A complex function

```
def split_and_stack(df, new_names):
  half = int(len(df.columns) / 2)
  left = df.iloc[:, :half]
  right = df.iloc[:, half:]
  return pd.DataFrame(
    data=np.vstack([left.values, right.values]),
    columns=new_names
  )
```

```
def split_and_stack(df, new_names):
  """Split a DataFrame's columns into two halves and then stack
  them vertically, returning a new DataFrame with `new_names` as the
  column names.

  Args:
    df (DataFrame): The DataFrame to split.
    new_names (iterable of str): The column names for the new DataFrame.

  Returns:
    DataFrame
  """
  half = int(len(df.columns) / 2)
  left = df.iloc[:, :half]
  right = df.iloc[:, half:]
  return pd.DataFrame(
    data=np.vstack([left.values, right.values]),
    columns=new_names
  )
```

Anatomy of a docstring

```
def function_name(arguments):
  """
  Description of what the function does.

  Description of the arguments, if any.

  Description of the return value(s), if any.

  Description of errors raised, if any.

  Optional extra notes or examples of usage.
  """
```

Docstring formats

- Google Style
- Numpydoc
- reStructuredText
- EpyText

Google Style - description

```
def function(arg_1, arg_2=42):
  """Description of what the function does.
  """
```

Google style - arguments

```
def function(arg_1, arg_2=42):
  """Description of what the function does.

  Args:
    arg_1 (str): Description of arg_1 that can break onto the next line
      if needed.
    arg_2 (int, optional): Write optional when an argument has a default
      value.
  """
```

Google style - return value(s)

```
def function(arg_1, arg_2=42):
  """Description of what the function does.

  Args:
    arg_1 (str): Description of arg_1 that can break onto the next line
      if needed.
    arg_2 (int, optional): Write optional when an argument has a default
      value.

  Returns:
    bool: Optional description of the return value
    Extra lines are not indented.
  """
```

```
def function(arg_1, arg_2=42):
  """Description of what the function does.

  Args:
    arg_1 (str): Description of arg_1 that can break onto the next line
      if needed.
    arg_2 (int, optional): Write optional when an argument has a default
      value.

  Returns:
    bool: Optional description of the return value
    Extra lines are not indented.

  Raises:
    ValueError: Include any error types that the function intentionally
      raises.

  Notes:
    See https://www.datacamp.com/community/tutorials/docstrings-python
    for more info.
  """
```

Numpydoc

```
def function(arg_1, arg_2=42):
  """
  Description of what the function does.

  Parameters
  ----------
  arg_1 : expected type of arg_1
    Description of arg_1.
  arg_2 : int, optional
    Write optional when an argument has a default value.
    Default=42.

  Returns
  -------
  The type of the return value
    Can include a description of the return value.
    Replace "Returns" with "Yields" if this function is a generator.
  """
```

Retrieving docstrings

```
def the_answer():
  """Return the answer to life,
  the universe, and everything.

  Returns:
    int
  """
  return 42
print(the_answer.__doc__)
```

```
Return the answer to life,
  the universe, and everything.

  Returns:
    int
```

```
import inspect
print(inspect.getdoc(the_answer))
```

```
Return the answer to life,
the universe, and everything.

Returns:
  int
```

Let's practice!

WRITING FUNCTIONS IN PYTHON

Don't repeat yourself (DRY)

```
train = pd.read_csv('train.csv')
train_y = train['labels'].values
train_X = train[col for col in train.columns if col != 'labels'].values
train_pca = PCA(n_components=2).fit_transform(train_X)
plt.scatter(train_pca[:,0], train_pca[:,1])
```

```
val = pd.read_csv('validation.csv')
val_y = val['labels'].values
val_X = val[col for col in val.columns if col != 'labels'].values
val_pca = PCA(n_components=2).fit_transform(val_X)
plt.scatter(val_pca[:,0], val_pca[:,1])
```

```
test = pd.read_csv('test.csv')
test_y = test['labels'].values
test_X = test[col for col in test.columns if col != 'labels'].values
test_pca = PCA(n_components=2).fit_transform(train_X)
plt.scatter(test_pca[:,0], test_pca[:,1])
```

