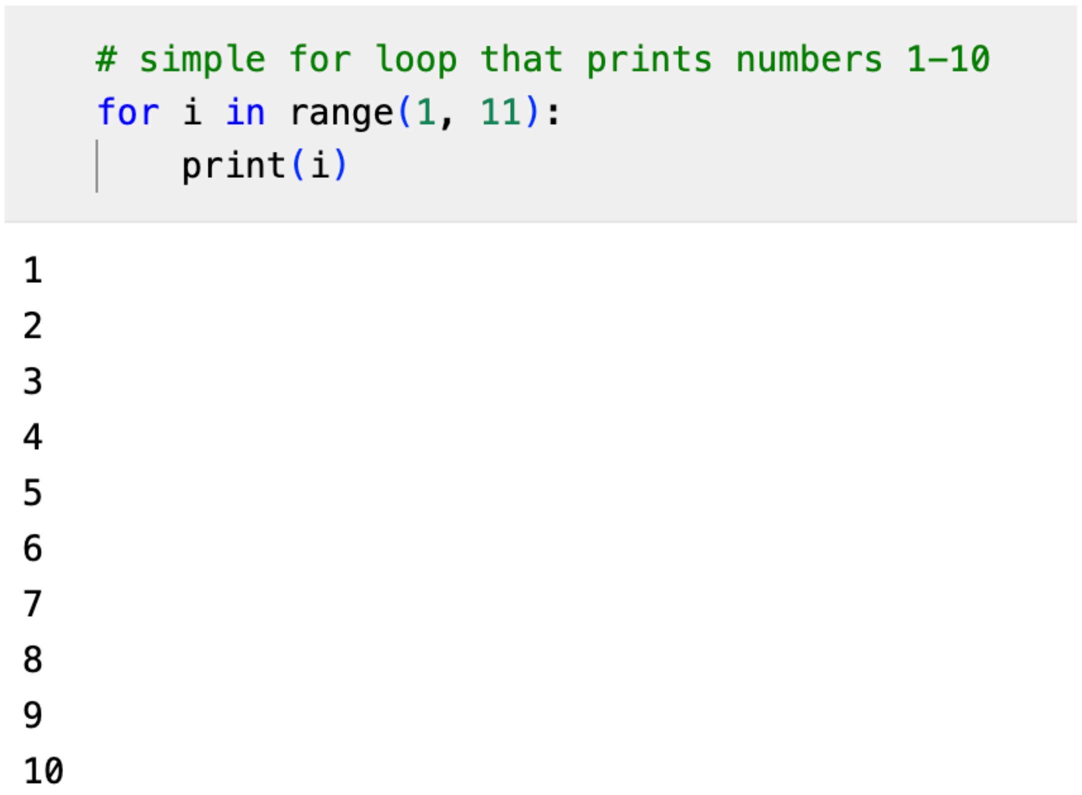
CS134:
Nested Lists & Comprehensions

Announcements & Logistics

- **Homework 4** is out on GLOW, due Monday at 10 pm
- **Lab 4** will be released today: has two parts!
    - Part 1 is due Wed/Thur (Oct 5/6) at 10 pm
    - Part 2 is due the following Wed/Thur (Oct 12/13) at 10 pm (after reading days!)
- **Final exam**: **Friday Dec 16 at 9:30 am**
- **Midterm exam**: **Thur Oct 20** evening exam (more details forthcoming regarding format)
    - Time Option 1: **6 pm - 7:30 pm in Wege (TCL 123)**
    - Time Option 2: **8 pm - 9:30 pm in Wege (TCL 123)**
    - TCL 206 for reduced distractions/extra time
    - Let us know asap if you have any class conflicts or need additional accommodations
    - Extra time accommodations should plan to start at 6pm if possible

Last Time

- Discussed **file reading** using lists and strings
  - Used string methods `.strip(), .split()`
  - Used list methods `.append(), .extend(), .count()`
- Learned about **ranges** (another sequence in Python)



```python
# simple for loop that prints numbers 1-10
for i in range(1, 11):
    print(i)
```

```
1
2
3
4
5
6
7
8
9
10
```

Today's Plan

- Learn about **list comprehensions** as a way to simplify list accumulations
    - Leads to simpler, more succinct code
- Begin exploring **lists of lists**
- Use our knowledge about lists and loops to analyze interesting properties of our student data
    - Help prepare for Lab 4

List Comprehensions

List Patterns: Map & Filter

- When using lists and loops, there are common patterns that appear
- **Mapping:** Iterate over a list and return a new list that results from ***performing an operation on each element*** of original list
    - E.g., take a list of integers `numList` and return a new list which contains the square of each number in `numList`
- **Filtering:** Iterate over a list and return a new list that results from ***keeping only elements of the original list that satisfy some condition***
    - E.g., take a list of integers `numList` and return a new list which contains only the even numbers in `numList`
- Python allows us to implement these patterns succinctly using **list comprehensions**

List Comprehensions

Mapping List Comprehension (perform operation on each element)

```
newList = [expression for item in sequence]
```

Filtering List Comprehension (only keep some elements)

```
newList = [item for item in sequence if conditional]
```

