Collections

```
tuple
str
range
list
dict
set
```

tuple

heterogeneous immutable sequence

tuple

- Delimited by parentheses
- Items separated by commas
- Element access with square brackets and zero-based index `t[index]`
- `len(t)` for number of elements
- Iteration with `for` loop
- Concatenation with + operator
- Repetition with * operator

tuple

- tuples can contain any type of object
- nested tuples
- chain square-brackets indexing to access inner elements

tuple

- Can't use one object in parentheses as a single element tuple
- For a single element tuple include a **trailing comma**
- The empty tuple is simply empty parentheses

tuple

- Delimiting parentheses are optional for one or more elements
- Tuples are useful for multiple return values
- Tuple unpacking allows us to destructure directly into named references

tuple

- The `in` and `not in` operators can be used with tuples – and other collection types – for membership testing

str

homogeneous immutable sequence of
Unicode codepoints (characters)

str

- `len(s)` gives number of codepoints (characters)

str

- The + operator can be used for string concatenation.
- Strings are immutable, so the += operator re-binds the reference to a new object.
- Use sparingly – concatenation with + or += can cause performance degradation.

str

- Call the `join()` method on the **separator** string
- Use `split()` to divide a string into a list
- Without an argument, `split()` divides on whitespace
- `join()`-ing on an **empty separator** is an important and fast way of concatenating a collection of strings

Moment of Zen

The way may not be obvious at first

To concatenate
Invoke join on empty text
Something for nothing

str

- The `partition()` method divides a string into three around a separator: *prefix*, *separator*, *suffix*
- Tuple unpacking is useful to destructure the result
- Use underscore as a dummy name for the separator
- Underscore convention understood by many tools

str

- Use `format()` to insert values into strings
- *Replacement fields* delimited by `{` and `}`
- Integer field names matched with positional arguments
- Field names can be omitted if used in sequence
- Named fields are matched with keyword arguments

str

- Access values through keys or indexes with square brackets in the replacement field.
- Access attributes using dot in the replacement field.
- The replacement field mini-language provides *many* value and alignment formatting options.

range

arithmetic progression of integers

range

- *stop* value is one-past-the-end
- ranges are "half-open" – *start* is included but *stop* is not
- *stop* value of a range used as *start* value of consecutive range
- optional third *step* value

Constructor	Arguments	Result
`range(5)`	stop	0, 1, 2, 3, 4
`range(5, 10)`	start, stop	5, 6, 7, 8, 9
`range(10, 20, 2)`	start, stop, step	10, 12, 14, 16, 18

abusing `range`

- Avoid `range()` for iterating over lists
- Python is not C
- Don't be un-pythonic!

- Prefer direct iteration over iterable objects, such as lists

not using `range` – `enumerate`

- Prefer `enumerate()` for counters
- `enumerate()` yields (*index*, *value*) tuples

- Often combined with tuple unpacking

python™

list

heterogeneous mutable sequence

0	1	2	3	4	5
show	how	to	index	into	sequences

0	1	2	3	4	5
show	how	to	index	into	sequences

`list`

- Zero and positive integers for indexing from the front

-6	-5	-4	-3	-2	-1
show	how	to	index	into	sequences

list

- Negative integers index from the end
- The last element is at index -1
- Avoid `seq[len(seq) - 1]`

start

stop

0	1	2	3	4	5
show	how	to	index	into	sequences

list

- *Slicing* extracts part of a list
- `slice = seq[start:stop]`
- Slice range is half-open – stop not included

start

stop

0	1	2	3	4	5
-6	-5	-4	-3	-2	-1
show	how	to	index	into	sequences

`list`

- Slicing works with negative indexes

start

stop

0	1	2	3	4	5
show	how	to	index	into	sequences

list

- Omitting the *stop* index slices to the end

```
slice_to_end = seq[start:]
```

start

stop

0	1	2	3	4	5
show	how	to	index	into	sequences

list

- Omitting the *start* index slices from the beginning

```
slice_from_beginning = seq[:stop]
```

start

stop

`s[:3]`

0	1	2	3	4	5
show	how	to	index	into	sequences

start

stop

`s[3:]`

0	1	2	3	4	5
show	how	to	index	into	sequences

`list`

- Half-open ranges give complementary slices

```
s[:x] + s[x:] == s
```

start

stop

0	1	2	3	4	5
-6	-5	-4	-3	-2	-1
show	how	to	index	into	sequences

list

- Omitting the *start* and stop indexes slices from the beginning to the end – a *full slice*

```
full_slice = seq[:]
```