The problem with repeating yourself

```
train = pd.read_csv('train.csv')
train_y = train['labels'].values
train_X = train[col for col in train.columns if col != 'labels'].values
train_pca = PCA(n_components=2).fit_transform(train_X)
plt.scatter(train_pca[:,0], train_pca[:,1])
```

```
val = pd.read_csv('validation.csv')
val_y = val['labels'].values
val_X = val[col for col in val.columns if col != 'labels'].values
val_pca = PCA(n_components=2).fit_transform(val_X)
plt.scatter(val_pca[:,0], val_pca[:,1])
```

```
test = pd.read_csv('test.csv')
test_y = test['labels'].values
test_X = test[col for col in test.columns if col != 'labels'].values
test_pca = PCA(n_components=2).fit_transform(train_X)  ### yikes! ###
plt.scatter(test_pca[:,0], test_pca[:,1])
```

Another problem with repeating yourself

```
train = pd.read_csv('train.csv')
train_y = train['labels'].values  ### <- there and there --v ###
train_X = train[col for col in train.columns if col != 'labels'].values
train_pca = PCA(n_components=2).fit_transform(train_X)
plt.scatter(train_pca[:,0], train_pca[:,1])
```

```
val = pd.read_csv('validation.csv')
val_y = val['labels'].values  ### <- there and there --v ###
val_X = val[col for col in val.columns if col != 'labels'].values
val_pca = PCA(n_components=2).fit_transform(val_X)
plt.scatter(val_pca[:,0], val_pca[:,1])
```

```
test = pd.read_csv('test.csv')
test_y = test['labels'].values  ### <- there and there --v ###
test_X = test[col for col in test.columns if col != 'labels'].values
test_pca = PCA(n_components=2).fit_transform(test_X)
plt.scatter(test_pca[:,0], test_pca[:,1])
```

Use functions to avoid repetition

```
def load_and_plot(path):
  """Load a data set and plot the first two principal components.

  Args:
    path (str): The location of a CSV file.

  Returns:
    tuple of ndarray: (features, labels)
  """
  data = pd.read_csv(path)
  y = data['label'].values
  X = data[col for col in train.columns if col != 'label'].values
  pca = PCA(n_components=2).fit_transform(X)
  plt.scatter(pca[:,0], pca[:,1])
  return X, y
```

```
train_X, train_y = load_and_plot('train.csv')
val_X, val_y = load_and_plot('validation.csv')
test_X, test_y = load_and_plot('test.csv')
```

```
def load_and_plot(path):
  """Load a data set and plot the first two principal components.

  Args:
    path (str): The location of a CSV file.

  Returns:
    tuple of ndarray: (features, labels)
  """
  data = pd.read_csv(path)
  y = data['label'].values
  X = data[col for col in train.columns if col != 'label'].values

  pca = PCA(n_components=2).fit_transform(X)
  plt.scatter(pca[:,0], pca[:,1])

  return X, y
```

```
def load_and_plot(path):
  """Load a data set and plot the first two principal components.

  Args:
    path (str): The location of a CSV file.

  Returns:
    tuple of ndarray: (features, labels)
  """
  # load the data
  data = pd.read_csv(path)
  y = data['label'].values
  X = data[col for col in train.columns if col != 'label'].values

  pca = PCA(n_components=2).fit_transform(X)
  plt.scatter(pca[:,0], pca[:,1])

  return X, y
```

```
def load_and_plot(path):
  """Load a data set and plot the first two principal components.

  Args:
    path (str): The location of a CSV file.

  Returns:
    tuple of ndarray: (features, labels)
  """
  # load the data
  data = pd.read_csv(path)
  y = data['label'].values
  X = data[col for col in train.columns if col != 'label'].values

  # plot the first two principal components
  pca = PCA(n_components=2).fit_transform(X)
  plt.scatter(pca[:,0], pca[:,1])

  return X, y
```

```
def load_and_plot(path):
  """Load a data set and plot the first two principal components.

  Args:
    path (str): The location of a CSV file.

  Returns:
    tuple of ndarray: (features, labels)
  """
  # load the data
  data = pd.read_csv(path)
  y = data['label'].values
  X = data[col for col in train.columns if col != 'label'].values

  # plot the first two principle components
  pca = PCA(n_components=2).fit_transform(X)
  plt.scatter(pca[:,0], pca[:,1])

  # return loaded data
  return X, y
```

Do One Thing

```
def load_data(path):
  """Load a data set.

  Args:
    path (str): The location of a CSV file.

  Returns:
    tuple of ndarray: (features, labels)
  """
  data = pd.read_csv(path)
  y = data['labels'].values
  X = data[col for col in data.columns
           if col != 'labels'].values
  return X, y
```

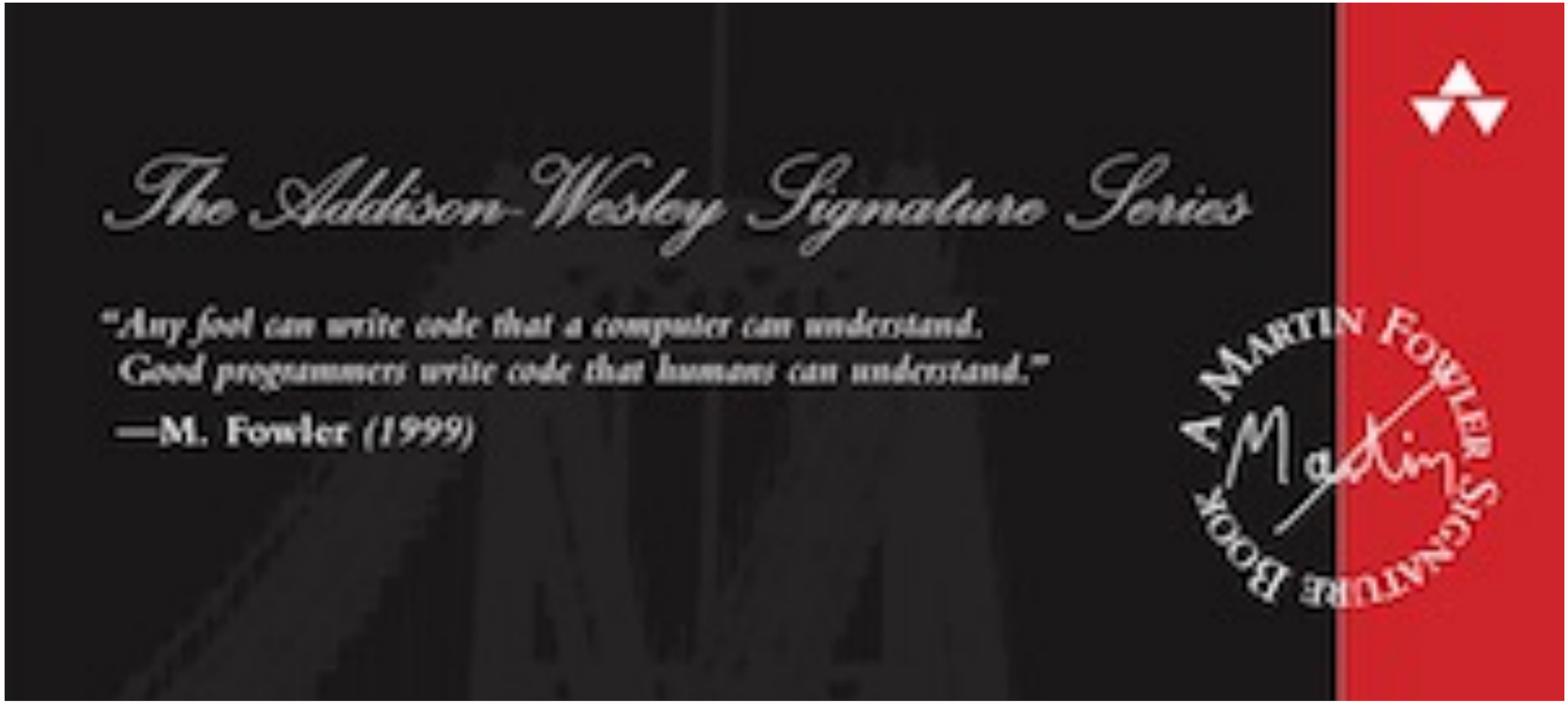
```
def plot_data(X):
  """Plot the first two principal components of a matrix

  Args:
    X (numpy.ndarray): The data to plot.
  """
  pca = PCA(n_components=2).fit_transform(X)
  plt.scatter(pca[:,0], pca[:,1])
```

Advantages of doing one thing

The code becomes:

- More flexible
- More easily understood
- Simpler to test
- Simpler to debug
- Easier to change

Code smells and refactoring



Let's practice!

