CompSci 101
Fall 2021

Lecture 10

Reminders

- Regrade Requests-9/28-9/30 via Gradescope
- Assignments
  - Assign 2 due 10/7
  - APT 3 due 10/7
- Small-group tutoring

Key instructions

- Input ←
- Output ←
- Assignments* ✔
- Math/Logic ✔
- Conditionals ✔
- Repetition ←

**not listed in book*

Python Data Types

- int, float, bool ✔
- Collections
  - Strings ✔
  - Lists ✔
  - Tuples
  - Sets
  - Dictionaries

PFTD

- Pancakes
- Loops
  - While loops
  - Nested for loops

“The mere imparting of information is not education.”

- Dr. Carter G. Woodson

KISS Principle

- Think of the non-computing context for any word/terms
- KISS model
  - Work smarter, not harder!!
- "Good programmers are simply good designers."
  - *-Dr. Washington*
- Design first and always!
- Importance of reusability
- *USE PyCharm/PythonTutor IF YOU HAVE QUESTIONS!*

People to Know: Dr. Patricia Ordóñez

- PhD (CS)-University of Maryland, Baltimore County
- Associate Professor, CS
  - University of Puerto Rico Rio Piedras
- Visual analytics, data mining, machine learning

Pancakes!

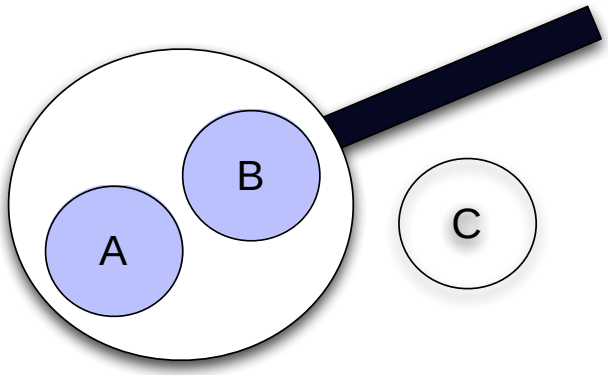
APT Pancake

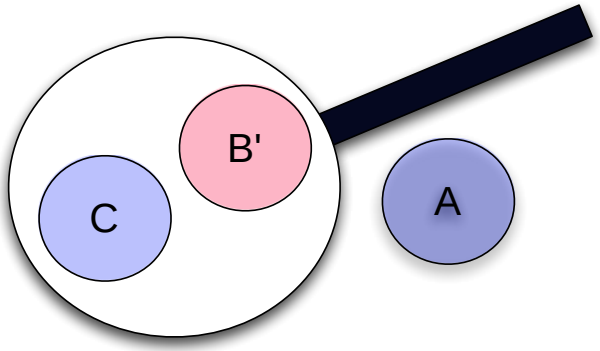
- *minutesNeeded(numCakes, capacity)*
- How do you solve this (or any) problem?
  - 7 Steps!

- Some APTs are hard problems to solve (step 1-4)
  - Translating to code easy
- Some APTs have easy-to-see algorithms (step 5)
  - Translating to code is hard

Step 1: Solve an instance
Three pancakes in a two-cake pan

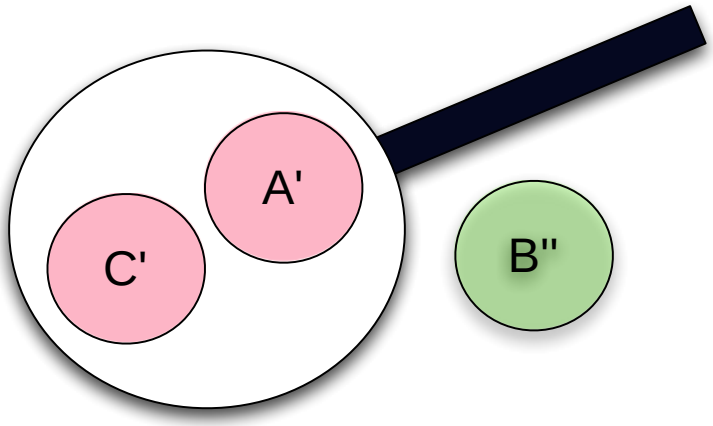
- First 5 minutes
  - 2 half cooking
  - 1 uncooked
- Second 5 minutes
  - 2 half cooking
  - 1 almost cooked

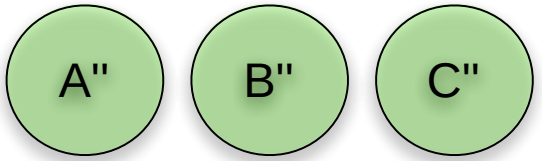




Step 1: Solve an instance
Three pancakes in a two-cake pan

- Third 5 minutes
  - 1 done
  - 2 almost cooked
- How many minutes to cook all three pancakes?





Step 1: Solve an instance

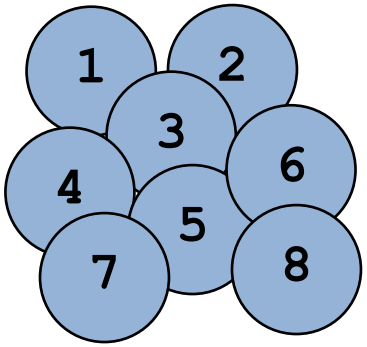
- What kind of instances? Simple cases that are quickly solved
  - What are these in Pancake problem?

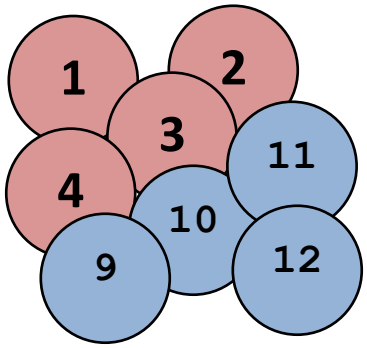
- Don't solve for N, solve for 5 (generalize is step 3)
  - What do when there are two parameters?
    - Fix one, vary the other one
  - Helps identify cases

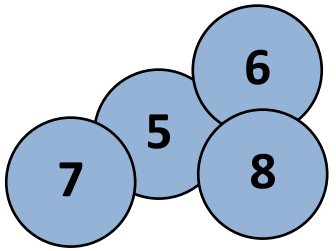
Step 1: Solve an instance

- Pan has capacity 8, vary # pancakes
  - Can you cook 12 in 15 minutes? Why?
  - Can you cook 13 in 15 minutes? Why?

cakes	5	6	7	8	9	10	11	12	13	14	15	16	17	18
time	10	10	10	10	?									







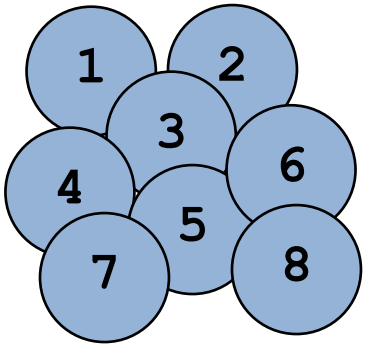
Step 2: What did we just do?

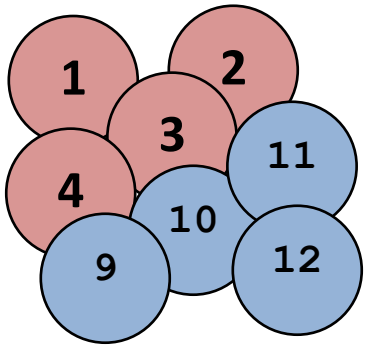
- 13 – 8 = 5
- 8/2 = 4 # Can only take off up to half
- Is 5 <= 4?
  - No, warmer trick won't work
- 10 minutes for 8 pancakes + 10 minutes for 5 more pancakes = 20 minutes

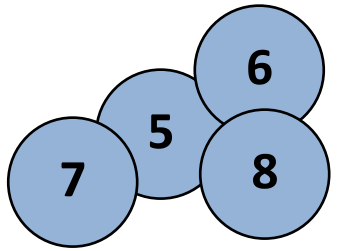
Step 1: Solve an instance

- Pan capacity 8, vary # pancakes, 17 pancakes?

cakes	5	6	7	8	9	10	11	12	13	14	15	16	17	18
time	10	10	10	10	15	15	15	15	20	20	20	20		







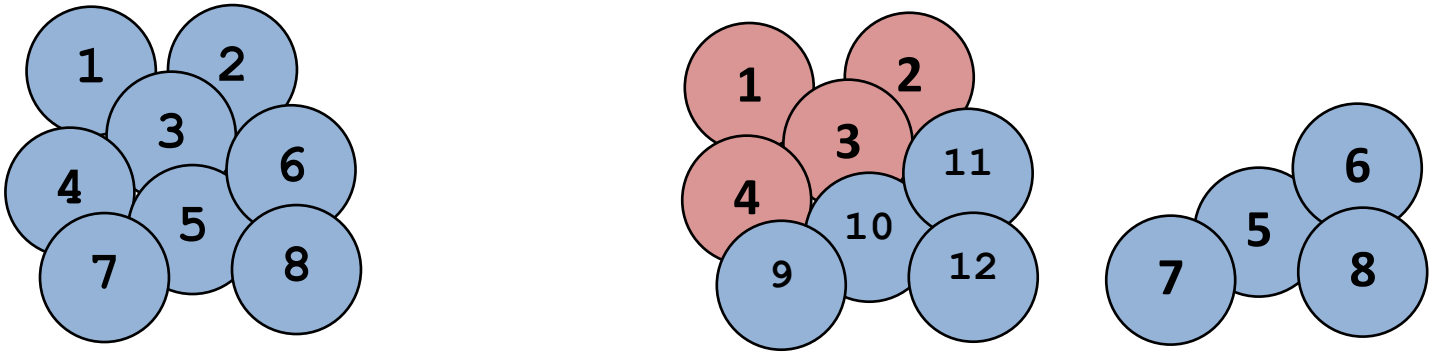
Step 2: What did we just do?

- 17 – 8 = 9, 9 – 8 = 1
- 8/2 = 4
- Is 1 <= 4? # Yes, warmer trick will work!
- Total: 25 minutes
  - 10 minutes for 8 pancakes +
  - 5 minutes for 8 pancakes +
  - Take 1 out, start 17th pancake
  - 5 minutes finish pancakes 8 to 15 +
  - 5 minutes finish pancake 16 and 17

Step 3: Generalize

- Pan has capacity 8, Generalize to algorithm?

cakes	5	6	7	8	9	10	11	12	13	14	15	16	17	18
time	10	10	10	10	15	15	15	15	20	20	20	20	25	25



Step 3: Generalize

- 13 – 8 = 5
- 8/2 = 4
- Is 5 <= 4?
  - No, warmer trick won't work
- 10 minutes for 8 pancakes + 10 minutes for 5 more pancakes = 20 minutes

- Remove as many as can with panCapacity
- Will the remainder fit in half the pan?
- Yes, use warmer
  - 5 minutes instead of 10 for last batch
- No, don't use warmer
  - 10 minutes for all sets of panCapacity

Step 4: Test Steps

- Remove as many as can with panCapacity
- Will the remainder fit in half the pan?
- Yes, use warmer
  - 5 minutes instead of 10 for last batch
- No, don’t use warmer
  - 10 minutes for all sets of panCapacity

- Case 1:
  - cap 17, cook 34

Step 4: Test Steps

- Remove as many as can with panCapacity
- Will the remainder fit in half the pan?
- Yes, use warmer
  - 5 minutes instead of 10 for last batch
- No, don't use warmer
  - 10 minutes for all sets of panCapacity

- Case 1:
  - cap 17, cook 34
  - remainder = 0
  - Edge case! No need for warmer
  - Total: 20 minutes
- Case 2:
  - cap 17, cook 42

Step 4: Test Steps

- Remove as many as can with panCapacity
- Will the remainder fit in half the pan?
- Yes, use warmer
  - 5 minutes instead of 10 for last batch
- No, don't use warmer
  - 10 minutes for all sets of panCapacity

- Case 1:
  - cap 17, cook 34
  - remainder = 0
  - Edge case! No need for warmer
  - Total: 20 minutes
- Case 2:
  - cap 17, cook 42
  - remainder = 8
  - Yes, use warmer
  - Total: 25 minutes

