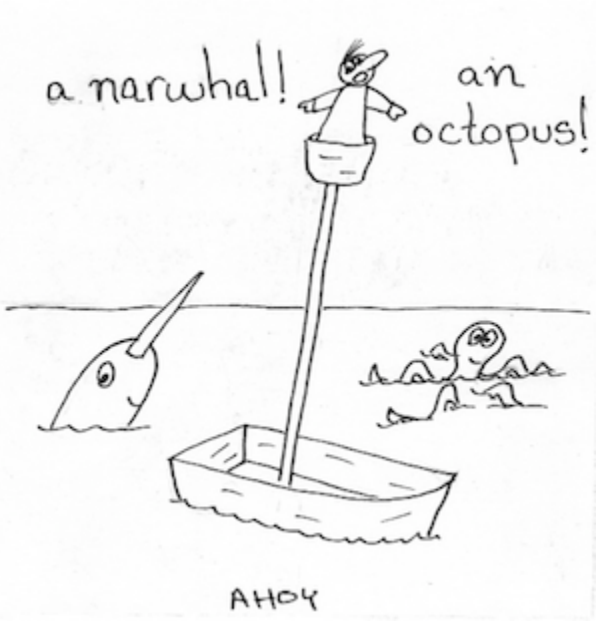
Chapter 3: The Crow's Nest: Working with strings

Avast, you corny-faced gollumpus! Ye are barrelman for this watch. D'ye ken what I mean, ye addle pated blunderbuss?! Ah, land lubber ye be! OK, then, you are the lookout in the crow's nest — the little bucket attached to the top of a mast of a sailing ship. Your job is to keep a lookout for interesting or dangerous things, like a ship to plunder or an iceberg to avoid. When you see something like a "narwhal," you are supposed to cry out, "Ahoy, Captain, ***a narwhal*** off the larboard bow!" If you see an octopus, you'll shout "Ahoy, Captain, ***an octopus*** off the larboard bow!" (We'll assume everything is "off the larboard bow" for this exercise. It's a great place for things to be.)



From this point on, I will describe a coding challenge that you should write on your own. I will discuss key ideas you'll need to solve the problems as well as how to use the provided tests to help you know when your program is correct. You should have a copy of the Git repository locally (see the setup instructions). You should write your program in the chapter's directory, like this program should be written in the `crowsnest` directory where the tests for the program live.

In this chapter, we're going to start off working with strings. By the end, you will be able to:

- Create a program that accepts a positional argument and produces usage documentation
- Create a new output string depending on the inputs to the program
- Run a test suite

Your program should be called `crowsnest.py`. It will accept a single positional argument and will print the given argument inside the "Ahoy" bit along with the word "a" or "an" depending on whether the argument starts with a consonant or a vowel.

That is, if given "narwhal," it should do this:

```
$ ./crowsnest.py narwhal
Ahoy, Captain, a narwhal off the larboard bow!
```

And if given "octopus":

```
$ ./crowsnest.py octopus
Ahoy, Captain, an octopus off the larboard bow!
```

This means we're going to need to write a program that accepts some input on the command line, decides on the proper article ("a" or "an") for the input, and prints out a new string that puts those two values into the "Ahoy" phrase.

Getting started

You're probably ready to start writing the program! Well, hold on just a minute longer, ye duke of limbs. We need to discuss how we'll use the tests to know when our program is working and how we might get started programming.

How to use the tests

> *"The greatest teacher, failure is." — Yoda*

In the code repository, I've included tests that will guide you in the writing of your program. Before you even write the first line of code, I'd like you to run `make test` or `pytest -xv test.py` so you can see how the first test fails. Be sure you are in the `crowsnest` directory for this!

Among all the output, you'll notice this line:

```
test.py::test_exists FAILED                                          [ 16%]
```

If you read more, you'll see lots of other output all trying to convince you that the expected file, `crowsnest.py` does not exist. Learning to read the test output is a skill in itself! It takes quite a bit of practice to learn to read test output, so try not to feel overwhelmed. In my terminal (iTerm on a Mac), the output from `pytest` shows colors and bold print to highlight key failures. The text in bold, red letters is usually where I start, but your terminal may behave differently.

Creating programs with `new.py`

In order to pass this test, we need to create a file called `crowsnest.py` inside the `crowsnest` directory where `test.py` is located. While it's perfectly fine to start writing from scratch, I suggest you use the `new.py` program to print some useful boilerplate code that you'll need in every exercise:

```
$ new.py crowsnest.py
Done, see new script "crowsnest.py."
```

If you don't want to use `new.py`, you could copy the `template/template.py` program:

```
$ cp template/template.py crowsnest/crowsnest.py
```

At this point you should have the outline of a working `crowsnest.py` program that accepts command-line arguments. If you run your new `crowsnest.py` with no arguments, it will print a short usage statement like the following (notice how "usage" is the first word of the output):

```
$ ./crowsnest.py
usage: crowsnest.py [-h] [-a str] [-i int] [-f FILE] [-o] str
crowsnest.py: error: the following arguments are required: str
```

Those are not the correct parameters for our program, just the default examples given to you by `new.py`. You will need to modify them to suit this program.