WRITING FUNCTIONS IN PYTHON

A surprising example

```
def foo(x):
  x[0] = 99
my_list = [1, 2, 3] # List are Mutable
foo(my_list)
print(my_list)
```

```
[99, 2, 3]
```

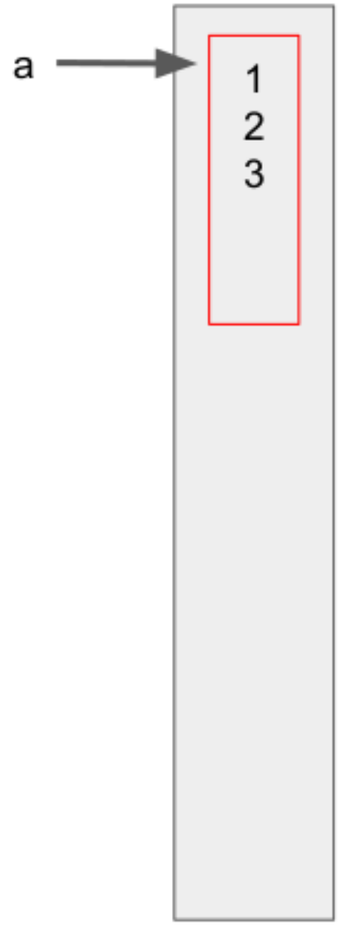
```
def bar(x):
  x = x + 90
my_var = 3  # integers are immutable
bar(my_var)
print(my_var)
```

```
3
```

