For each of the following problems, assume linked lists are defined as follows:

```python
class Link:
    empty = ()

    def __init__(self, first, rest=empty):
        assert rest is Link.empty or isinstance(rest, Link)
        self.first = first
        self.rest = rest
```

To check if a `Link` is empty, compare it against the class attribute `Link.empty`:

```python
if link is Link.empty:
    print('This linked list is empty!')
```
1. What will Python output? Draw box-and-pointer diagrams to help determine this.

```python
>>> a = Link(1, Link(2, Link(3)))
>>> a.first

>>> a.first = 5
>>> a.first

>>> a.rest.first

>>> a.rest.rest.rest.rest.first

>>> a.rest.rest.rest = a
>>> a.rest.rest.rest.first
```

2. Write a function `skip`, which takes in a `Link` and returns a new `Link`.

```python
def skip(lst):
    """
    >>> a = Link(1, Link(2, Link(3, Link(4))))
    >>> a
    Link(1, Link(2, Link(3, Link(4))))
    >>> b = skip(a)
    >>> b
    Link(1, Link(3))
    >>> a
    Link(1, Link(2, Link(3, Link(4))))  # Original is unchanged
    """
```
3. Now write function `skip` by mutating the original list, instead of returning a new list. Do NOT call the `Link` constructor.

```python
def skip(lst):
    """
    >>> a = Link(1, Link(2, Link(3, Link(4))))
    >>> b = skip(a)
    >>> b
    Link(1, Link(3))
    >>> a
    Link(1, Link(3))
    """
```

4. Write a function `reverse`, which takes in a `Link` and returns a new `Link` that has the order of the contents reversed.

   *Hint:* You may want to use a helper function if you’re solving this recursively.

```python
def reverse(lst):
    """
    >>> a = Link(1, Link(2, Link(3)))
    >>> b = reverse(a)
    >>> b
    Link(3, Link(2, Link(1)))
    >>> a
    Link(1, Link(2, Link(3)))
    """
```
5. (Optional) Now write `reverse` by modifying the existing Links. Assume `reverse` returns the head of the new list (so the last `Link` object of the previous list).

First, draw out the box and pointer for the following:
```python
>>> a = Link(1, Link(2))
>>> a.rest.rest = a
>>> a.rest = Link.empty
```
Observe how the pointers change, as well as the order in which they are modified.

Now, generalize this to reverse an entire linked list.
```python
def reverse(lst):
    """
    >>> a = Link(1, Link(2, Link(3)))
    >>> b = reverse(a)
    >>> b
    Link(3, Link(2, Link(1)))
    >>> a
    Link(3, Link(2, Link(1)))
    """
```
6. **(Optional) Write** `has_cycle` which takes in a `Link` and returns `True` if and only if there is a cycle in the `Link`.

```python
def has_cycle(s):
    """
    >>> has_cycle(Link.empty)
    False
    >>> a = Link(1, Link(2, Link(3)))
    >>> has_cycle(a)
    False
    >>> a.rest.rest.rest = a
    >>> has_cycle(a)
    True
    """
```