If you run your tests again, you will pass the first *two* tests that check:

1. Does the program exist?

2. Does the program print something that looks like "usage."

And then you will fail the third test. There are more tests after this, but that's all your see if you run `pytest -xv test` because the `-x` flag tells `pytest` to stop at the first failing test. Note that we can combine the `-x` and `-v` flags into `-xv` and that the order doesn't matter, so `-vx` is fine, too:

```
test.py::test_exists PASSED                                          [ 16%] 1
test.py::test_usage PASSED                                           [ 33%] 2
test.py::test_consonant FAILED                                       [ 50%] 3
```

1. This test checks if the file `crowsnest.py` exists.
2. This test runs `crowsnest.py` to see if it produces a "usage" statement.
3. This test runs the program and passes it a word starting with a consonant to see if it produces the expected output. It has `FAILED`, and so all testing stops because of the `-x` flag.

Now we have a working program that accepts some arguments (but not the right ones). Next we need to make our program accept the "narwhal" or "octopus" value that needs to be announced, and we'll use command-line arguments to do that.

Defining your arguments

Here is a diagram sure to shiver your timbers showing the inputs (or *parameters*) and output of the program. We'll use these throughout the book to imagine how code and data work together. In this program, some "word" is the input, and a phrase incorporating that word with the correct article is the ouptut.

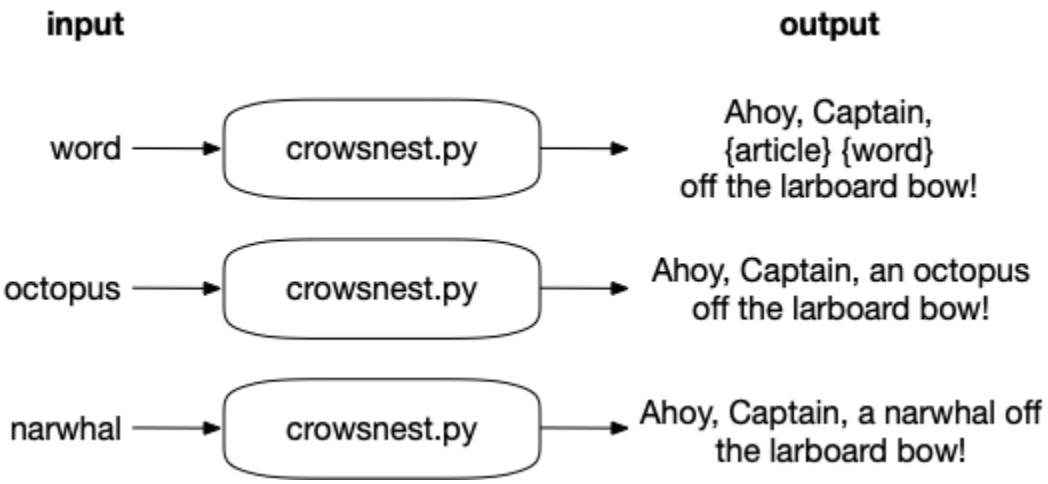


Figure 1. The input to the program is a word, and the output is that word plus it's proper article (and some other stuff).

We need to modify the part of the program that gets the arguments — the aptly named `get_args` function. This function uses the `argparse` module to parse the command-line arguments. Refer to the `argparse` chapter, particularly the section "A single, positional argument." The default `get_args` names the first argument `'positional'`, and that's the only one you need. Remember that positional arguments are defined by their position and don't have names that start with dashes. You can delete all the arguments except for the positional `word`.

Modify the `get_args` part of your program until it will print this usage:

```
$ ./crowsnest.py
usage: crowsnest.py [-h] str
crowsnest.py: error: the following arguments are required: str
```

Likewise, it should print a longer usage for the `-h` or `--help` flag:

```
$ ./crowsnest.py -h
usage: crowsnest.py [-h] str

Crow's Nest -- choose the correct article

positional arguments:
  str         A word  1

optional arguments:
  -h, --help  show this help message and exit  2
```

1. You need to define a `word` parameter. Notice that it is listed as a "positional" argument.
2. The `-h` and `--help` flags are created automatically by `argparse`. You are not allowed to use these as options. They are used to create the documentation for your program.