Digging deeper

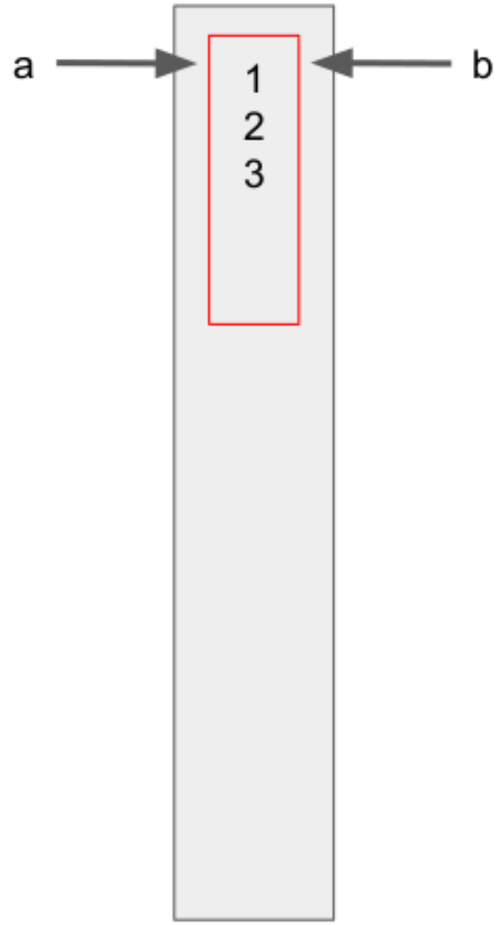
Digging deeper

```
a = [1, 2, 3]
```



Digging deeper

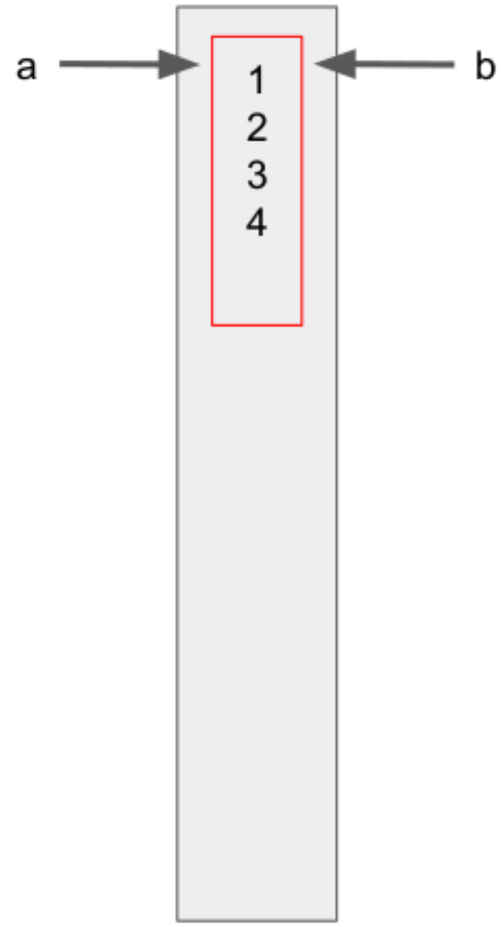
```
a = [1, 2, 3]
b = a
```



Digging deeper

```
a = [1, 2, 3]
b = a
a.append(4)
print(b)
```

```
[1, 2, 3, 4]
```



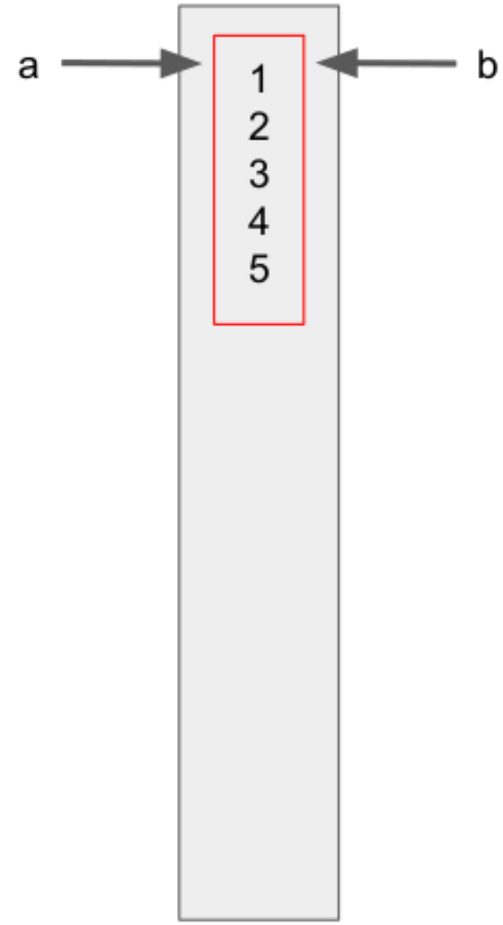
Digging deeper

```
a = [1, 2, 3]
b = a
a.append(4)
print(b)
```

```
[1, 2, 3, 4]
```

```
b.append(5)
print(a)
```

```
[1, 2, 3, 4, 5]
```



Digging deeper

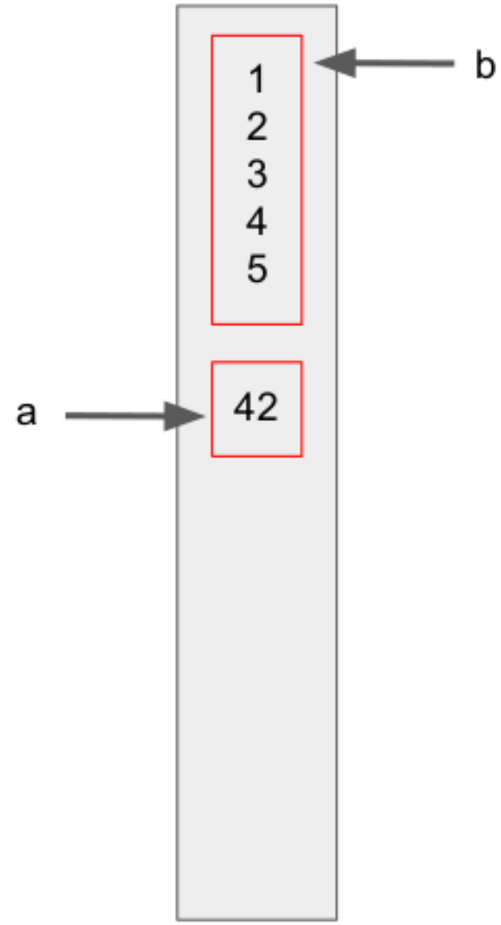
```
a = [1, 2, 3]
b = a
a.append(4)
print(b)
```

```
[1, 2, 3, 4]
```

```
b.append(5)
print(a)
```

```
[1, 2, 3, 4, 5]
```

```
a = 42
```