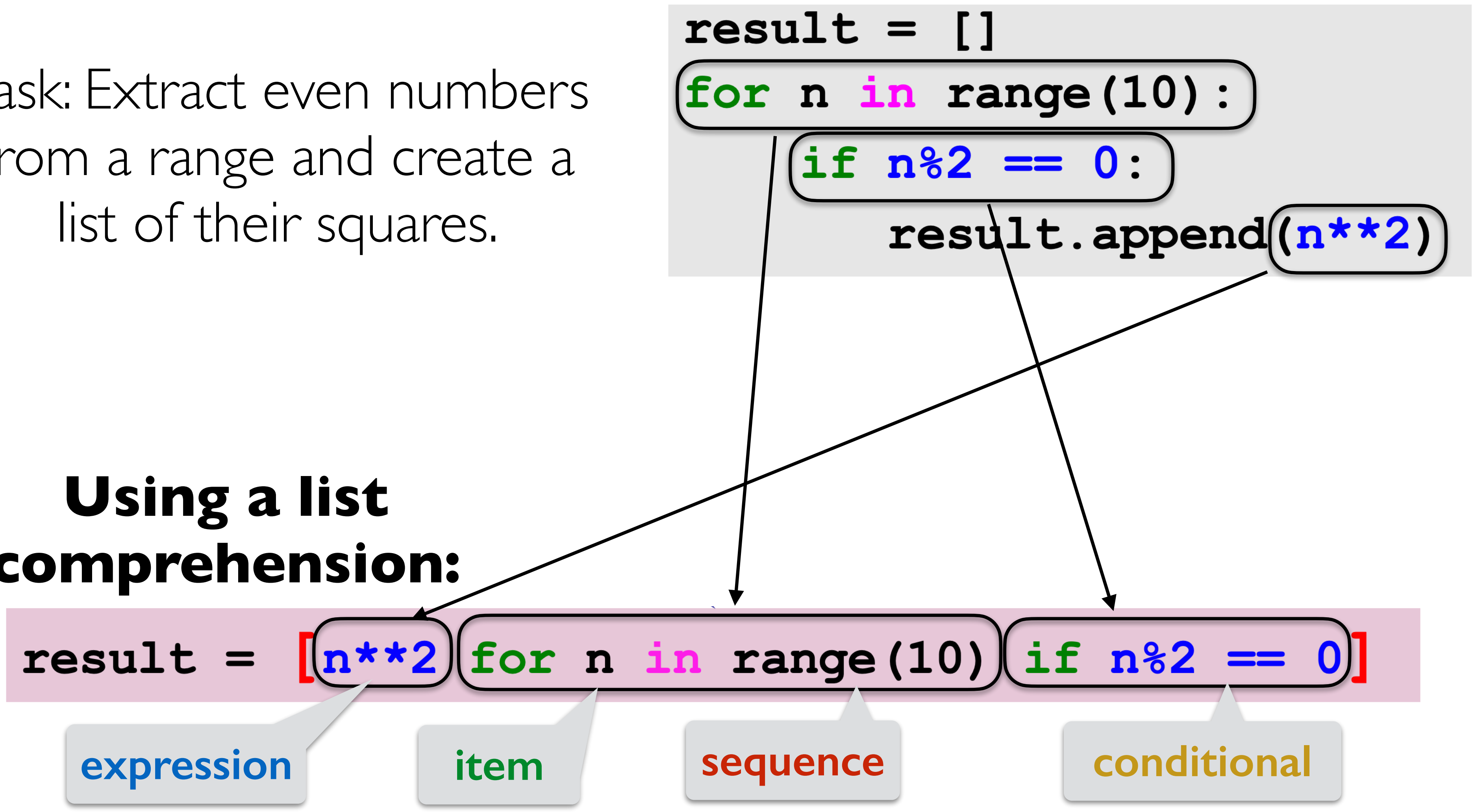
- Important points:
  - List comprehensions always start with an **expression** (even a variable name like "item" is an expression!)
  - We **never use append( )** inside of list comprehensions
  - We can **combine mapping and filtering** into a single list comprehension:

```
newList = [expression for item in sequence if conditional]
```

Dissecting List Comprehensions

```
newList = [expression for item in sequence if conditional]
```

Task: Extract even numbers from a range and create a list of their squares.



```
result = []
for n in range(10):
    if n%2 == 0:
        result.append(n**2)
```

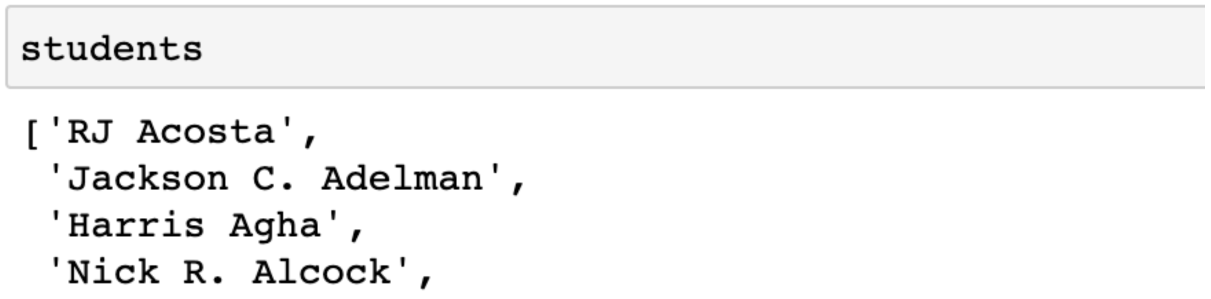
Using a list comprehension:

```
result = [n**2 for n in range(10) if n%2 == 0]
```

All list comprehensions can be rewritten using a for loop!

Using List Comprehensions

- **List comprehensions** are convenient when working with files
- Recall our list of student names from before



```
students
```

```
['RJ Acosta',
 'Jackson C. Adelman',
 'Harris Agha',
 'Nick R. Alcock',
```

- Example: How can we find the list of student names that begin with a vowel? (Hint: we'll use our `isVowel()` function again)
  - Idea:
    - Iterate over students (list of strings)
    - For each name in list, check if first letter is a vowel
    - If it is, add name to result list

Using List Comprehensions

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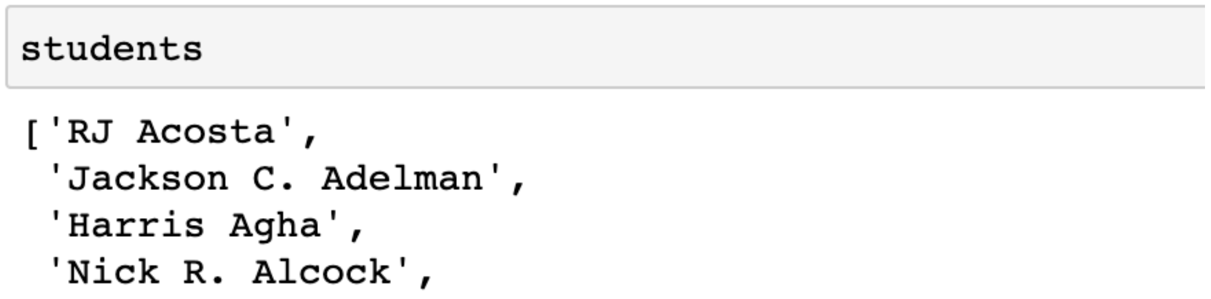