Step 5: Code

- Remove as many as can with panCapacity
- Will the remainder fit in half the pan?
- Yes, use warmer
  - 5 minutes instead of 10 for last batch
- No, don't use warmer
  - 10 minutes for all sets of panCapacity

- N pancakes
- How many panCapacity can remove?
  - N // panCapacity
- remainder
  - N % panCapacity
- Half of pan?
  - panCapacity / 2

In Summary

- When it comes to planning the algorithm (Steps 1-4) and coding (Step 5), each part can be easy or hard

```
7   def minutesNeeded(numCakes, capacity):
8       full = numCakes // capacity
9       left = numCakes % capacity
10      minutes = 10 * full
11      if left > capacity/2:
12          minutes += 10
13      elif left > 0:
14          minutes += 5
15      return minutes
```

What are the next steps?

6: Testing!
7: Debugging

Why > and not >=?

Why Solve This? In Python?

- https://en.wikipedia.org/wiki/Collatz_conjecture
- 3n+1 sequence
  - Start with n
  - Next number:
    - n/2 →n is even
    - 3n+1 →n is odd
  - End sequence when n==1

- How many numbers are generated before it reaches 1?

- Mathematics is foundational in computer science, but
  - Not everyone enjoys logic/math puzzles, but …

Developing and Reasoning about While Loops

- Don't know: *how many times* loop executes
  - we'll know after finishes

- Do know: condition that should be true to enter/repeat (**BOOL_CONDITION-loop guard)**
  - When `BOOL_CONDITION NOT TRUE`→`ends`

```
while BOOL_CONDITION:
    LOOP_BODY
    # modify variables, affect expression
```

History: From while to for loops

while loop (sum list)

```
lst = [4,1,8,9]
s = 0
i = 0
while i < len(lst):
    s += lst[i]
    i += 1
print(s)
```

for loop (sum list)

```
lst = [4,1,8,9]
s = 0
for n in lst:
    s += n
print(s)
```

Concrete Example: Collatz

- Don't know: *how many times* loop executes
  - some numbers: long sequences, others short

- Do know: condition that should be true to enter/repeat (**BOOL_CONDITION-loop guard)**
  - What is true after loop below finishes?

```
while value != 1:
    loop body
    # modify value somehow
```

Activity 2: Collatz and While
https://bit.ly/101f21-09-30-2

Parallel Lists

- Case Study: FileFrequency.py

- We'd like to analyze word occurrences
  - Google N-Gram, it's easy to do, but …
  - What about Rotten Tomatoes?

- This code is built using the tools that we have
  - In the future, learn of more efficient structures
- We'll use an API for opening files

High Level View

- We will use parallel lists to track data
  - Each word is stored in a list named **`words`**
  - Word's count is stored in a list named **`counts`**
  - # occurrences of **`words[k]`** is in **`counts[k]`**

```
["apple", "fox", "vacuum", "lime"]
[5,2,25,15]
```

- What happens when we read a word?

