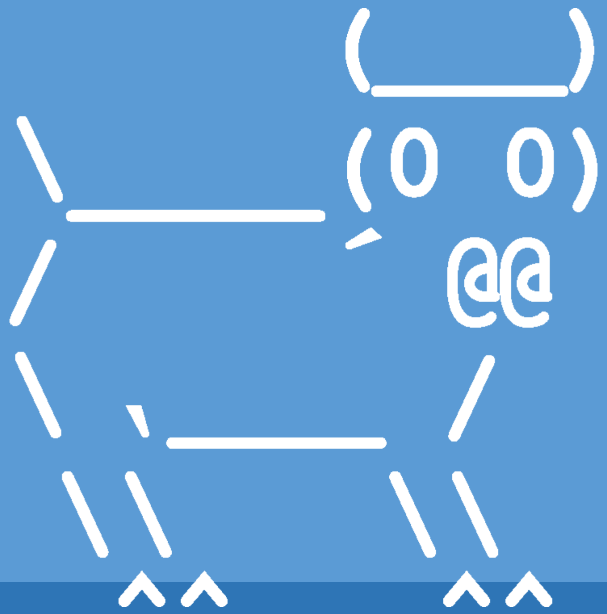
building our own

RECURSIVE DATA STRUCTURES

WEEK-AT-A-GLANCE



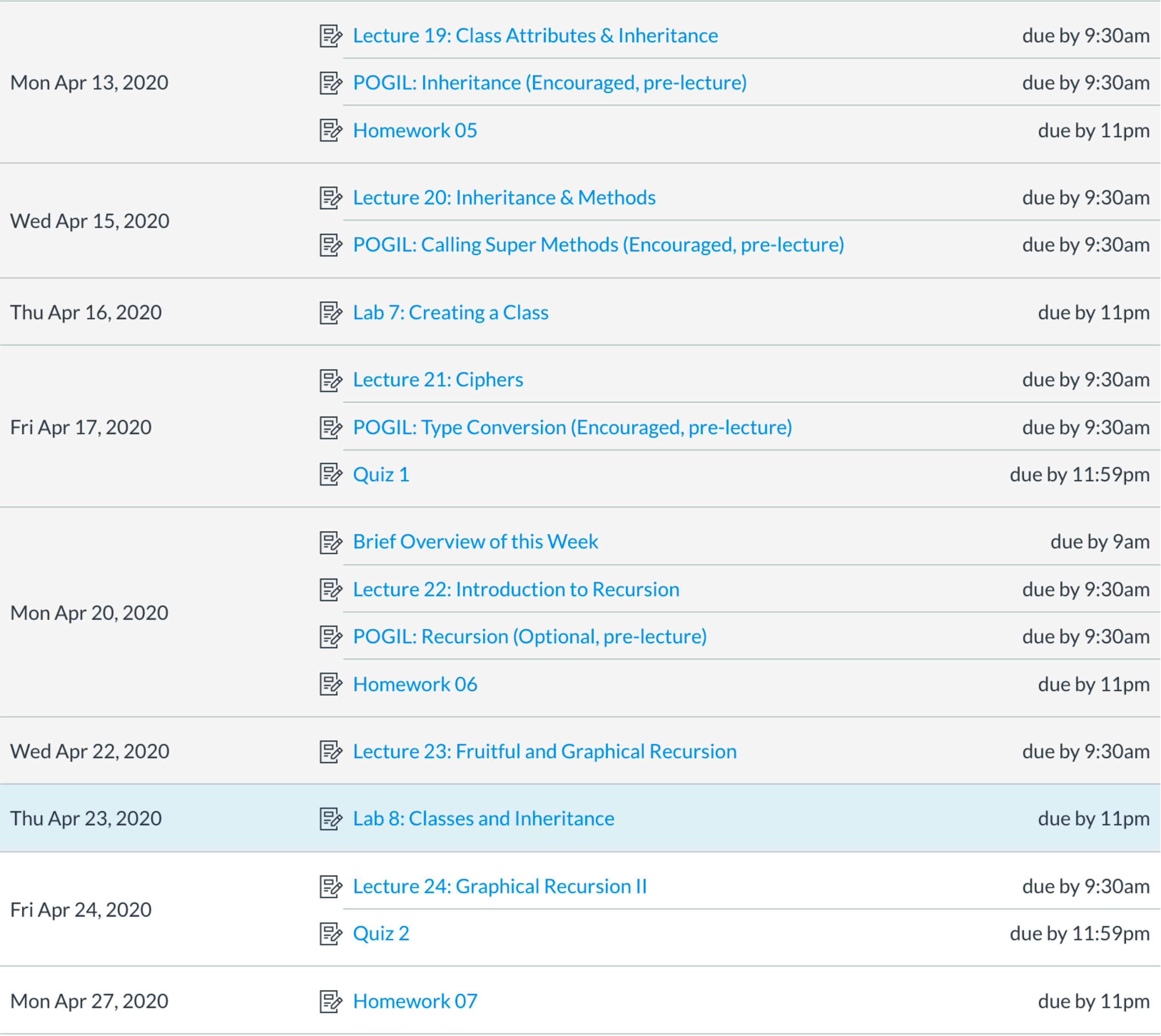
Introduction to Computer Science

Iris Howley

"It would be no small advantage if every college were thus located in a Glow/Canvas LMS."

Adapted from Thoreau (1844)

CS134 Glow Homepage



Mon Apr 13, 2020	Lecture 19: Class Attributes & Inheritance	due by 9:30am
	POGIL: Inheritance (Encouraged, pre-lecture)	due by 9:30am
	Homework 05	due by 11pm
Wed Apr 15, 2020	Lecture 20: Inheritance & Methods	due by 9:30am
	POGIL: Calling Super Methods (Encouraged, pre-lecture)	due by 9:30am
Thu Apr 16, 2020	Lab 7: Creating a Class	due by 11pm
Fri Apr 17, 2020	Lecture 21: Ciphers	due by 9:30am
	POGIL: Type Conversion (Encouraged, pre-lecture)	due by 9:30am
	Quiz 1	due by 11:59pm
Mon Apr 20, 2020	Brief Overview of this Week	due by 9am
	Lecture 22: Introduction to Recursion	due by 9:30am
	POGIL: Recursion (Optional, pre-lecture)	due by 9:30am
	Homework 06	due by 11pm
Wed Apr 22, 2020	Lecture 23: Fruitful and Graphical Recursion	due by 9:30am
Thu Apr 23, 2020	Lab 8: Classes and Inheritance	due by 11pm
Fri Apr 24, 2020	Lecture 24: Graphical Recursion II	due by 9:30am
	Quiz 2	due by 11:59pm
Mon Apr 27, 2020	Homework 07	due by 11pm

Assignments & Deadlines appear here!

HAPPENING THIS WEEK

- There is **no** quiz this week!
  - (*unless you're watching this on Friday, April 24*)
- Homework 7 is due Monday, April 27
  - Homework 8 will be released Wednesday
- Lab 9 was released Friday, April 24