- Important idiom for copying lists

`list`

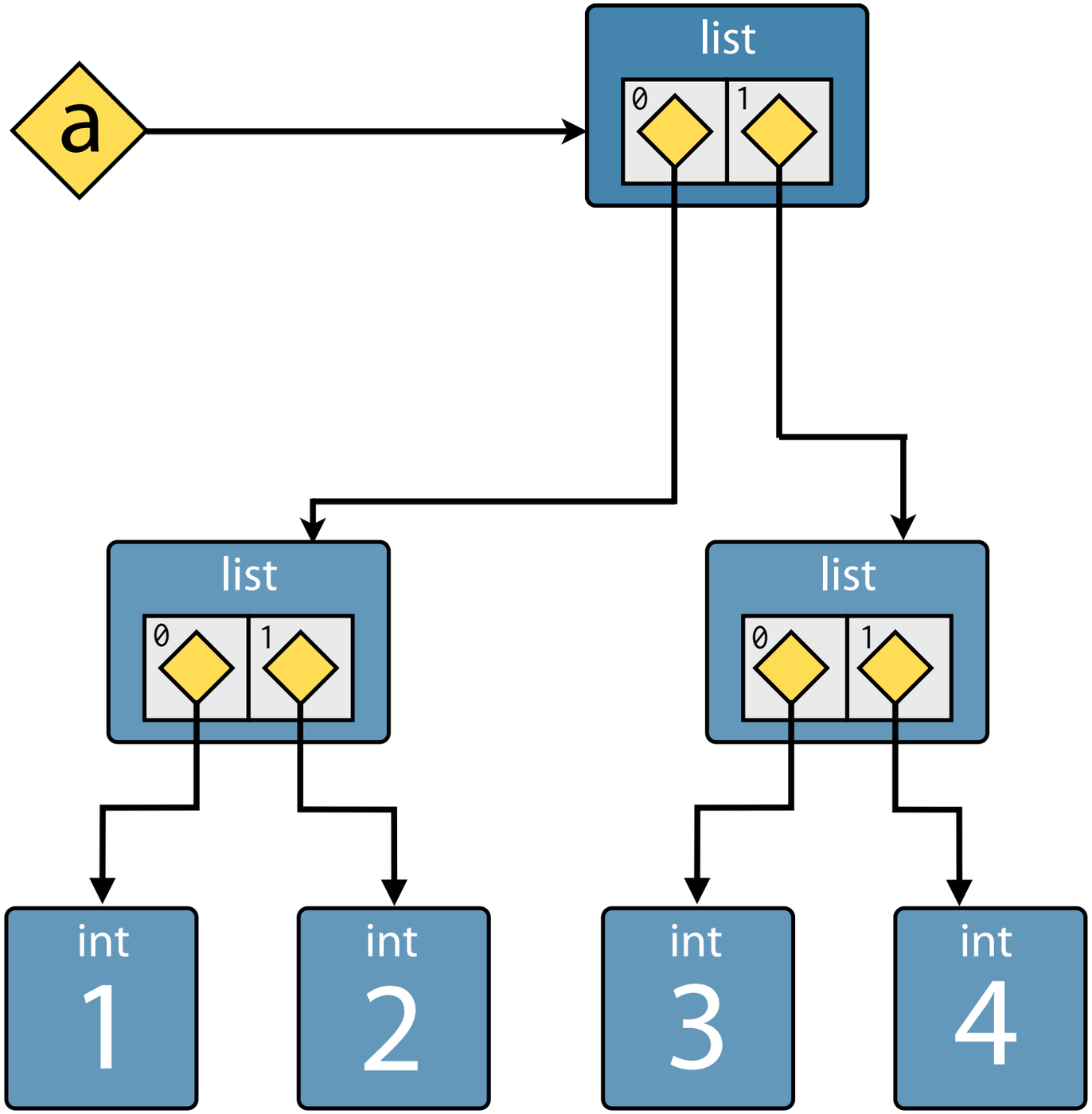
Copying lists

Full slice: `t = seq[:]`

`copy()` method: `u = seq.copy()`

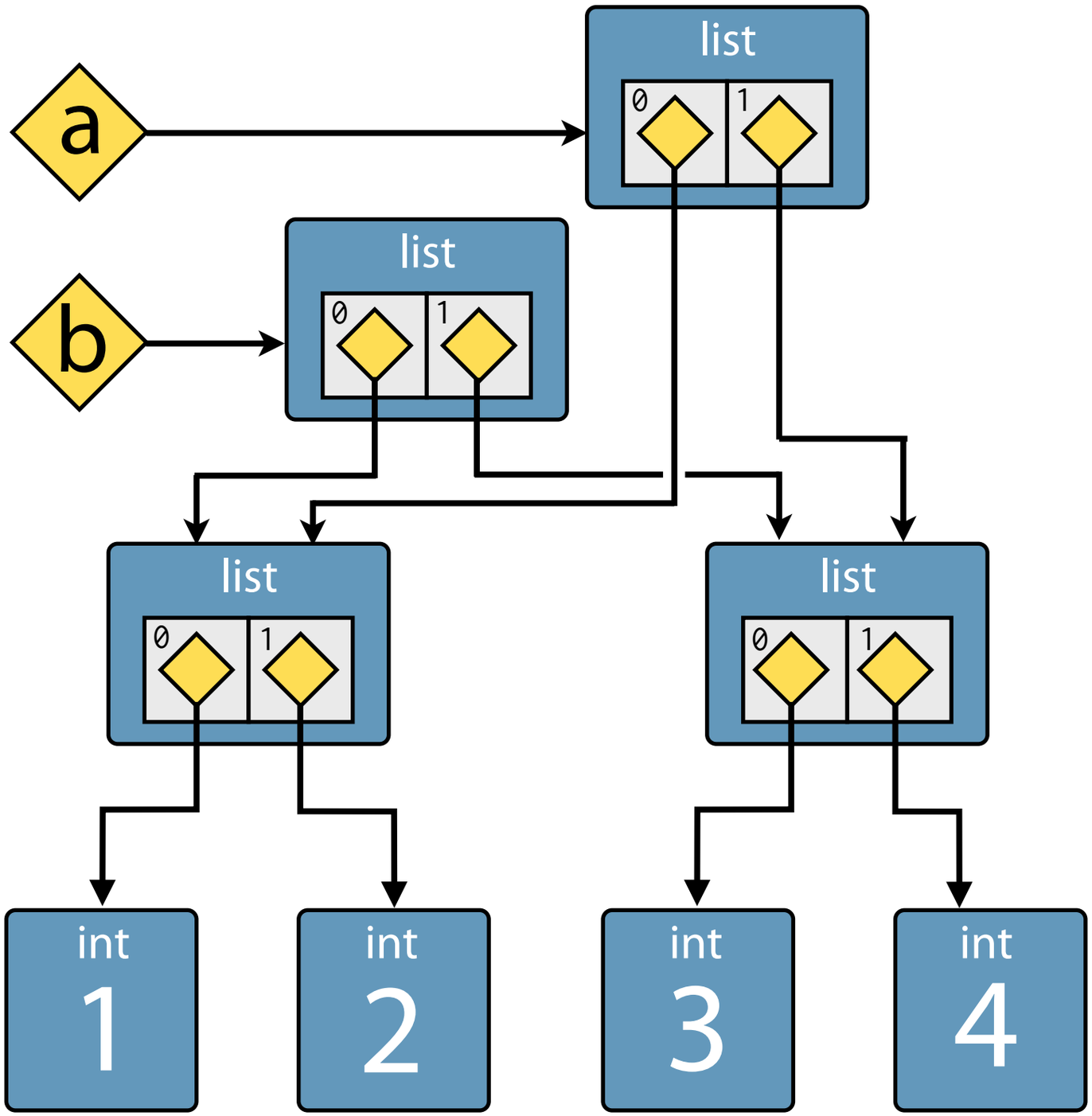
`list()` constructor: `v = list(seq)`

Copies are shallow




