Announcements
Lists

['Demo']
Working with Lists
Working with Lists

```python
>>> digits = [1, 8, 2, 8]
```
Working with Lists

```python
>>> digits = [1, 8, 2, 8]                     >>> digits = [2//2, 2+2+2, 2, 2*2*2]
```
Working with Lists

```python
>>> digits = [1, 8, 2, 8]
>>> digits = [2//2, 2+2+2, 2, 2*2*2]

The number of elements
```
Working with Lists

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>>> digits = [1, 8, 2, 8]
>>> digits = [2//2, 2+2+2+2, 2, 2*2*2]

The number of elements
```
Working with Lists

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>>> digits = [1, 8, 2, 8]
>>> digits = [2//2, 2+2+2+2, 2, 2*2*2]

The number of elements
```
Working with Lists

```python
>>> digits = [1, 8, 2, 8]
```

The number of elements

```python
>>> len(digits)
4
```

An element selected by its index

```python
>>> digits[3]
digits[3]
8
```
Working with Lists

```python
>>> digits = [1, 8, 2, 8]

The number of elements
```
```python
>>> len(digits)
4
```

```python
An element selected by its index
```
```python
>>> digits[3]
8
```

```python
>>> digits = [2//2, 2+2+2+2, 2, 2*2*2]

>>> getitem(digits, 3)
8
```
Working with Lists

```python
>>> digits = [1, 8, 2, 8]

The number of elements
>>> len(digits)
4

An element selected by its index
>>> digits[3]
8

Concatenation and repetition
>>> digits = [2//2, 2+2+2+2, 2, 2*2*2]
```

```python
>>> digits = [2//2, 2+2+2+2, 2, 2*2*2]
```

```python
>>> getitem(digits, 3)
8
```
Working with Lists

```python
>>> digits = [1, 8, 2, 8]

The number of elements

>>> len(digits)
4

An element selected by its index

>>> digits[3]
8

Concatenation and repetition

>>> [2, 7] + digits * 2
[2, 7, 1, 8, 2, 8, 1, 8, 2, 8]

```
Working with Lists

```python
>>> digits = [1, 8, 2, 8]

The number of elements
```
```python
>>> len(digits)
4
```

An element selected by its index
```
>>> digits[3]
8
```

Concatenation and repetition
```
>>> [2, 7] + digits * 2
[2, 7, 1, 8, 2, 8, 1, 8, 2, 8]
```

```python
>>> digits = [2//2, 2+2+2+2, 2, 2*2*2]

>>> getitem(digits, 3)
8
```

```python
>>> add([2, 7], mul(digits, 2))
[2, 7, 1, 8, 2, 8, 1, 8, 2, 8]
```
Working with Lists

```python
>>> digits = [1, 8, 2, 8]

The number of elements

>>> len(digits)
4

An element selected by its index

>>> digits[3]
8

Concatenation and repetition

>>> [2, 7] + digits * 2
[2, 7, 1, 8, 2, 8, 1, 8, 2, 8]

Nested lists

>>> digits = [2//2, 2+2+2+2, 2, 2*2*2]

>>> getitem(digits, 3)
8

>>> add([2, 7], mul(digits, 2))
[2, 7, 1, 8, 2, 8, 1, 8, 2, 8]
```
Working with Lists

```python
>>> digits = [1, 8, 2, 8]
>>> len(digits)
4

An element selected by its index
```  

```python
>>> digits[3]
8
```

```python
The number of elements
```  

```python
>>> len(digits)
4
```

```python
An element selected by its index
```  

```python
>>> digits[3]
8
```

```python
Concatenation and repetition
```  

```python
>>> [2, 7] + digits * 2
[2, 7, 1, 8, 2, 8, 1, 8, 2, 8]
```

```python
>>> add([2, 7], mul(digits, 2))
[2, 7, 1, 8, 2, 8, 1, 8, 2, 8]
```

```python
Nested lists
```  

```python
>>> pairs = [[10, 20], [30, 40]]
>>> pairs[1]
[30, 40]
>>> pairs[1][0]
30
```
Containers
Containers
Containers

Built-in operators for testing whether an element appears in a compound value
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Built-in operators for testing whether an element appears in a compound value

```python
>>> digits = [1, 8, 2, 8]
```
Containers

Built-in operators for testing whether an element appears in a compound value

```python
>>> digits = [1, 8, 2, 8]
>>> 1 in digits
True
```
Containers

