This assignment focuses on classes and objects. Turn in ant.py, bird.py, hippo.py, vulture.py, and wildcat.py. Download supporting files from the course web site. Run critters.py to start the simulation.

**Program Behavior:**
You are provided with a class that implements a graphical simulation of a 2D world of animals (affectionately called critters). You will write classes that define the behavior of a few different animals, specifically, ants, birds, hippos, vultures and wildcats. Animals move and behave in different ways. Your classes will define the unique behaviors for each animal.

The **critter world** is divided into cells with integer coordinates. The world is 60 cells wide and 50 cells tall. The upper-left cell has coordinates (0, 0); x increases to the right and y increases downward.

**Movement**
On each round of the simulation, the simulator asks each critter object which direction it wants to move. On each round, a critter can move one square north, south, east, west, or stay at its current location ("center"). The world has a finite size, but it wraps around in all four directions. For example, moving east from the right edge brings you back to the left edge.

In this assignment, you will not write a main function; your code is not in control of the overall execution. Instead, your objects are part of a larger system. You might want your critters make several moves at once using a loop, but you can't. The only way a critter moves is when the simulator calls a method on one of your critter objects and it returns the move it would like to make. This is a new experience for you, but it is a good introduction to object-oriented programming.

**Fighting/Mating**
As the simulation runs, animals may collide by moving onto the same location. When two animals collide, if they are from different species, they fight. The winning animal survives and the losing animal is removed from the game. Each animal chooses one of ATTACK_ROAR, ATTACK_POUNCE, or ATTACK_SCRATCH. Each attack is strong against one other (e.g. roar beats scratch) and weak against another (roar loses to pounce). The following table summarizes the choices and which animal will win in each case. To remember which beats which, notice that the starting letters of "Roar, Pounce, Scratch" match those of "Rock, Paper, Scissors." If the animals make the same choice, the winner is chosen at random.

<table>
<thead>
<tr>
<th>Critter #1</th>
<th>ATTACK_ROAR</th>
<th>ATTACK_POUNCE</th>
<th>ATTACK_SCRATCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATTACK_POUNCE</td>
<td>random roar</td>
<td>#2 wins</td>
<td>#1 wins</td>
</tr>
<tr>
<td>ATTACK_SCRATCH</td>
<td>#1 wins</td>
<td>random winner</td>
<td>#2 wins</td>
</tr>
</tbody>
</table>

If two animals of the same species collide, they "mate" to produce a baby. Animals are vulnerable to attack while mating: any other animal that collides with them will defeat them. An animal can mate only once during its lifetime.

**Eating**
The simulation world also contains food (represented by the period character, ".") for the animals to eat. There are pieces of food on the world initially, and new food slowly grows into the world over time. As an animal moves, it may encounter food, in which case the simulator will ask your animal whether it wants to eat it. Different kinds of animals have different eating behavior; some always eat, and others only eat under certain conditions.

Every time one class of animals eats a few pieces of food, that animal will be put to "sleep" by the simulator for a small amount of time. While asleep, animals cannot move, and if they enter a fight with another animal, they will always lose.

**Scoring**
The simulator keeps a score for each class of animal. The scores are displayed in the grey area just above the control buttons. A class's score is based on how many animals of that class are alive, how much food they have eaten, and how many other animals they have killed.
Provided Files:
Each class you write will inherit from a class named Critter. Inheritance is discussed in lectures 35 and 36. Using inheritance ensures that each animal class you implement has all the methods required for the simulation. Your class headers should indicate inheritance by using the proper syntax. The following shows the syntax for the Ant class inheriting from the Critter class:

```python
class Ant(Critter): ...
```

The Critter class contains the following methods which you must override as appropriate for the behavior of your class:

- **eat()**
  When your animal encounters food, our code calls this on it to ask whether it wants to eat (true) or not (false).

- **fight(opponent)**
  When two animals move onto the same square of the grid, they fight. When they collide, our code calls this on each animal to ask it what kind of attack it wants to use in a fight with the given opponent.

- **get_color()**
  Every time the board updates, our code calls this on your animal to ask it what color it wants to be drawn with.

