def fastcount(words):
    d = {}
    for w in words:
        if w in d:
            d[w] += 1
        else:
            d[w] = 1
    return sorted(d.items())
Q is for ...

- QR code
  - Black and white and read all over
- Quicksort
  - Sort of choice before Timsort?
- QWERTY
  - When bad ideas persist
Christine Alvarado

• Teaching Professor, UCSD
• PhD Computer Science, MIT
• Her work is in designing CS curriculum that is more accessible and more appealing to all
• LogiSketch – draw and simulate digital circuits

“It’s important to choose your own path, and try not to compare yourself to others. You have your own unique circumstance, so what others do or don’t do shouldn’t really affect your life.”
Announcements

• Assignment 4 GuessWord due today!
• APT-5 due Thur, March 30
  • Recommend to do before Assignment 5/APT Quiz 2
• Assign 5 Clever Guess Word out – due April 6
  • Talk about next time
• Lab 8 Friday, do prelab
• Next Week
  • APT Quiz 2 Thurs, March 30-April 3
• Exam 2 regrades request
PFTD

• Venmo Apt
• Dictionaries
  • More Practice
  • Fast!
• Family APT
• Clever GuessWord next time
Assignment 5 - How to play
Guess Word Cleverly

• Make it hard for the player to win!

• One way: Try hard words to guess?
  • "jazziest", "joking", "bowwowing"

• Another Way: Keep changing the word, sortof
Clever GuessWord

• Current GuessWord: Pick random secret word
  • User starts guessing

• Can you change secret word?
  • Yes, but must have letters in same place you have told user
    • Change consistent with all guesses
  • Make the user work harder to guess!

• Discuss how next time
VenmoTracker APT

- If Harry pays Sally $10.23,
  - "Harry:Sally:10.23" then Harry is out $10.23
Problem Statement

You've been asked to help manage reports on how often people spend money using Venmo and whether they receive more money than they pay out. The input to your program is a list of transactions from Venmo. Each transaction has the same form: "from:to:amount" where from is the name of the person paying amount dollars to the person whose name is to. The value of amount will be a valid float with at most two decimal places.

Return a list of strings that has each person who appears in any transaction with the net cash flow through Venmo that person has received. Every cent paid by the person to someone else is a pay-out and every cent received by a person is a pay-in. The difference between pay-out and pay-in is the cash flow received. This will be negative for each person who pays out more than they get via pay-in. See the examples for details.

The list returned should be sorted by name. Strings in the list returned are in the format "name:netflow" where the netflow is obtained by using \texttt{str(val)} where val is a float representing the net cash flow for that person.

Store money as int values, multiplying by 100 and dividing by 100 as needed for processing input and output, respectively.

Specification

```python
filename: VenmoTracker.py
def networth(transactions):
    ""
    return list of strings based on transactions, which is also a list of strings
    ""
    # you write code here
    return []
```
APT Venmo Tracker Example

Examples

1. `transactions: ["owen:susan:10", "owen:robert:10", "owen:drew:10"]`
   returns `["drew:10.0", "owen:-30.0", "robert:10.0", "susan:10.0"]`

Owen pays everyone.
WOTO-1 VenmoTracker
Tools We’ve Used Before

• Keep track of every person we see
  • Use a list

• Keep track of net worth: money in, money out
  • Use a parallel list

• Maintain invariant: \( \text{name}_k \leftrightarrow \text{money}_k \)
  • \( k^{\text{th}} \) name has \( k^{\text{th}} \) money
Example:

[ "Harry:Sally:10.23", "Zeyu:Sally:20.00", "Sally:Barak:10.00"]

• How would we solve this?
• Could we use a parallel list?
• What would be the output?
Process Transaction
"Harry:Sally:10.23"

names = [ ]

money = [ ]
Put Harry in:
"Harry:Sally:10.23"

names = [ "Harry" ]
0

money = [ -10.23 ]
0
Put Sally in:
"Harry:Sally:10.23"