  - And it's due Thursday, April 30
- Lab 10 (extra credit) will be released Friday, May 1

THIS WEEK’S LESSON

Building our own recursive data structures

(We have the tools to build our own data structures)

LECTURES THIS WEEK

- Monday
  - Week Overview
  - Building our own data structures
  - Elements
- Wednesday
  - Element Methods
  - Introducing the LinkedList wrapper class
  - Building out the LinkedList class
- Friday
  - Binary Trees
  - Using Binary Trees
  - Extra Credit Lab Intro

Steps for Recursion

1. Know when to stop.
2. Decide how to take one, repeated step.
3. Break the journey down into that step plus a smaller journey.

Recursive Approach

- REDUCE the problem to smaller subproblem(s) (smaller version(s) of itself)
- DELEGATE the smaller problems to the recursion fairy *(formally known as induction hypothesis)* and assume they're solved correctly
- COMBINE the solution(s) of the smaller subproblems to reach/return the solution

Prior to lecture videos…

Complete:

1. POGIL Activities: Element & LinkedList & Binary Trees
   - *available under Glow > Modules*
   - *also posted to the course website under Remote Lectures*

- Best done prior to watching lectures!
- Good for working with a partner (virtually, too!)
  - But will work without a partner, as well

Prior to this week's lessons…

Be able to:

1. Build & instantiate new classes & objects
   - …with attributes and methods

2. Implement recursive functions

NO BOOK CHAPTERS THIS WEEK

Consult POGILs, slides, Lecture Notes

Highly recommended

QUESTIONS?