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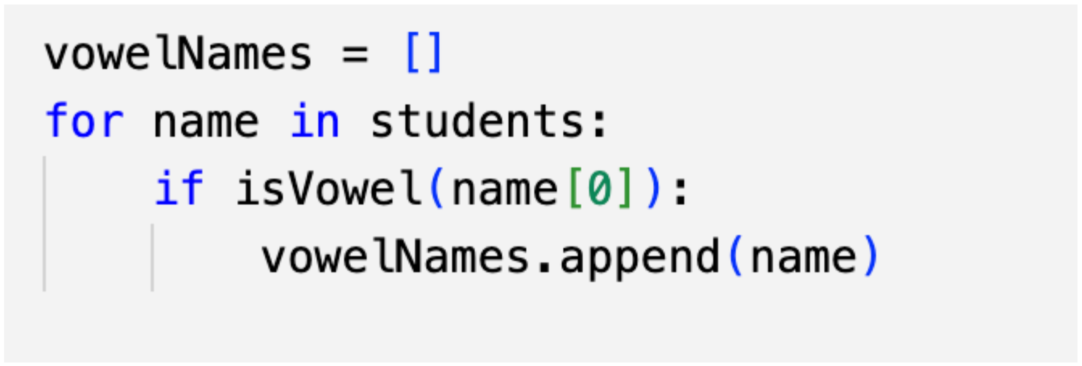

```
vowelNames = []
for name in students:
    if isVowel(name[0]):
        vowelNames.append(name)
```

Using List Comprehensions

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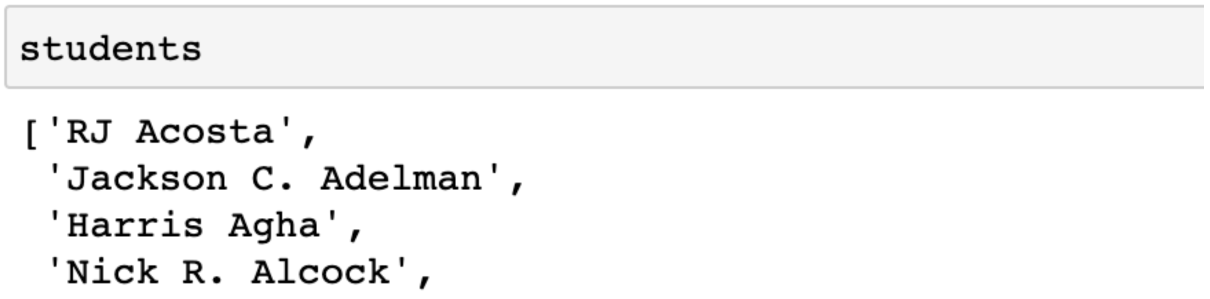

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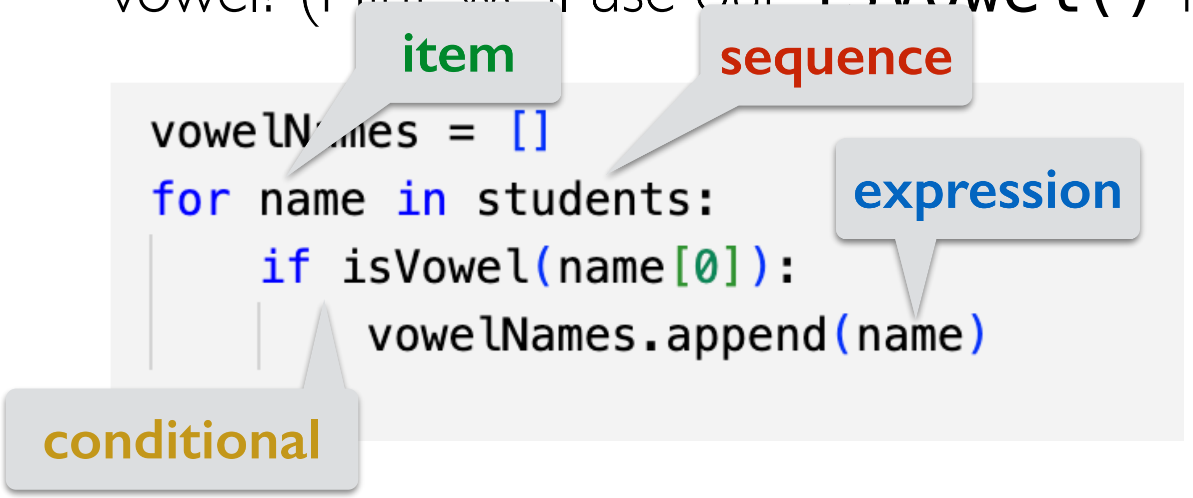

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students
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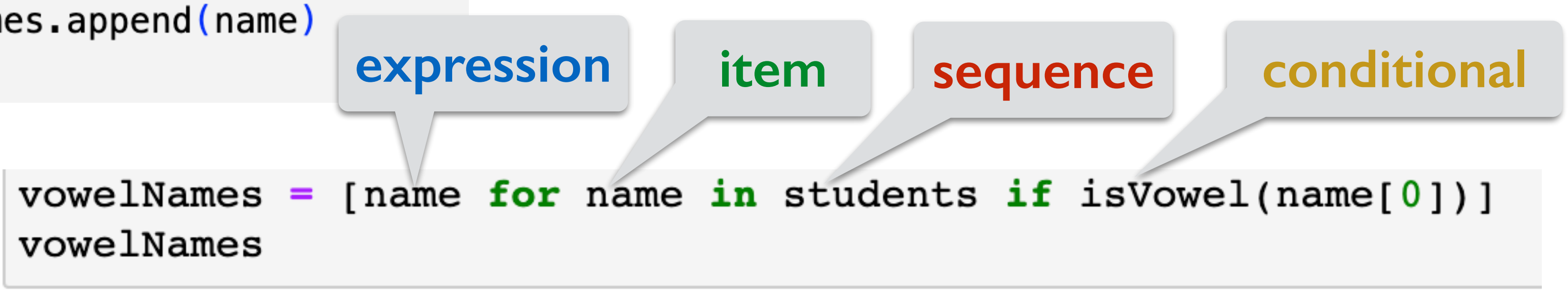

```
vowelNames = [name for name in students if isVowel(name[0])]
vowelNames
```