```
>>> a = [ [1, 2], [3, 4] ]
>>> b = a[:]
```

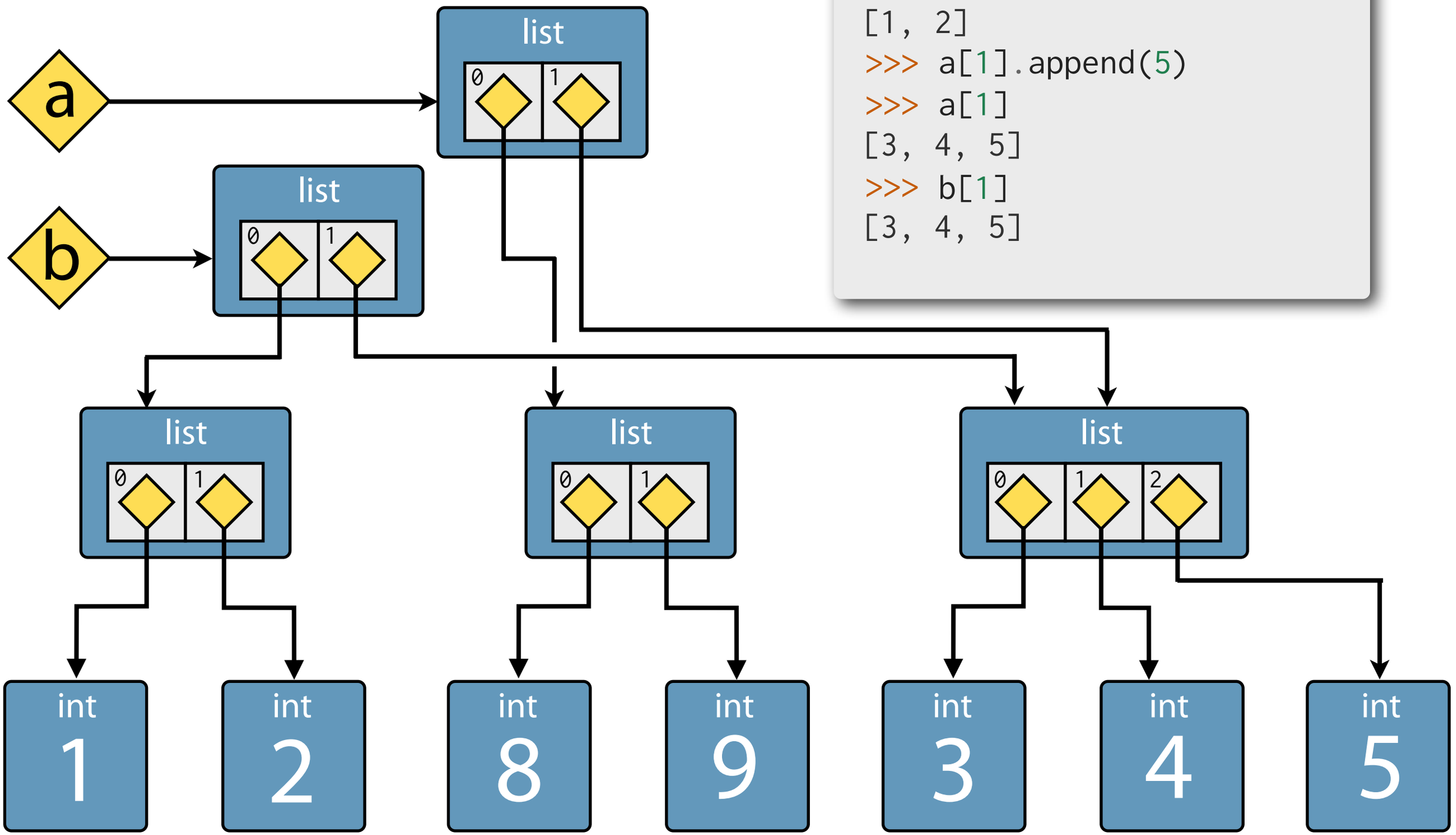
Copies are shallow




```
>>> a = [ [1, 2], [3, 4] ]
>>> b = a[:]
>>> a is b
False
>>> a == b
True
>>> a[0]
[1, 2]
>>> b[0]
[1, 2]
>>> a[0] is b[0]
True
```