Please contact me!

Building Our Own Data Structures

```
       (___)
\______(0 0)
/      ´ @@
\ `_____ /
 \\     \\
  ^^     ^^
```

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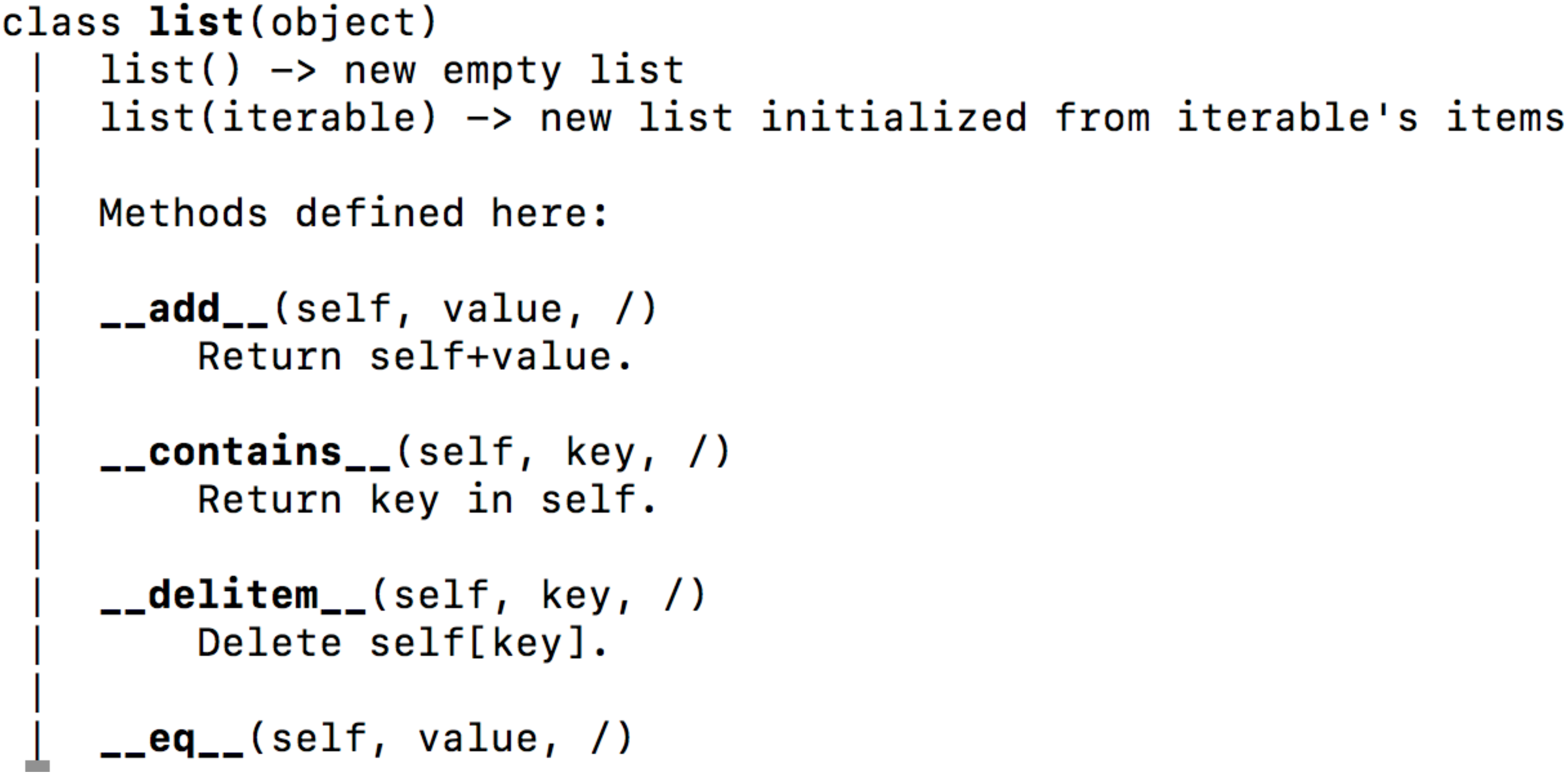
TODAY'S LESSON