When your program prints the correct usage, you can get the `word` argument inside the `main` function like so:

```
def main():
    args = get_args()
    word = args.word
```

Make your program print the given `word`:

```
$ ./crowsnest.py narwhal
narwhal
```

And now run your tests. You should still be passing two and failing the third. Let's read the test failure:

```
================================== FAILURES ===================================
_____________________________ test_consonant ______________________________

    def test_consonant():
        """brigatine -> a brigatine"""

        for word in consonant_words:
            out = getoutput('{} {}'.format(prg, word))
>           assert out.strip() == template.format('a', word)                                  1
E           AssertionError: assert 'brigatine' == 'Ahoy, Captain, a brigatine off the larboard bow!'  2
E             - brigatine                                                                     3
E             + Ahoy, Captain, a brigatine off the larboard bow!                              4
```

1. The line starting with `>` shows code that produced an error. The output of the program is compared to an expected string. Since it didn't match, the `assert` produces an exception.
2. This line starts with `E` to indicate the "error."
3. The line starting with a `-` is what the test got when it ran with the argument `'brigatine'` — it got back just the word "brigatine."
4. The line starting with the `+` is what the test expected, "Ahoy, Captain, a brigatine off the larboard bow!"

So, we need to get the `word` into the "Ahoy" phrase. How can we do that?

Concatenating strings

Putting strings together is called "concatenating" or "joining" strings. To demonstrate, I'm going to enter some code directly into the Python interpreter. I want you to type along. No, really! Type everything you see, and try it for yourself.

Open a terminal and type `python3` or `ipython` to start a REPL, a "Read-Evaluate-Print-Loop" because Python will *read* each line of input, *evaluate* and *print* the results in a *loop*. Here's what it looks like on my system:

```
$ python3
Python 3.7.3 (default, Mar 27 2019, 16:54:48)
[Clang 4.0.1 (tags/RELEASE_401/final)] :: Anaconda, Inc. on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

You may also like to use Python's IDLE (integrated development and learning environment) program, or you can use Jupyter Notebooks to interact with the language. I'll stick to the `python3` REPL for showing code examples. To exit the REPL, either type `quit()` or `CTRL-d` (the `Control` key plus the `d`).

The `>>>` is a prompt where you can type code. Let's start off by assigning the variable `word` to the value "narwhal." In the REPL, type `word = 'narwhal'<Enter>`:

```
>>> word = 'narwhal'
```

Note that you can put as many (or no) spaces around the `=` as you like, but convention and readability (and tools like `pylint` or `flake8` that help you find errors in your code) would ask you to use exactly one space on either side. If you type `word<Enter>`, Python will print the current value of `word`:

```
>>> word
'narwhal'
```

Now type `werd<Enter>`:

```
>>> werd
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'werd' is not defined
```

There is no `werd` variable because we haven't set `werd` to be anything. Using an undefined variable causes an *exception* that will crash your program. Python will happily create a `werd` for you when you assign it a value.

In Python, there are many ways we can concatenating strings. The `+` operator can be used to join strings together:

```
>>> 'Ahoy, Captain, a ' + word + ' off the larboard bow!'
'Ahoy, Captain, a narwhal off the larboard bow!'
```

If you change your program to `print` that instead of just the `word`, you should be able to four tests:

```
test.py::test_exists PASSED                                              [ 16%]
test.py::test_usage PASSED                                               [ 33%]
test.py::test_consonant PASSED                                           [ 50%]
test.py::test_consonant_upper PASSED                                     [ 66%]
test.py::test_vowel FAILED                                               [ 83%]
```

If we look closely at the failure, you'll see this:

```
E             - Ahoy, Captain, a aviso off the larboard bow!
E             + Ahoy, Captain, an aviso off the larboard bow!
E             ?                  +
```

So we hard-coded the "a" before the `word`, but we really need to figure out whether to put "a" or "an" depending on whether the `word` starts with a vowel. How can we do that?

Variable types

Before we go much further, I need to take a small step back and point out that our `word` variable is a "string." Every variable in Python has a "type" that describes the kind of data they hold. Because we put the value for `word` in quotes (`'narwhal'`), the `word` holds a "string" which Python represents with a class called `str`. (A "class" is a collection of code and functions that we can use.)

The `type` function will tell us what kind of data Python thinks this is:

```
>>> type(word)
<class 'str'>
```

Whenever you put a value in single (`''`) or double quotes (`""`), Python will interpret it as a `str`:

```
>>> type("submarine")
<class 'str'>
```

If you forget the quotes, then Python will look for some variable or function by that name. If there is no variable or function by that name, it will cause an exception.