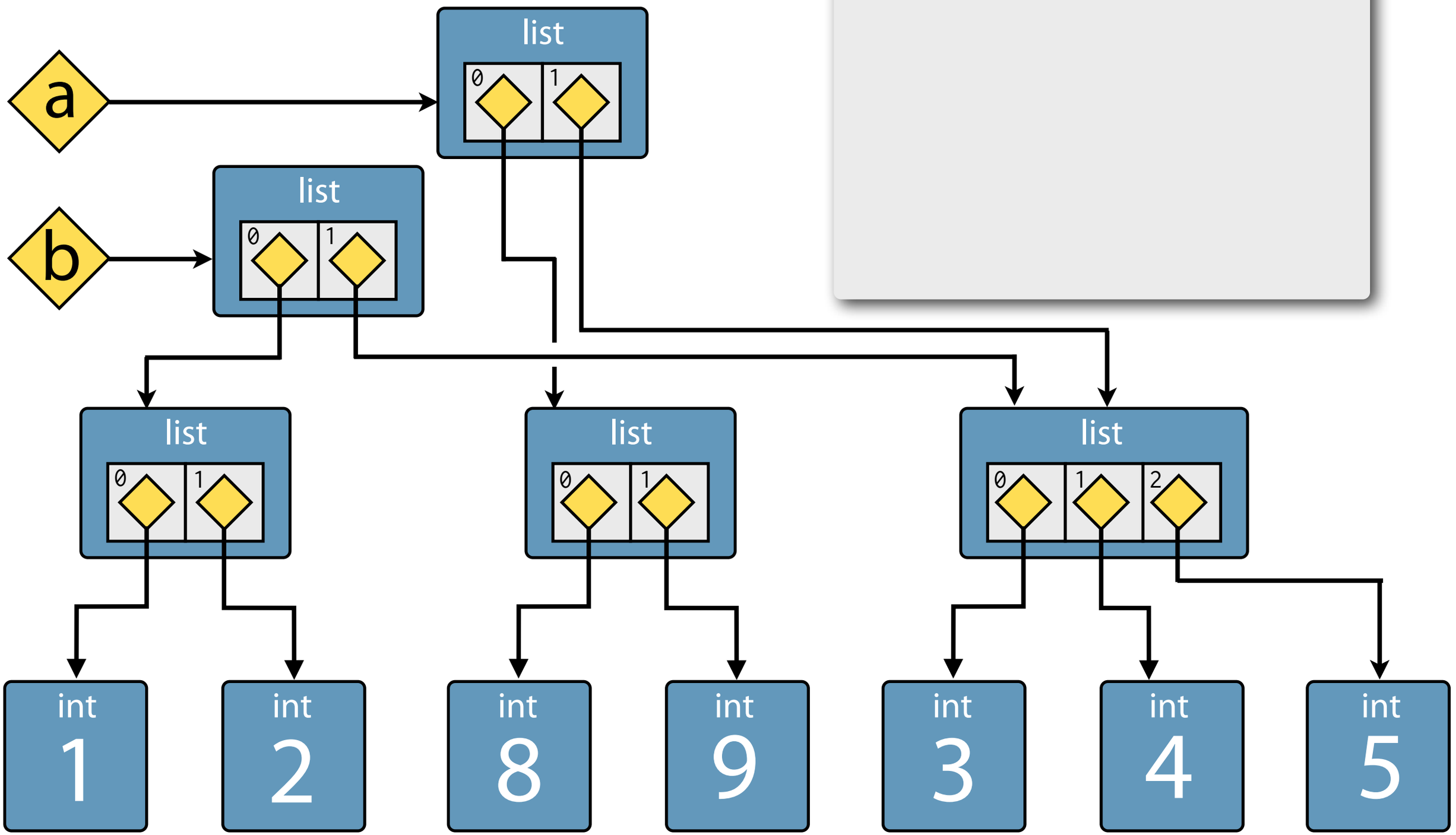
Copies are shallow

```
>>> a[0] = [8, 9]
>>> a[0]
[8, 9]
>>> b[0]
[1, 2]
>>> a[1].append(5)
>>> a[1]
[3, 4, 5]
>>> b[1]
[3, 4, 5]
```