Using List Comprehensions

- **List comprehensions** are convenient when working with files
- Recall our list of student names from before

```
students
```

```
['RJ Acosta',
 'Jackson C. Adelman',
 'Harris Agha',
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```

- Example: How can we find the list of student names that begin with a vowel? (Hint: we'll use our `isVowel()` function again)

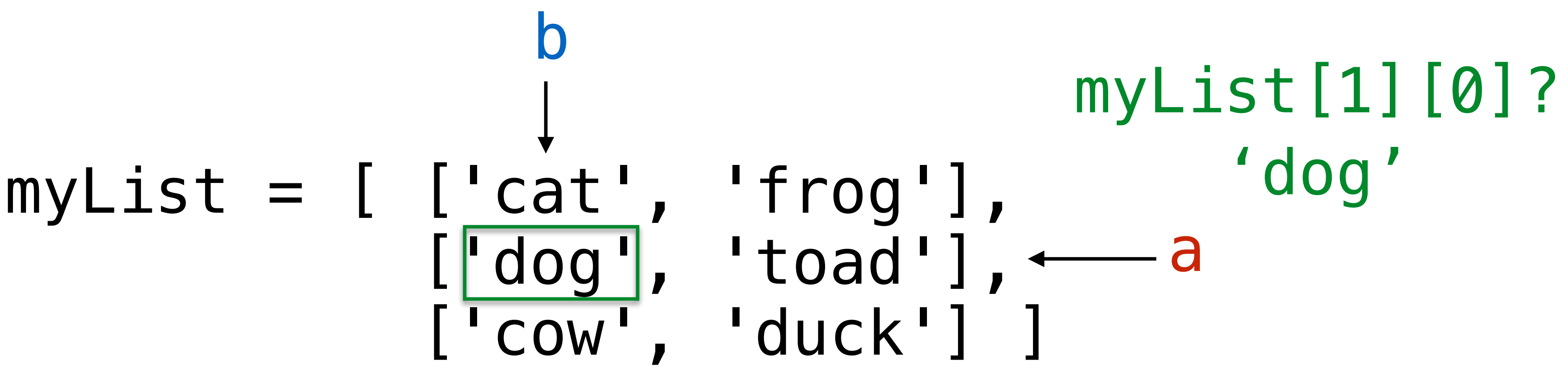
```
vowelNames = [name for name in students if isVowel(name[0])]
vowelNames
```

```
['Emir C. Atli',
 'Anjali K. Bhatia',
 'Alex W. Choi',
 'Ethan Cooper',
 'Edith N. Edwards-Mizel',
 'Amir H. Estejab',
 'Arden N. Fluehr',
```

Lists of Lists

Lists of Lists!

- We have already seen lists of strings
- We can also have **lists of lists** (sometimes called a two-dimensional list)!
- Often arise when using list comprehensions
- Suppose we have a **list of lists of strings** called `myList`
- `word = myList[a][b] (# word is a string)`
    - `a` is index into "***outer***" list (identifies ***which inner list*** we want)
    - `b` is index into "***inner***" list (identifies ***which element*** within the inner list)



```
myList = [ ['cat', 'frog'],
           ['dog', 'toad'],
           ['cow', 'duck'] ]
```

We Don’t Talk About ~~Bruno~~ Data Types

- Python is a loosely typed programming language
  - We don’t explicitly declare data types of variables
  - But like Bruno, the creepy uncle in *Encanto* who lurks behind the walls and predicts the future, data types are always there
  - It’s important to make sure we pay attention to what a function expects, especially with lists and strings! (remember this in Lab 4)
- **Lists of lists of strings** versus **list of strings**:

```
myList = [ ['cat', 'frog'],
           ['dog', 'toad'],
           ['cow', 'duck'] ]
```

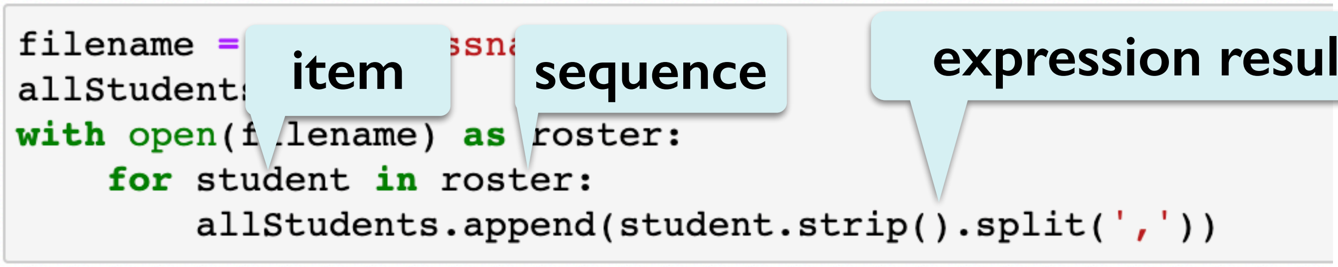
```
myList = ['cat’, 'frog',
          'dog’, 'toad',
          'cow’, 'duck']
```

```
myList[1][0] is 'dog'
```

```
myList[1][0] is 'f'
```

Lists of Lists and Comprehensions

- Suppose we want to create a list of lists of strings using our student data



```
filename =          ssna
allStudent
with open(f lename) as roster:
    for student in roster:
        allStudents.append(student.strip().split(','))
```

item

sequence

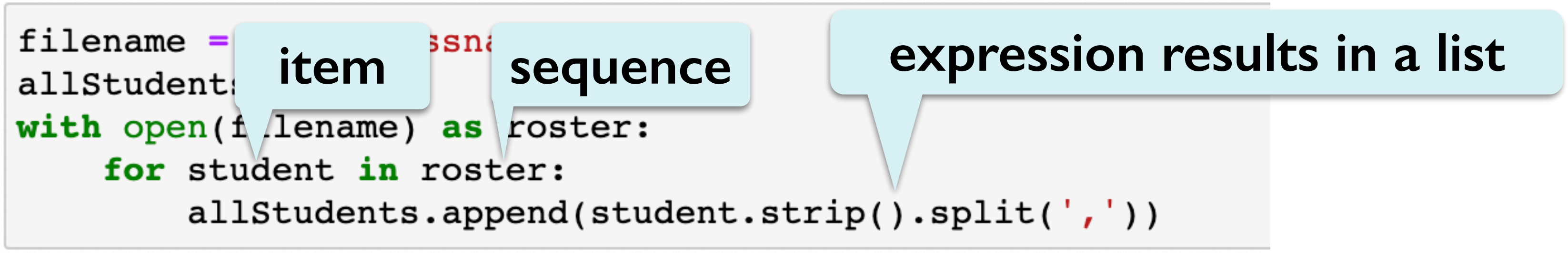
expression results in a list

```
Acosta,RJ,26,rja3
Agha,Harris,25,hha1
Alcock,Nick R.,25,nra2
Atli,Emir C.,26,eca2
Chang,Daniel Y.,25,dyc1
Durham,Keelan S.,25,ksd2
Felten,Timothy E.,26,tef2
Gwilt,Kyle E.,25,kg15
Hartman,Sarah A.,25,sah4
Howard-Sarin,Brij C.,26,bch6
Jiang,Weiran,26,wj4
Joy,Matt L.,26,mlj2
Keyes,Mikey A.,26,mak5
Kubomiya,Reona,26,rk20
Lee,Gabe,26,gjl1
Lee,Yuri J.,26,yjl1
Nguyen,Trung Nguyen T.,26,ttn2
```

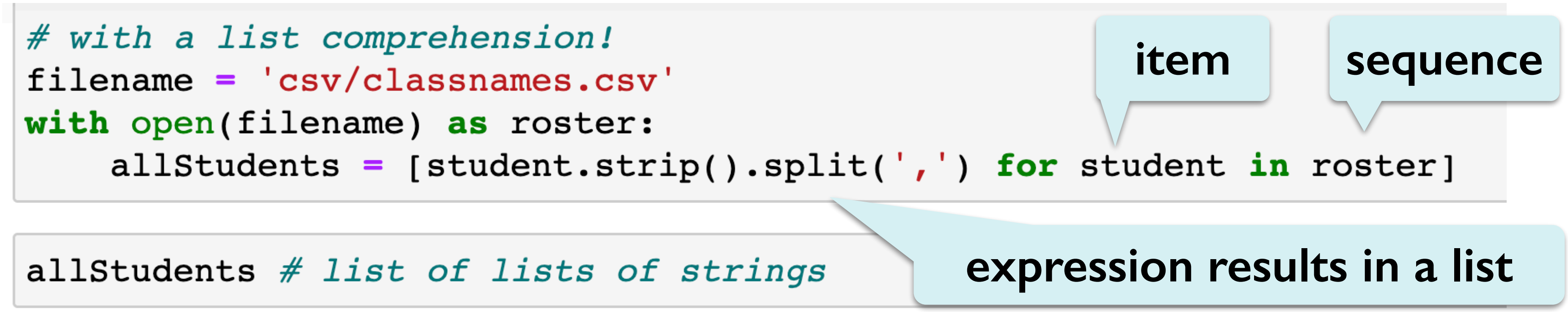
classnames.csv

Lists of Lists and Comprehensions

- Suppose we want to create a list of lists of strings using our student data



```
filename =           ssna
allStudent
with open(f lename) as roster:
    for student in roster:
        allStudents.append(student.strip().split(','))
```



```
# with a list comprehension!
filename = 'csv/classnames.csv'
with open(filename) as roster:
    allStudents = [student.strip().split(',') for student in roster]
```

```
allStudents # list of lists of strings
```

```
[['Acosta', 'RJ', '26', 'rja3'],
 ['Agha', 'Harris', '25', 'hha1'],
 ['Alcock', 'Nick R.', '25', 'nra2'],
 ['Atli', 'Emir C.', '26', 'eca2'],
 ['Chang', 'Daniel Y.', '25', 'dyc1'],
 ['Durham', 'Keelan S.', '25', 'ksd2'],
 ['Felten', 'Timothy E.', '26', 'tef2'],
 ['Gwilt', 'Kyle E.', '25', 'kg15'],
 ['Hartman', 'Sarah A.', '25', 'sah4'],
```

```
Acosta,RJ,26,rja3
Agha,Harris,25,hha1
Alcock,Nick R.,25,nra2
Atli,Emir C.,26,eca2
Chang,Daniel Y.,25,dyc1
Durham,Keelan S.,25,ksd2
Felten,Timothy E.,26,tef2
Gwilt,Kyle E.,25,kg15
```

classnames.csv

list of lists of strings

More List Comprehensions

```
allStudents:  [['Acosta', 'RJ', '26', 'rja3'],
               ['Agha', 'Harris', '25', 'hha1'],
               ['Alcock', 'Nick R.', '25', 'nra2'],
```

- Generate list of only last names using allStudents

```
# generate list of only student last names
lastNames = [s[0] for s in allStudents]
lastNames
```

```
['Acosta',
 'Agha',
 'Alcock',
 'Atli',
 'Chang',
```

- Generate list of only first names

```
# List comprehension to generate a list of first names
# (without middle initial)
firstNames = [s[1].split()[0] for s in allStudents]
firstNames
```

```
['RJ',
 'Harris',
 'Nick',
 'Emir',
 'Daniel',
```

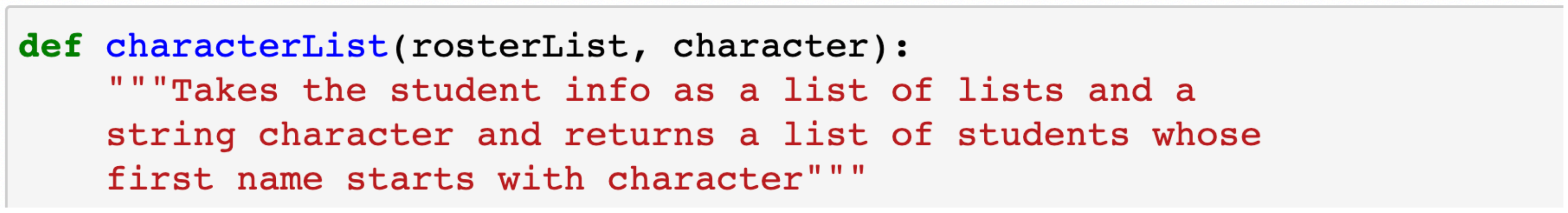
split() first name, return first element
(effectively removes middle initial)

Exercise:
Student Fun Facts

Exercise: Student Fun Facts!

- Write a function `characterList` which takes in two arguments `rosterList` (list of lists of strings) and `character` (a string) and returns the list of students in the class whose first name starts with character.

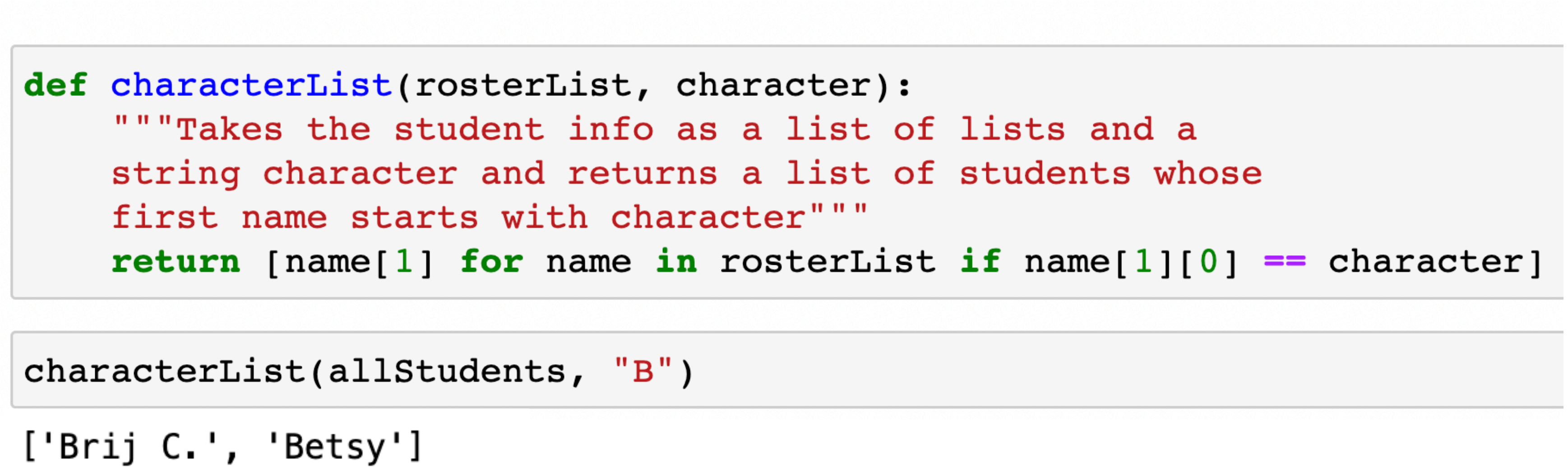
- Can we do this with a list comprehension?



```python
def characterList(rosterList, character):
    """Takes the student info as a list of lists and a
    string character and returns a list of students whose
    first name starts with character"""
```

Exercise: Student Fun Facts!

- Write a function `characterList` which takes in two arguments `rosterList` (list of lists of strings) and `character` (a string) and returns the list of students in the class whose first name starts with character.
- Can we do this with a list comprehension?



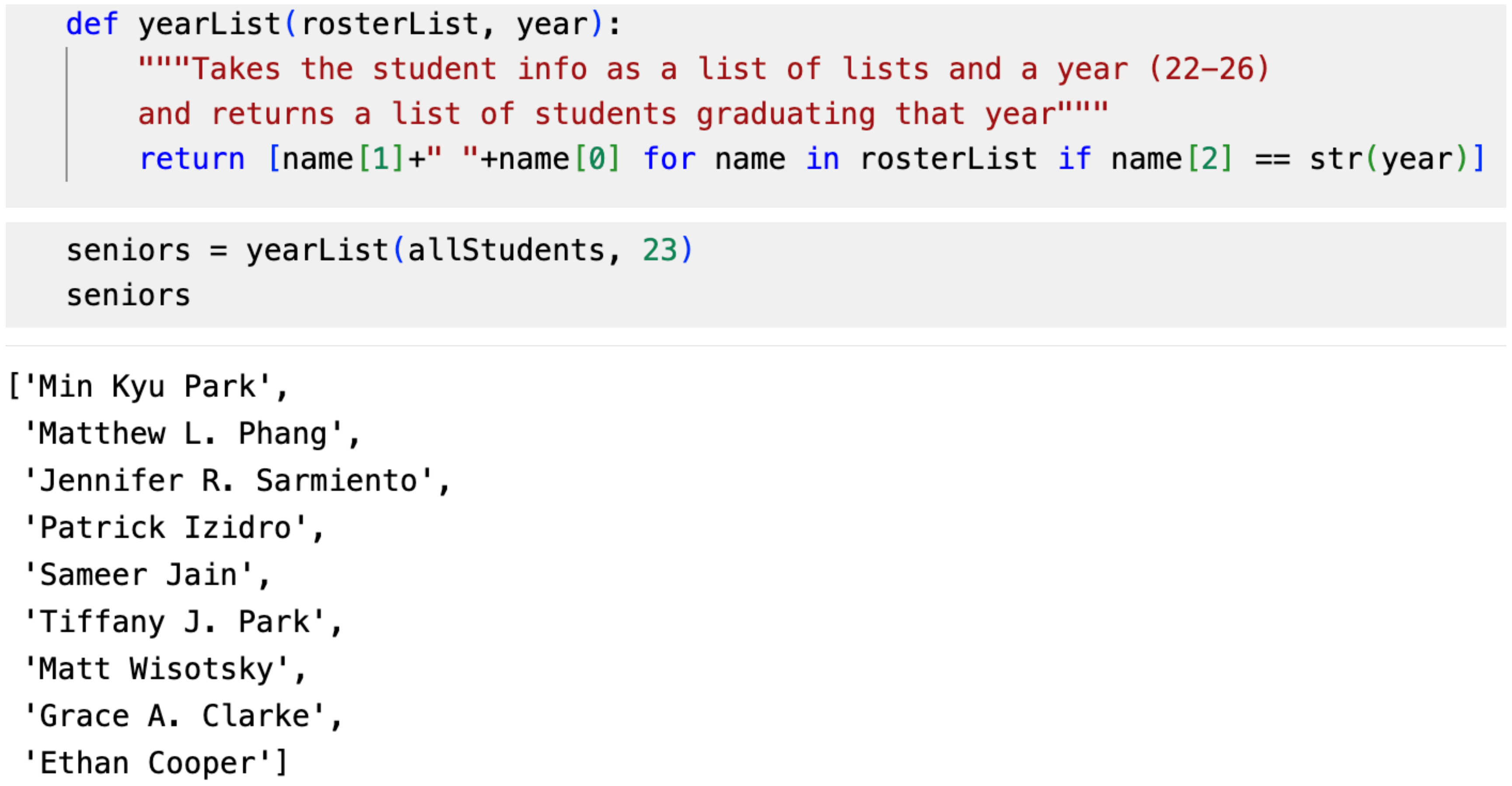
```
def characterList(rosterList, character):
    """Takes the student info as a list of lists and a
    string character and returns a list of students whose
    first name starts with character"""
    return [name[1] for name in rosterList if name[1][0] == character]
```