<table>
<thead>
<tr>
<th>names</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&quot;Harry&quot;</td>
</tr>
<tr>
<td>1</td>
<td>&quot;Sally&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>money</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-10.23</td>
</tr>
<tr>
<td>1</td>
<td>10.23</td>
</tr>
</tbody>
</table>
Process next transaction
"Zeyu:Sally:20.00"

names = [ "Harry", "Sally" ]

money = [ -10.23, 10.23 ]
Put Zeyu in:
“Zeyu:Sally:20.00”

names = [“Harry”, “Sally”, “Zeyu”]

money = [-10.23, 10.23, -20.00]
Update Sally in:
“Zeyu:Sally:20.00”

defined variables:

names = [ "Harry", "Sally", "Zeyu" ]
    0      1      2

money = [ -10.23, 30.23, -20.00 ]
         0      1      2
Process next Transaction
“Sally:Barak:10.00”

names = [ "Harry", "Sally", "Zeyu" ]

money = [ -10.23, 30.23, -20.00 ]
Update Sally in:
“Sally:Barak:10.00”

names = [ “Harry”, “Sally”, “Zeyu” ]
0 1 2

money = [ -10.23, 20.23, -20.00 ]
0 1 2
Add Barak in:
“Sally:Barak:10.00”

names = [“Harry”, “Sally”, “Zeyu”, “Barak”]
0 1 2 3

money = [-10.23, 20.23, -20.00, 10.00]
0 1 2 3
def networth(transactions):
    names = [ ]
    money = [ ]
    for trans in transactions:
        # split up trans
def networth(transactions):
    names = [ ]
    money = [ ]
    for trans in transactions:
        # split up trans
        data = trans.split("":"")
        sender = data[0]
        receiver = data[1]
        amount = float(data[2])
Coding up Venmo

if sender not in names:
    names.append(sender)
    money.append(0)

# similar if receiver not in names

# update money

indexSender = names.index(sender)
indexReceiver = names.index(receiver)
money[indexSender] -= amount
money[indexReceiver] += amount

# create output in correct format
Seen parallel lists before

- Solution outlined is reasonable, efficient?
  - How long does it take to find index of name?
  - It depends. Why?

- `list.index(elt)` or `elt in list` – fast?
  - What does "fast" mean? Relative to what?
Let’s try Dictionaries....
Example:

[ "Harry:Sally:10.23", "Zeyu:Sally:20.00", "Sally:Barak:10.00"

- How would we solve this?
- Could we use a dictionary?
- What would be the output?
Example with Dictionary

1) "Harry:Sally:10.23"

- Start with empty dictionary, insert Harry
Example with Dictionary
1) "Harry:Sally:10.23"

- Insert Sally
Example with Dictionary

2) “Zeyu:Sally:20.00"

- Insert Zeyu, next update Sally

- Zeyu → -20.00
- Harry → -10.23
- Sally → 10.23
Example with Dictionary

2) “Zeyu:Sally:20.00"

- Update Sally
Example with Dictionary
3) “Sally:Barak:10.00"

- Next Transaction – First update Sally

- Zeyu \(-20.00\)
- Harry \(-10.23\)
- Sally \(30.23\)
Example with Dictionary

3) “Sally:Barak:10.00"

- Update Sally

-20.00

Zeyu

-10.23

Harry

20.23

Sally
Example with Dictionary

3) “Sally:Barak:10.00"

- Insert Barak:
  
  Zeyu -> -20.00
  Harry -> -10.23
  Sally -> 20.23
  Barak -> 10.00
• List of (key, value) pairs
• [("Zeyu", -20.00), ("Harry", -10.23), ("Sally", 20.23), ("Barak", 10.00)]
Return Value

Zeyu  -20.00
Harry -10.23
Sally  20.23
Barak  10.00

• [("Zeyu", -20.00), ("Harry", -10.23), ("Sally", 20.23), ("Barak", 10.00)]

Sort by name:
• [("Barak", 10.00), ("Harry", -10.23), ("Sally", 20.23), ("Zeyu", -20.00)]
Return Value

- Zeyu: -20.00
- Harry: -10.23
- Sally: 20.23
- Barak: 10.00

• ["Barak": 10.00], ["Harry": -10.23], ["Sally": 20.23], ["Zeyu": -20.00]]

Put in final format:

• ["Barak:10.00", "Harry:-10:23", "Sally:20.23", "Zeyu:-20.00"]
How would the code be different if we used a dictionary?
def networth(transactions):
    venmo = {}
    for trans in transactions:
        # split up trans
def networth(transactions):
    venmo = { }
    for trans in transactions:
        # split up trans
        data = trans.split(":")
        sender = data[0]
        receiver = data[1]
        amount = float(data[2])

Initialize dictionary

This part the same
Coding up Venmo with Dictionary

if sender not in venmo:
    venmo[sender] = 0
# similar if receiver not in names
# update money
venmo[sender] -= amount
venmo[receiver] += amount
# create output in correct format

Code is shorter for dictionaries!
Code is faster for dictionaries!
You will need to finish it

• Now onto more on Dictionaries...
Dictionary Iteration (unordered!)

- Iterate through keys:
  - for k in d:
  - for k in d.keys():

- Iterate through pairs:
  - for (k,v) in d.items():
  - for k,v in d.items():
Sorting a list from dictionary - `sorted()`

d = {'k': 3, 'h': 8, 'a': 12, 'd': 5}

x = sorted(d.keys())
y = sorted(d.values())
z = sorted(d.items())
Sorting a list from dictionary - `sorted()`

d = {'k': 3, 'h': 8, 'a': 12, 'd': 5}

\[
x = \text{sorted(d.keys())}
x \text{ is } \ ['a', 'd', 'h', 'k']
\]

\[
y = \text{sorted(d.values())}
y \text{ is } \ [3, 5, 8, 12]
\]

\[
z = \text{sorted(d.items())}
z \text{ is } \ [( 'a', 12), ( 'd', 5), ( 'h', 8), ( 'k', 3) ]
\]
WordFrequencies
Dictionary Example

• Let’s see an example that compares using a dictionary vs not using a dictionary
slowcount function
Short Code and Long Time

• See module WordFrequencies.py
  • Find # times each word in a list of words occurs
  • We have tuple/pair: word and word-frequency

```python
37  def slowcount(words):
38      pairs = [(w,words.count(w)) for w in set(words)]
39      return sorted(pairs)
```

• Think: How many times is \texttt{words.count(w)} called?
  • Why is \texttt{set(words)} used in list comprehension?
WordFrequencies with Dictionary

• If start with a million words, then...
• We look at a million words to count # "cats"
  • Then a million words to count # "dogs"
  • Could update with parallel lists, but still slow!
  • Look at each word once: dictionary!

• Key idea: use word as the "key" to find occurrences, update as needed
  • Syntax similar to `counter[k] += 1`
Using fastcount

- Update count if we've seen word before
- Otherwise it's the first time, occurs once

```python
28 def fastcount(words):
29    d = {}
30    for w in words:
31        if w in d:
32            d[w] += 1
33        else:
34            d[w] = 1
35    return sorted(d.items())
```
Using fastcount

- Update count if we've seen word before
- Otherwise it's the first time, occurs once

```python
def fastcount(words):
    d = {}
    for w in words:
        if w in d:
            d[w] += 1
        else:
            d[w] = 1
    return sorted(d.items())
```
Let’s run them and compare them!

- Run with Melville and observe time
- Run with Hawthorne and observe time
Let’s run them and compare them!

• Run with Melville and observe time
  • slowcount about 0.76 seconds
  • fastcount about 0.00 seconds

• Run with Hawthorne and observe time
  • slowcount about 14.6 seconds
  • fastcount about 0.03 seconds
WOTO-2 Counting Dictionaries
Problem Solving

• Given Brodhead University. They have a basketball team.

• Data on players and how they did when playing against another team.

• List of lists named datalist
  • Each list has
    • school opponent name
    • player name
    • Points player scored
    • Whether game was ‘won’ or ‘lost’
Example: lists of 20 lists
dataList =

[ ['Duke', 'Bolton', '2', 'lost'],
 ['NCSU', 'Stone', '12', 'won'],
 ['Duke', 'Kreitz', '3', 'lost'],
 ['Duke', 'Pura', '6', 'lost'],
 ['GT', 'Dolgin', '4', 'lost'],
 ['WFU', 'Laveman', '20', 'won'],
 ['ECU', 'Parlin', '15', 'won'],
 ['UNC', 'Stone', '17', 'won'],
 ['UNC', 'Dolgin', '12', 'won'],
 ['UNC', 'Kreitz', '5', 'won'],
 ['Duke', 'Stone', '16', 'lost'],
 ['Duke', 'Laveman', '13', 'lost'],
 ['NCSU', 'Kreitz', '8', 'won'],
 ['NCSU', 'Dolgin', '18', 'won'],
 ['NCSU', 'Parlin', '13', 'won'],
 ['GT', 'Bolton', '7', 'lost'],
 ['GT', 'Stone', '9', 'lost'],
 ['WFU', 'Parlin', '14', 'won'],
 ['ECU', 'Laveman', '16', 'won'],
 ['ECU', 'Pura', '15', 'won'] ]
1) Write function `dictPlayerToNumGamesPlayedIn`

Build a dictionary of players mapped to number of games they have played in.

```python
def dictPlayerToNumGamesPlayedIn( datalist):
    # With previous example, player 'Laveman' would be mapped to 3 games
```

Write function `dictPlayerToNumGamesPlayedIn`

def dictPlayerToNumGamesPlayedIn(datalist):
    d = {}
    for line in datalist:
        player = line[1]
        if player in d:
            d[player] += 1
        else:
            d[player] = 1
    return d

When each item needs its own count, build a dictionary

This is a counting dictionary
def dictPlayerToNumGamesPlayedIn(datalist):
    d = {}
    for line in datalist:
        player = line[1]
        if player not in d:
            d[player] = 0
        d[player] += 1
    return d
2) Write function
playersPlayedInNumGames(number, datalist)
Calculate list of players who played in 3 or more games, give (player name, number of games played in), sort by player name

[('Dolgin', 3), ('Kreitz', 3), ('Laveman', 3), ('Parlin', 3), ('Stone', 4)]

[ ['Duke', 'Bolton', '2', 'lost'],
 ['NCSU', 'Stone', '12', 'won'],
 ['Duke', 'Kreitz', '3', 'lost'],
 ['Duke', 'Pura', '6', 'lost'],
 ['GT', 'Dolgin', '4', 'lost'],
 ['WFU', 'Laveman', '20', 'won'],
 ['ECU', 'Parlin', '15', 'won'],
 ['UNC', 'Stone', '17', 'won'],
 ['UNC', 'Dolgin', '12', 'won'],
 ['UNC', 'Kreitz', '5', 'won'],
 ['Duke', 'Stone', '16', 'lost'],
 ['Duke', 'Laveman', '13', 'lost'],
 ['NCSU', 'Kreitz', '8', 'won'],
 ['NCSU', 'Dolgin', '18', 'won'],
 ['NCSU', 'Parlin', '13', 'won'],
 ['GT', 'Bolton', '7', 'lost'],
 ['GT', 'Stone', '9', 'lost'],
 ['WFU', 'Parlin', '14', 'won'],
 ['ECU', 'Laveman', '16', 'won'],
 ['ECU', 'Pura', '15', 'won'] ]
2) Write function

`playersPlayedInNumGames(number, datalist)`

def playersPlayedInNumGames(number, datalist):
    d = dictPlayerToNumGamesPlayedIn(datalist)
    # build a list of tuples
    answer = [ ]
    for player in d.keys():
        if d[player] >= number:
            answer.append( (player, d[player] ) )
    return sorted(answer)
ANOTHER WAY 2) Write function

playersPlayedInNumGames(number, datalist)

def playersPlayedInNumGames(number, datalist):
    d = dictPlayerToNumGamesPlayedIn(datalist)
    # build a list of tuples
    answer = []
    for (player, count) in d.items():
        if count >= number:
            answer.append((player, count))
    return sorted(answer)
Another way using a list comprehension!
However, this is putting a lot in one long line.
It may be better to break it up into steps as the previous two slides do. Less chance to make a mistake.

```python
def playersPlayedInNumGames(number, datalist):
    d = dictPlayerToNumGamesPlayedIn(datalist)
    # build a list of tuples
    return sorted([(player, count) for (player, count) in d.items() if count >= number])
```
Problem Statement

You have two lists: parents and children. The ith element in parents is the parent of the ith element in children. Count the number of grandchildren (the children of a person's children) for the person in the person variable.

Hint: Consider making a helper function that returns a list of a person's children.