Lecture 13

More with Sequences

Announcements for This Lecture

Readings

- Today: Chapter 11
- Next Week: Sec. 5.8-5.10

- **Prelim, Oct 16th 7:30-9:00**
  - Material up to **TODAY**
  - Study guide is posted
- **Will Review on Thursday**
  - Will cover what is on exam
  - Set up practice problems

Assignments

- A2 has been graded
  - Pick up in Gates 216
  - **Mean**: 33, **StdDev**: 8
  - Grades explained in Piazza
- A3 is due on **FRIDAY**
  - Turn in before you leave
  - Will post survey today
  - Survey due next week
- A4 posted **after** the exam

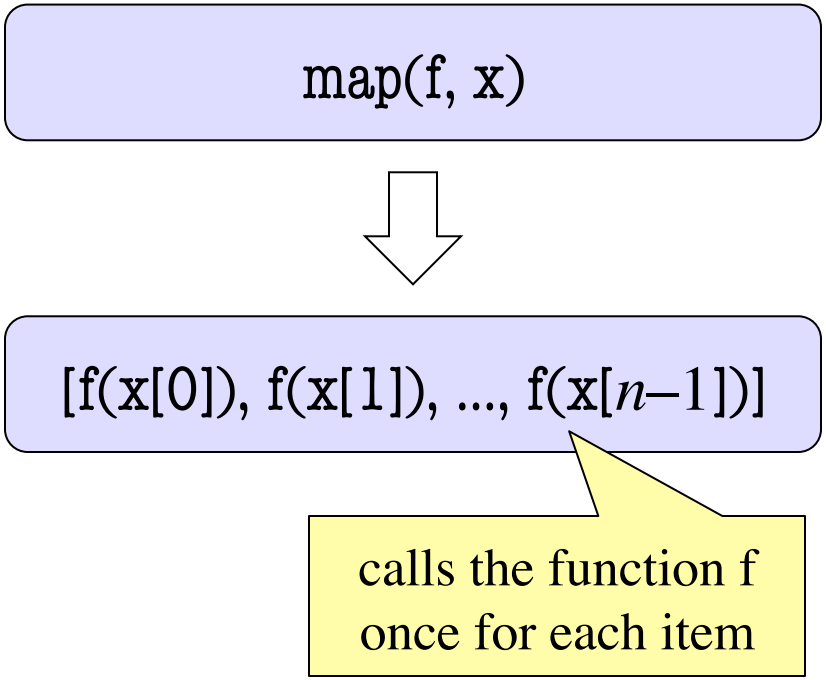
Processing Lists: builtins

- `sum(x)` adds up all the elements in the list `x`
  - They must all be numbers!
- `min(x)` or `max(x)` find the min/max value in list `x`
  - They use the same ordering as `sort()`
- `range(a,b,c)` produces `[a,a+c,a+2*c,...,a+c*((b-a)/c)]`
  - Starts at a, increases by c each time, until b (or less)
  - The argument `c` is optional; `c = 1` by default
- `list(x)` converts `x` (such as a string) to a list
  - Example: list('mimsy') produces ['m', 'i', 'm', 's', 'y']

The Map Function

- map(⟨*function*⟩, ⟨*list*⟩)
  - Function has to have exactly **1 parameter**
  - Otherwise, get an error
  - Returns a new list
- Does the same thing as

```
def map(f,x):
    result = [] # empty list
    for y in x:
        result.append(f(y))
    return result
```