```
characterList(allStudents, "B")
```

```
['Brij C.', 'Betsy']
```

Exercise: Student Fun Facts!

- Write a function **`yearList`** which takes in two arguments, **`rosterList`** (**`list`** of **`lists`** of **`strings`**) and **`year`** (**`int`**) and returns the **`list`** of students in the class with that graduating year



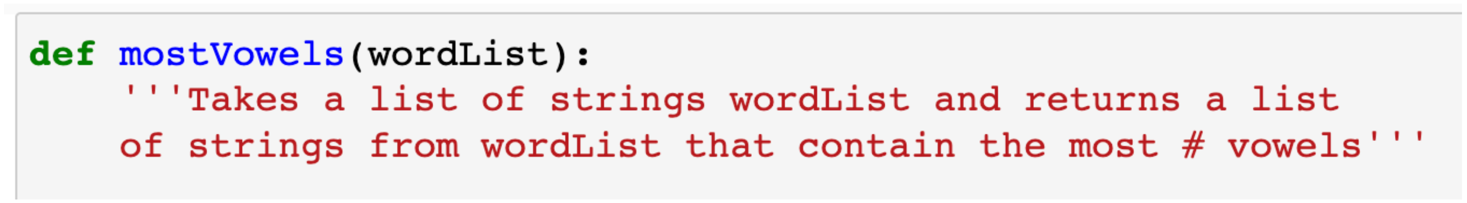
```python
def yearList(rosterList, year):
    """Takes the student info as a list of lists and a year (22-26)
    and returns a list of students graduating that year"""
    return [name[1]+" "+name[0] for name in rosterList if name[2] == str(year)]
```

```python
seniors = yearList(allStudents, 23)
seniors
```

```
['Min Kyu Park',
 'Matthew L. Phang',
 'Jennifer R. Sarmiento',
 'Patrick Izidro',
 'Sameer Jain',
 'Tiffany J. Park',
 'Matt Wisotsky',
 'Grace A. Clarke',
 'Ethan Cooper']
```

Exercise: Student Fun Facts!

- Write a function **`mostVowels`** that can be used to compute the list of students with the most vowels in their first name. (Hint: use `countVowels()`.)

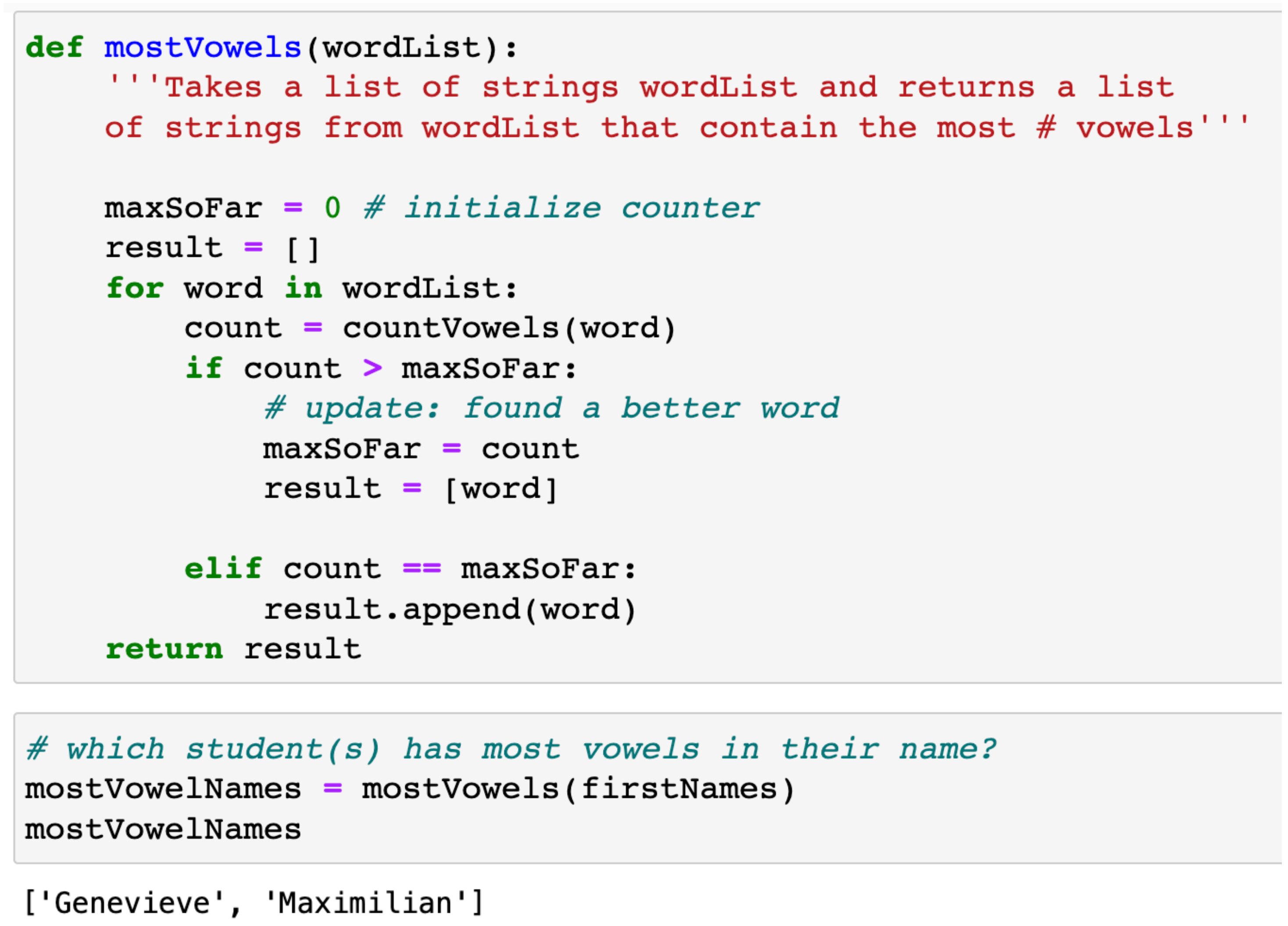