`Building our own list class`

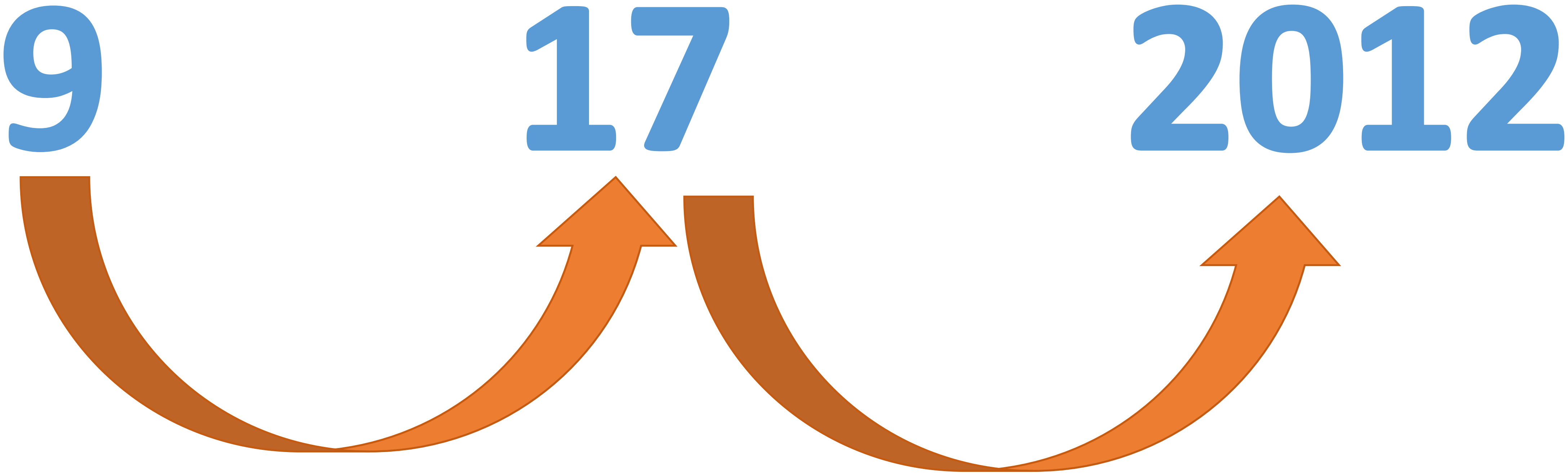
(We have the tools to build our own data structures)

What is a list? -> pydoc3 list



```
class list(object)
 |  list() -> new empty list
 |  list(iterable) -> new list initialized from iterable's items
 |
 |  Methods defined here:
 |
 |  __add__(self, value, /)
 |      Return self+value.
 |
 |  __contains__(self, key, /)
 |      Return key in self.
 |
 |  __delitem__(self, key, /)
 |      Delete self[key].
 |
 |  __eq__(self, value, /)
```

What is a list?