Copies are shallow

```
>>> a
[[8, 9], [3, 4, 5]]
>>> b
[[1, 2], [3, 4, 5]]
```



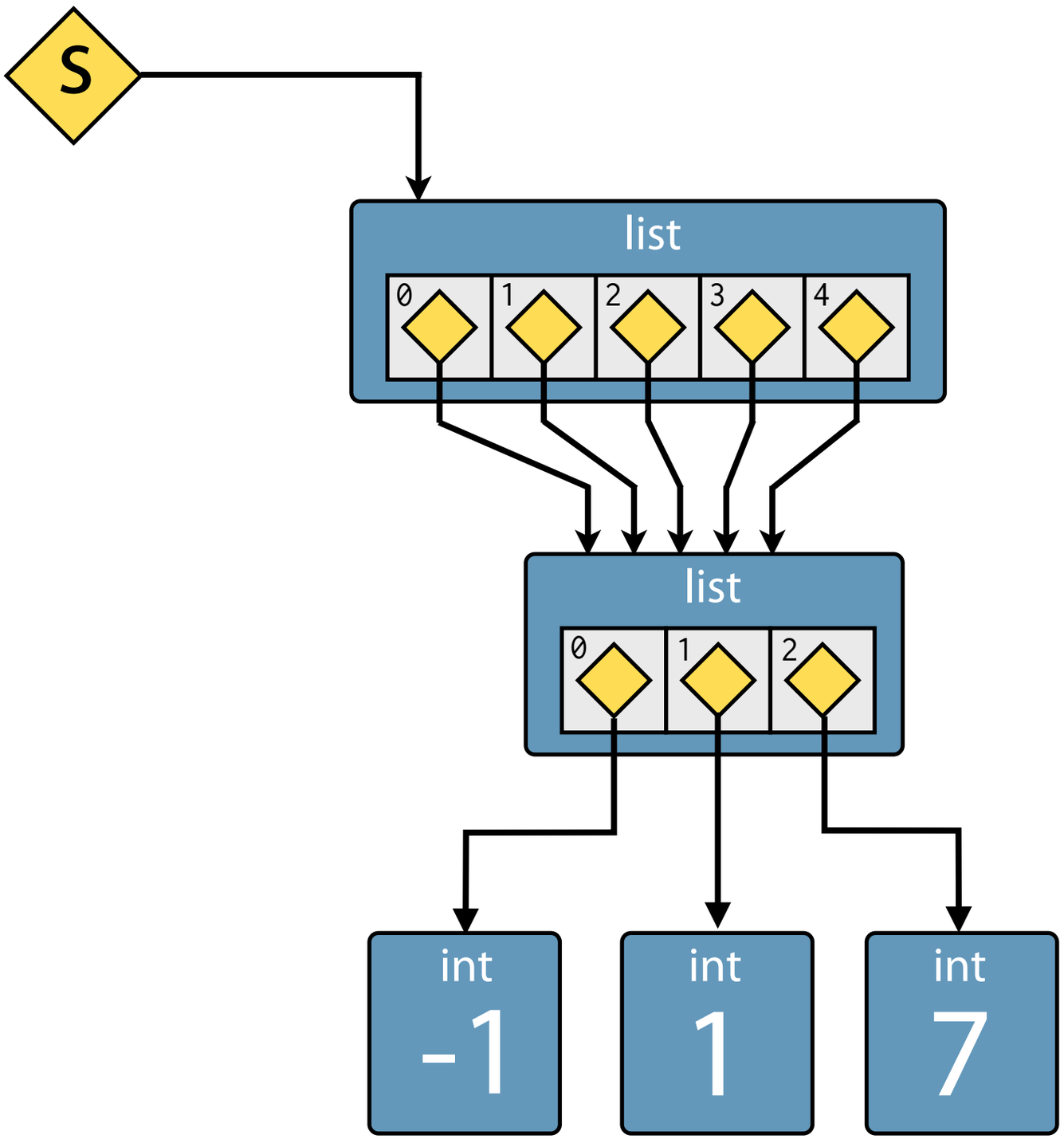
list

- Repeat lists using the * operator
- Most often used for initializing a list of known size with a constant:

```
s = [constant] * size
```

  Multiple references to *one instance* of the constant in the produced list
- **Repetition is shallow!**

Repetition is Shallow




```
>>> s = [ [-1, +1] ] * 5
>>> s
[[-1, 1], [-1, 1], [-1, 1],
 [-1, 1], [-1, 1]]
>>> s[3].append(7)
>>> s
[[-1, 1, 7], [-1, 1, 7], [-1,
 1, 7], [-1, 1, 7], [-1, 1, 7]]
```

list

Finding elements

- `index(item)` returns the integer index of the first equivalent element raises `ValueError` if not found
- `count(item)` returns the number of matching elements
- The `in` and `not in` operators test for membership

list

- `del seq[index]` to remove by index
- `seq.remove(item)` to remove by value; raises `ValueError` if not present
- `remove()` equivalent to `del seq[seq.index(item)]`

list

- Insert items with

```
seq.insert(index, item)
```

list

- Concatenate lists with `+` operator
- In-place extension with `+=` operator or `extend()` method.
- All accept any iterable series on the right-hand side.

list

- `k.reverse()` *reverses in place*

- `k.sort()` *sorts in place*
- `k.sort(reverse=True)` *gives descending sort*

`list`

- `key` argument to `sort()` method accepts a function for producing a sort key from an item