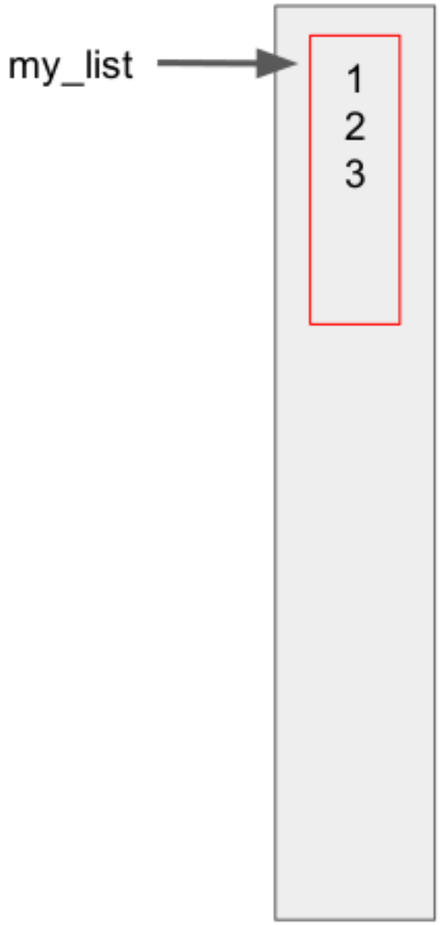


Pass by assignment

```
def foo(x):
  x[0] = 99
```

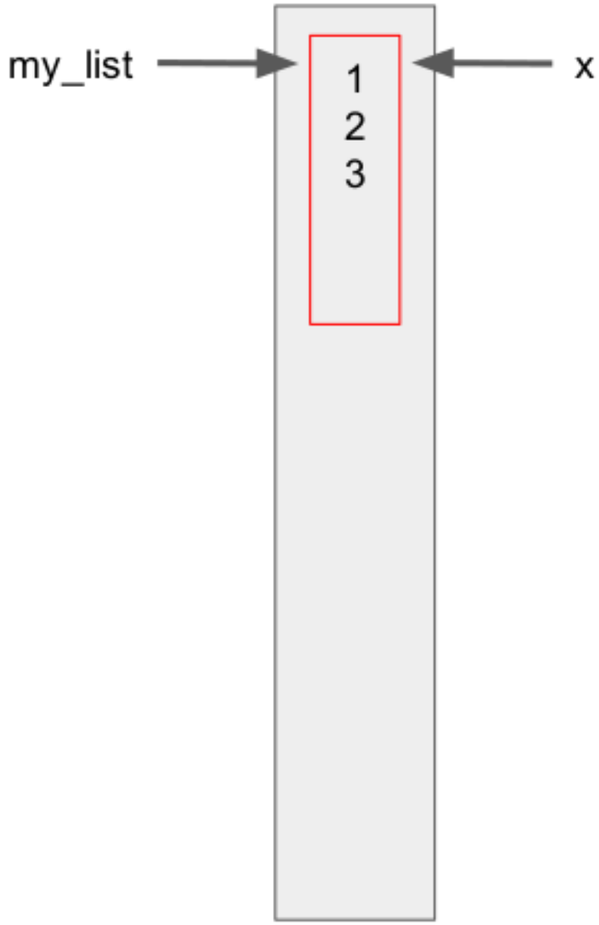
Pass by assignment

```
def foo(x):
  x[0] = 99
my_list = [1, 2, 3]
```