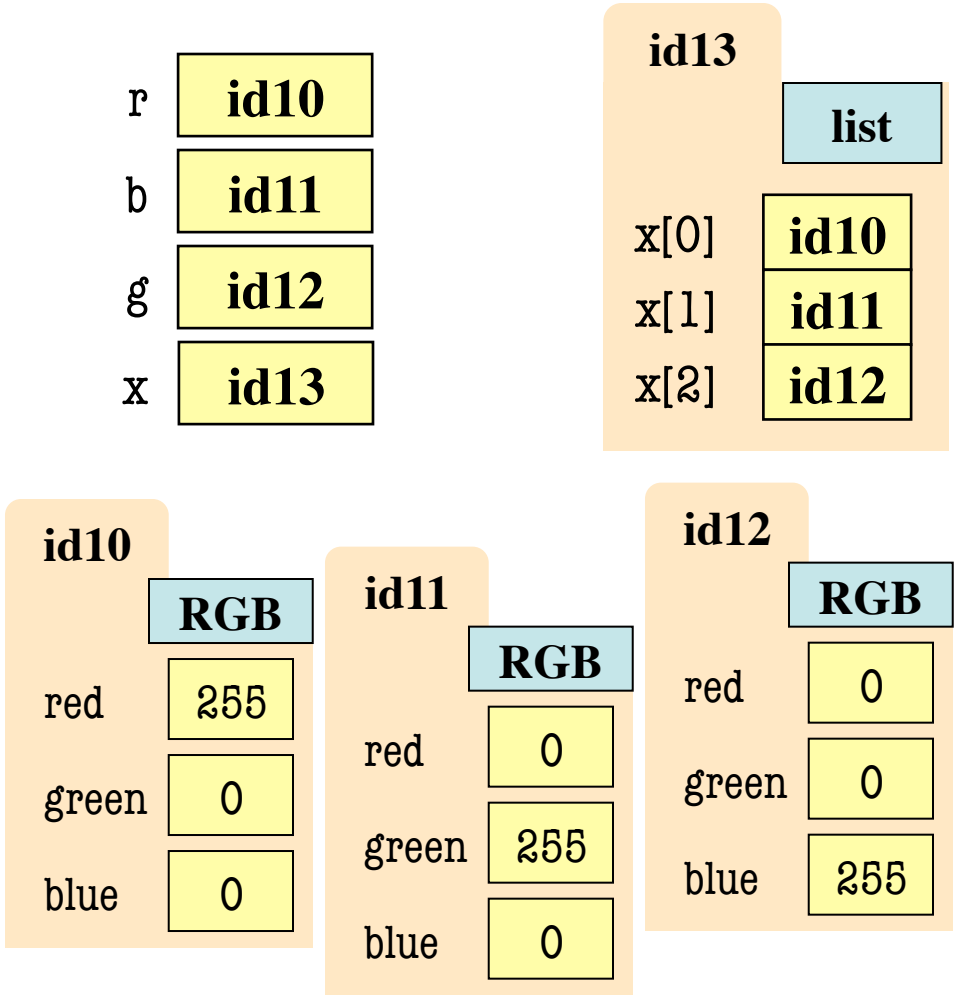


map(len, ['a', 'bc', 'defg'])
returns [1, 2, 4]

Lists of Objects

- List positions are variables
  - Can store base types
  - But cannot store folders
  - Can store folder identifiers
- Folders linking to folders
  - Top folder for the list
  - Other folders for contents
- Example:

```
>>> r = colormodel.RED
>>> b = colormodel.BLUE
>>> g = colormodel.GREEN
>>> x = [r,b,g]
```