- *be aware of unintentional side-effects with in situ rearrangements*

list

- `sorted()` built-in function sorts any iterable series and returns a list

- `reversed()` built-in function reverses any iterable series
- returns a reverse iterator

dict

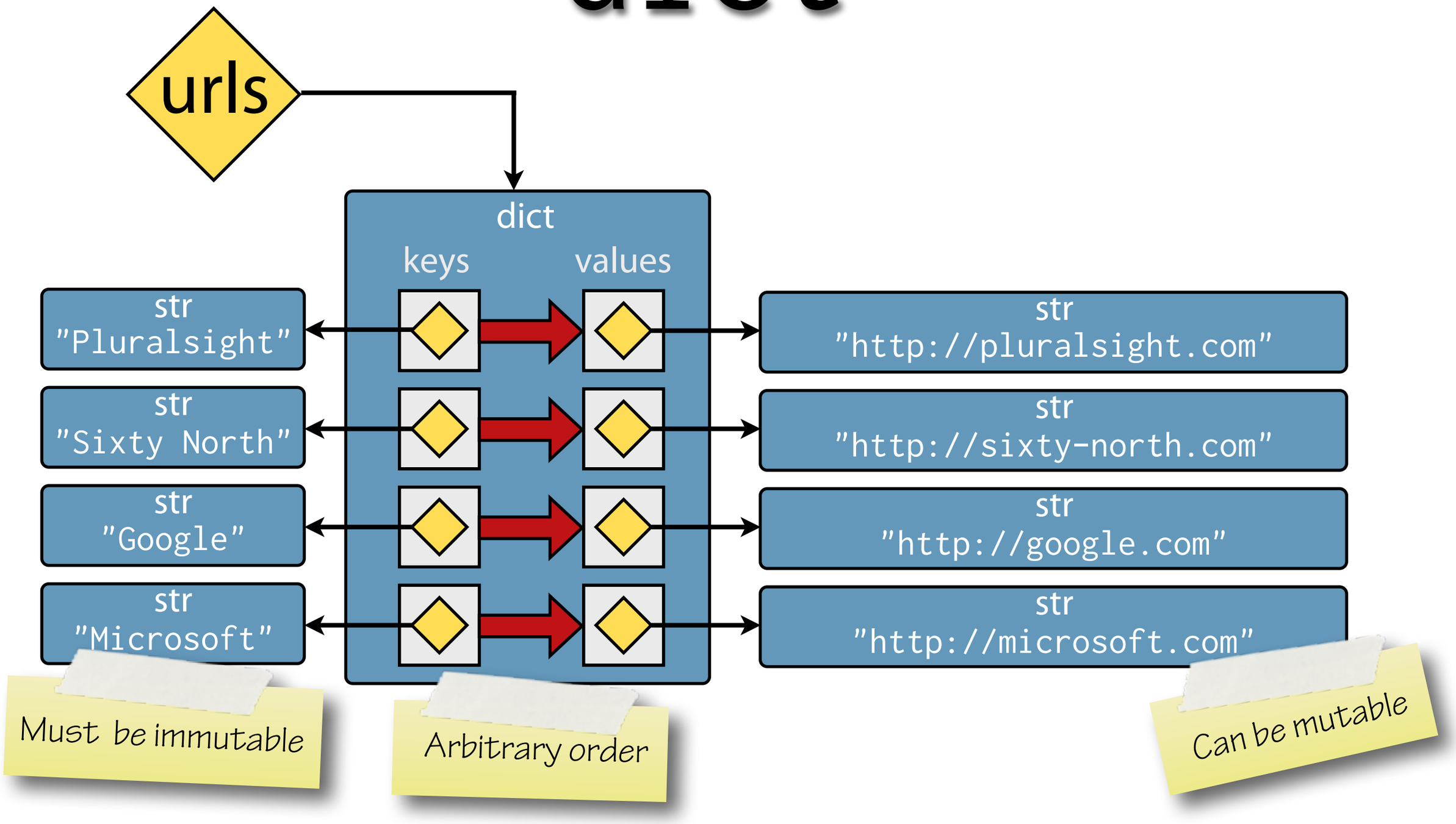
unordered mapping from
unique, immutable keys
to mutable values

dict

Recap literals:

- delimited by { and }
- key-value pairs comma separated
- corresponding keys and values joined by colon
- keys must be unique

dict


urls
dict
keys
values
str
"Pluralsight"
str
"http://pluralsight.com"
str
"Sixty North"
str
"http://sixty-north.com"
str
"Google"
str
"http://google.com"
str
"Microsoft"
str
"http://microsoft.com"
Must be immutable
Arbitrary order
Can be mutable

dict

`dict()` constructor accepts:

- iterable series of key-value 2-tuples
- keyword arguments – requires keys are valid Python identifiers
- a mapping, such as another dict

dict

Copying

- `d.copy()` for copying dictionaries
- or simply `dict(d)` constructor

dict

Updating a dictionary

- Extend a dictionary with `update()`
- update replaces values corresponding to duplicate keys

dict

Iteration

- Iteration is over *keys*
- Get corresponding value with `d[key]` lookup
- **Remember! Order is arbitrary!**

dict

Iteration

- Use `values()` for an iterable view onto the series of *values*.
- No efficient way to get the key corresponding to a value
- `keys()` method gives iterable view onto keys - not often needed.

dict

Iteration

- Use `items()` for an iterable view onto the series of *key-value* tuples.
- Use with tuple unpacking.