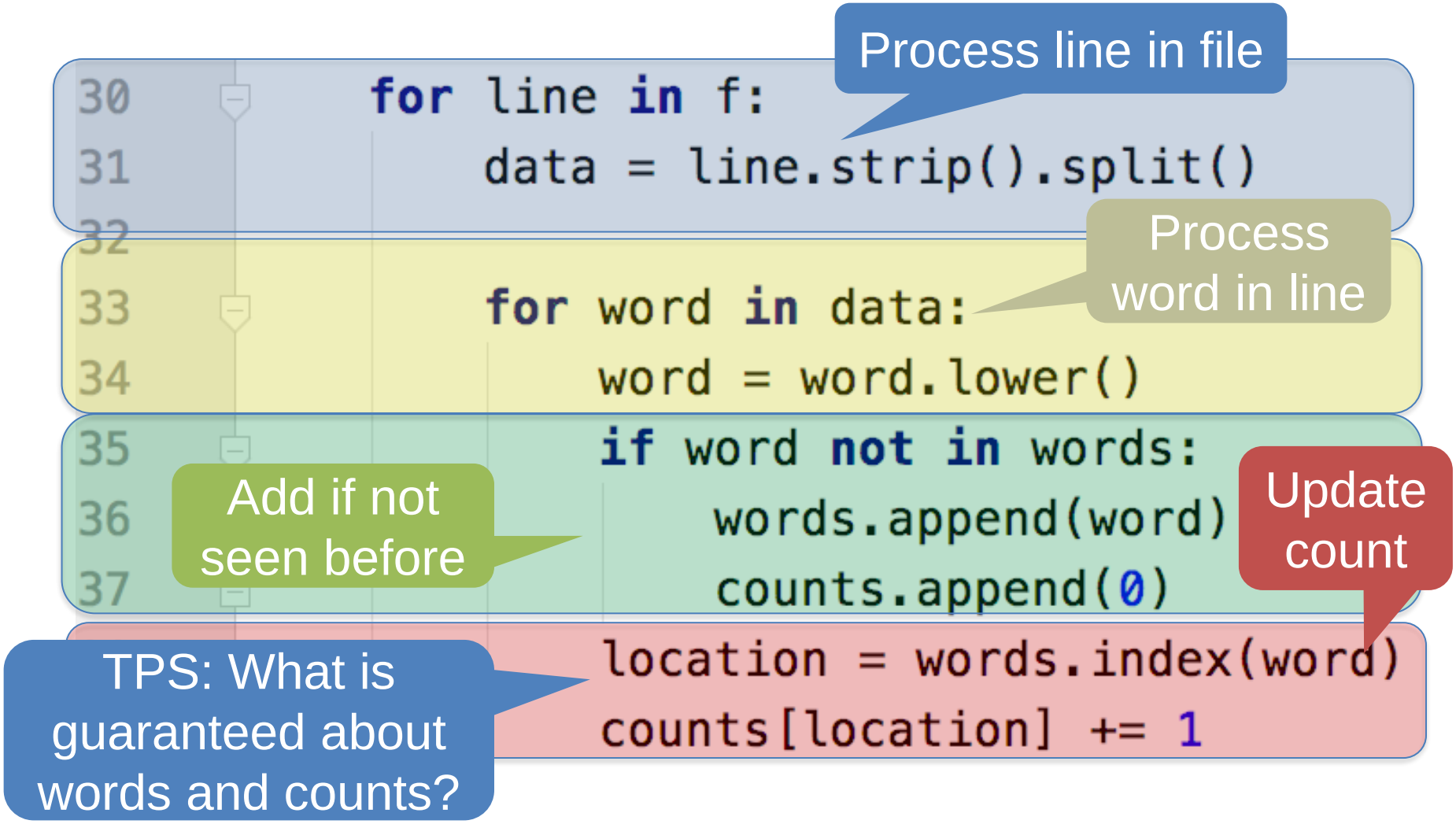
Pseudo-code for getFileData

- Let user choose a file to open
- Read each line of the file
  - Process each word on the line
    - If word never seen before? Add to words and counts
    - Update # occurrences using .index and location

Step 3 of 7 steps: Generalize

- TPS: What would we do for each color when doing step 5 (translate to code) of the 7 steps?

From Pseudo to Code



Comparing Two Approaches

- Why do we have a loop in a loop?
  - Code mirrors structure:
    - file has lines, lines have words
- Notice:
  - `.strip`
  - `.split`
  - `.lower`
  - `not in`
  - `.append`
  - `.index`
  - `+=`

Outer loop

Inner loop

```
for line in f:
    data = line.strip().split()

    for word in data:
        word = word.lower()
        if word not in words:
            words.append(word)
            counts.append(0)
        location = words.index(word)
        counts[location] += 1
```

Comparing Two Approaches

- Why do we have only one loop?
  - Code mirrors structure, which is better?
  - File is a sequence of characters!!

```
for word in f.read().lower().split():
    if word not in words:
        words.append(word)
        counts.append(0)
    location = words.index(word)
    counts[location] += 1
```

Activity 3: File Frequency
https://bit.ly/101f21-09-30-3

Reminders

- Work smarter, not harder
- Design first
- Try to identify where you are stuck
  - Identify resources to help solve problem
- Leverage your design and PythonTutor to understand program flow of control
  - http://pythontutor.com