Lecture 12: Nested Lists and Dictionaries

(Sections 11.1-11.5)

CS 1110

Introduction to Computing Using Python

[E. Andersen, A. Bracy, D. Gries, L. Lee, S. Marschner, C. Van Loan, W. White]

- Someone asked about iterating through the elements of a dict so I've added a new slide about this (slide 12)

Announcements

- TA Office Hours: *Come to them!*
  - *Ask any question… or don't even ask a question!*
    - *"I don't know what's going on…" ← say this!*
  - Attend early!
- A3 is out
  - Show your code only to your partner or course staff
  - Look only at the code of your partner
- Masking policy:
  - Keep wearing masks in non-distanced educational settings: this does mean all in-person office/consulting hours

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)

Python Syntax

- Create with format:

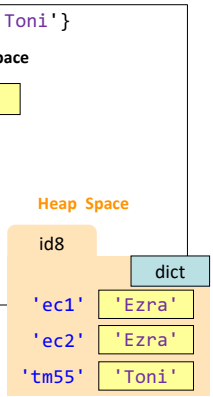
```
{key1:value1,
 key2:value2, …}
```

- Keys must be **immutable**
  - ints, floats, bools, strings
  - **Not** lists or custom objects
- Values can be anything
- Example:

```
d = {'js1':'John Smith',
     'js2':'John Smith',
    'tm55':'Toni Morrison'}
```


Using Dictionaries (Type `dict`)

```
>>> d = {'ec1':'Ezra', 'ec2':'Ezra', 'tm55':'Toni'}
>>> d['ec1']
'Ezra'
>>> d[0]
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
KeyError: 0
>>> d[:1]
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: unhashable type: 'slice'
>>>
```



- Can access elements like a list, but…
  - Must use the key, not an index
  - Cannot slice ranges

Dictionaries are **mutable** (1, before)

1. Can reassign values
   - `d['ec1'] = 'Ellis'`

```
d = {'ec1':'Ezra',
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     'tm55':'Toni'}
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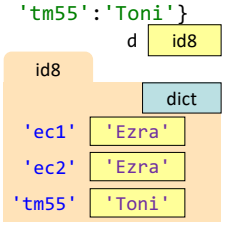

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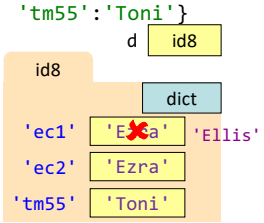
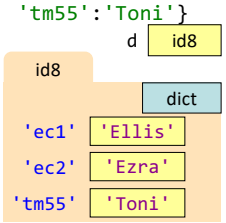


Dictionaries are **mutable** (2, before)

1. Can reassign values
   - `d['ec1'] = 'Ellis'`
2. Can add new keys
   - `d['psb26'] = 'Pearl'`

```
d = {'ec1':'Ezra',
     'ec2':'Ezra',
     'tm55':'Toni'}
```



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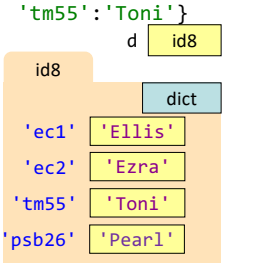
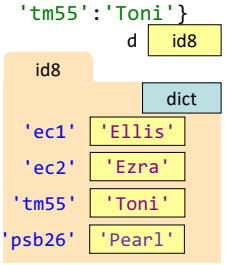


Dictionaries are **mutable** (3, before)

1. Can reassign values
   - `d['ec1'] = 'Ellis'`
2. Can add new keys
   - `d['psb26'] = 'Pearl'`
3. Can delete keys
   - `del d['tm55']`

```
d = {'ec1':'Ezra',
     'ec2':'Ezra',
     'tm55':'Toni'}
```



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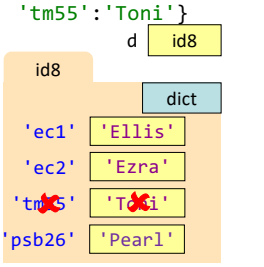


Deleting key deletes both key and value

Be sure to read Textbook 11.1-11.5 for additional examples!

A student asked about iterating through a dict

```
students = {'ec1':'Ezra','ec2':'Ezra',
      'tm55':'Toni'}

# loop variable iterates through each key
for netID in students:
   print(netID + ":" + students[netID])
```

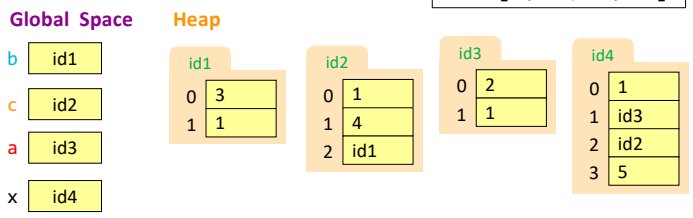
prints to the screen:

```
ec1:Ezra
ec2:Ezra
tm55:Toni
```

Nested Lists

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

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

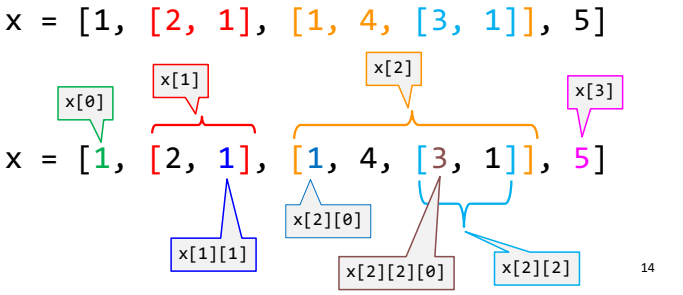


This is drawing accurate, but a little hard to reason about…

Nested Lists

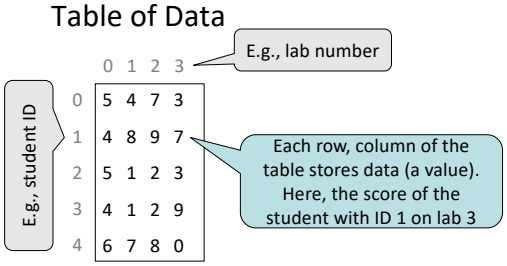
Conceptually, you can visualize nested lists like this:

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



"Table-shaped" Two-Dimensional Lists

Table of Data



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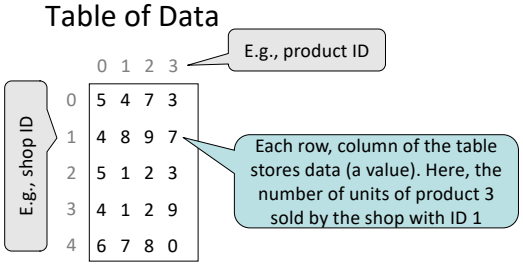

"Table-shaped" Two-Dimensional Lists

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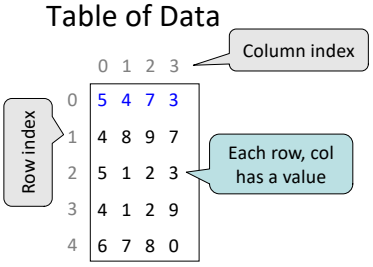
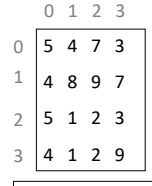


Really a list of lists, but convenient to think about it as a table, since all inner lists (rows) have the same number of elements.

Store them as a list of lists ("row-major order")

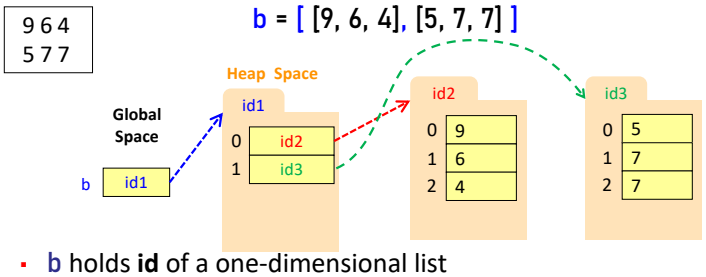
```
tdlist = [[5,4,7,3], [4,8,9,7], [5,1,2,3],
          [4,1,2,9], [6,7,8,0]]
```


Overview of Two-Dimensional Lists



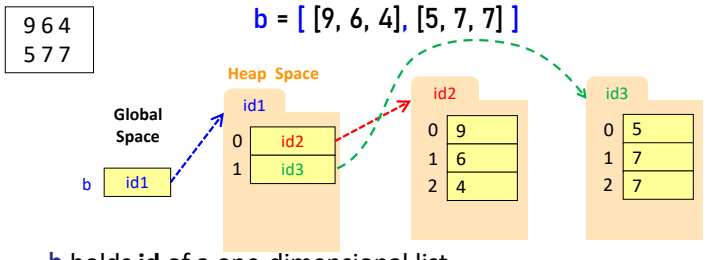

```
>>> tdlist = [[5,4,7,3],[4,8,9,7],[5,1,2,3],[4,1,2,9]]
>>> tdlist[3][2]              Access value at row 3, col 2
2
>>> tdlist[3][2] = 8          Assign value at row 3, col 2
>>> tdlist
[[5, 4, 7, 3], [4, 8, 9, 7],[5, 1, 2, 3], [4, 1, 8, 9]]
>>> len(tdlist)               Number of rows of tdlist
4
>>> len(tdlist[2])            Number of cols in row 2 of tdlist
4
```

How Multidimensional Lists are Stored



- b holds **id** of a one-dimensional list
  - Has len(b) elements
- b[i] holds **id** of a list
  - Has len(b[i]) elements

How to access every element of nested list?



- b holds **id** of a one-dimensional list
  - Has len(b) elements `# len(b) rows`
- b[i] holds **id** of a list
  - Has len(b[i]) elements

`# row i has len(b(i)) elements`

Need: a loop to go row by row. At each row, a loop to go column by column.
→ Nested loops!

Exercise 1

```
def print_all_rows(my_table):
    """Prints all rows of the table,
    one row (list) on each line.
    Preconditions:  my_table is a table of numbers
                    my_table is not empty  """
```

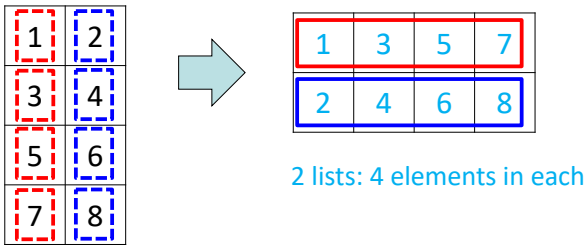
See table.py

Exercise 2

```
def print_all_elements(my_table):
    """Prints all elements of the table,
    one element on each line.
    Preconditions:  my_table is a table of numbers
                    my_table is not empty  """
```

See table.py

Data Wrangling: Transpose Idea

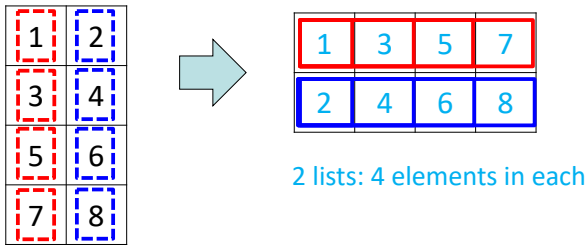


2 lists: 4 elements in each

4 lists: 2 elements in each
How to transpose?

- 1st element of each list gets appended to 1st list
- 2nd element of each list gets appended to 2nd list

Data Wrangling: Transpose Idea



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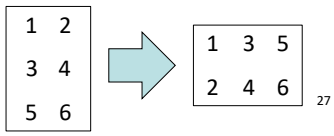
Data Wrangling: Transpose Code

```
def transpose(table):
    """Returns: copy of table with rows and columns swapped
    Precondition: table is a (non-ragged) 2d List"""
    n_rows = len(table)
    n_cols  = len(table[0]) # All rows have same no. cols
    new_table = [] # Result accumulator

    return new_table

d = [[1,2],[3,4],[5,6]]
d_v2 = transpose(d)
```



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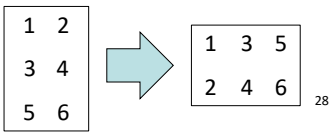

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    new_table = [] # Result accumulator

    for c in range(n_cols):
        row = [] # Single row accumulator
        for r in range(n_rows):
            row.append(table[r][c]) # Build up new row
        new_table.append(row) # Add new row to new table
    return new_table

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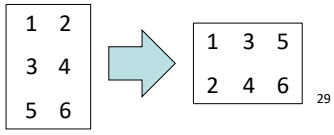
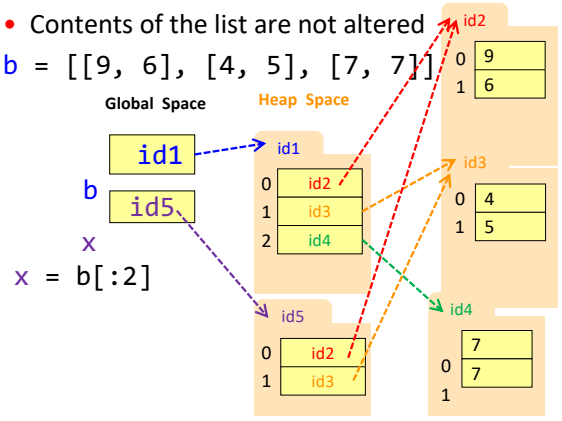


Slices and Multidimensional Lists

- Only "top-level" list is copied.
- Contents of the list are not altered

```
b = [[9, 6], [4, 5], [7, 7]]
x = b[:2]
```



Slices & Multidimensional Lists (Q1)

- 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)`

What is now in x?

A: `[[9,6,10]]`
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

Slices & Multidimensional Lists (Q2)

- 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 is now 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