dict

Membership

- The `in` and `not in` operators work on the *keys*.

dict

Removal

- Use `del` keyword to remove by key

```
del d[key]
```

dict

Mutability

- keys *must* be immutable
- values *may* be mutable
- The dictionary itself *is* mutable

Pretty printing

- Python Standard Library `pprint` module
- Be careful not to rebind the module reference!
- Knows how to pretty-print all built-in data structures, including **`dict`**

python™

set

unordered collection of
unique, immutable objects

set

Literals

- delimited by { and }
- single comma separated items
- empty `{}` makes a `dict`, so for empty set use the `set()` constructor.

set

`set()` constructor accepts:

- iterable series of values
- duplicates are discarded
- often used specifically to remove duplicates – not order preserving

set

Membership / containment

- Fundamental operation for sets
- Use `in` and `not in` operators

set

Adding elements

- `add(item)` inserts a single element
- Duplicates are silently ignored
- For multiple elements use `update(items)` passing any iterable series

set

Removing elements

- `remove(item)` requires that item is present, otherwise raises `KeyError`.
- `discard(item)` always succeeds.

set

Copying

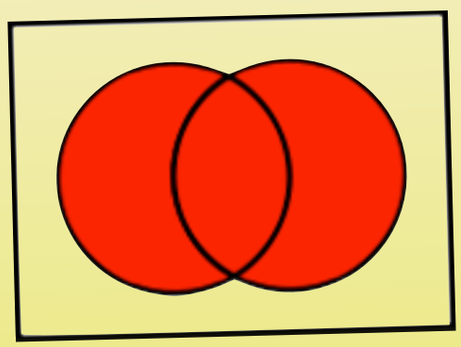
- `s.copy()` method.
- Use constructor: `set(s)`
- **Copies are shallow!**

python™ set **algebra**

set

Union

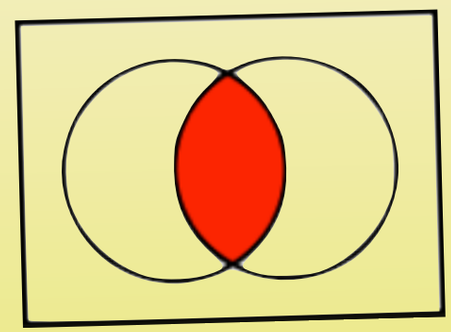
- `s.union(t)` method.
- commutative



set

Intersection

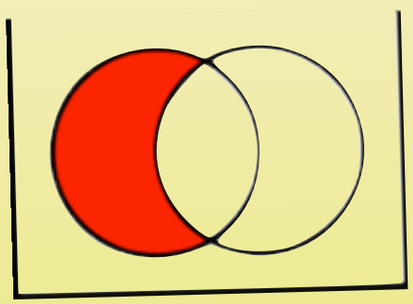
- `s.intersection(t)` method.
- commutative



Difference

set

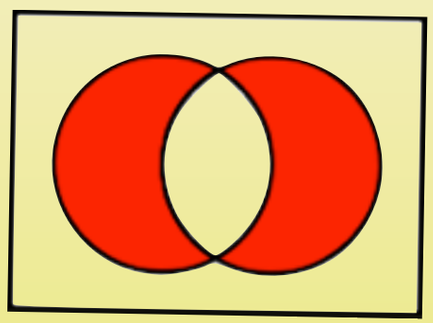
- `s.difference(t)` method.
- non-commutative



set

Symmetric Difference

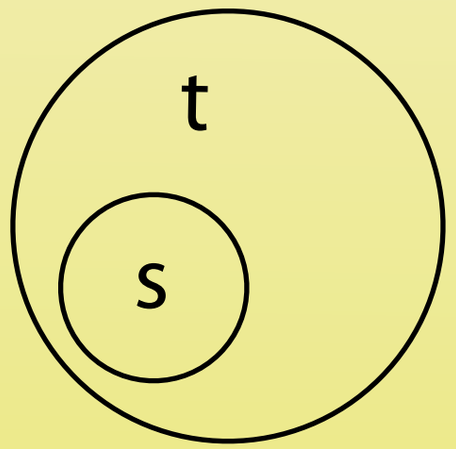
- `s.symmetric_difference(t)` method.
- commutative



set

Subset

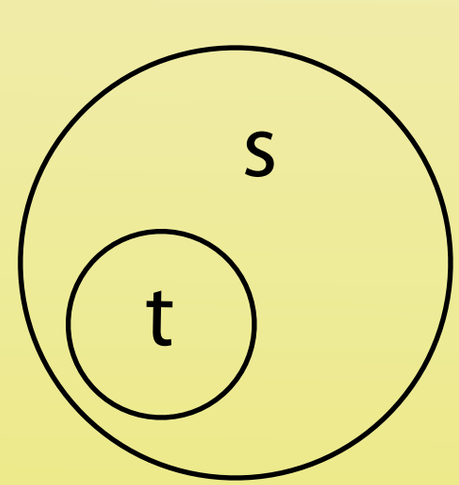
`s.issubset(t)` method.



