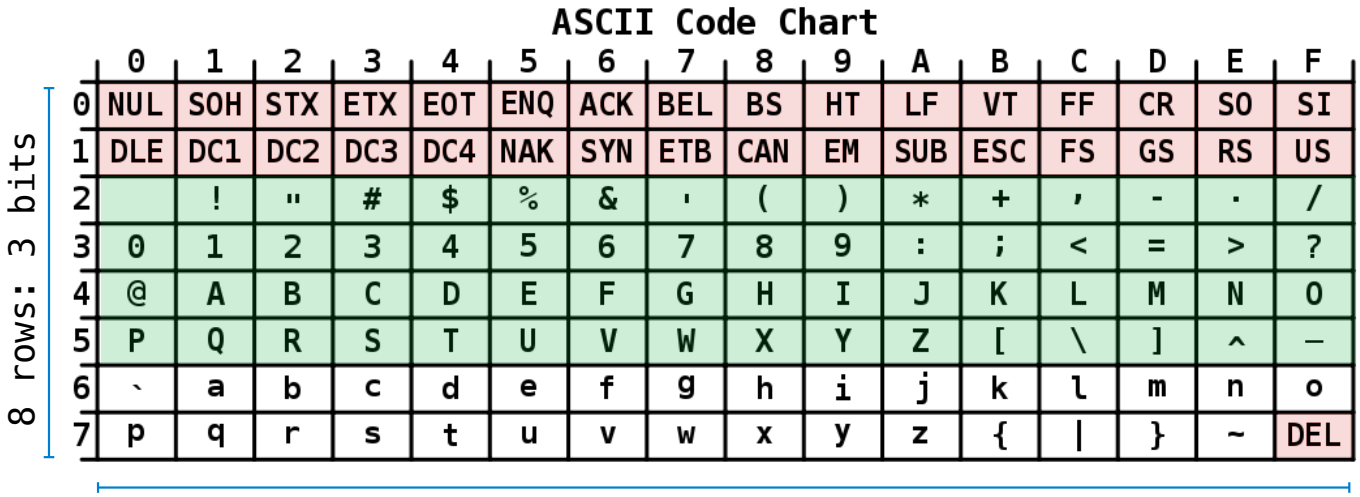

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
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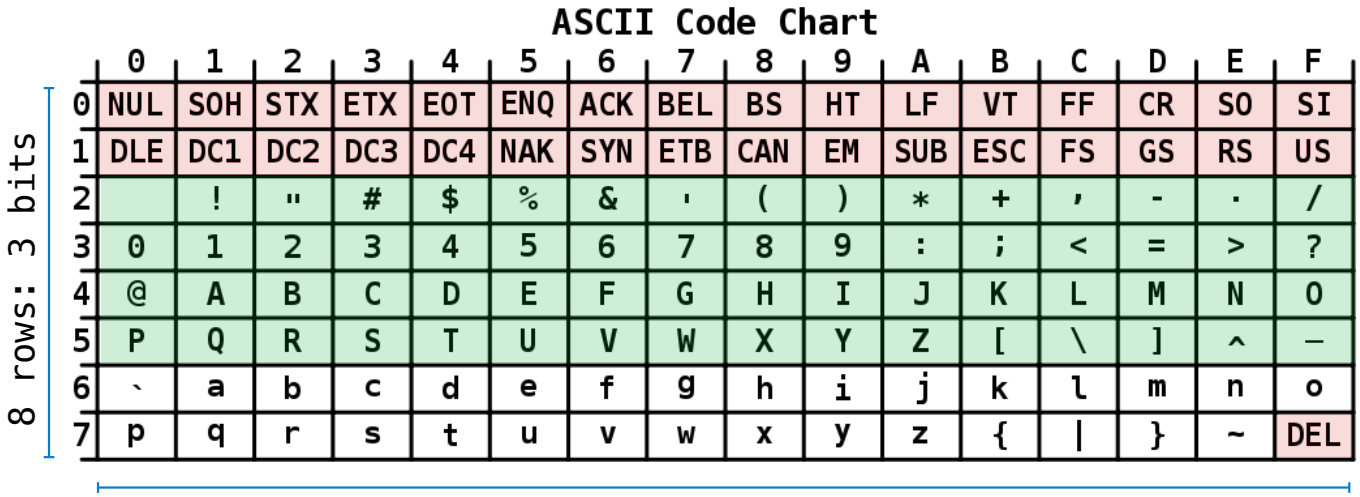

