http://www.cs.cornell.edu/courses/cs1110/2021sp

Lecture 12: Nested Lists and Dictionaries

(Sections 11.1-11.5)

CS 1110

Introduction to Computing Using Python

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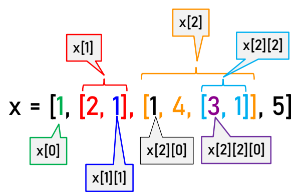
Announcements

- Be sure to go to section for Labs 11 & 12
- A3: first submission ("part A") due Mar 24; final submission due Mar 28
- Definitive source for due dates is the course webpage, but we try to also put due dates on the Canvas calendar
- A2 grades and solutions available around Wednesday
- Next lecture will be a review session
- Tues 3/30 lecture will be open office hour
- Prelim 1 Study Guide available tonight. Be sure to read it!
- Exam logistics: seat number and Zoom link to be distributed via CMS by end of the week. Online exam takers will be contacted by proctor to do a ***required*** short mock exam *before* actual exam.

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]
```



Two Dimensional Lists

Table of Data

E.g., lab number

E.g., student ID

	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, column of the table stores data (a value). Here, the score of the student with ID 1 on lab 3

Two Dimensional Lists

Table of Data

E.g., product ID

E.g., shop ID

	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, column of the table stores data (a value). Here, the number of units of product 3 sold by the shop with ID 1

Two Dimensional Lists

Table of Data

Column index

Row index

	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

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")

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

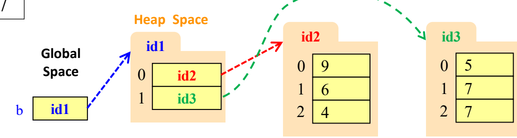
	0	1	2	3
0	5	4	7	3
1	4	8	9	7
2	5	1	2	3
3	4	1	2	9

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

How Multidimensional Lists are Stored

9 6 4
5 7 7

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



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

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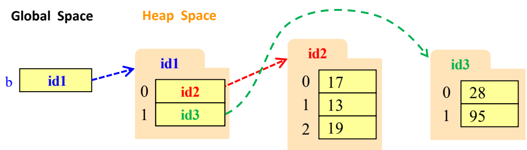
Ragged Lists: Rows w/ Different Length

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



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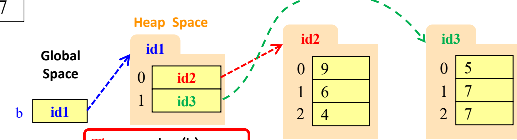
How to access every element of nested list?

9 6 4
5 7 7

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



There are len(b) rows

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

Row i has len(b(i)) elements

A loop to go row to row. Then at each row, set a loop to go column to column.
→ Nested loops!

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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

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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

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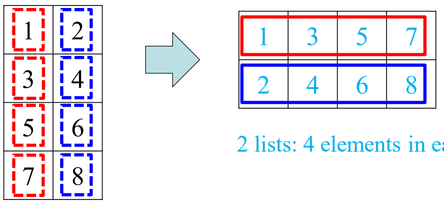
Data Wrangling: Transpose Idea



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

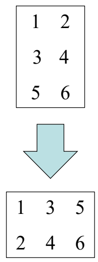
Data Wrangling: Transpose Code

```
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)
```

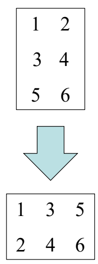


Data Wrangling: Transpose Code

```
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

    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

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

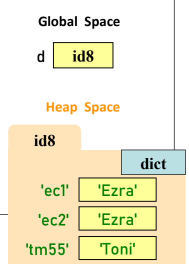


Dictionaries (Type dict)

Description	Python Syntax
• 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)	• 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'
>>>
```

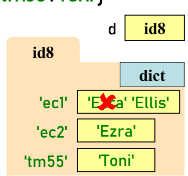


- Can access elements like a list
- Must use the key, not an index
- Cannot slice ranges

Using Dictionaries (Type dict)

- Dictionaries are **mutable**
  - Can reassign values
  - d['ec1'] = 'Ellis'

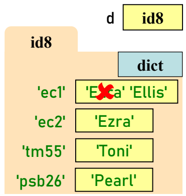
d = {'ec1':'Ezra','ec2':'Ezra',
'tm55':'Toni'}



Using Dictionaries (Type dict)

- Dictionaries are **mutable**
  - Can reassign values
  - d['ec1'] = 'Ellis'
  - Can add new keys
  - d['psb26'] = 'Pearl'

d = {'ec1':'Ezra','ec2':'Ezra',
'tm55':'Toni','psb26':'Pearl'}



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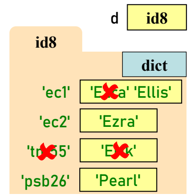
Using Dictionaries (Type dict)

- Dictionaries are **mutable**
  - Can reassign values
  - d['ec1'] = 'Ellis'
  - Can add new keys
  - d['psb26'] = 'Pearl'
  - Can delete keys
  - del d['tm55']

d = {'ec1':'Ezra','ec2':'Ezra',
'psb26':'Pearl'}



Deleting key deletes both key *and value*

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

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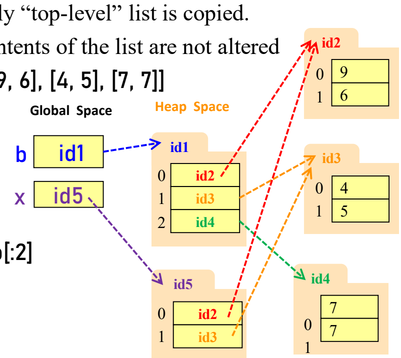
Slices and Multidimensional Lists

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

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



x = b[:2]

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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

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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

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