

Containers

Announcements

Box-and-Pointer Notation

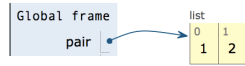
The Closure Property of Data Types

- A method for combining data values satisfies the *closure property* if:
 - The result of combination can itself be combined using the same method
- Closure is powerful because it permits us to create hierarchical structures
- Hierarchical structures are made up of parts, which themselves are made up of parts, and so on

Lists can contain lists as elements (in addition to anything else)

Box-and-Pointer Notation in Environment Diagrams

Lists are represented as a row of index-labeled adjacent boxes, one per element
 Each box either contains a primitive value or points to a compound value

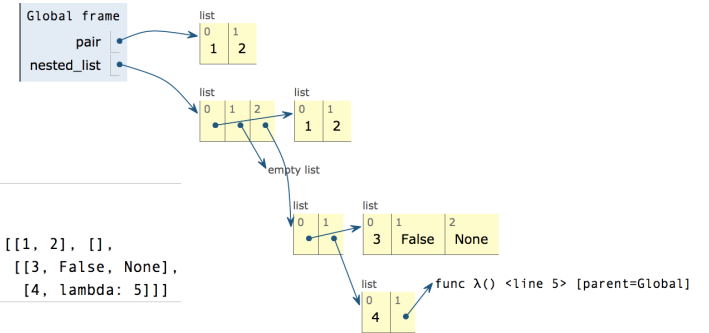


```
pair = [1, 2]
```

5

Box-and-Pointer Notation in Environment Diagrams

Lists are represented as a row of index-labeled adjacent boxes, one per element
 Each box either contains a primitive value or points to a compound value



```
1 pair = [1, 2]
2
3 nested_list = [[1, 2], []].
4                 [3, False, None],
5 → 5             [4, lambda: 5]]
```

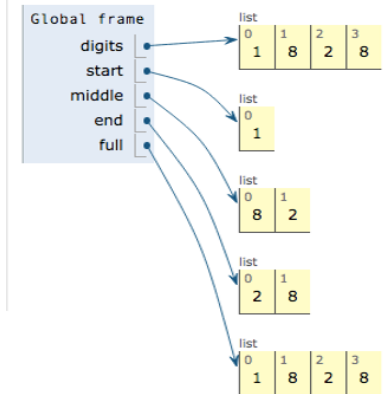
6

Slicing

(Demo)

Slicing Creates New Values

```
1 digits = [1, 8, 2, 8]
2 start = digits[:1]
3 middle = digits[1:3]
4 end = digits[2:]
5 → full = digits[:]
```



9

Processing Container Values

Aggregation

Several built-in functions take iterable arguments and aggregate them into a value

- `sum(iterable[, start])` -> value

Return the sum of an iterable (not of strings) plus the value of parameter 'start' (which defaults to 0). When the iterable is empty, return start.

- `max(iterable[, key=func])` -> value
`max(a, b, c, ..., [key=func])` -> value

With a single iterable argument, return its largest item.
With two or more arguments, return the largest argument.

- `all(iterable)` -> bool

Return True if `bool(x)` is True for all values `x` in the iterable.
If the iterable is empty, return True.

10

Strings

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.  
"""
```

Representing programs:

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

(Demo)

12

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\nclaims, Readability counts.\nRead more: import this.'
```

Single-quoted and double-quoted strings are equivalent

A backslash "escapes" the following character

"Line feed" character represents a new line

13

Dictionaries

```
{'Dem': 0}
```

Limitations on Dictionaries

Dictionaries are 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

14

Dictionary Comprehensions

```
{<key exp>: <value exp> for <name> in <iter exp> if <filter exp>}
```

Short version: {<key exp>: <value exp> for <name> in <iter exp>}

An expression that evaluates to a dictionary using this evaluation procedure:

1. Add a new frame with the current frame as its parent
 2. Create an empty *result dictionary* 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
 - B. If `<filter exp>` evaluates to a true value, then add to the result dictionary an entry that pairs the value of `<key exp>` to the value of `<value exp>`
- `{x * x: x for x in [1, 2, 3, 4, 5] if x > 2}` evaluates to `{9: 3, 16: 4, 25: 5}`

15

Example: Indexing

Implement `index`, which takes a sequence of `keys`, a sequence of `values`, and a two-argument `match` function. It returns a dictionary from `keys` to lists in which the list for a key `k` contains all `values` `v` for which `match(k, v)` is a true value.

```
def index(keys, values, match):
    """Return a dictionary from keys k to a list of values v for which
    match(k, v) is a true value.

    >>> index([7, 9, 11], range(30, 50), lambda k, v: v % k == 0)
    {7: [35, 42, 49], 9: [36, 45], 11: [33, 44]}
    """
    return {k: [v for v in values if match(k, v)] for k in keys}
```