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1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
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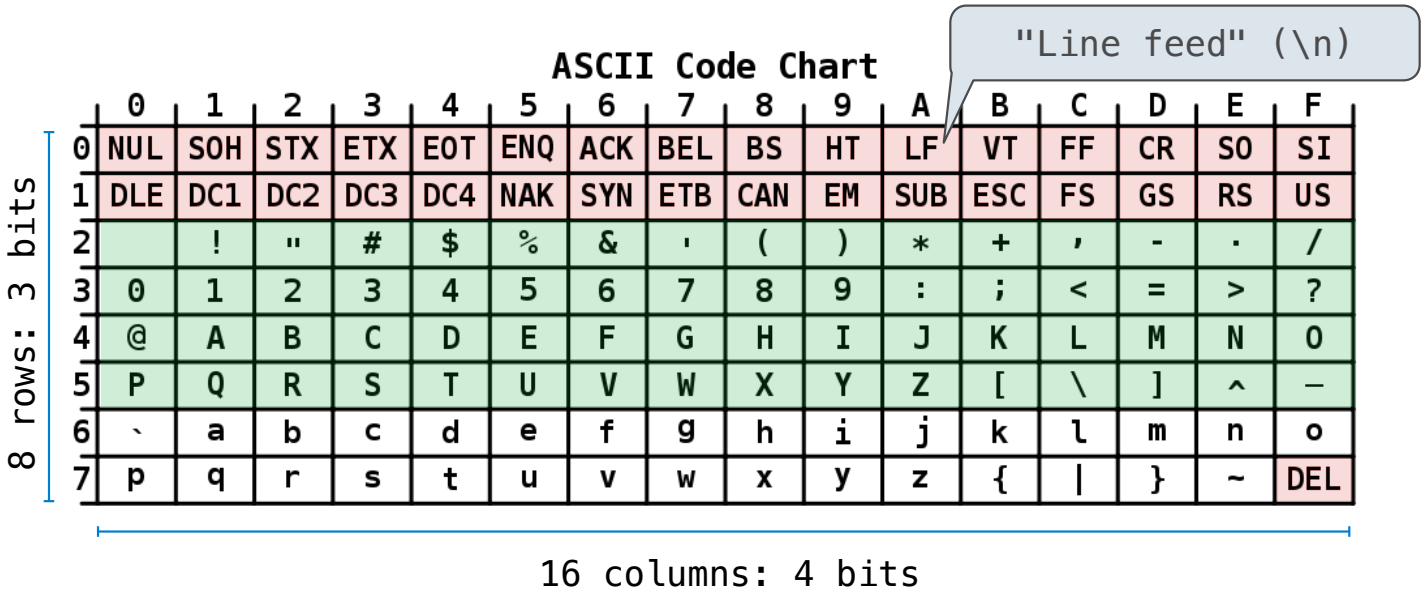