Built-in operators for testing whether an element appears in a compound value

```python
>>> digits = [1, 8, 2, 8]
>>> 1 in digits
True
>>> 8 in digits
True
```
Built-in operators for testing whether an element appears in a compound value

```python
>>> digits = [1, 8, 2, 8]
>>> 1 in digits
True
>>> 8 in digits
True
>>> 5 not in digits
True
```
Containers

Built-in operators for testing whether an element appears in a compound value

```python
>>> digits = [1, 8, 2, 8]
>>> 1 in digits
True
>>> 8 in digits
True
>>> 5 not in digits
True
>>> not(5 in digits)
True
```
Containers

Built-in operators for testing whether an element appears in a compound value

```python
>>> digits = [1, 8, 2, 8]
>>> 1 in digits
True
>>> 8 in digits
True
>>> 5 not in digits
True
>>> not(5 in digits)
True
```

(Demo)
For Statements

(Demo)
Sequence Iteration
def count(s, value):
    total = 0
    for element in s:
        if element == value:
            total = total + 1
    return total
def count(s, value):
    total = 0
    for element in s:
        if element == value:
            total = total + 1
    return total

Name bound in the first frame of the current environment (not a new frame)
For Statement Execution Procedure
For Statement Execution Procedure

```
for <name> in <expression>:
    <suite>
```
For Statement Execution Procedure

for <name> in <expression>:
    <suite>

1. Evaluate the header <expression>, which must yield an iterable value (a sequence)
For Statement Execution Procedure

```
for <name> in <expression>:
    <suite>
```

1. Evaluate the header `<expression>`, which must yield an iterable value (a sequence)

2. For each element in that sequence, in order:
For Statement Execution Procedure

```
for <name> in <expression>:
    <suite>
```

1. Evaluate the header `<expression>`, which must yield an iterable value (a sequence)

2. For each element in that sequence, in order:
   
   A. Bind `<name>` to that element in the current frame
For Statement Execution Procedure

for <name> in <expression>:
  <suite>

1. Evaluate the header <expression>, which must yield an iterable value (a sequence)

2. For each element in that sequence, in order:
   
   A. Bind <name> to that element in the current frame

   B. Execute the <suite>
Sequence Unpacking in For Statements
Sequence Unpacking in For Statements

```python
>>> pairs = [[1, 2], [2, 2], [3, 2], [4, 4]]
>>> same_count = 0
```
Sequence Unpacking in For Statements

A sequence of fixed-length sequences

```python
>>> pairs = [[1, 2], [2, 2], [3, 2], [4, 4]]
>>> same_count = 0
```
Sequence Unpacking in For Statements

```python
>>> pairs = [[1, 2], [2, 2], [3, 2], [4, 4]]
>>> same_count = 0

>>> for x, y in pairs:
...     if x == y:
...         same_count = same_count + 1

>>> same_count
2
```
Sequence Unpacking in For Statements

A sequence of fixed-length sequences

```python
>>> pairs = [[1, 2], [2, 2], [3, 2], [4, 4]]

>>> same_count = 0

>>> for x, y in pairs:
...     if x == y:
...         same_count = same_count + 1

>>> same_count
2
```
Sequence Unpacking in For Statements

A sequence of fixed-length sequences

```python
>>> pairs = [[1, 2], [2, 2], [3, 2], [4, 4]]
>>> same_count = 0
```  
A name for each element in a fixed-length sequence

```python
>>> for x, y in pairs:
...     if x == y:
...         same_count = same_count + 1

>>> same_count
2
```  
Each name is bound to a value, as in multiple assignment
Ranges
The Range Type

A range is a sequence of consecutive integers.*
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* Ranges can actually represent more general integer sequences.
The Range Type

A range is a sequence of consecutive integers.*

..., -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, ...

* Ranges can actually represent more general integer sequences.
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A range is a sequence of consecutive integers.*

..., −5, −4, −3, −2, −1, 0, 1, 2, 3, 4, 5, ...

range(−2, 2)

* Ranges can actually represent more general integer sequences.
The Range Type

A range is a sequence of consecutive integers.*

..., -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, ...

range(-2, 2)

* Ranges can actually represent more general integer sequences.
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A range is a sequence of consecutive integers.*

\[
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\]

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Length: ending value – starting value

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Length: ending value - starting value

Element selection: starting value + index

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The Range Type

A range is a sequence of consecutive integers.*

\[
..., -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, ...
\]

**Length:** ending value – starting value

**Element selection:** starting value + index

```python
>>> list(range(-2, 2))
[-2, -1, 0, 1]
```

```python
>>> list(range(4))
[0, 1, 2, 3]
```

* Ranges can actually represent more general integer sequences.
The Range Type

A range is a sequence of consecutive integers.*

... , -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, ...

