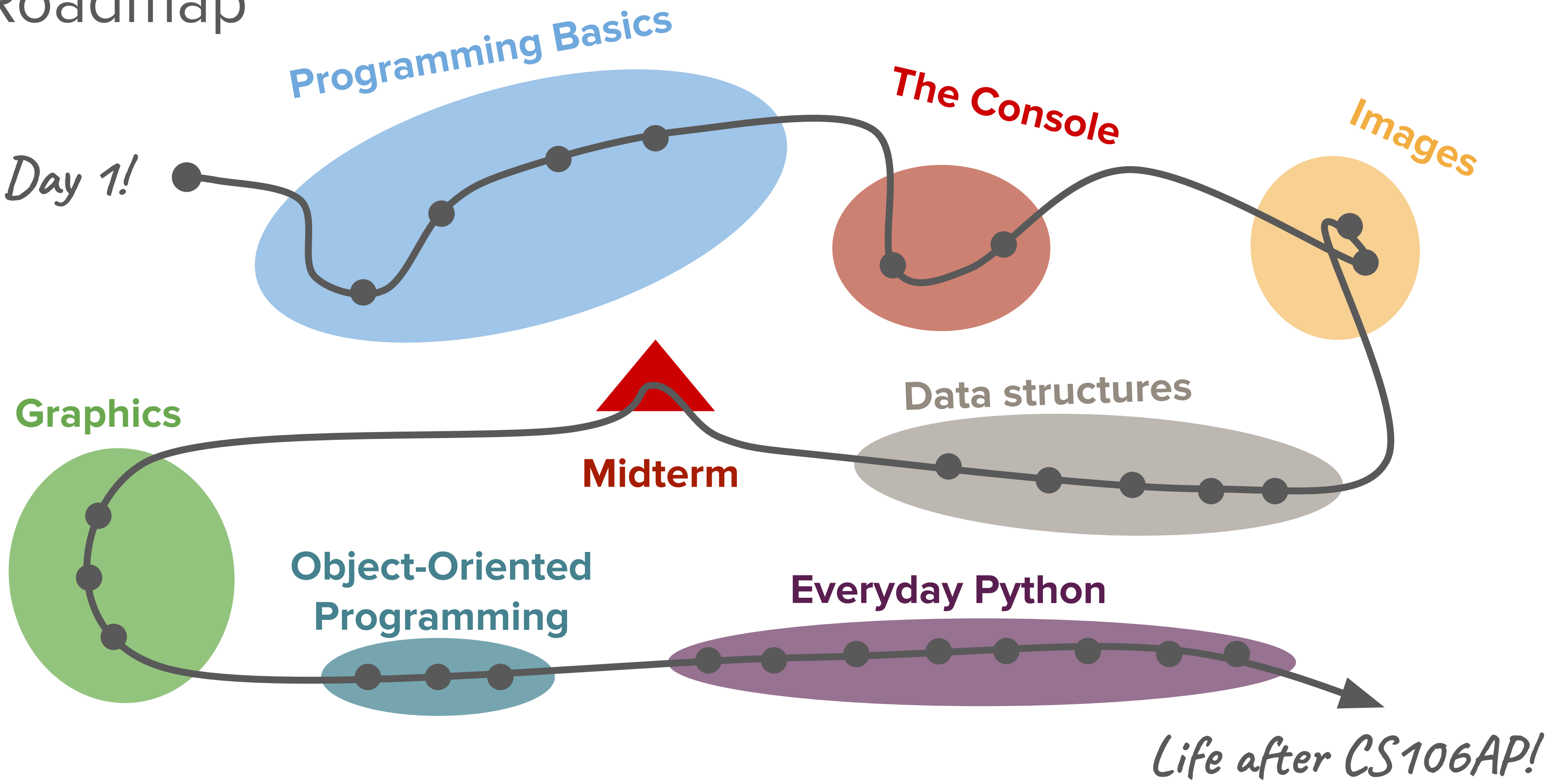
Lambdas and Custom Sort

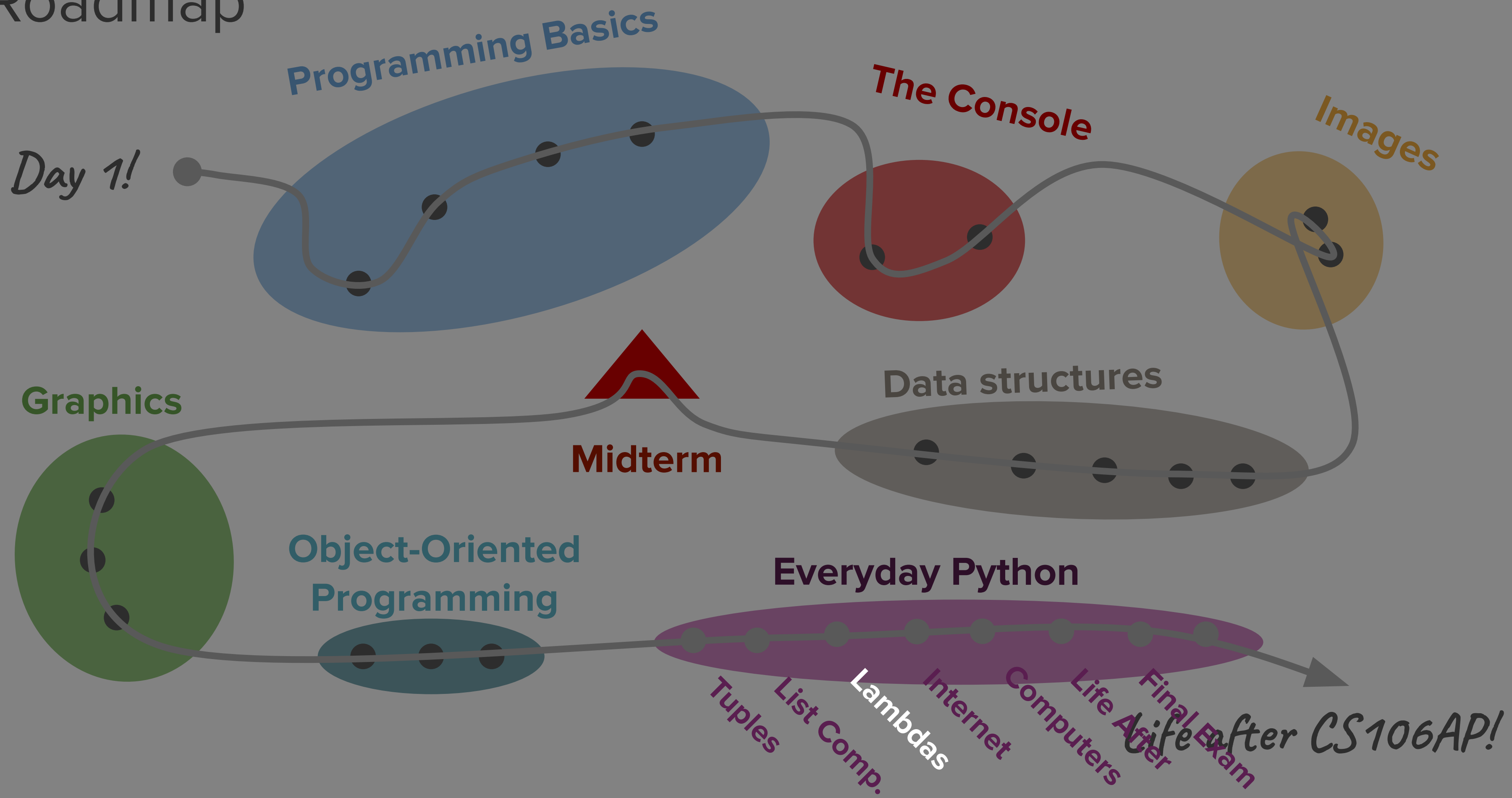
CS106AP Lecture 25

Roadmap



Day 1!
Programming Basics
The Console
Images
Data structures
Midterm
Graphics
Object-Oriented Programming
Everyday Python
Life after CS106AP!

Roadmap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Programming Basics
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Tuples
List Comp.
Lambdas
Internet
Computers
Life After
Final Exam
Life after CS106AP!