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
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2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
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4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
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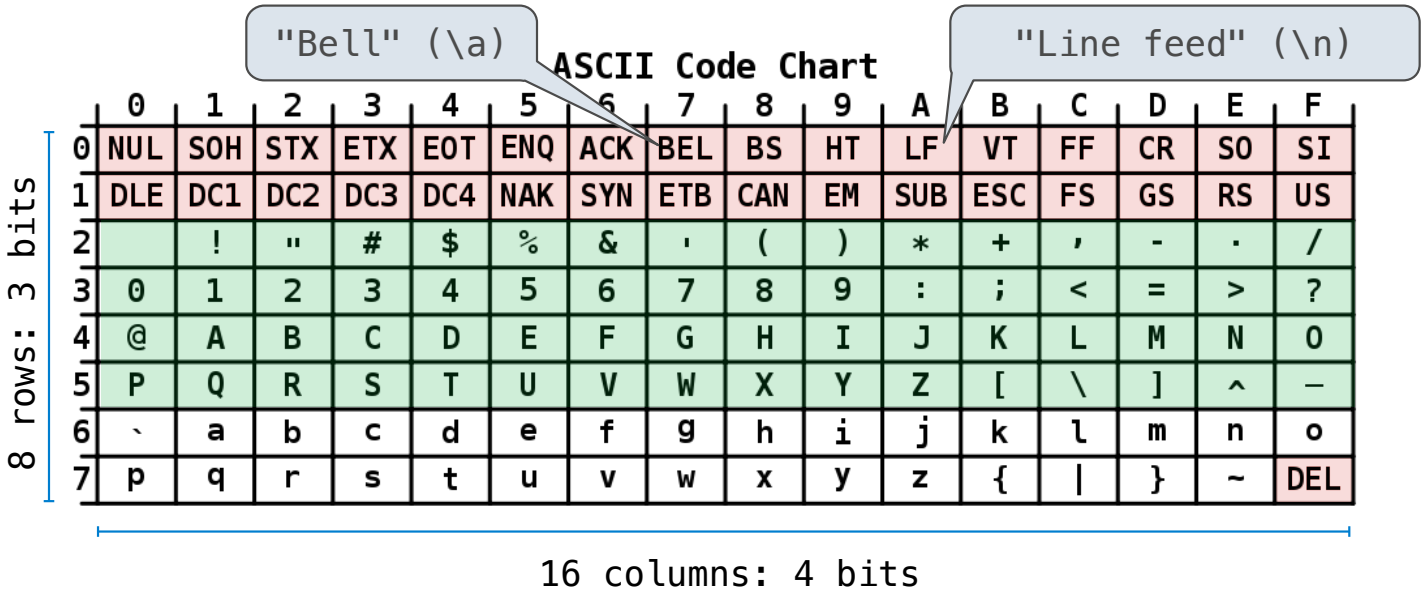

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
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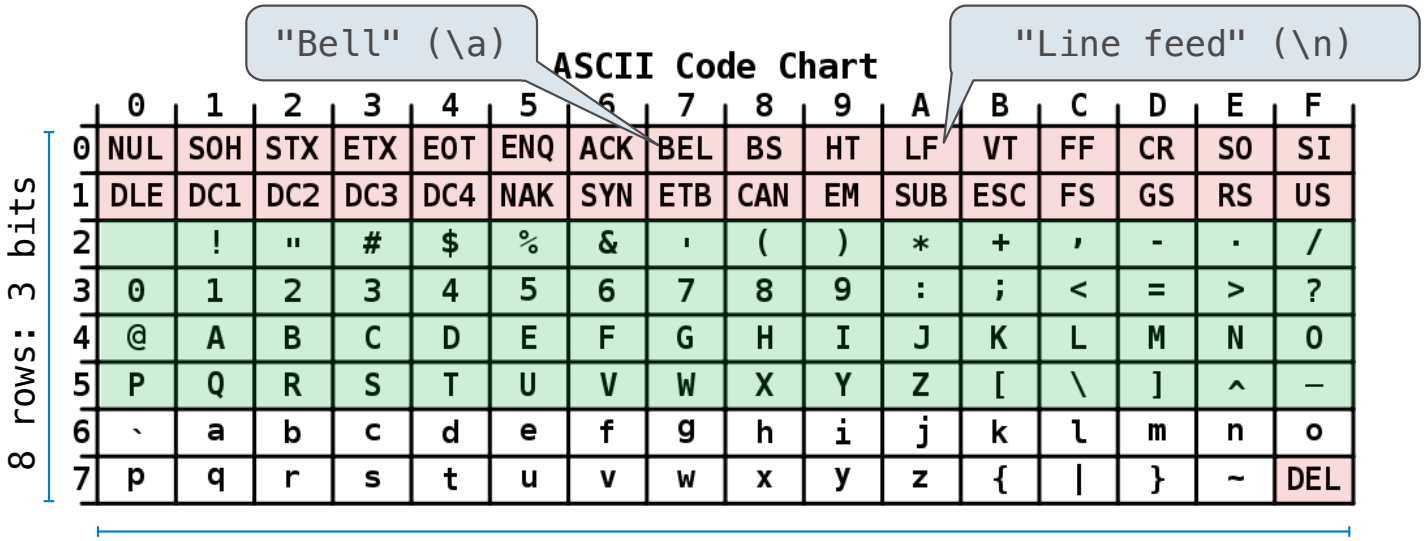

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(Demo)

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☺ ☹

(Demo)

Representing Strings: UTF-8 Encoding

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UTF (UCS (Universal Character Set) Transformation Format)

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Unicode: Correspondence between characters and integers

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A byte is 8 bits and can encode any integer 0–255.

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```
                          00000000       0

        bytes                                    integers
```

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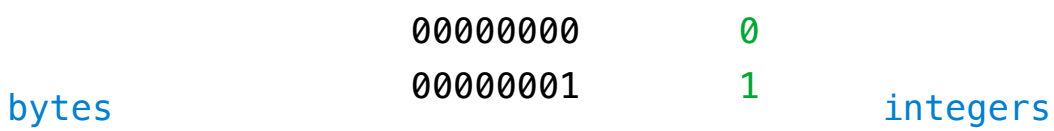

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bytes	integers
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00000010	2

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In Python: `string` length is measured in characters, `bytes` length in bytes.

(Demo)

Mutation Operations

Some Objects Can Change

[Demo]

Some Objects Can Change

[Demo]

First example in the course of an object changing state

Some Objects Can Change

[Demo]

First example in the course of an object changing state

The same object can change in value throughout the course of computation

Some Objects Can Change

[Demo]

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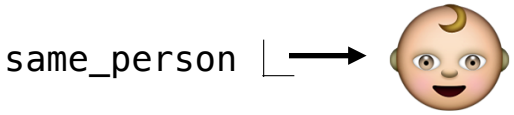

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[Demo]

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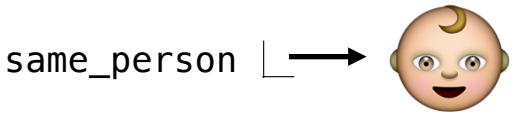

BABY

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[Demo]

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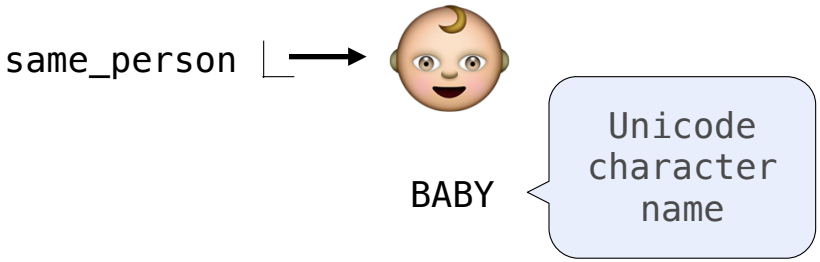

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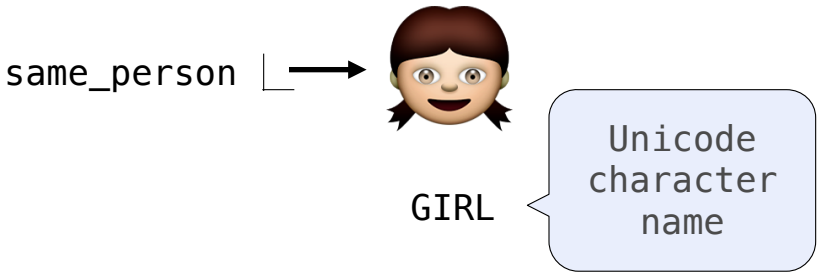

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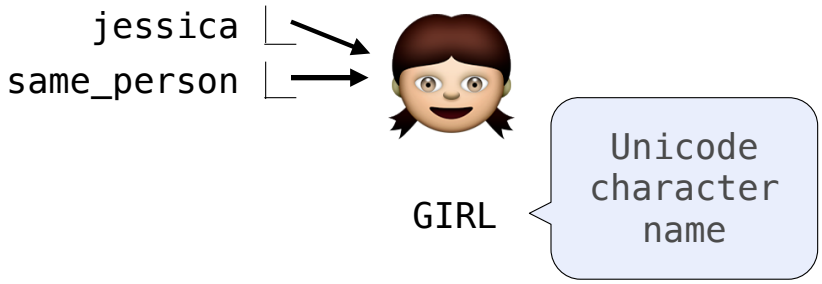

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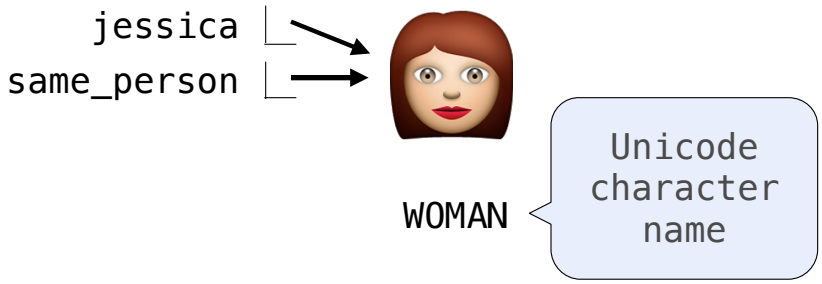

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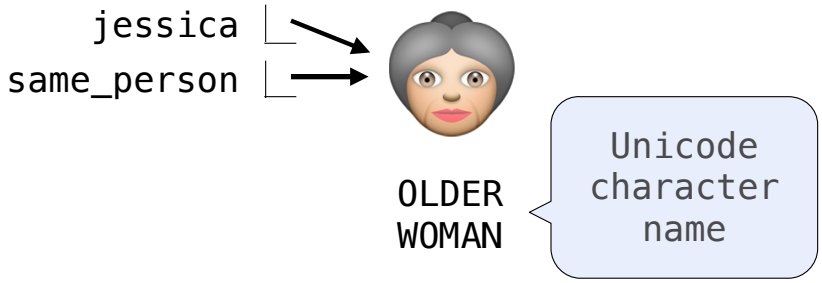

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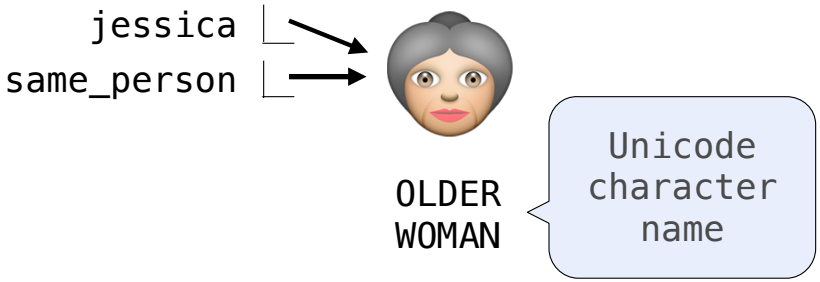

All names that refer to the same object are affected by a mutation

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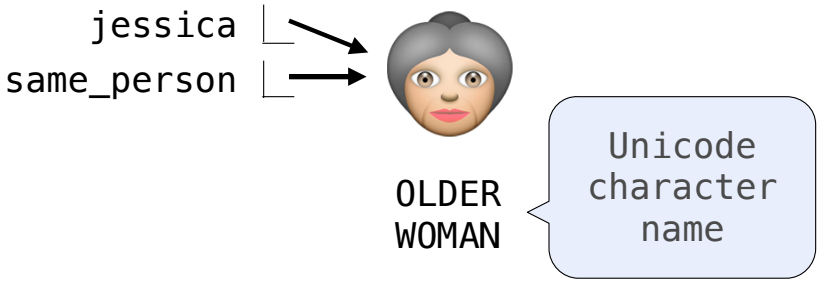

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Only objects of *mutable* types can change: lists & dictionaries

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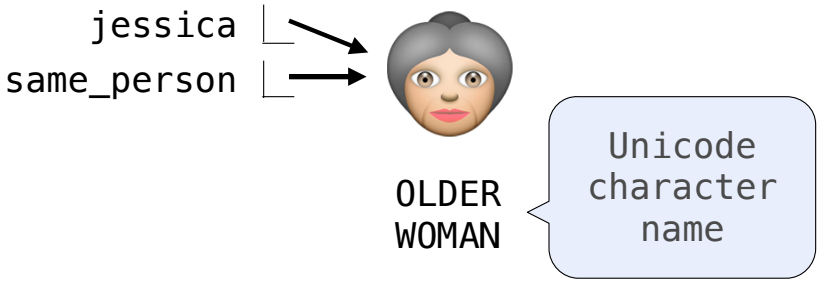
The same object can change in value throughout the course of computation



All names that refer to the same object are affected by a mutation

Only objects of *mutable* types can change: lists & dictionaries

{Demo}

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
```

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
>>> len(four)
4
```

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
>>> len(four)
4
>>> mystery(four)
```

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A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
>>> len(four)
4
>>> mystery(four)
>>> len(four)
2
```

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
>>> len(four)
4
>>> mystery(four)
>>> len(four)
2
```

```
def mystery(s):
    s.pop()
    s.pop()
```

Interactive Diagram

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
>>> len(four)
4
>>> mystery(four)
>>> len(four)
2
```

```
def mystery(s):
    s.pop()
    s.pop()
```

or

```
def mystery(s):
    s[2:] = []
```

Interactive Diagram

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
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```

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def mystery(s):
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    s.pop()
```

or

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or

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def mystery(s):
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>>> four = [1, 2, 3, 4]
>>> len(four)
4
```

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    s.pop()
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or

```
def mystery(s):
    s[2:] = []
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```
>>> four = [1, 2, 3, 4]
>>> len(four)
4
>>> another_mystery() # No arguments!
```

Interactive Diagram

Mutation Can Happen Within a Function Call

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def another_mystery(s):
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    four.pop()
```

Interactive Diagram

Tuples

(Demo)

Tuples are Immutable Sequences

Tuples are Immutable Sequences

Immutable values are protected from mutation

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```
>>> turtle = (1, 2, 3)
```

Tuples are Immutable Sequences

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```
>>> turtle = (1, 2, 3)
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```
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['Anything could be inside!']
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>>> turtle = (1, 2, 3)
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(1, 2, 3)
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Next lecture: ooze can change turtle's binding

```
>>> turtle = [1, 2, 3]
>>> ooze()
>>> turtle
['Anything could be inside!']
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```
>>> turtle = (1, 2, 3)
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Next lecture: ooze can change turtle's binding

```
>>> turtle = [1, 2, 3]
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>>> turtle
['Anything could be inside!']
```

The value of an expression can change because of changes in names or objects

Tuples are Immutable Sequences

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>>> turtle = (1, 2, 3)
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Next lecture: ooze can change turtle's binding

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Name change:

Tuples are Immutable Sequences

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```
>>> turtle = (1, 2, 3)
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>>> turtle
(1, 2, 3)
```

Next lecture: ooze can change turtle's binding