```
>>> word = narwhal
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'narwhal' is not defined
```

Exceptions are bad, and we will try to write code that avoids them or at least knows how to handle them gracefully.

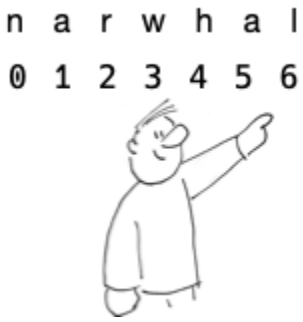
Getting just part of a string

Back to our problem! We need to put either "a" or "an" in front of the `word` we're given based on whether the first character of `word` is a vowel or a consonant. In Python, we use square brackets and an *index* to get an individual character from a string. The index is the numeric position of an element in a sequence, and we must remember that indexing starts at `0`. You can use this with a variable:

```
>>> word[0]
'n'
```

Or directly on a string:

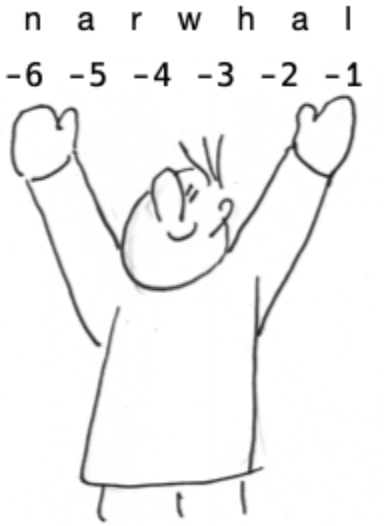
```
>>> 'narwhal'[0]
'n'
```



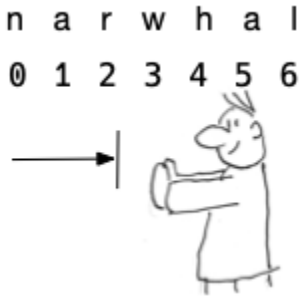
This means that the last index is *one less than the length*, which is often confusing. The length of "narwhal" is 7, but the last character is found at index `6`:

```
>>> word[6]
'l'
```

You can also use negative numbers to count backwards from the end, so the last index is also `-1`:




```
>>> word[-1]
'l'
```



You can use the "slice" notation `[start:stop]` to get a range of characters. Both `start` and `stop` are optional. The default value for start is `0` (the beginning of the string), and the `stop` value is *not inclusive*:

```
>>> word[:3]
'nar'
```

And the default value for `stop` is the end of the string:

```
>>> word[3:]
'whal'
```

In the next chapter, we'll see that this is the same syntax for slicing lists. A string is (sort of) a list of characters, so this isn't too strange.

Finding help in the REPL

The class `str` has a ton of functions we can use to handle strings, but what are they? A large part of programming is knowing how to ask questions and where to look for answers. A common refrain you may hear is "RTFM" — Read the Fine Manual. The Python community has created reams of documentation which are all available at https://docs.python.org/3/. You will need to refer to the documentation constantly to remind yourself how to use certain functions.

The docs for the string class are here:

https://docs.python.org/3/library/string.html

I prefer to read the docs directly inside the REPL by typing `help(str)`:

```
>>> help(str)
```

Inside the `help`, you move up and down in the text using the up and down cursor arrows on your keyboard. You can also press the `<Space>` bar or `CTRL-f` to jump forward to the next page, and `CTRL-b` to jump backward. You can search through the documentation by pressing `/` and then the text you want to find. If you press `n` (for "next") after a search, you will jump to the next place that string is found. To leave the help, press `q` (for "quit").

String methods

Now that we know `word` is a string (`str`), we have all these incredibly useful *methods* we can call on the variable. (A "method" is a function that belongs to a variable like `word`.) For instance, if I wanted to shout about the fact that we have a "narwhal," I could print it in UPPERCASE LETTERS. If I search through the help, I see there is a function called `upper`. Here is how to call it:

```
>>> word.upper()
'NARWHAL'
```

You must include the parentheses `()` or else you're talking about the *function itself*:

```
>>> word.upper
<built-in method upper of str object at 0x10559e500>
```

That will actually come in handy later when we use functions like `map` and `filter`, but for now we want Python to *execute* or *call* the `upper` function on the varible `word`, so we add the parens. Note that the function returns an uppercase version of the word but *does not* change the value of `word` itself:

```
>>> word
'narwhal'
```

There is another `str` function with "upper" in the name called `isupper`. The name helps you know that this will return a True/False type answer. Let's try it:

```
>>> word.isupper()
False
```

We can chain methods together like so:

```
>>> word.upper().isupper()
True
```

That makes sense. If I convert the `word` to uppercase, then `isupper` is `True`.

I find it odd that the `str` class does not include a method to get the length of a string. For that, we use a separate function called `len`, short for "length":


```
>>> len('narwhal')
7
```

Are you typing all this into Python yourself? I recommend you do! Find other methods in the `str` help and try them out.

String comparisons

So now you know how to get the first letter of `word` by using `word[0]`. Let's assign it to the variable `char`:

```
>>> word = 'octopus'
>>> char = word[0]
>>> char
'o'
```

Now we need to figure out if `char` is a vowel or a consonant. We'll say that letters "a," "e," "i," "o," and "u" make up our set of "vowels." You can use `==` to compare strings:

