1 Learning Goals

- Learn to approach complex tree questions
- Touch on iterators and generators in the context of other topics
- Learn the basics of object-oriented programming
Trees (Exam-Level)

2.1 We can represent the hailstone sequence as a tree in the figure below, showing the route different numbers take to reach 1. Remember that a hailstone sequence starts with a number \( n \), continuing to \( n/2 \) if \( n \) is even or \( 3n + 1 \) if \( n \) is odd, ending with 1. Write a function \( \text{hailstone_tree}(n, h) \) which generates a tree of height \( h \), containing hailstone numbers that will reach \( n \).

**Hint:** A node of a hailstone tree will always have at least one, and at most two branches (which are also hailstone trees). Under what conditions do you add the second branch?

```
def hailstone_tree(n, h):
    
    def tree(n, h):
        if h == 0:
            return [n]
        else:
            return [n] + [tree(n/2 if n % 2 == 0 else 3*n + 1, h-1)]

    return tree(n, h)

>>> hailstone_tree(1, 0)
[1]
>>> hailstone_tree(1, 4)
[1, [2, [4, [8, [16]]]]]
>>> hailstone_tree(8, 3)
[8, [16, [32, [64]], [5, [10]]]]
```

Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.
Fall 2018 Midterm 2, Question 7: Trictionary or Treat

A trictionary is a pair of Tree instances \( k \) and \( v \) that have identical structure: each node in \( k \) has a corresponding node in \( v \). The labels in \( k \) are called keys. Each key may be the label for multiple nodes in \( k \), and the values for that key are the labels of all the corresponding nodes in \( v \).

A lookup function returns one of the values for a key. Specifically, a lookup function for a node in \( k \) is a function that takes \( v \) as an argument and returns the label for the corresponding node in \( v \).

Implement the generator function `lookups`, which takes a Tree instance \( k \) and some key. It yields all lookup functions for nodes in \( k \) that have key as their label.

```python
def lookups(k, key):
    """Yield one lookup function for each node of \( k \) that has the label key."
    >>> [f(v) for f in lookups(k, 2)]
    ['C', 'A']
    >>> [f(v) for f in lookups(k, 3)]
    ['S']
    >>> [f(v) for f in lookups(k, 6)]
    []
    """
    if ________________________________:
        yield lambda v: ________________________________

    for i in range(len(k.branches)):
        ________________________________:
        yield new_lookup(i, lookup)

def new_lookup(i, f):
```

Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.
def g(v):

    return

return
3 Object-Oriented Programming

3.1 What is the relationship between a class and an ADT?

3.2 What is the definition of a Class? What is the definition of an Instance?

3.3 What is a Class Attribute? What is an Instance Attribute?

3.4 What Would Python Display?

```python
class Foo():
    x = 'bam'
    def __init__(self, x):
        self.x = x
    def baz(self):
        return self.x

class Bar(Foo):
    x = 'boom'
    def __init__(self, x):
        Foo.__init__(self, 'er' + x)
    def baz(self):
        return Bar.x + Foo.baz(self)

foo = Foo('boo')

Foo.x

foo.x

foo.baz()

Foo.baz()

Foo.baz(foo)

bar = Bar('ang')

Bar.x

bar.x

bar.baz()
```

Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.
3.5 What Would Python Display?

```python
class Student:
    def __init__(self, subjects):
        self.current_units = 16
        self.subjects_to_take = subjects
        self.subjects_learned = {}
        self.partner = None

    def learn(self, subject, units):
        print('I just learned about ' + subject)
        self.subjects_learned[subject] = units
        self.current_units -= units

    def make_friends(self):
        if len(self.subjects_to_take) > 3:
            print('Whoa! I need more help!')
            self.partner = Student(self.subjects_to_take[1:3])
        else:
            print('I'm on my own now!')
            self.partner = None

    def take_course(self):
        course = self.subjects_to_take.pop()
        self.learn(course, 4)
        if self.partner:
            print('I need to switch this up!')
            self.partner = self.partner.partner
            if not self.partner:
                print('I have failed to make a friend :(')

tim = Student(['Chem1A', 'Bio1B', 'CS61A', 'CS70', 'CogSci1'])
tim.make_friends()

print(tim.subjects_to_take)

tim.partner.make_friends()

tim.take_course()

tim.partner.take_course()

tim.take_course()

tim.make_friends()
```

Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.
3.6 Fill in the implementation for the Cat and Kitten classes. When a cat meows, it should say "Meow, (name) is hungry" if it is hungry, and "Meow, my name is (name)" if not. Kittens do the same thing as cats, except they say "i'm baby" instead of "meow", and they say "I want mama (parent's name)" after every call to meow().

```python
>>> cat = Cat('Tuna')
>>> kitten = kitten('Fish', cat)
>>> cat.meow()
meow, Tuna is hungry
>>> kitten.meow()
i'm baby, Fish is hungry
I want mama Tuna
>>> cat.eat()
meow
>>> cat.meow()
meow, my name is Tuna
>>> kitten.eat()
i'm baby
>>> kitten.meow()
meow, my name is Fish
I want mama Tuna

class Cat():
    noise = 'meow'
    def __init__(self, name):
        
        def meow(self):

            def eat(self):
                print(self.noise)
                self.hungry = False

class Kitten(Cat):
```

Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.