Today's questions

How can we write operations that help us better organize and process information inside data structures?

How can we visualize our data?

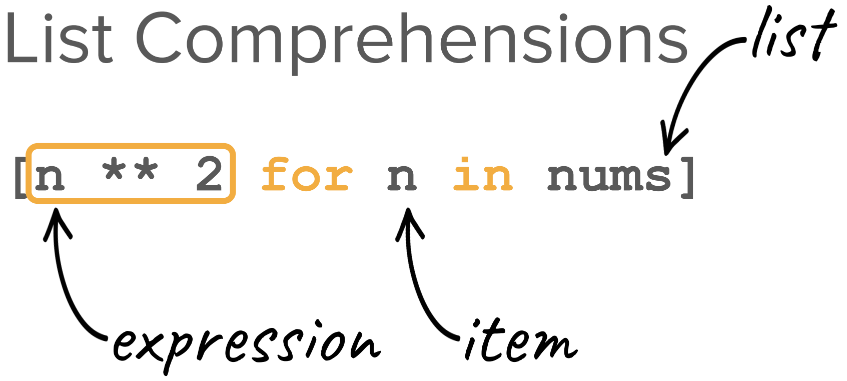
Today's topics

1. Review
2. Lambdas
    - Map, Filter
    - Sorted, Min, Max
3. Matplotlib
4. What's next?

Review

List Comprehensions

List Comprehensions



```
[n ** 2 for n in nums]
```

Definition

List Comprehension
A way to create a list based on existing lists

List Comprehensions

```
[n ** 2 for n in nums]
```

- Reuses syntax from other features:
  - `[]` to create new list
  - foreach loop over other list

Definition

List Comprehension
A way to create a list based on existing lists

Combining functions with list comprehensions

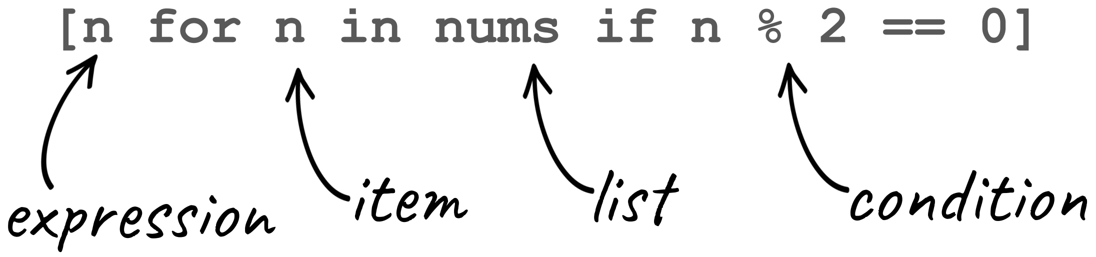
```
def name_case(s):
    return s[0].upper() + s[1:].lower()


strings = [‘SOnja’, ‘nicHOLAs’, ‘KYLiE’]
name_strings = [name_case(s) for s in strings]
```

you can call a function in the expression part of a list comp!

Conditions in list comprehensions

- You can add a condition for additional “filtering”

```
[expression for item in list if condition]
```



```
[n for n in nums if n % 2 == 0]
```

Why list comprehensions?

- They’re more concise
- They’re faster
- They’re Pythonic

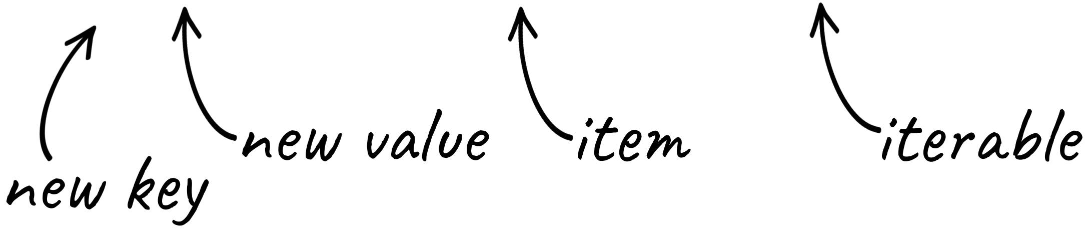
When to **not** use list comprehensions

- When you need more than one condition
- ~~When the expression is complex~~
  - Break it out into a separate function!