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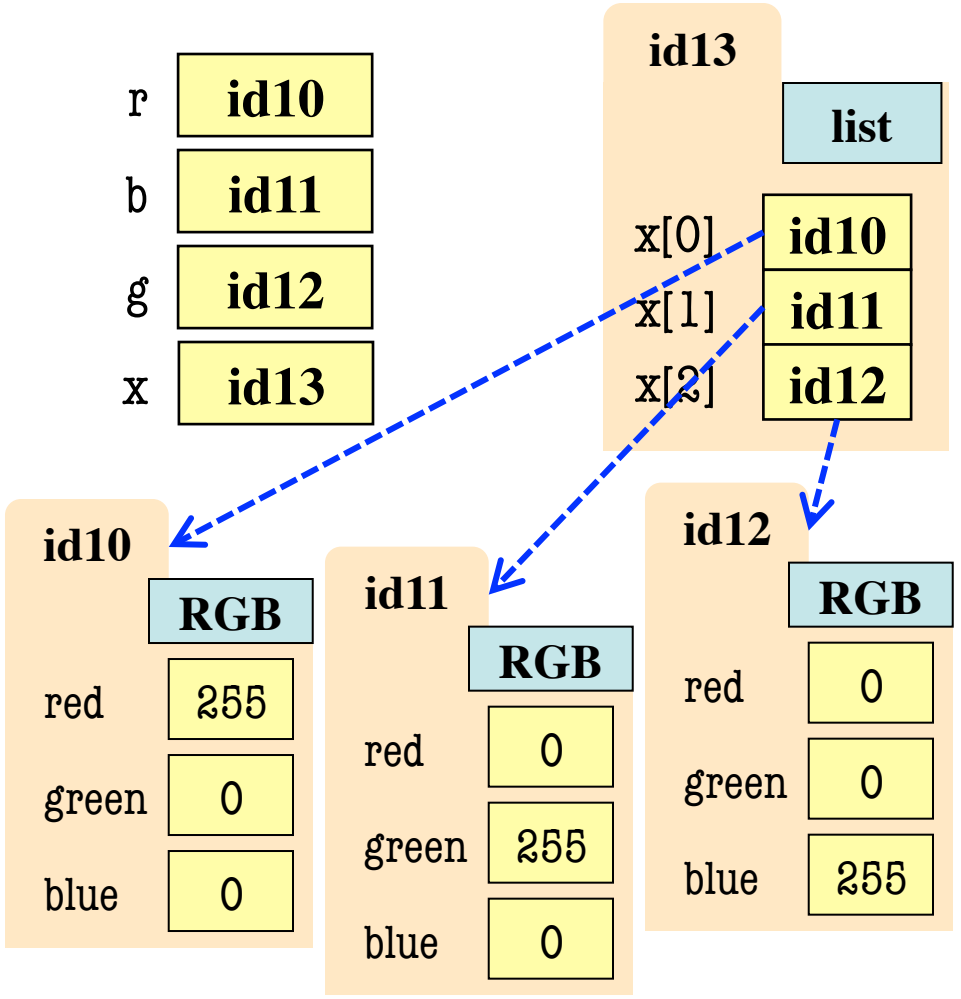
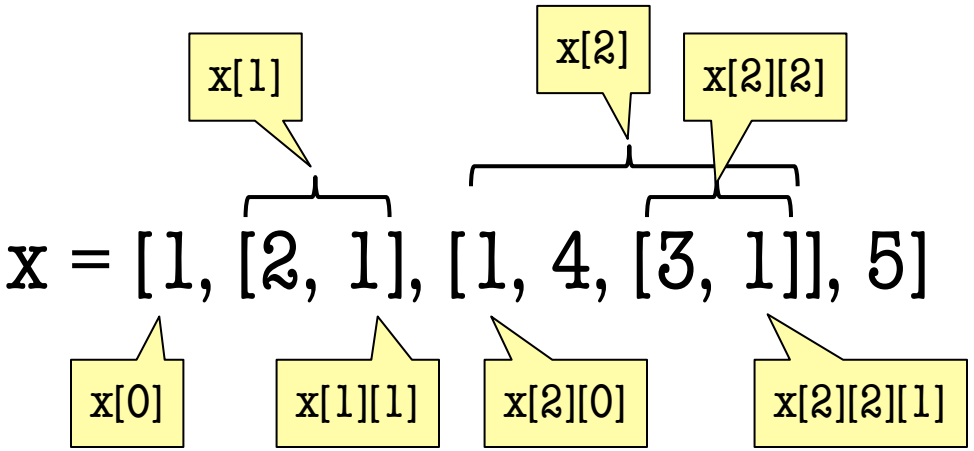


Nested Lists

- Lists can hold any objects
- Lists are objects
- Therefore lists can hold other lists!

```
a = [2, 1]
b = [3, 1]
c = [1, 4, b]
x = [1, a, c, 5]
```



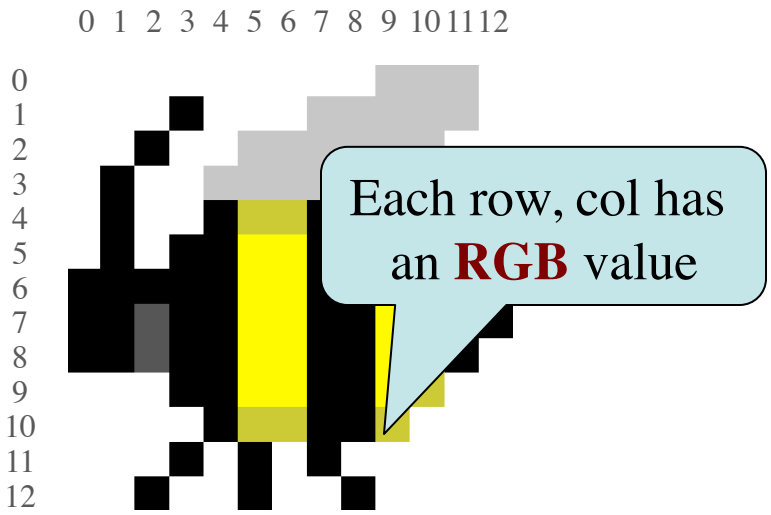
Two Dimensional Lists

Table of Data

	0	1	2	3
0	5	4	7	3
1	4	8	9	7
2	5	1	2	3
3	4	1	2	9
4	6	7	8	0

Each row, col has a value

Images



Store them as lists of lists (**row-major order**)

```
d = [[5,4,7,3],[4,8,9,7],[5,1,2,3],[4,1,2,9],[6,7,8,0]]
```

Overview of Two-Dimensional Lists

- Access value at row 3, col 2:

  `d[3][2]`

- Assign value at row 3, col 2:

  `d[3][2] = 8`

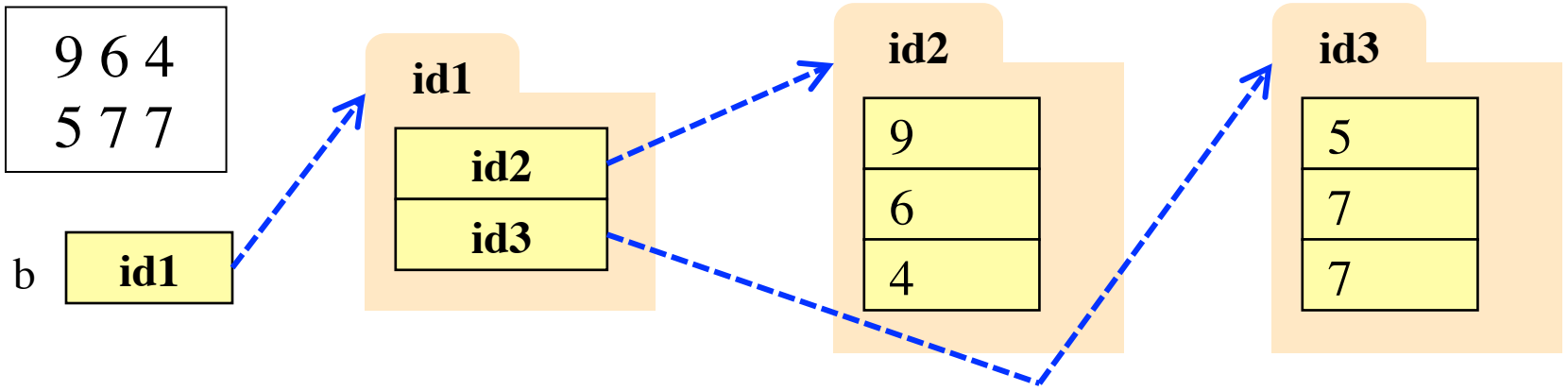
- **An odd symmetry**
  - Number of rows of d: `len(d)`
  - Number of cols in row r of d: `len(d[r])`