- **get_move()**
  Every time the board updates, our code calls this on your animal to ask it which way it wants to move.

- **__str__()**
  Every time the board updates, our code calls this on your animal to ask what letter it should be drawn as.

By inheriting from the Critter class, you receive a default version of these methods. The default behavior is to never eat, to always forfeit fights, to use the color gray, to always stand still (a move of CENTER), and a __str__ of "?". If you don't want this default, override (rewrite) the methods in your class with your own behavior.

For example, below is a critter class Stone. A Stone is displayed with the letter S, is gray in color, never moves or eats, and always roars in a fight. Your classes will look like this class but in addition will have attributes, an __init__ method (a constructor), and more sophisticated code for the methods. The Stone does not need an eat or get_move method; it uses the default behavior for those operations.

```python
class Stone(Critter):
    def fight(self, opponent):
        return ATTACK_ROAR
    def get_color(self):
        return "gray"
    def __str__(self):
        return "S"
```

NOTE: You are not necessarily required to inherit from the Critter class for every animal class you write. If you find that two animal classes are very similar to each other, you should have one inherit from the other to reduce redundancy.

Running the Simulator:
When you press the Go button, it begins a series of turns. On each turn, the simulator does the following for each animal:

- move the animal once (calling its get_move method), in random order
- if the animal has moved onto an occupied square, fight! (call both animals' fight methods) or mate
- if the animal has moved onto food, ask it if it wants to eat (call the animal's eat method)

After moving all animals, the simulator redraws the screen, asking each animal for its __str__ and get_color values. It can be difficult to test and debug with many animals. We suggest adjusting the initial settings to use a smaller world and fewer animals.
Critter Classes:
There are five animal classes to implement, listed from 1 to 5 in the second table below, with the behavior for each method described. Note that each class constructor accepts exactly the parameter(s) listed in the table and must call its superclass __init__ method. The first two lines of the class constructors for Ant and Bird are given below:

<table>
<thead>
<tr>
<th>Ant</th>
<th>Bird</th>
</tr>
</thead>
</table>
| def __init__(self, walk_south):
  super(Ant, self).__init__() |
| def __init__(self):
  super(Bird, self).__init__() |

For behavior that results in random moves, each choice must be equally likely; use random for this.

1. Ant

<table>
<thead>
<tr>
<th>constructor</th>
<th><strong>init</strong> (self, walk_south)</th>
</tr>
</thead>
<tbody>
<tr>
<td>color</td>
<td>red</td>
</tr>
<tr>
<td>eating behavior</td>
<td>always returns True</td>
</tr>
<tr>
<td>fighting behavior</td>
<td>always scratch</td>
</tr>
<tr>
<td>movement</td>
<td>if the Ant was constructed with a walk_south value of True, then alternates between south and east in a zigzag (S, E, S, E, ...); otherwise, if the Ant was constructed with a walk_south value of False, then alternates between north and east in a zigzag (N, E, N, E, ...)</td>
</tr>
<tr>
<td><strong>str</strong></td>
<td>&quot;%&quot; (percent)</td>
</tr>
</tbody>
</table>

2. Bird

<table>
<thead>
<tr>
<th>constructor</th>
<th><strong>init</strong> (self)</th>
</tr>
</thead>
<tbody>
<tr>
<td>color</td>
<td>blue</td>
</tr>
<tr>
<td>eating behavior</td>
<td>never eats (always returns False)</td>
</tr>
<tr>
<td>fighting behavior</td>
<td>roars if the opponent looks like an Ant (&quot;v&quot;); otherwise pounces</td>
</tr>
<tr>
<td>movement</td>
<td>a clockwise square: first goes north 3 times, then east 3 times, then south 3 times, then west 3 times, then repeats</td>
</tr>
</tbody>
</table>
| __str__     | "^" (caret) if the bird’s last move was north or it has not moved; 
              | 
              | ">" (greater-than) if the bird’s last move was east; 
              | 
              | "v" (uppercase letter v) if the bird’s last move was south; 
              | 
              | "<" (less-than) if the bird’s last move was west |