Dictionary Comprehensions

Dict Comprehensions

```
d = {‘a’: 1, ‘b’: 2, ‘c’: 3, ‘d’: 4}

flipped = {v:k for (k, v) in d.items()}
```



Dict Comprehensions

```
d = {‘a’: 1, ‘b’: 2, ‘c’: 3, ‘d’: 4}

flipped = {v:k for (k, v) in d.items()}
```

Two differences:

{ } instead of [ ]

key expression:val expression

Jupyter Notebooks

Jupyter Notebook

- Interactive “notebook” where you can run parts of code
  - Can develop code step-by-step
  - Great for data analysis
- Built on top of regular Python code

Jupyter Notebook Setup

```
$ python3 -m pip install jupyter
```

How can we write operations that help us better organize and process information inside data structures?

Recall: sorting lists with tuples

```
>>> fruit = [('mango', 3), ('apple', 6), ('lychee', 1), ('apricot', 10)]
>>> sorted(fruit)
[('apple', 6), ('apricot', 10), ('lychee', 1), ('mango', 3)]
```

sorts by the first element in each tuple

Recall: sorting lists with tuples

```
>>> fruit = [(‘mango’, 3), (‘apple’, 6), (‘lychee’, 1), (‘apricot’, 10)]

>>> sorted(fruit)

[(‘apple’, 6), (‘apricot’, 10), (‘lychee’, 1), (‘mango’, 3)]
```

what if we want to sort by the second element in the tuple?

Lambda Functions

Lambda Functions

```
lambda n: n * 2

lambda x, y: x ** y

lambda tup: tup[0]
```

$\uparrow$ parameter(s)

$\leftarrow$ expression

Definition

Lambda
A one-line, unnamed function

Lambda Functions

```
lambda n: n * 2

lambda x, y: x ** y

lambda tup: tup[0]
```

expression

parameter(s)

Note:

no **def**, no **return**

Definition

Lambda
A one-line, unnamed function

Lambdas vs. Regular Functions

```
lambda x: x * 2
```

```
def double(x):
    return x * 2
```

Lambdas vs. Regular Functions

```python
lambda x: x * 2
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this expression is automatically returned

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Lambdas vs. Regular Functions

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this expression is automatically returned

```
def double(x):
    return x * 2
```

we need **return** in order to return!

How can I use a lambda function? - map()

- **`map(function, list)`**
    - calls (lambda) function once for each element in the list
    - returns a list containing the output of each function
    - like **`[function(x) for x in list]`**
    - but returns an *iterable*
        - use **`list(map(fn, lst))`** to get a list

How can I use a lambda function? - map()

```
# usage: map(function, list)
>>> nums = [1, 3, 6, 7]
>>> squared = map(lambda n: n ** 2, nums)
>>> list(squared)
[1, 9, 36, 29]
```

lambda function

we have to use list() because map returns an iterable

How can I use a lambda function? - map()

- Say we have a list of strings, and we want a list of the strings' lengths.

in: `[‘i’, ‘rly’, ‘love’, ‘breakout’]`

out: `[1, 3, 4, 8]`

Think/Pair/Share:
How would you produce the output list using map()?

How can I use a lambda function? - map()

```
# usage: map(function, list)

>>> lst = ['i', 'rly', 'love', 'breakout']

>>> lengths = map(len, lst)

>>> list(lengths)

[1, 3, 4, 8]
```

How can I use a lambda function? - filter()

- **`filter(function, list)`**
  - calls (lambda) function once for each element in the list
  - function is a boolean that acts as a filter
    - if it doesn't evaluate to **`True`**, exclude the element
  - like **`[x for x in list if function(x)]`**

How can I use a lambda function? - filter()

```
# usage: filter(function, list)

>>> nums = [4, 23, 9, 18, 63, 42]

>>> even = filter(lambda n: n % 2 == 0, nums)

>>> list(even)