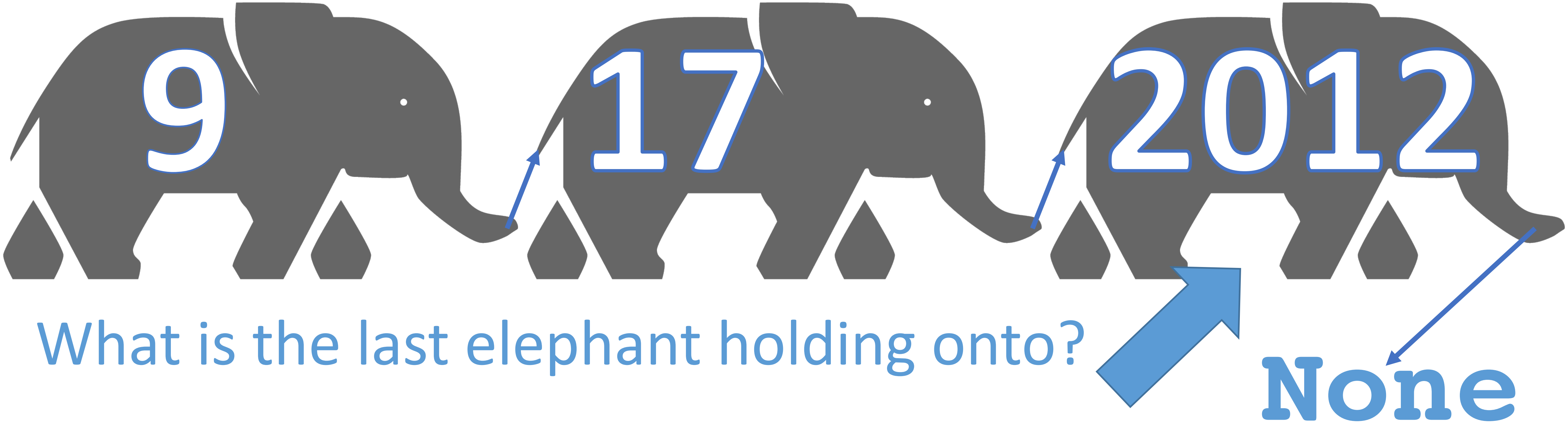


9

17

2012

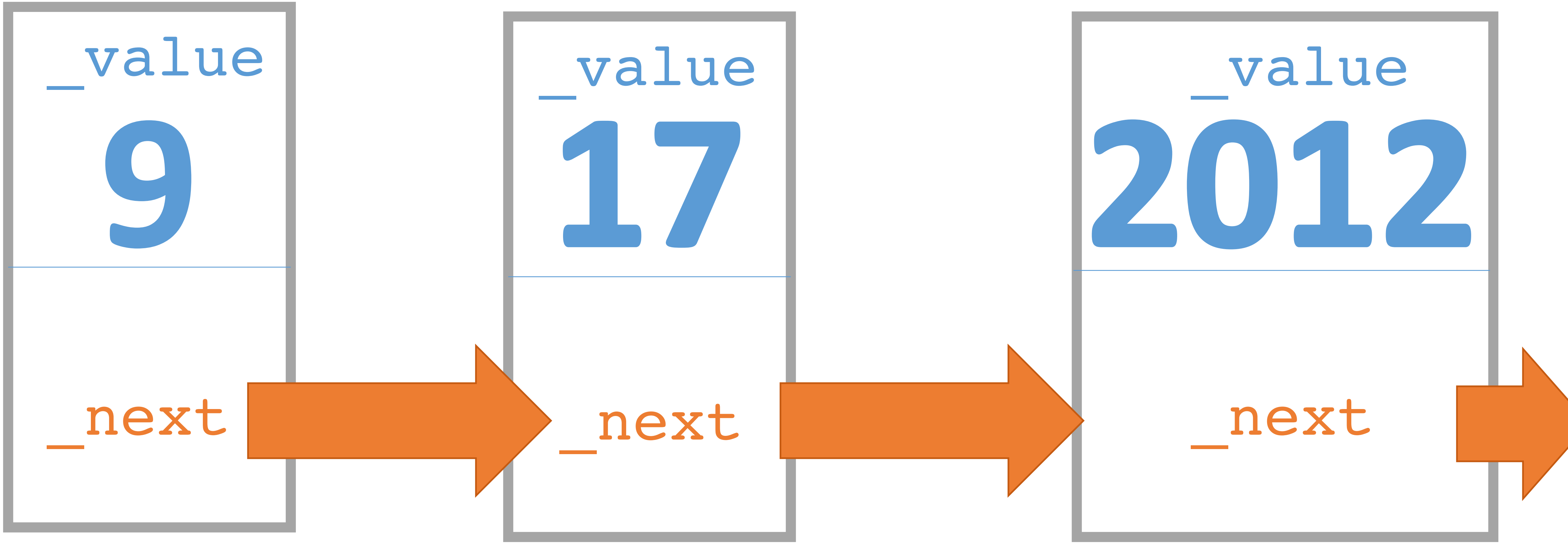
What is a list?



What is the last elephant holding onto?