3. Hippo

<table>
<thead>
<tr>
<th>constructor</th>
<th><strong>init</strong> (self, hunger)</th>
</tr>
</thead>
<tbody>
<tr>
<td>color</td>
<td>gray if the hippo is still hungry (if eat would return True); otherwise white</td>
</tr>
<tr>
<td>eating behavior</td>
<td>returns True the first hunger times it is called, and False after that</td>
</tr>
<tr>
<td>fighting behavior</td>
<td>if this Hippo is hungry (if eat would return True), then scratches; else pounces</td>
</tr>
<tr>
<td>movement</td>
<td>moves 5 steps in a random direction (north, south, east, or west), then chooses a new random direction and repeats</td>
</tr>
<tr>
<td><strong>str</strong></td>
<td>the number of pieces of food this Hippo still wants to eat, as a String</td>
</tr>
</tbody>
</table>

The Hippo constructor accepts a parameter for the maximum number of times a Hippo will eat food in its lifetime (the number of times it will return True from a call to eat). For example, a Hippo constructed with a parameter value of 8 will return True the first 8 times eat is called and False after that. Assume that the value passed is non-negative.

The __str__ method for a Hippo returns the number of times that a call to eat would return True for that Hippo. For example, if a Hippo(4) is constructed, initially its __str__ returns "4". After eat has been called on it once, calls to __str__ return "3", and so on, until the Hippo is no longer hungry, after which all calls to __str__ return "0".
### 4. Vulture

<table>
<thead>
<tr>
<th>constructor</th>
<th><strong>init</strong> (self)</th>
</tr>
</thead>
<tbody>
<tr>
<td>color</td>
<td>black</td>
</tr>
<tr>
<td>eating behavior</td>
<td>Returns True if vulture is hungry. A vulture is initially hungry, and he remains hungry until he eats once. After eating once he will become non-hungry until he gets into a fight. After one or more fights, he will be hungry again. (see below)</td>
</tr>
<tr>
<td>fighting behavior</td>
<td>roars if the opponent looks like an Ant (&quot;%&quot;); otherwise pounces</td>
</tr>
<tr>
<td>movement</td>
<td>a clockwise square: first goes north 3 times, then east 3 times, then south 3 times, then west 3 times, then repeats</td>
</tr>
</tbody>
</table>
| __str__ | "^" (caret) if the vulture's last move was north or has not moved; 
>" (greater-than) if the vulture's last move was east; 
"V" (uppercase letter v) if the vulture's last move was south; 
"<" (less-than) if the vulture's last move was west |

A Vulture is a specific sub-category of bird with some changes. Think of the Vulture as having a "hunger" that is enabled when he is first born and also by fighting. Initially the Vulture is hungry (so eat would return True from a single call). Once the Vulture eats a single piece of food, he becomes non-hungry (so future calls to eat would return False). But if the Vulture gets into a fight or a series of fights (if fight is called on it one or more times), it becomes hungry again. When a Vulture is hungry, the next call to eat should return True. Eating once causes the Vulture to become "full" again so that future calls to eat will return False, until the Vulture's next fight or series of fights.

### 5. Wild Cat

<table>
<thead>
<tr>
<th>constructor</th>
<th><strong>init</strong> (self) (must not accept any parameters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>all behavior</td>
<td>you decide (see below)</td>
</tr>
</tbody>
</table>

You will decide the behavior of your WildCat class. Part of your grade will be based upon writing creative and non-trivial WildCat behavior. The following are some guidelines and hints about how to write an interesting WildCat.

Your WildCat's fighting behavior may want to utilize the opponent parameter to the fight method, which tells you what kind of critter you are fighting against (such as "%" if you are fighting against an Ant). Your WildCat can return any text you like from __str__ and any color from get_color. Each critter's get_color and __str__ are called on each simulation round, so you can have a WildCat that displays differently over time. The __str__ text is also passed to other animals when they fight you; you may want to try to fool other animals.

Unlike on most assignments, your WildCat can use any advanced material you happen to know in Python. If your WildCat uses additional classes you have written, contact your TA or instructor to make sure it will be compatible with our system.

Each critter class has some additional methods that it receives by inheritance from Critter. Your WildCat may want to use these methods to guide its behavior. None of the methods below are needed for Ant, Bird, Hippo, or Vulture.