```
>>> turtle = [1, 2, 3]
>>> ooze()
>>> turtle
['Anything could be inside!']
```

The value of an expression can change because of changes in names or objects

```
>>> x + x
```

Name change:

```
>>> x + x
```

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```
>>> turtle = (1, 2, 3)
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>>> x + x
```

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An immutable sequence may still change if it *contains* a mutable value as an element

Tuples are Immutable Sequences

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```

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```
>>> s = ([1, 2], 3)
```

Tuples are Immutable Sequences

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An immutable sequence may still change if it *contains* a mutable value as an element

```
>>> s = ([1, 2], 3)
>>> s[0] = 4
```

Tuples are Immutable Sequences

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An immutable sequence may still change if it *contains* a mutable value as an element

```
>>> s = ([1, 2], 3)
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ERROR
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```
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>>> s[0][0] = 4
>>> s
```

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```
>>> s = ([1, 2], 3)
>>> s[0] = 4
ERROR
```

```
>>> s = ([1, 2], 3)
>>> s[0][0] = 4
>>> s
([4, 2], 3)
```

Mutation

Sameness and Change

Sameness and Change

- As long as we never modify objects, a compound object is just the totality of its pieces

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```
>>> a = [10]
```

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```
>>> a = [10]
>>> b = a
```

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```
>>> a = [10]
>>> b = a
>>> a == b
True
```

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```
>>> a = [10]
>>> b = a
>>> a == b
True
>>> a.append(20)
```

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True
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>>> a == b
True
>>> a
[10, 20]
```

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- This view is no longer valid in the presence of change
- A compound data object has an "identity" in addition to the pieces of which it is composed
- A list is still "the same" list even if we change its contents
- Conversely, we could have two lists that happen to have the same contents, but are different

```
>>> a = [10]
>>> b = a
>>> a == b
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>>> a.append(20)
>>> a == b
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Sameness and Change

- As long as we never modify objects, a compound object is just the totality of its pieces
- A rational number is just its numerator and denominator
- This view is no longer valid in the presence of change
- A compound data object has an "identity" in addition to the pieces of which it is composed
- A list is still "the same" list even if we change its contents
- Conversely, we could have two lists that happen to have the same contents, but are different

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evaluates to `True` if both `<exp0>` and `<exp1>` evaluate to the same object

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(Demo)

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>>> def f(s=[]):
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A default argument value is part of a function value, not generated by a call

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...
>>> f()
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>>> f()
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```

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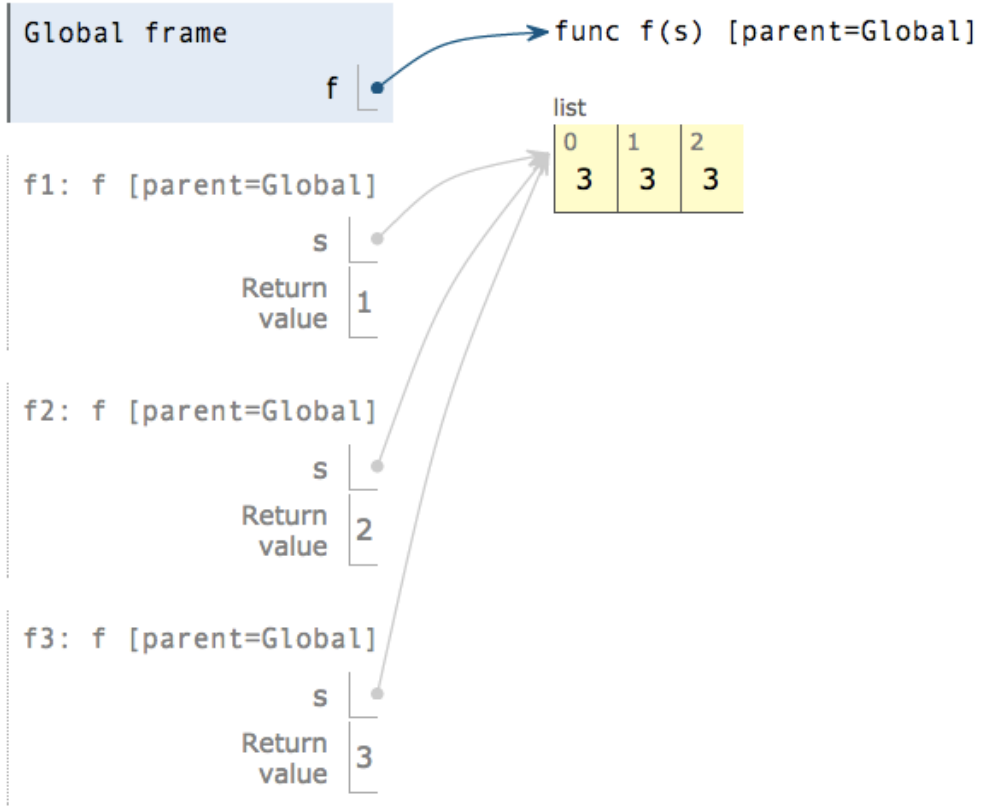