```
>>> char == 'a'
False
>>> char == 'o'
True
```

Be careful to always use one equal sign (`=`) when *assigning a value* to a variable, like `word = 'narwhal'` and two equal signs (`==`, which, in my head, I say "equal-equal") when you *compare two values* like `word == 'narwhal'`. The first is a statement that changes the value of `word`, and the second is an *expression* that returns `True` or `False`.

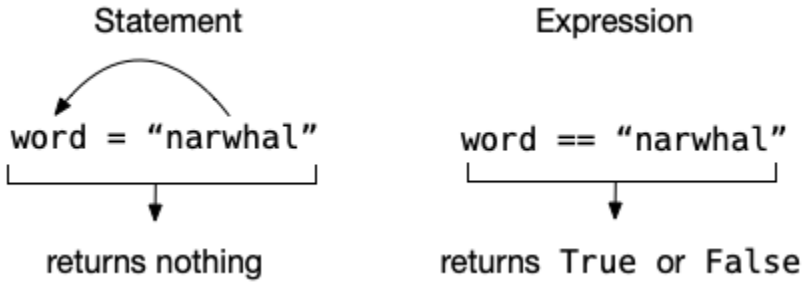


Figure 2. An expression returns a value. A statement does not.

We need to compare our `char` to *all* the vowels. You can use `and` and `or` in such comparisons and they will be combined according to standard Boolean algebra:

```
>>> char == 'a' or char == 'e' or char == 'i' or char == 'o' or char == 'u'
True
```

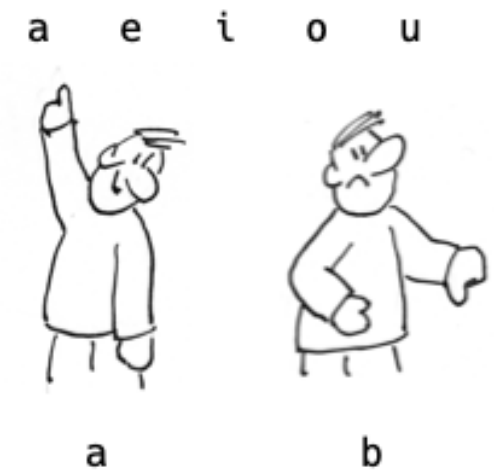
What if the `word` is "Octopus" or "OCTOPUS"?

```
>>> word = 'OCTOPUS'
>>> char = word[0]
>>> char == 'a' or char == 'e' or char == 'i' or char == 'o' or char == 'u'
False
```

Do we have to make 10 comparisons in order to check the uppercase versions, too? What if we were to lowercase `word[0]`? Remember, that `word[0]` returns a `str`, and so we can chain other `str` methods onto that:

```
>>> word = 'OCTOPUS'
>>> char = word[0].lower()
>>> char == 'a' or char == 'e' or char == 'i' or char == 'o' or char == 'u'
True
```

An easier way to determine if `char` is a vowel would be to use Python's `x in y` construct where we want to know if the value `x` is in the collection `y`. We can ask if the letter `'a'` is in the longer string `'aeiou'`:




```
>>> 'a' in 'aeiou'
True
```

But the letter `'b'` is not:

```
>>> 'b' in 'aeiou'
False
```

Let's use that to test the first character of the lowercased `word` (which is `'o'`):

```
>>> word = 'OCTOPUS'
>>> word[0].lower() in 'aeiou'
True
```

Conditional branching

Once you have figured out if the first letter is a vowel, you will need to select an article. We'll use a very simple rule that, if the word starts with a vowel, choose "an," otherwise choose "a." This misses exceptions like when the initial "h" in a word is silent, for instance, we say "a hat" but "an honor". Nor will we consider when an initial vowel has a consonant sound as in "union" where the "u" sounds like a "y."

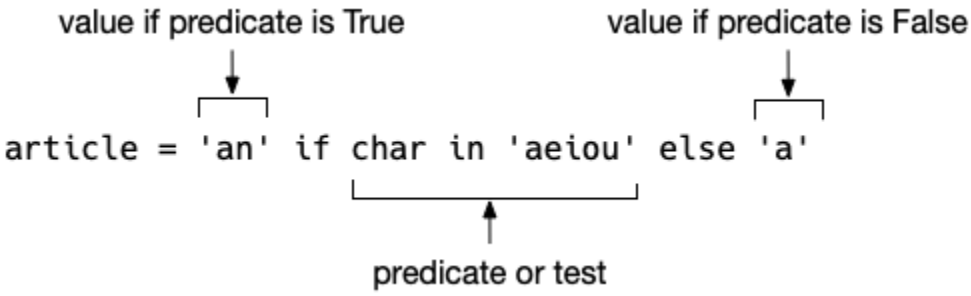
We can create a new variable called `article` that we will set to the empty string and then use an `if`/`else` statement to figure out what to put in it:

```
>>> article = ''                    1
>>> if word[0].lower() in 'aeiou':  2
...     article = 'an'              3
... else:                           4
...     article = 'a'               5
...
```

1 Initialize `article` to the empty string.

2. Check if the first, lowercased character of `word` is a vowel.
3. If it is, set `article` to `'an'`
4. Otherwise,
5. Set `article` to `'an'`.

Here is a much shorter way to write that with an `if` *expression* (expressions return values, statements do not). The `if` expression is written a little backwards. First comes the value if the test (or "predicate") is `True`, then the predicate, then the value if the predicate is `False`.



This way is also safer because the `if` expression is *required* to have the `else`. There's no chance that we could forget to handle both cases:

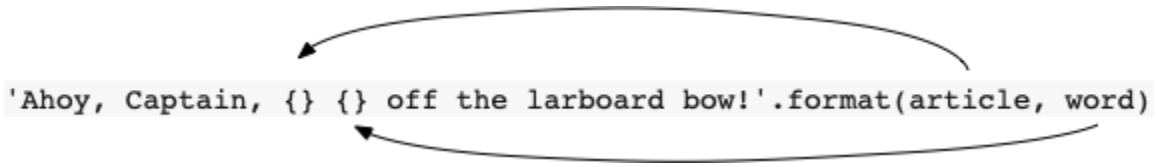
```
>>> article = 'an' if char in 'aeiou' else 'a'
```

Let's verify that we have the correct `article`:

```
>>> article
'an'
```

String formatting

Now we have two variables, `article` and `word` that need to be incorporated into our "Ahoy!" phrase. We saw earlier that we can use the plus sign (`+`) to concatenate strings. Another method to create new strings from other strings is to use the `str.format` method. To do so, you create a string template with curly brackets `{}` that indicate placeholders for values. The values that will be substituted go as arguments to the `format`, and they are substituted in the same order that the `{}` appear:



Here it is in code:

```
>>> 'Ahoy, Captain, {} {} off the larboard bow!'.format(article, word)
'Ahoy, Captain, an octopus off the larboard bow!'
```

Another method uses the special "f-string" where you can put the variables directly into the `{}` brackets. It's a matter of taste which one you choose.

```
>>> f'Ahoy, Captain, {article} {word} off the larboard bow!'
'Ahoy, Captain, an octopus off the larboard bow!'
```

Python variables are very variable

A note that in some programming languages, you have to declare the variable's name and what *type* of data it will hold. If a variable is declared to be a number, then it can never hold a value of a different type like a string. This is called *static typing* because the type of the variable can never change. Python is a *dynamically typed* language because you do not have to declare a variable or what kind of data the variable will hold. You can change the value and type of data at any time. This could be either great or terrible news. As Hamlet says, "There is nothing either good or bad, but thinking makes it so."

Hints:

- Start your program with `new.py` and fill in the `get_args` with a single position argument called `word`.
- You can get the first character of the word by indexing it like a list, `word[0]`.
- Unless you want to check both upper- and lowercase letters, you can use either the `str.lower` or `str.upper` method to force the input to one case for checking if the first character is a vowel or consonant.
- There are fewer vowels (five, if you recall) than consonants, so it's probably easier to check if the first character is one of those.
- You can use the `x in y` syntax to see if the element `x` is `in` the collection `y` where "collection" here is a `list`.
- Use the the `str.format` or f-strings to insert the correct article for the given word into the longer phrase.
- Run `make test` (or `pytest -xv test.py`) *after every change to your program* to ensure your program compiles and is on the right track.

Now go write the program before you turn the page and study a solution! Look alive, you ill-tempered shabaroon!

Solution

```
#!/usr/bin/env python3
"""Crow's Nest"""

import argparse


# --------------------------------------------------
def get_args():             1
    """Get command-line arguments"""

    parser = argparse.ArgumentParser(                               2
        description="Crow's Nest -- choose the correct article",    3
        formatter_class=argparse.ArgumentDefaultsHelpFormatter)     4

    parser.add_argument('word', metavar='str', help='A word')       5

    return parser.parse_args()                                      6


# --------------------------------------------------
def main():                 7
    """Make a jazz noise here"""

    args = get_args()       8
    word = args.word        9
    article = 'an' if word[0].lower() in 'aeiou' else 'a'           10