`d`

	0	1	2	3
0	5	4	7	3
1	4	8	9	7
2	5	1	2	3
3	4	1	2	9
4	6	7	8	0

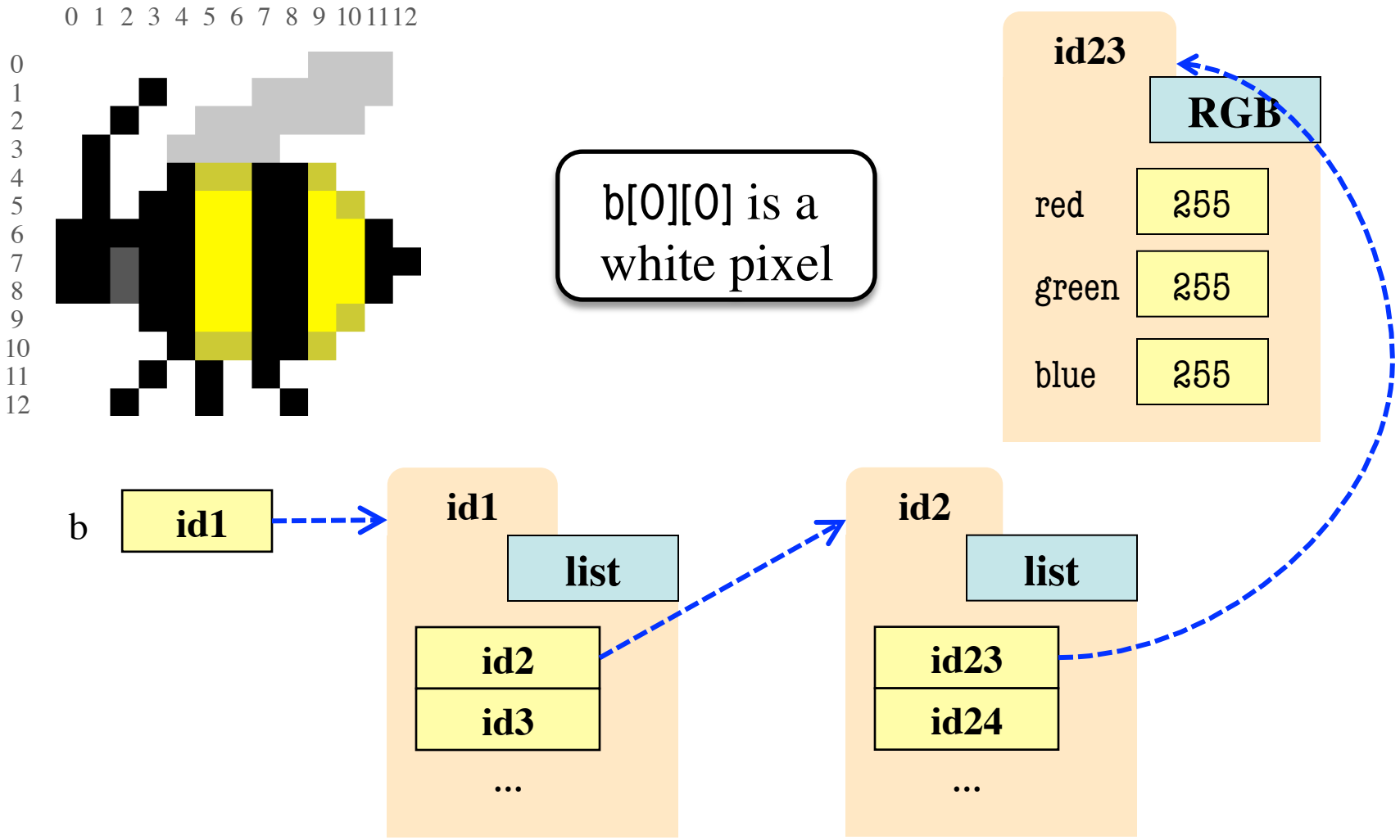
How Multidimensional Lists are Stored

- b = [[9, 6, 4], [5, 7, 7]]



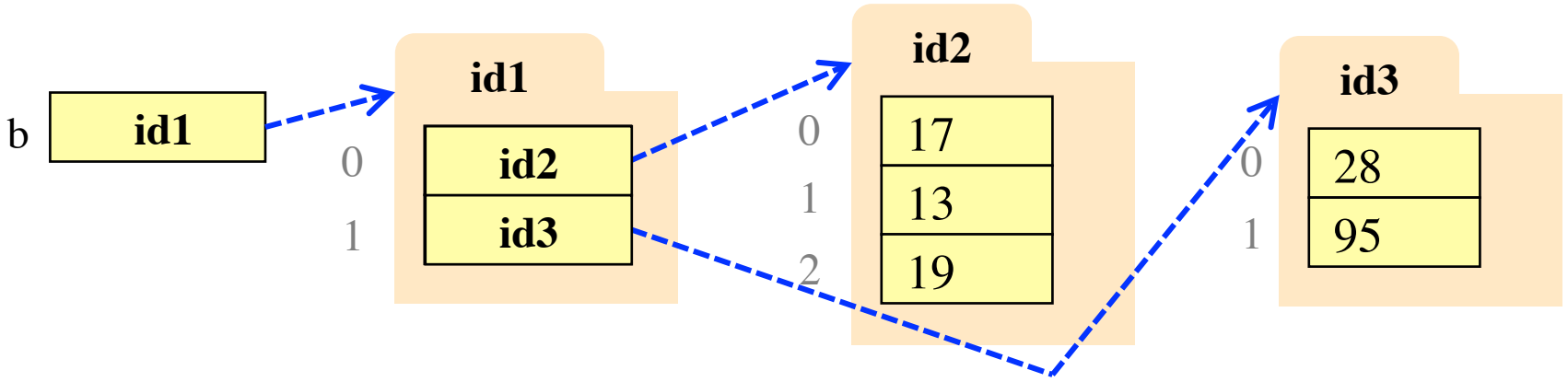
- b holds name of a one-dimensional list
  - Has len(b) elements
  - Its elements are (the names of) 1D lists
- b[i] holds the name of a one-dimensional list (of ints)
  - Has len(b[i]) elements

Image Data: 2D Lists of Pixels



Ragged Lists: Rows w/ Different Length

- `b = [[17,13,19],[28,95]]`

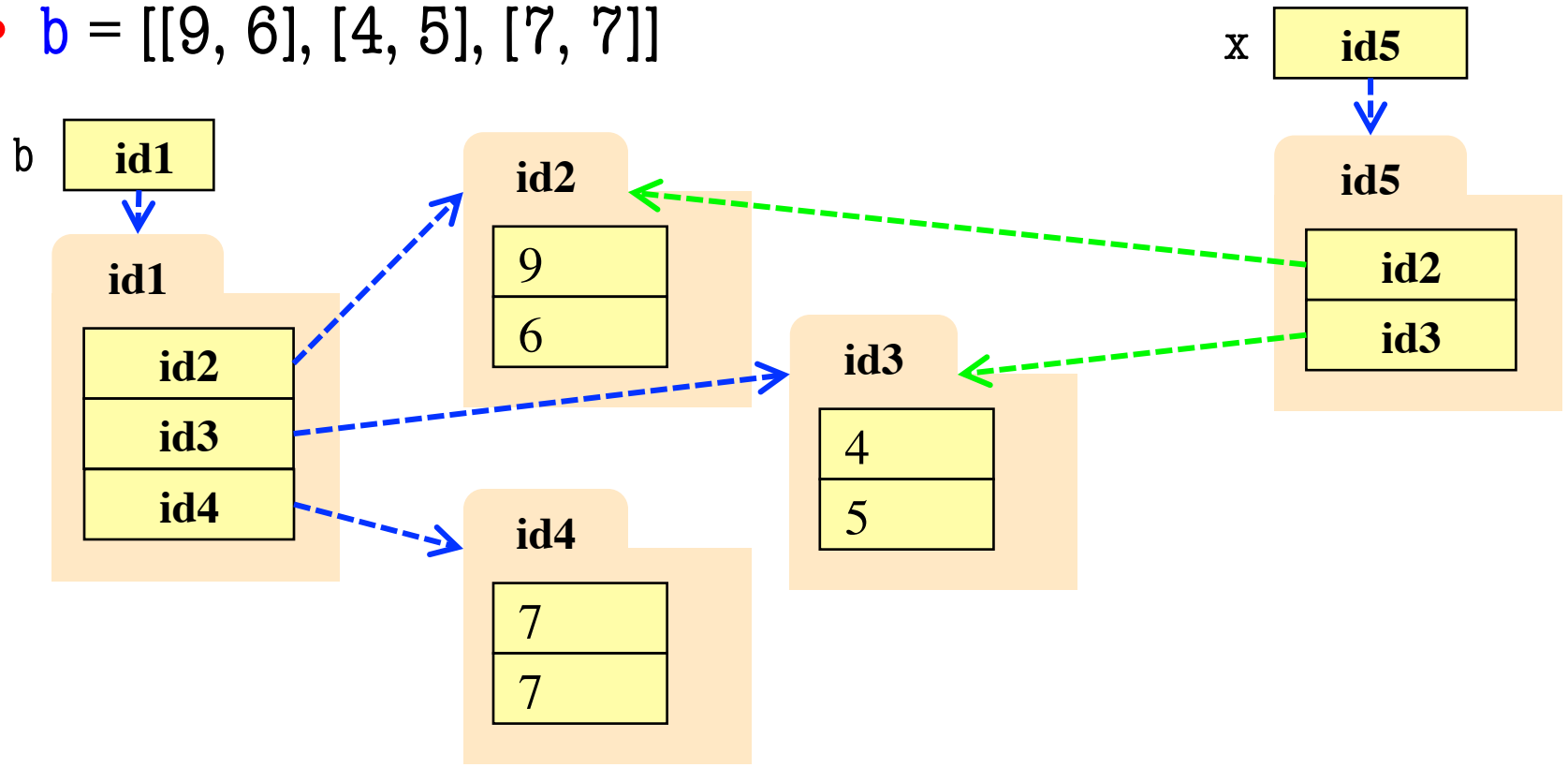


- Will see applications of this later

Slices and Multidimensional Lists

- Only "top-level" list is copied.
- Contents of the list are not altered
- `b = [[9, 6], [4, 5], [7, 7]]`

`x = b[:2]`



Slices and Multidimensional Lists

- Create a nested list

```
>>> b = [[9,6],[4,5],[7,7]]
```

- Get a slice

```
>>> x = b[:2]
```

- Append to a row of x

```
>>> x[1].append(10)
```

- x now has nested list

```
[[9, 6], [4, 5, 10]]
```

- What are the contents of the list (with name) in b?

A: [[9,6],[4,5],[7,7]]
B: [[9,6],[4,5,10]]
C: [[9,6],[4,5,10],[7,7]]
D: [[9,6],[4,10],[7,7]]
E: I don't know

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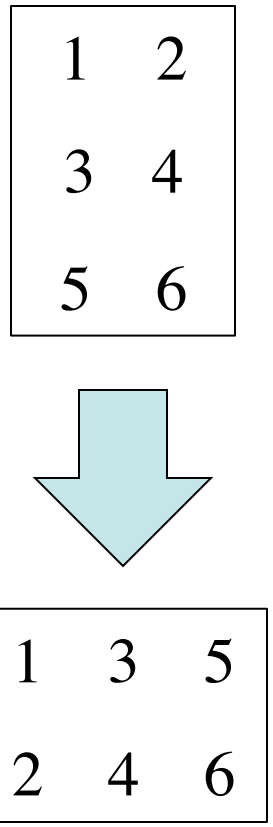
Functions and 2D Lists

```
def transpose(table):
    """Returns: copy of table with rows and columns swapped
    Precondition: table is a (non-ragged) 2d List"""
    numrows = len(table)
    numcols  = len(table[0]) # All rows have same no. cols
    result = [] # Result accumulator
    for m in range(numcols):
        row = [] # Single row accumulator
        for n in range(numrows):
            row.append(table[n][m]) # Build up row
        result.append(row) # Add result to table
    return result
```



Dictionaries (Type dict)

Description

- List of key-value pairs
  - Keys are unique
  - Values need not be
- Example: net-ids
  - net-ids are **unique** (a key)
  - names need not be (values)
  - js1 is John Smith (class '13)
  - js2 is John Smith (class '16)
- Many other applications

Python Syntax

- Create with format:
  `{k1:v1, k2:v2, ...}`
- Keys must be non-mutable
  - ints, floats, bools, strings
  - **Not** lists or custom objects
- Values can be anything
- Example:

```
d = {'js1':'John Smith',
     'js2':'John Smith',
     'wmw2':'Walker White'}
```

Using Dictionaries (Type dict)

- Access elts. like a list
  - d['js1'] evaluates to 'John'
  - But cannot slice ranges!
- Dictionaries are **mutable**
  - Can reassign values
  - d['js1'] = 'Jane'
  - Can add new keys
  - d['aa1'] = 'Allen'
  - Can delete keys
  - del d['wmw2']

```
d = {'js1':'John','js2':'John',
     'wmw2':'Walker'}
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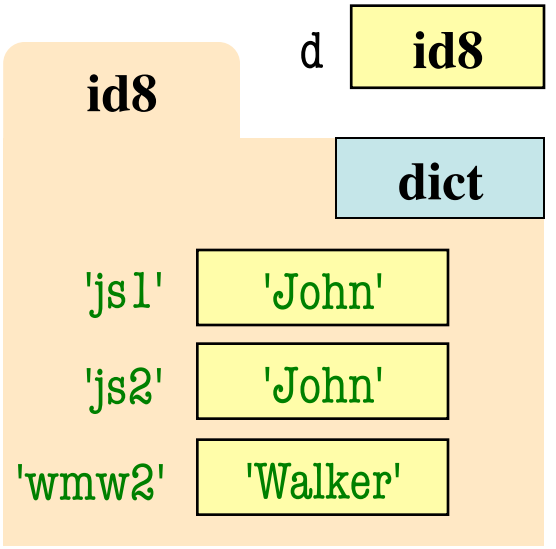

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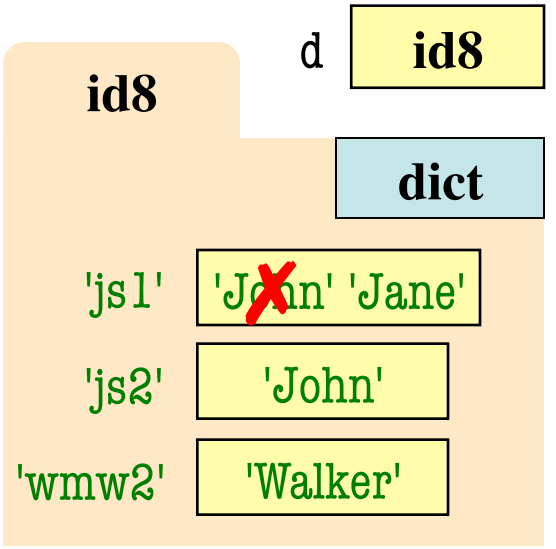

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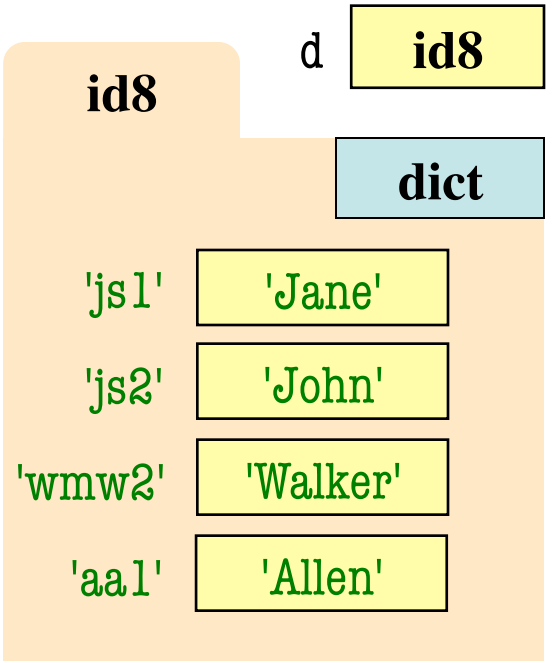

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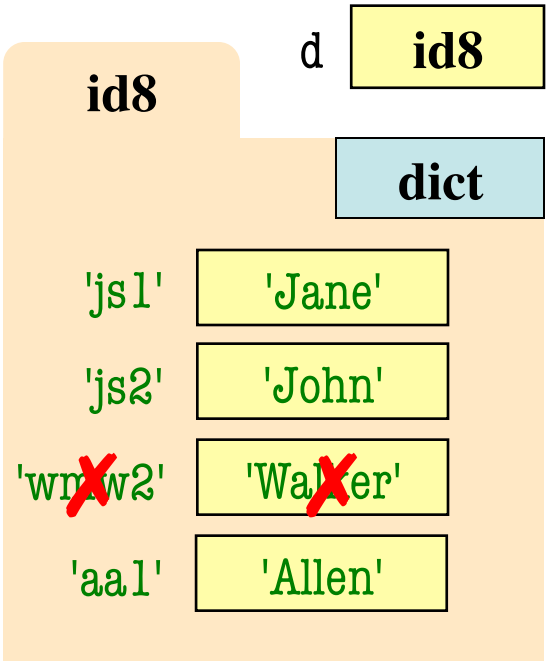

Deleting key deletes both

Dictionaries and For-Loops

- Dictionaries != sequences
  - Cannot slice them
- *Different* inside for loop
  - Loop variable gets the key
  - Then use key to get value
- Has **methods** to *convert* dictionary to a sequence
  - Seq of keys: d.keys()
  - Seq of values: d.values()
  - key-value pairs: d.items()

```
for k in d:
    # Loops over keys
    print k      # key
    print d[k]   # value

# To loop over values only
for v in d.values():
    print v      # value
```

See grades.py

Dictionaries and Lists

- The values can be lists
  - Works just like 2D lists
  - But first index is a key
- **Example**:

```
>>> d = { } # Empty dict
>>> d['wmw2'] = [9,6]
>>> d['aal'] = [4]
>>> d['aal'].append(5)
```

- **We will use this in A4!**