- getX(), getY()
  Returns your critter's current x and y coordinates. For example, to check whether your critter's x-coordinate is greater than 10, you would write code such as: if (self.getX() > 10):

- get_width(), get_height()
  Returns the width and height of the simulation grid.

- get_neighbor(direction)
  Returns a String representing what is next to your critter in the given direction. " " means an empty square. For example, to check if your neighbor to the west is a "Q", you could write this in your get_move method:

  ```python
  if (self.get_neighbor(DIRECTION_WEST) == "Q"):
  ```

- win(), sleep(), mate(), reset(), lose(), wakeup(), mate_end()
  The simulator calls these methods on your critter to notify you when you have won/lost a fight, been put to sleep/wake up, start/end mating, or when the game world has reset, respectively.
Development Strategy:
The simulator runs even if you haven't completed all the critters. The classes increase in difficulty from Ant to Bird to Hippo to Vulture. We suggest doing Ant first. Look at stone.py and the lecture/section examples to see the general structure.

It will be impossible to implement each behavior if you don't have the right state in your object. As you start writing each class, spend some time thinking about what state will be needed to achieve the desired behavior.

One thing that students in the past have found particularly difficult to understand is the various constructors for each type of animal. Some of the constructors accept parameters that guide the behavior of later methods of the animal. It is your job to store data from these parameters into attributes of the animal as appropriate, so that it will "remember" the proper information and will be able to use it later when the animal's other methods are called by the simulator.

Test your code incrementally. A critter class will run even if you have not written all of the methods (the unwritten ones will use default behavior). So add one method, run the simulator to see that it works, then add another.

Critter Tournament:
On the last day of class, we will host a Critter tournament. In each battle, two students' WildCat classes will be placed into the simulator along with the other standard animals. The student with the higher score in the right sidebar advances.

A "battle" is defined as the following: We run Critters with a standard 60x50 world, using 25 of each kind of animal. The animals present are Ants, Birds, Hippos, Vultures, Stones, and two students' WildCats. We start the simulator and let it run until either one student's WildCats are completely eliminated or until roughly 1000 moves have passed. At this point whichever student's WildCat species has the more points wins the battle.

Think of the tournament like one of the major pro sports. We will run a "regular season" in which every student's WildCat species will play many battles against randomly chosen opponent WildCat classes. We run a season of many games (at least 64 for each student), then we grab the top 16 students that have the best win/loss records. They advance to the "playoffs", which will take place live in lecture on the last day of class.

The playoffs consists of a 16- WildCat bracket similar to part of an NCAA basketball tournament bracket. WildCat #1 battles #16, #2 battles #15, and so on. Winners advance and losers are eliminated. Eventually one WildCat is the champion.

No grade points will be based on tournament performance. For example, a WildCat that sits completely still might fare well in the tournament, but it will not receive full grade points because it is too trivial.

Style Guidelines:
Since this assignment is largely about classes and objects, much of the style grading will be about how well you follow proper object-oriented programming style. You should encapsulate the data inside your objects, and you should not declare unnecessary attributes to store information that isn't vital to the state of the object. Style points will also be awarded for expressing each critter's behavior elegantly.

Another aspect of the style of this program is inheritance. Your critter classes should properly extend the Critter superclass as described. Inheritance can also be used to remove redundancy between classes that are similar, and you should make use of this concept in your classes as appropriate. In other words, if two of your critter classes A and B are very much alike, you should have B inherit from A rather than having both simply inherit from Critter.

Some of the style points for this assignment will be awarded on the basis of how much energy and creativity you put into defining an interesting WildCat class. These points allow us to reward the students who spend time writing an interesting critter definition. Your WildCat's behavior should not be trivial or closely match that of an existing animal shown in class.

Follow past style guidelines about spacing, identifiers, and localizing variables. Place comments at the beginning of each class documenting that critter's behavior, and on any complex code. Your critters should not produce any console output.

Include a comment line in the ants.py file that tells us how many hours you spent on this homework using the format # HW 12 hours spent: 3.5. Put in your own estimate of time spent.