What is a list?

```
class Element:
```



_value

9

_next

_value

17

_next

_value

2012

_next

SPECIAL METHODS

- We're familiar with `__str__(self)` which is called implicitly with str(object) and `__init__(self)` which is called implicitly when instantiating objects

- POGIL 27. Special Methods gives you broader exposure to more!

- Think: *every* built-in function we call + every operator

Special Methods

- **`len(object)`**
- **ex: `len('hello, world!')`**
    - Returns the **len**gth of the sequence, if possible

    - **`def __len__(self):`**
        - **`# Write your own code`**
        - **`# that calculates & returns`**
        - **`# the length of the object, self`**

Special Methods

- **`indexableSequence[index]`**
- **ex: `myList[5]`**
  - Returns the object located at **index** of the indexableSequence, if possible
  - **`def __getitem__(self, index):`**
    - **`# Write your own code`**
    - **`# that finds the item at index`**
    - **`# and returns it`**

Special Methods

- **`indexableSequence[index] = val`**
- **ex: `myList[5] = 'Something else.'`**
  - Assigns the object located at **index** to the value, **val**, if possible

  - **`def __setitem__(self, index, val):`**
    - **`# Write your own code`**
    - **`# that finds the item at index`**
    - **`# and sets its value to val`**

Special Methods

- `val in collection`
- ex: `'s' in 'iris'`
  - Returns True if **val** exists in **collection**, False otherwise
  - `def __contains__(self, val):`
    - `# Write your own code`
    - `# that finds if val exists in self`
    - `# and returns True if found`

Special Methods

- `for item in iterableCollection:`
- **ex:** `for word in wordList:`
  - Iterate across the items of the list

  - `def __iter__(self):`
    - `# Write your own code`
    - `# to yield the next object in self`

Some Common List Functions

- **`def append(self, val)`** : Add **val** to the end of the list
- **`def extend(self, seq)`** : Extend list by adding elements of **seq**
- **`def pop(self, index=None)`** : Returns and removes the object located at **index** of the list, if possible
- **`def reverse(self)`** : Reverse the list (destructively)
- **`def sort(self)`** : Sort the list (destructively)

Common Features of All Classes

- Docstrings
- **`__all__`**
- **`__slots__`**
- Hidden attributes → **`@property, @____.setter`**

`Tuples`, `Strings`, other built-in types aren’t particularly special!

You can build your own!

QUESTIONS?

Please contact me!

Elements of a Linked List

```
      (___)
\_____(0 0)
/     ´  @@
\ `____/
 \\    \\
  ^^    ^^
```

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TODAY'S LESSON

A private class holding values in a list

(Building the Element class)

Linked Lists – Element Class

- See example code on the course website!

LinkedList.py

Testing @property + initializer in interactive python

```
>>> from LinkedList import Element
>>> ele1 = Element('a')
>>> ele1.value
'a'
>>> ele1.next
>>> ele2 = Element('b', ele1)
>>> ele2.value
'b'
>>> ele2.next
<LinkedList.Element object at 0x10feee8d0>
>>> ele2.next.value
'a'
```

Testing @next.setter in interactive python

```
>>> ll = Element(3)
>>> ll.next = Element(7)
>>> ll.value
3
>>> ll.next
<LinkedList.Element object at
0x10feeebe0>
>>> ll.next.value
7
>>> ll.next.next = Element(1715)
>>> ll.next.next.value
1715
>>> ll.next.next.next = ll
```

Careful! We can make an infinite list by connecting the end to the beginning!

```
>>> ll.value
3
>>> ll.next.value
7
>>> ll.next.next.value
1715
>>> ll.next.next.next.value
3
>>> ll.next.next.next.next.value
7
>>> ll.next.next.next.next.next.value
1715
>>> ll.next.next.next.next.next.next.value
3
>>> ll.next.next.next.next.next.next.next.value
7
>>> ll.next.next.next.next.next.next.next.next.value
1715
>>>
ll.next.next.next.next.next.next.next.next.next.value
3
>>> ll.next
<LinkedList.Element object at 0x10feeebe0>
```

QUESTIONS?

Please contact me!

Leftover Slides

Steps for Recursion

- Know when to stop.
- Decide how to take one step.
- Break the journey down into that step plus a smaller journey.