# CS50’s Introduction to Programming with Python

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## NUMB3RS

In Season 5, Episode 23 of NUMB3RS (https://en.wikipedia.org/wiki/Numbers_(TV_series)), a supposed IP address (https://en.wikipedia.org/wiki/IP_address) appears on screen, `275.3.6.28`, which isn’t actually a valid IPv4 (https://en.wikipedia.org/wiki/IPv4) (or IPv6 (https://en.wikipedia.org/wiki/IPv6)) address.

An IPv4 address is a numeric identifier that a device (or, on TV, hacker) uses to communicate on the internet, akin to a postal address in the real world, typically formatted in dot-decimal notation (https://en.wikipedia.org/wiki/Dot-decimal_notation) as `#.#.#.#`. But each `#` should be a number between `0` and `255`, inclusive. Suffice it to say `275` is not in that range! If only NUMB3RS had validated the address in that scene!

In a file called `numb3rs.py`, implement a function called `validate` that expects an IPv4 address as input as a `str` and then returns `True` or `False`, respectively, if that input is a valid IPv4 address or not.

Structure `numb3rs.py` as follows, wherein you're welcome to modify `main` and/or implement other functions as you see fit, but you may not import any other libraries. You're welcome, but not required, to use `re` and/or `sys`.

```python
import re
import sys


def main():
    print(validate(input("IPv4 Address: ")))


def validate(ip):
    ...


...


if __name__ == "__main__":
    main()
```

Either before or after you implement `validate` in `numb3rs.py`, additionally implement, in a file called `test_numb3rs.py`, **two or more** functions that collectively test your implementation of `validate` thoroughly, each of whose names should begin with `test_` so that you can execute your tests with:

```
pytest test_numb3rs.py
```

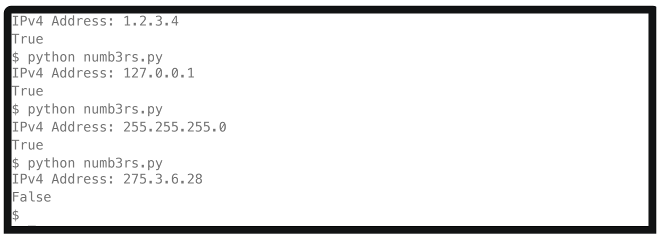
▼ **Hints**

- Recall that the `re` module comes with quite a few functions, per docs.python.org/3/library/re.html (https://docs.python.org/3/library/re.html), including `search`.
- Recall that regular expressions support quite a few special characters, per docs.python.org/3/library/re.html#regular-expression-syntax (https://docs.python.org/3/library/re.html#regular-expression-syntax).
- Because backslashes in regular expressions could be mistaken for escape sequences (like `\n`), best to use Python's raw string notation for regular expression patterns

(https://docs.python.org/3/library/re.html#module-re), else `pytest` will warn with `DeprecationWarning: invalid escape sequence`. Just as format strings are prefixed with `f`, so are raw strings prefixed with `r`. For instance, instead of `"harvard\.edu"`, use `r"harvard\.edu"`.

- Note that `re.search`, if passed a pattern with "capturing groups" (i.e., parentheses), returns a "match object," per docs.python.org/3/library/re.html#match-objects (https://docs.python.org/3/library/re.html#match-objects), wherein matches are 1-indexed, which you can access individually with `group`, per docs.python.org/3/library/re.html#re.Match.group (https://docs.python.org/3/library/re.html#re.Match.group), or collectively with `groups`, per docs.python.org/3/library/re.html#re.Match.groups (https://docs.python.org/3/library/re.html#re.Match.groups).

## Demo



```
IPv4 Address: 1.2.3.4
True
$ python numb3rs.py
IPv4 Address: 127.0.0.1
True
$ python numb3rs.py
IPv4 Address: 255.255.255.0
True
$ python numb3rs.py
IPv4 Address: 275.3.6.28
False
$
```

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## Before You Begin

Log into cs50.dev (https://cs50.dev/), click on your terminal window, and execute `cd` by itself. You should find that your terminal window's prompt resembles the below:

```
$
```

Next execute

```
mkdir numb3rs
```

to make a folder called `numb3rs` in your codespace.

Then execute

```
cd numb3rs
```

to change directories into that folder. You should now see your terminal prompt as `numb3rs/ $`. You can now execute

```
code numb3rs.py
```

to make a file called `numb3rs.py` where you'll write your program. Be sure to also execute

```
code test_numb3rs.py
```

to create a file called `test_numb3rs.py` where you'll write tests for your program.

## How to Test

### How to Test `numb3rs.py`

Here's how to test `numb3rs.py` manually:

- Run your program with `python numb3rs.py`. Ensure your program prompts you for an IPv4 address. Type `127.0.0.1`, followed by Enter. