Let’s imagine you order a mushroom and cheese pizza from Domino’s, and that they represent your order as a list:

```python
>>> pizza1 = ['cheese', 'mushrooms']
```

A couple minutes later, you realize that you really want onions on the pizza. Based on what we know so far, Domino’s would have to build an entirely new list to add onions:

```python
>>> pizza2 = pizza1 + ['onions']  # creates a new python list
>>> pizza2
['cheese', 'mushrooms', 'onions']
>>> pizza1  # the original list is unmodified
['cheese', 'mushrooms']
```

But this is silly, considering that all Domino’s had to do was add onions on top of `pizza1` instead of making an entirely new `pizza2`.

Python actually allows you to *mutate* some objects, including lists and dictionaries. Mutability means that the object’s contents can be changed. So instead of building a new `pizza2`, we can use `pizza1.append('onions')` to mutate `pizza1`.

```python
>>> pizza1.append('onions')
>>> pizza1
['cheese', 'mushrooms', 'onions']
```

Although lists and dictionaries are mutable, many other objects, such as numeric types, tuples, and strings, are *immutable*, meaning they cannot be changed once they are created. We can use the familiar indexing operator to mutate a single element in a list. For instance `lst[4] = 'hello'` would change the fifth element in `lst` to be the string `'hello'`. In
addition to the indexing operator, lists have many mutating methods. List \textit{methods} are functions that are bound to a specific list. Some useful list methods are listed here:

1. \texttt{append(el)} adds \texttt{el} to the end of the list
2. \texttt{insert(i, el)} inserts \texttt{el} at index \texttt{i}
3. \texttt{remove(el)} removes the first occurrence of \texttt{el} in list, otherwise errors
4. \texttt{sort()} sorts elements of list \textit{in place}

List methods are called via \textit{dot notation}, as in:

```python
>>> colts = ['andrew luck', 'reggie wayne']
>>> colts.append('trent richardson')
```

None of the mutating list methods \texttt{return} a new list — they simply modify the original list and \texttt{return} \texttt{None}. 

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\textit{Discussion 3: Lists}
2 For Loops and List Comprehensions

There are two common methods of looping through lists. If you don’t need indices, looping
over elements is usually more clear.

- for el in lst loops through the elements in lst
- for i in range(len(lst)) loops through the valid, positive indices of lst

A list comprehension is a compact way to create a list whose elements are the results of
applying a fixed expression to elements in another sequence.

[<map exp> for <name> in <iter exp> if <filter exp>]

Let’s break down an example:

[x * x - 3 for x in [1, 2, 3, 4, 5] if x % 2 == 1]

In this list comprehension, we are creating a new list after performing a series of opera-
tions to our initial sequence [1, 2, 3, 4, 5]. We only keep the elements that satisfy
the filter expression x % 2 == 1 (1, 3, and 5). For each retained element, we apply the
map expression x * x - 3 before adding it to the new list that we are creating, resulting
in the output [-2, 6, 22].

Note: The if clause in a list comprehension is optional.
3 Questions

1. What would Python print?
   >>> [i + 1 for i in [1, 2, 3, 4, 5] if i % 2 == 0]

   >>> [i * i - i for i in [5, -1, 3, -1, 3] if i > 2]

   >>> [[y * 2 for y in [x, x + 1]] for x in [1, 2, 3, 4]]

2. Define a function foo that takes in a list lst and returns a new list that keeps only the even-indexed elements of lst and multiples each of those elements by the corresponding index.
   ```python
def foo(lst):
    """
    >>> x = [1, 2, 3, 4, 5, 6]
    >>> foo(x)
    [0, 6, 20]
    """
    return [_________________________________________]
   ```
3. Write a function `square_elements` which takes a `lst` and replaces each element with the square of that element. Mutate `lst` rather than returning a new list.

```python
def square_elements(lst):
    """
    >>> lst = [1, 2, 3]
    >>> square_elements(lst)
    >>> lst
    [1, 4, 9]
    """
```

4. Write a function that takes in two values `x` and `el`, and a list, and adds as many `el`’s to the end of the list as there are `x`’s.

```python
def add_this_many(x, el, lst):
    """ Adds el to the end of lst the number of times x occurs in lst.
    >>> lst = [1, 2, 4, 2, 1]
    >>> add_this_many(1, 5, lst)
    >>> lst
    [1, 2, 4, 2, 1, 5, 5]
    """
```
5. Reverse a list \textit{in place}, i.e. mutate the given list itself, instead of returning a new list.

```python
def reverse(lst):
    """ Reverses lst in place."
    >>> x = [3, 2, 4, 5, 1]
    >>> reverse(x)
    >>> x
    [1, 5, 4, 2, 3]
    """
```