set

Superset

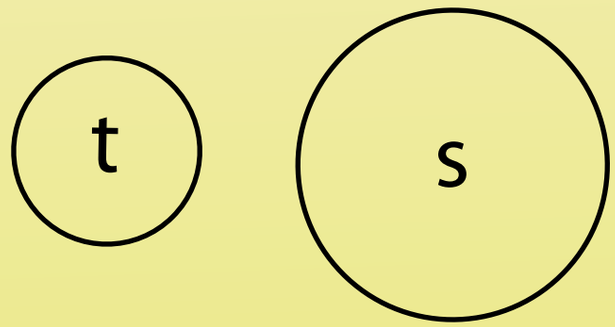
`s.issuperset(t)` method.



set

Disjoint

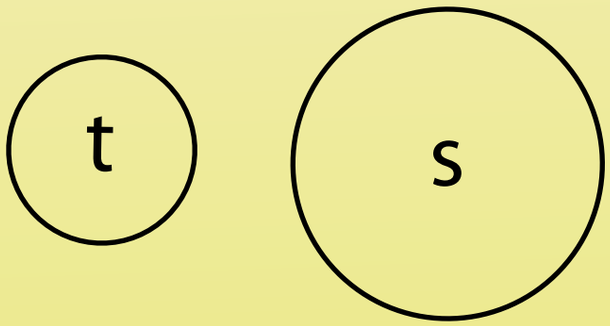
`s.isdisjoint(t)` method.



set

Disjoint

`s.isdisjoint(t)` method.



Collections

```
tuple
str
range
list
dict
set
```

Collection Protocols

Protocol	Implementing Collections
Container	`str, list, range, tuple, bytes, set, dict`
Sized	`str, list, range, tuple, bytes, set, dict`
Iterable	`str, list, range, tuple, bytes, set, dict`
Sequence	`str, list, range, tuple, bytes`
Mutable Sequence	`list`
Mutable Set	`set`
Mutable Mapping	`dict`

Collection Protocols

Protocol	Implementing Collections
Container	`str, list, range, tuple, bytes, set, dict`
Sized	`str, list, range, tuple, bytes, set, dict`
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Mutable Mapping	`dict`

Protocols

- To implement a protocol, objects must support certain operations.
- Most collections implement container, sized and iterable.
- All except set and dict are sequences.

Collection Protocols

Protocol	Implementing Collections
Container	`str`, `list`, `range`, `tuple`, `bytes`, `set`, `dict`
Sized	`str`, `list`, `range`
Iterable	
Sequence	
Mutable Sequence	`list`
Mutable Set	`set`
Mutable Mapping	`dict`

Container Protocol

- Membership testing using `in` and `not in`

Collection Protocols

Protocol	Implementing Collections
Container	`str, list, range, tuple, bytes, set, dict`
Sized	`str, list, range, tuple, bytes, set, dict`
Iterable	`s… range, …le, bytes, set, dict`
Sequence	`s…`
Mutable Sequence	`list`
Mutable Set	`set`
Mutable Mapping	`dict`

Sized Protocol

- Determine number of elements with `len(s)`

Collection Protocols

Protocol	Implementing Collections
Container	`str, list, range, tuple, bytes, set, dict`
Sized	`str, list, range, tuple, bytes, set, dict`
Iterable	`str, list, range, tuple, bytes, set, dict`
Sequence	`str, list, range, t`
Mutable Sequence	`li`
Mutable Set	`se`
Mutable Mapping	`dic`

Iterable Protocol

- Can produce an *iterator* with `iter(s)`

```
for item in iterable:
    do_something(item)
```

Collection Protocols

Protocol	Implementing Collections
Container	`str, list, range, tuple, bytes, set, dict`
Sized	`str, list, range, tuple, bytes, set, dict`
Iterable	`str, list, range, tuple, bytes, set, dict`
Sequence	`str, list, range, tuple, bytes`
Mutable Sequence	`list`
Mutable Set	`set`
Mutable Mapping	`dict`

Sequence Protocol

- Retrieve elements by index

```
item = seq[index]
```

- Find items by value

```
index = seq.index(item)
```

- Count items

```
num = seq.count(item)
```

- Produce a reversed sequence

```
r = reversed(seq)
```

Collections Summary

- **Tuples are immutable sequence types**
  - Literal syntax: optional parentheses around a comma separated list
  - Single element tuples must use trailing comma
  - Tuple unpacking - return values and idiomatic swap
- **Strings are immutable sequence types of Unicode codepoints**
  - String concatenation is most efficiently performed with `join()` on an empty separator
  - The `partition()` method is a useful and elegant string parsing tool.
  - The `format()` method provides a powerful way of replacing placeholders with values.
- **Ranges represent integer sequences with regular intervals**
  - Ranges are arithmetic progressions
  - The `enumerate()` function is often a superior alternative to `range()`

Collections Summary

- **Lists are heterogeneous mutable sequence types**
  - Negative indexes work backwards from the end.
  - Slicing allows us to copy all or part of a list.
  - The full slice is a common idiom for copying lists, although the `copy()` method and `list()` constructor are less obscure.
  - List (and other collection) copies are shallow.
  - List repetition is shallow.
- **Dictionaries map immutable keys to mutable values**
  - Iteration and membership testing is done with respect to the keys.
  - Order is arbitrary
  - The `keys()`, `values()` and `items()` methods provide views onto different aspects of a dictionary, allowing convenient iteration.
- **Sets store an unordered collection of unique elements**
  - Sets support powerful and expressive set algebra operations and predicates.
- **Protocols such as *iterable*, *sequence* and *container* characterise the collections.**