    print(f'Ahoy, Captain, {article} {word} off the larboard bow!') 11


# --------------------------------------------------
if __name__ == '__main__': 12
    main()                 13
```

1 Defines the function `get_args` to handle the command-line arguments. I like put this first so I can see it right away when I'm reading the code.

2 The `parser` will do the work of parsing the arguments.

3 The `description` shows in the usage to describe what the program does.

4 Show the default values for each parameter in the usage.

5 Define a positional argument called `word`.

6 The result of parsing the arguments will be returned to line 24.

7 Defines the `main` function where the program will start.

8 `args` contains the return value from the `get_args` function.

9 Put the `args.word` value from the arguments into the variable `word`.

10 Choose the correct `article` using an `if` expression to see if the lowercased, first character of `word` is or is not in the set of vowels.

11 Print the output string using an f-string to interpolate the `article` and `word` variables inside the string.

12 Check if we are in the "main" namespace, which means the program is *running*.

13 If so, call the `main()` function to make the program start.

Discussion

I'd like to stress that the preceeding is *a* solution, not *the* solution. There are many ways to express the same idea in Python. As long as your code passes the test suite, it is correct.

That said, I created my program with `new.py` which automatically gives me two functions:

1. `get_args` where I define the arguments to the program
2. `main` where the program starts

Let's talk about these two functions.

Defining the arguments with `get_args`

I prefer to put the `get_args` function first so that I can see right away what the program expects as input. You don't have to define this as a separate function. You could put all this code inside `main`, if you prefer. Eventually our programs are going to get longer, though, and I think it's nice to keep this as a separate idea. Every program I present will have a `get_args` function that will handle defining and validating the input.

Our program specifications (the "specs") say that the program should accept one positional argument. I changed the `'positional'` argument name to `'word'` because I'm expecting a single word:

```
parser.add_argument('word', metavar='str', help='Word')
```

I would really recommend you never leave the "positional" argument named `'positional'` because it is an entirely undescriptive term. Naming your variables *what they are* will make your code more readable. Since the program doesn't need any of the other options created by `new.py`, you can delete the rest of the `parser.add_argument` calls. The `get_args` function will `return` the result of parsing the command line arguments which I put into the variable `args`:

```
return parser.parse_args()
```

If `argparse` is not able to parse the arguments — for example, there are none — it will never `return` from `get_args` but will instead print the "usage" for the user and exit with an error code to let the operating system know that the program exited without success. (In the Unix world, an exit value of `0` means there were 0 errors. Anything other than `0` is considered an error.)

The `main` thing

Many programming languages will automatically start from the `main` function, so I always define a `main` function and start my programs there. This is not a requirement, just how I like to write programs. Every program I present will start with the `main` function which will first call `get_args` to get the program's inputs:

```
args = get_args()
```

I can now access the `word` by call `args.word`. Note the lack of parentheses. It's not `args.word()` because is not a function call. Think of `args.word` like a slot where the value of the "word" lives:

```
word = args.word
```

I like to work through my ideas using the REPL, so I'm going to pretend that `word` has been set to "octopus":

```
>>> word = 'octopus'
```

Classifying the first character of a word

To figure out whether the article I choose should be `a` or `an`, I need to look at the first character of the `word` which we can get like so. In the introduction, we used this:

```
>>> word[0]
'o'
```

I can check if the first character is `in` the string of vowels, both lower- and uppercase:

```
>>> word[0] in 'aeiouAEIOU'
True
```

I can make this shorter, however, if I use `word.lower` function so I'd only have to check the lowercase vowels:

```
>>> word[0].lower() in  'aeiou'
True
```

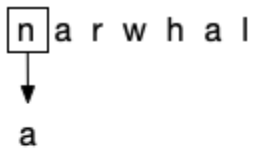
Remember that the `x in y` form is a way to ask if element `x` is in the collection `y`. You can use it for letters in a longer string (like the vowels):

```
>>> 'a' in 'aeiou'
True
```

Or for a string in list of other strings:

```
>>> 'tanker' in ['yatch', 'tanker', 'vessel']
True
```

We can use membership in the "vowels" as a condition to choose "an," otherwise we choose "a": As mentioned in the introduction, the `if` expression is the shortest and safest for a "binary" choice (where there are only two possibilities):




```
>>> article = 'an' if word[0].lower() in  'aeiou' else 'a'
>>> article
'an'
```

The safety comes from the fact that Python will not even run this program if you forget the `else`. We can change the `word` to "galleon" and check that it still works:

```
>>> word = 'galleon'
>>> article = 'an' if word[0].lower() in  'aeiou' else 'a'
>>> article
'a'
```

Printing the results

Finally we need to `print` out the phrase with our `article` and `word`. As noted in the introduction, you can use `str.format`:

```
>>> article = 'a'
>>> word = 'ketch'
>>> print('Ahoy, Captain, {} {} off the larboard bow!'.format(article, word))
Ahoy, Captain, a ketch off the larboard bow!
```

Python's f-strings will *interpolate* any code inside the `{}` placeholders, so variables get turned into their contents:

```
>>> print(f'Ahoy, Captain, {article} {word} off the larboard bow!')
Ahoy, Captain, a ketch off the larboard bow!
```

However you chose to print out the article and word is fine as long as it passes the tests.

Running the test suite

> *"A computer is like a mischievous genie. It will give you exactly what you ask for, but not always what you want. - Joe Sondow"*

Computers are a bit like bad genies. They will do exactly what you tell them but not necessarily what you *want*. In an episode of *The X-Files*, the character Mulder wishes for peace on Earth and a genie removes all humans but him. Tests are what we can use to verify that our programs are doing what we *actually* want them to do. Tests they can never prove that our program is truly free from errors, only that the bugs we imagined or found while writing the program no longer exist. Still, we write and run tests because they are really quite effective and much better than not doing so.

This is the idea behind "test-driven development":

- We can write tests *even before* we write the software.
- We run the tests to verify that our as-yet-unwritten software definitely fails to deliver on some task.
- Then we write the software to fulfill the request.
- Then we run the test to check that it now *does* work.
- We keep running all the tests to ensure that, when we add some new code, we do not break existing code.

Passing Tests

I would encourage you to look at the `test.py` program to see how it is testing your program. Eventually I'll recommend you write your own tests, but for now just see what's being expected of your code. I use the `pytest` module to write tests. There are other testing frameworks in Python, but I find `pytest` to be relatively easy to use. The `pytest` module will run any functions that begin with `test_` in the order they are found in the source code.

The first `test_` function is `test_exists` that uses the `assert` function to check if the `crowsnest.py` program exists. This is why your program must be named `'crowsnest.py'`. It must exist as this name so that we can run it and check the output:

```
prg = './crowsnest.py'

def test_exists():
    """exists"""

    assert os.path.isfile(prg)
```

The next is `test_usage` to check if the program will print something that looks like "usage" when run with `-h` and `--help` flags:

```
def test_usage():
    """usage"""

    for flag in ['-h', '--help']:
        rv, out = getstatusoutput(f'{prg} {flag}')
        assert rv == 0
        assert out.lower().startswith('usage')
```

Inside `test.py`, there are two lists of words starting with consonants and others starting with vowels.

```
consonant_words = [
    'brigatine', 'clipper', 'dreadnought', 'frigate', 'galleon', 'haddock',
    'junk', 'ketch', 'longboat', 'mullet', 'narwhal', 'porpoise', 'quay',
    'regatta', 'submarine', 'tanker', 'vessel', 'whale', 'xebec', 'yatch',
    'zebrafish'
]
vowel_words = ['aviso', 'eel', 'iceberg', 'octopus', 'upbound']
```

There is also a string `template` for what the program should print:

```
template = 'Ahoy, Captain, {} {} off the larboard bow!'
```

The `test_consonant` test runs through each of the `consonant_words` and checks if the program puts an "a" in front of the word.

```
def test_consonant():
    """brigatine -> a brigatine"""

    for word in consonant_words:
        out = getoutput(f'{prg} {word}')
        assert out.strip() == template.format('a', word)
```

The next function does the same thing but uses a capitalized version of the consonant word. The next two tests then use the `vowel_words`, checking both lower- and uppercase versions.

When all tests are passing, this is the output you should see (some output elided):

```
$ make test
pytest -xv test.py
============================= test session starts ==============================
...
collected 6 items

test.py::test_exists PASSED                                              [ 16%]
test.py::test_usage PASSED                                               [ 33%]
test.py::test_consonant PASSED                                           [ 50%]
test.py::test_consonant_upper PASSED                                     [ 66%]
test.py::test_vowel PASSED                                               [ 83%]
test.py::test_vowel_upper PASSED                                         [100%]

========================== 6 passed in 2.28 seconds ===========================
```

Summary

- All Python's documentation is available on https://docs.python.org/3/ and with the `help` command in the REPL.
- Variables in Python are dynamically typed according to whatever value you assign them and the come into existence when you assign a value to them.
- Strings have methods like `upper` and `isupper` that you can call to alter them or get information.
- You can get parts of a string by using square brackets and indexes like `[0]` for the first letter or `[-1]` for the last.
- You can concatenate strings with the `+` operator.
- The `str.format` method allows you to create a template with `{}` placeholders that get filled in with the arguments.
- F-strings like `f'{article} {word}'` allow variables and code to go directly inside the brackets.
- The `x in y` expression will report if the value `x` is present in the collection `y`.
- Statements like `if`/`else` do not return a value while expressions like `x if y else z` do return a value.
- Test-driven development is a way to ensure programs meet some minimum critieria of correctness. Every feature of a program should have tests, and writing and running test suites should be an integral part of writing programs.

Going Further

- Have your program match the case of the incoming word, e.g., "an octopus" and "An Octopus." Copy an existing `test_` function in the `test.py` to verify that your program works correctly while still passing all the other tests. Try writing the test first, then make your program pass the test. That's *test-driven development*!
- Accept a new parameter that changes "larboard" (the left side of the boat) to "starboard" (the right side.[1]). You could either make an option called `--side` that defaults to "larboard," or you could make a `--starboard` flag that, if present, changes the side to "starboard."
- The provided tests only give you words that start with an actual alphabetic character. Expand your code to handle words that start with numbers or punctuation. Should your program reject these? Add more tests to ensure that your program does what you intend.

1. "Starboard" has nothing to do with stars but with the "steering board" or a rudder which typically would be on the right-side of the boat for right-handed sailors!

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