Length: ending value - starting value

Element selection: starting value + index

>>> list(range(-2, 2))
[-2, -1, 0, 1]

>>> list(range(4))
[0, 1, 2, 3]

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The Range Type

A range is a sequence of consecutive integers.*

... , -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, ...

Length: ending value - starting value

Element selection: starting value + index

```python
>>> list(range(-2, 2))
[-2, -1, 0, 1]
```

```python
>>> list(range(4))
[0, 1, 2, 3]
```

* Ranges can actually represent more general integer sequences.
The Range Type

A range is a sequence of consecutive integers.*

\[ \ldots, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, \ldots \]

\[ \text{range}(-2, 2) \]

**Length:** ending value - starting value

**Element selection:** starting value + index

\[ \text{list(range(-2, 2))} \]
\[ [-2, -1, 0, 1] \]

\[ \text{list(range(4))} \]
\[ [0, 1, 2, 3] \]

* Ranges can actually represent more general integer sequences.
List Comprehensions
List Comprehensions

```python
>>> letters = ['a', 'b', 'c', 'd', 'e', 'f', 'm', 'n', 'o', 'p']
>>> [letters[i] for i in [3, 4, 6, 8]]
```
List Comprehensions

```python
code snipped
```

```
>>> letters = ['a', 'b', 'c', 'd', 'e', 'f', 'm', 'n', 'o', 'p']
>>> [letters[i] for i in [3, 4, 6, 8]]
['d', 'e', 'm', 'o']
```
List Comprehensions
List Comprehensions

[<map exp> for <name> in <iter exp> if <filter exp>]
List Comprehensions

\[
[\text{map exp} \ for \ \text{name} \ in \ \text{iter exp} \ if \ \text{filter exp}]
\]

Short version: \[
[\text{map exp} \ for \ \text{name} \ in \ \text{iter exp}]
\]
List Comprehensions

\[[\text{map exp} \text{ for } \text{name} \text{ in } \text{iter exp} \text{ if } \text{filter exp}]\]

Short version: \[[\text{map exp} \text{ for } \text{name} \text{ in } \text{iter exp}]\]

A combined expression that evaluates to a list using this evaluation procedure:
List Comprehensions

\[
[\text{map exp} \ for \ <name> \ in \ <iter \ exp> \ if \ <filter \ exp>]
\]

Short version: [\text{map exp} \ for \ <name> \ in \ <iter \ exp>]

A combined expression that evaluates to a list using this evaluation procedure:
1. Add a new frame with the current frame as its parent
List Comprehensions

\[
\left[ \text{map exp} \right. \text{ for } \left. \text{name} \right. \text{ in } \left. \text{iter exp} \text{ if } \left. \text{filter exp} \right. \]
\]

Short version: \[
\left[ \text{map exp} \right. \text{ for } \left. \text{name} \right. \text{ in } \left. \text{iter exp} \right]
\]

A combined expression that evaluates to a list using this evaluation procedure:

1. Add a new frame with the current frame as its parent
2. Create an empty result list that is the value of the expression
List Comprehensions

\[
[\text{map exp} \ for \ <\text{name}> \ in \ <\text{iter exp}> \ if \ <\text{filter exp}>]
\]

Short version: \[<\text{map exp} \ for \ <\text{name}> \ in \ <\text{iter exp}>]\]

A combined expression that evaluates to a list using this evaluation procedure:
1. Add a new frame with the current frame as its parent
2. Create an empty result list that is the value of the expression
3. For each element in the iterable value of \(<\text{iter exp}>\):
List Comprehensions

[<map exp> for <name> in <iter exp> if <filter exp>]

Short version: [<map exp> for <name> in <iter exp>]

A combined expression that evaluates to a list using this evaluation procedure:

1. Add a new frame with the current frame as its parent
2. Create an empty result list that is the value of the expression
3. For each element in the iterable value of <iter exp>:
   A. Bind <name> to that element in the new frame from step 1
List Comprehensions

\[
<\text{map exp}> \text{ for } <\text{name}> \text{ in } <\text{iter exp}> \text{ if } <\text{filter exp}>
\]

Short version: \[
<\text{map exp}> \text{ for } <\text{name}> \text{ in } <\text{iter exp}>
\]

A combined expression that evaluates to a list using this evaluation procedure:

1. Add a new frame with the current frame as its parent
2. Create an empty result list that is the value of the expression
3. For each element in the iterable value of \(<\text{iter exp}>\):
   
   A. Bind \(<\text{name}>\) to that element in the new frame from step 1
   
   B. If \(<\text{filter exp}>\) evaluates to a true value, then add the value of \(<\text{map exp}>\) to the result list
Strings
Strings are an Abstraction
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Representing data:

'200'   '1.2e-5'   'False'   '[1, 2]'
Strings are an Abstraction

Representing data:

'200'    '1.2e-5'    'False'    '[1, 2]'

Representing language:

""""""And, as imagination bodies forth
The forms of things unknown, the poet's pen
Turns them to shapes, and gives to airy nothing
A local habitation and a name.""""
Strings are an Abstraction

Representing data:

'200'  '1.2e-5'  'False'  '[1, 2]'  

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Representing programs:

'curry = lambda f: lambda x: lambda y: f(x, y)'
Strings are an Abstraction

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Representing programs:

'curry = lambda f: lambda x: lambda y: f(x, y)'

(Demo)
String Literals Have Three Forms

>>> 'I am string!'
'I am string!'

>>> "I've got an apostrophe"
"I've got an apostrophe"

>>> '您好'
'您好'
String Literals Have Three Forms

```python
>>> 'I am string!'
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>>> "I've got an apostrophe"
"I've got an apostrophe"

>>> '您好'
'您好'
```

Single-quoted and double-quoted strings are equivalent
String Literals Have Three Forms

>>> 'I am string!'
'I am string!'

>>> "I've got an apostrophe"
"I've got an apostrophe"

>>> '您好'
'您好'

>>> """The Zen of Python
claims, Readability counts.
Read more: import this.""
'The Zen of Python
claims, Readability counts.
Read more: import this.'
String Literals Have Three Forms

>>> 'I am string!'
'I am string!'

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String Literals Have Three Forms

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"I've got an apostrophe"

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'您好'

>>> """The Zen of Python
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Read more: import this."""
'The Zen of Python
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Read more: import this.'
Dictionaries

{"Dem": 0}
Limitations on Dictionaries
Limitations on Dictionaries

Dictionaries are **unordered** collections of key-value pairs
Limitations on Dictionaries

Dictionaries are unordered collections of key-value pairs.

Dictionary keys do have two restrictions:
Limitations on Dictionaries

Dictionaries are unordered collections of key-value pairs

Dictionary keys do have two restrictions:

- A key of a dictionary cannot be a list or a dictionary (or any mutable type)
Limitations on Dictionaries

Dictionaries are unordered collections of key–value pairs

Dictionary keys do have two restrictions:

• A key of a dictionary cannot be a list or a dictionary (or any mutable type)

• Two keys cannot be equal; There can be at most one value for a given key
Limitations on Dictionaries

Dictionaries are unordered collections of key–value pairs

Dictionary keys do have two restrictions:

• A key of a dictionary cannot be a list or a dictionary (or any mutable type)

• Two keys cannot be equal; There can be at most one value for a given key

This first restriction is tied to Python's underlying implementation of dictionaries
Limitations on Dictionaries

Dictionaries are *unordered* collections of key–value pairs

Dictionary keys do have two restrictions:

- A key of a dictionary **cannot be** a list or a dictionary (or any *mutable type*)

- Two **keys cannot be equal**; There can be at most one value for a given key

This first restriction is tied to Python's underlying implementation of dictionaries

The second restriction is part of the dictionary abstraction
Limitations on Dictionaries

Dictionaries are unordered collections of key-value pairs

Dictionary keys do have two restrictions:

• A key of a dictionary cannot be a list or a dictionary (or any mutable type)

• Two keys cannot be equal; There can be at most one value for a given key

This first restriction is tied to Python's underlying implementation of dictionaries

The second restriction is part of the dictionary abstraction

If you want to associate multiple values with a key, store them all in a sequence value