Pass by assignment

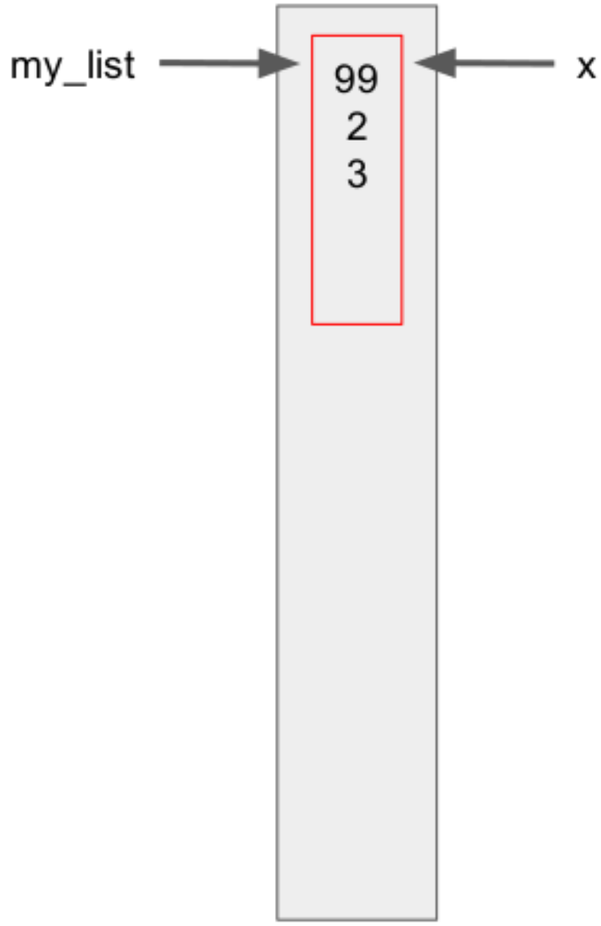
```
def foo(x):
  x[0] = 99
my_list = [1, 2, 3]
foo(my_list)
```



Pass by assignment

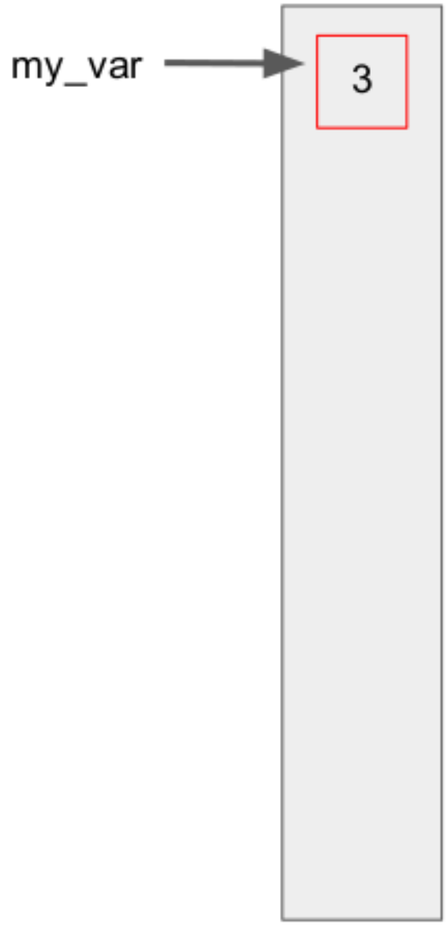
```
def foo(x):
  x[0] = 99
my_list = [1, 2, 3]
foo(my_list)
print(my_list)
```

```
[99, 2, 3]
```