[4, 18, 42]
```

lambda function

Why lambdas?

- Powerful in the context of custom sort and min/max
- Great for when you need a tiny function
- Use less memory than regular functions in Python

How can I use a lambda function? - sorted()

- **`sorted(iterable, key, reverse)`** ← key and reverse are optional arguments
  - **key** is where you can pass in a lambda
  - key function transforms each element before sorting
    - it outputs the value to use for comparison when sorting

Recall: sorting lists with tuples

```
>>> fruit = [(‘mango’, 3), (‘apple’, 6), (‘lychee’, 1), (‘apricot’, 10)]
>>> sorted(fruit)
[(‘apple’, 6), (‘apricot’, 10), (‘lychee’, 1), (‘mango’, 3)]
```

what if we want to sort by the second element in the tuple?

Recall: sorting lists with tuples

```
>>> fruit = [(‘mango’, 3), (‘apple’, 6), (‘lychee’, 1), (‘apricot’, 10)]
>>> sorted(fruit)
[(‘apple’, 6), (‘apricot’, 10), (‘lychee’, 1), (‘mango’, 3)]
# get the second value from the tuple and sort on it
>>> sorted(fruit, key=lambda elem: elem[1])
[(‘lychee’, 1), (‘mango’, 3), (‘apple’, 6), (‘apricot’, 10)]
```

How can I use a lambda function? - sorted()

- Say we have a list of strings, and we want to sort them alphabetically by the last character in the string.

in: `[‘llamas’, ‘love’, ‘my’, ‘lambda’]`

out: `[‘lambda’, ‘love’, ‘llamas’, ‘my’]`

Think/Pair/Share:
How would you produce the output list using sorted()?

How can I use a lambda function? - sorted()

```
>>> lst = [‘llamas’, ‘love’, ‘my’, ‘lambda’]

>>> sorted(lst, key=lambda s: s[len(s)-1])

[‘lambda’, ‘love’, ‘llamas’, ‘my’]
```

How can I use a lambda function? - sorted()

- Say we have a list of strings, and we want to sort them by length.

in: **`[‘lambdas’, ‘are’, ‘so’, ‘cool!’]`**

out: **`[‘so’, ‘are’, ‘cool!’, ‘lambdas’]`**

Think/Pair/Share:
How would you produce the output list using sorted()?

How can I use a lambda function? - sorted()

```
>>> lst = [‘lambdas’, ‘are’, ‘so’, ‘cool!’]

>>> sorted(lst, key=len)

[‘so’, ‘are’, ‘cool!’, ‘lambdas’]
```

How can I use a lambda function? - min()/max()

- **`min(iterable, key)`** ← key is an optional argument
  - if you just care about min/max, less costly than sorting a list
    - faster!
  - key function transforms each element before comparing

How can I use a lambda function? - min()/max()

- Say you have a list of tuples containing ints. You want to find the tuple whose ints add up to the greatest value.

in: `[(23, 4 ,5), (9, 1, 3), (-27, 3, 300)]`

out: `(-27, 3, 300)`

How can I use a lambda function? - min()/max()

```
>>> nums = [(23, 4 ,5), (9, 1, 3), (-27, 3, 300)]

>>> max(nums, key=lambda elem: elem[0] + elem[1] + elem[2])

(-27, 3, 300)

>>> max(nums, key=sum)

(-27, 3, 300)
```

New Function: sum()

- **`sum(iterable)`**
- Returns the sum of the elements contained in a list, dict, or tuple

How can I use a lambda function? - min()/max()

- Back to the zoo-ture! We want to find our hungriest and least hungry animals.
    - Find the animal that eats the fewest times per day and the animal that eats the most times per day.

Think/Pair/Share:
How would you find the animals with min/max feedings?

When to use lambdas

- map(), filter()
  - actually not used that frequently
- sorted()
- min(), max()

How can we visualize our data?

Matplotlib

- A library for creating plots
    - especially useful inside of Jupyter notebooks
- To install:

```
$ python3 -m pip install matplotlib
```

Using Matplotlib

```
import matplotlib.pyplot as plt

# x = list of x vals, y = list of y vals

plt.plot(x, y)  # line or scatter plot

plt.scatter(x, y)  # scatter plot

plt.title(text)  # adds a title

plt.show()  # display
```

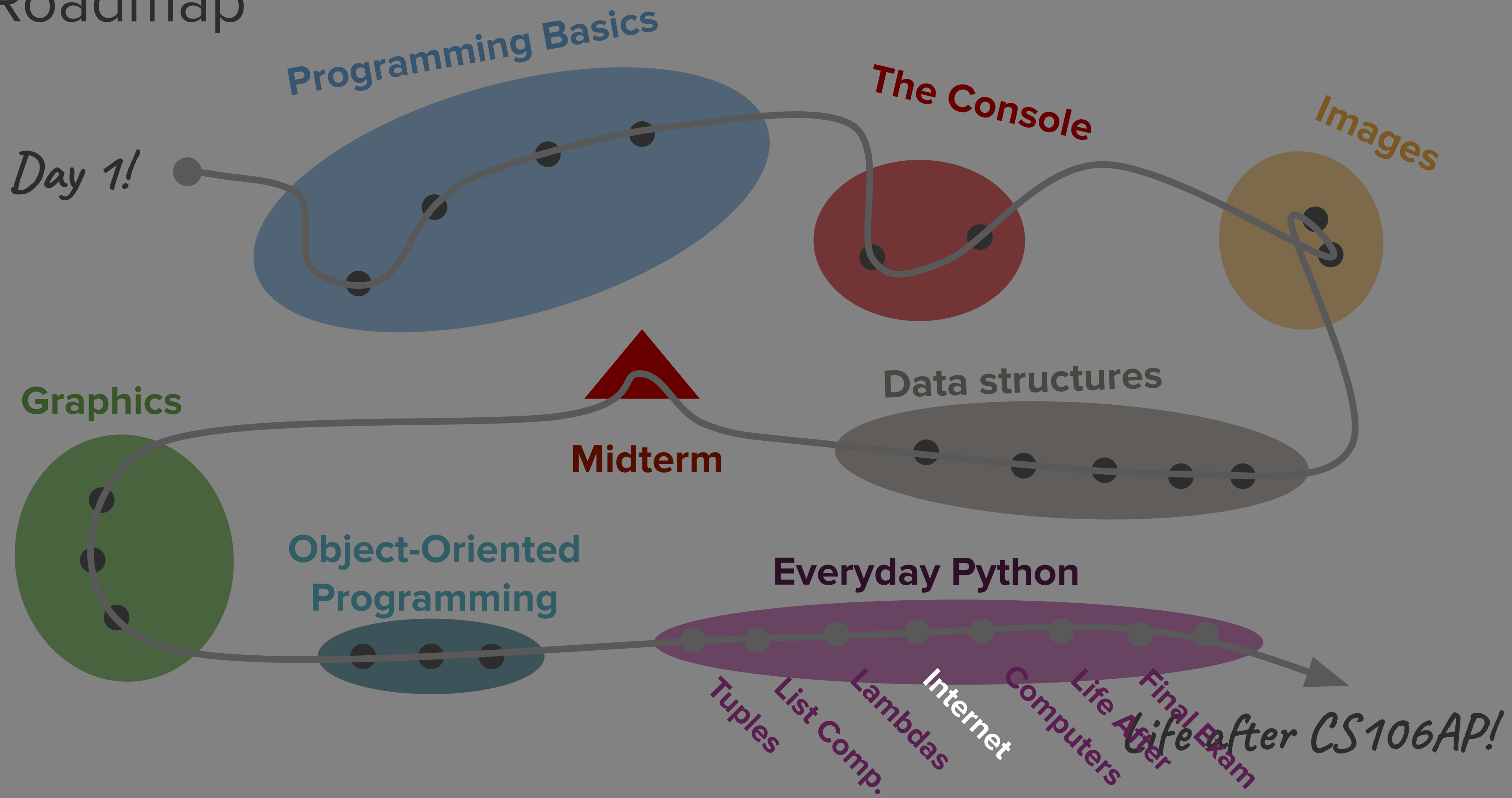
Using Matplotlib

- There are many, many more features!
- You read the docs here.
    - Here’s a useful tutorial!

Jupyter Notebook: Investigating California Air Quality

What’s next?

Roadmap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