```
def mostVowels(wordList):
    '''Takes a list of strings wordList and returns a list
    of strings from wordList that contain the most # vowels'''
```

- General strategy for finding max in list of lists?
  - Initialize a max value BEFORE the loop to a very small number
  - If you see a value bigger than max, update max

Exercise: Student Fun Facts!

- Write a function `mostVowels` that can be used to compute the list of students with the most vowels in their first name. (Hint: use `countVowels()`.)



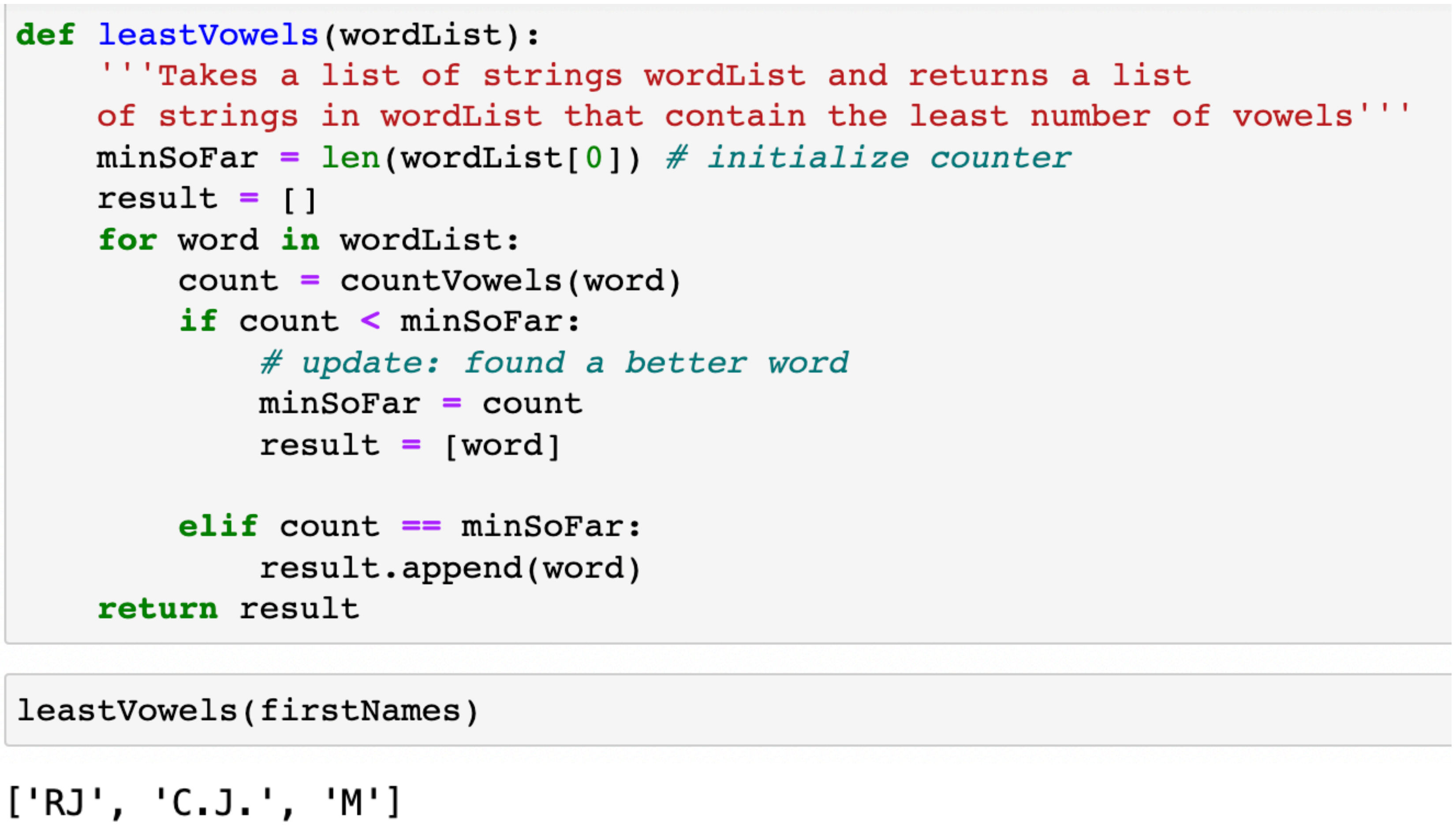
```python
def mostVowels(wordList):
    '''Takes a list of strings wordList and returns a list
    of strings from wordList that contain the most # vowels'''

    maxSoFar = 0 # initialize counter
    result = []
    for word in wordList:
        count = countVowels(word)
        if count > maxSoFar:
            # update: found a better word
            maxSoFar = count
            result = [word]

        elif count == maxSoFar:
            result.append(word)
    return result
```

```python
# which student(s) has most vowels in their name?
mostVowelNames = mostVowels(firstNames)
mostVowelNames
```

```
['Genevieve', 'Maximilian']
```

Exercise: Student Fun Facts!

- Write a function `leastVowels` that can be used to compute the list of students with the least vowels in their first name. (Hint: use `countVowels()`.)



```
def leastVowels(wordList):
    '''Takes a list of strings wordList and returns a list
    of strings in wordList that contain the least number of vowels'''
    minSoFar = len(wordList[0]) # initialize counter
    result = []
    for word in wordList:
        count = countVowels(word)
        if count < minSoFar:
            # update: found a better word
            minSoFar = count
            result = [word]

        elif count == minSoFar:
            result.append(word)
    return result
```

```
leastVowels(firstNames)
```

```
['RJ', 'C.J.', 'M']
```

The end!

CS134:
Nested Lists & Comprehensions