Interactive Diagram

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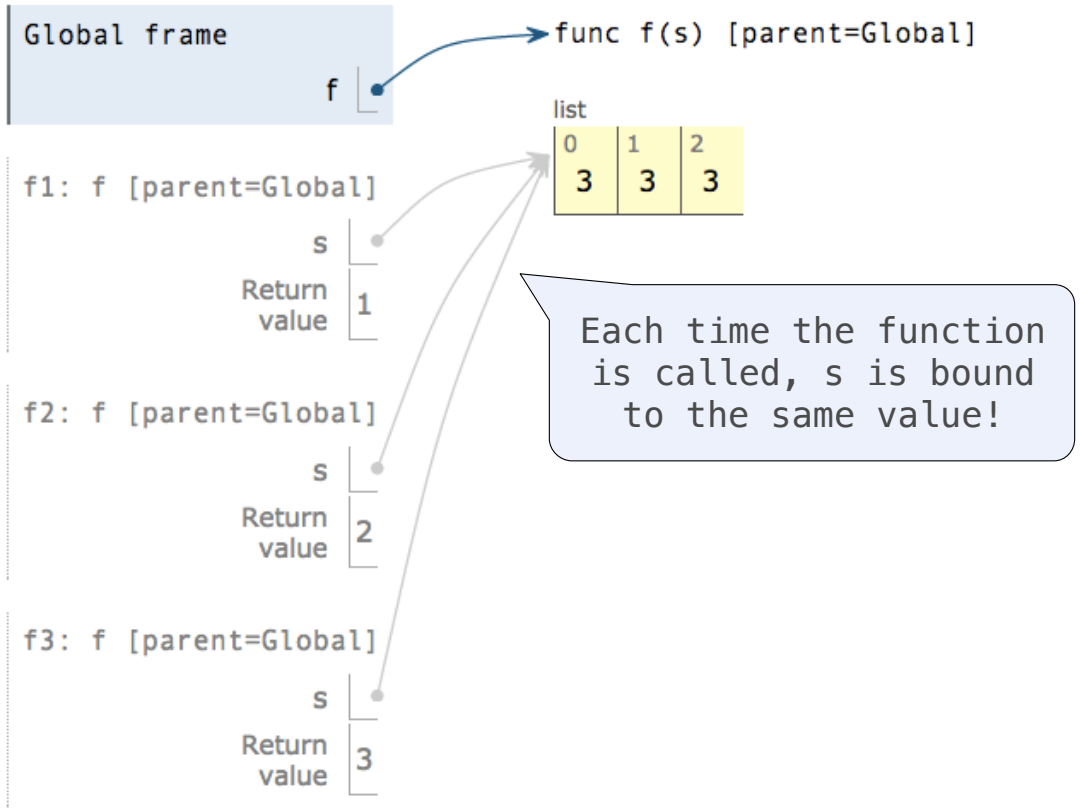

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