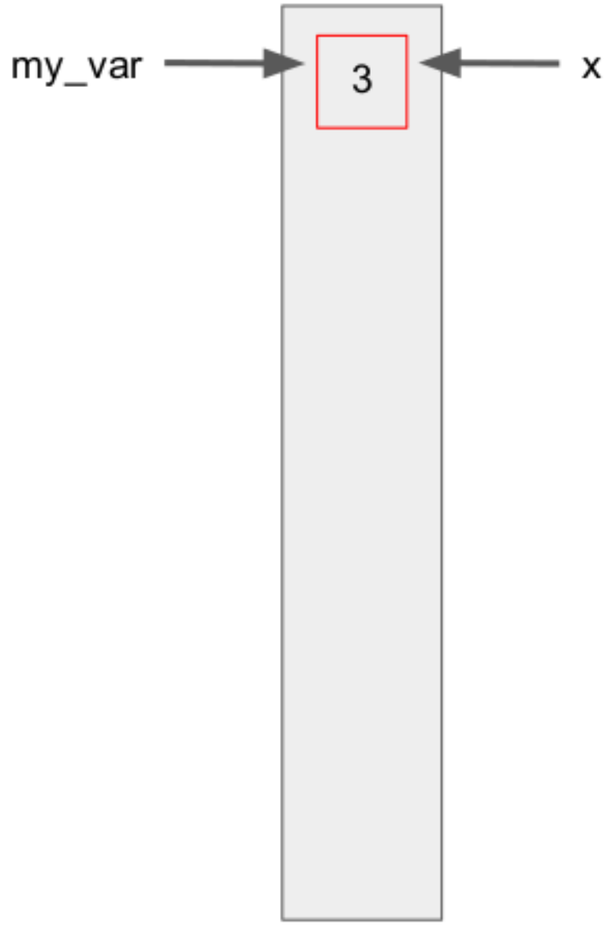
Pass by assignment

```
def bar(x):
  x = x + 90
my_var = 3
```



Pass by assignment

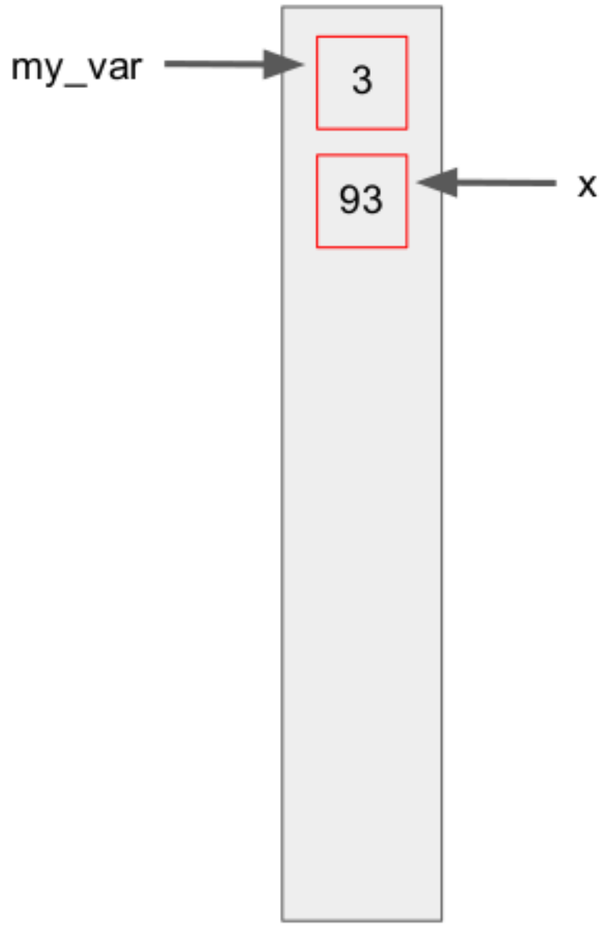
```
def bar(x):
  x = x + 90
my_var = 3
bar(my_var)
```



Pass by assignment

```
def bar(x):
  x = x + 90
my_var = 3
bar(my_var)
my_var
```

```
3
```



Immutable or Mutable?

Immutable BFSBINFT

- int
- float
- bool
- string
- bytes
- tuple
- frozenset
- None

Mutable LSDOFAB

- list
- dict
- set
- bytearray
- objects
- functions
- almost everything else!

Mutable default arguments are dangerous!

```
def foo(var=[]):
  var.append(1)
  return var
foo()
```

```
[1]
```

```
foo()
```

```
[1, 1]
```

```
def foo(var=None):
  if var is None:
    var = []
  var.append(1)
  return var
foo()
```

```
[1]
```

```
foo()
```

```
[1]
```

Let's practice!

WRITING FUNCTIONS IN PYTHON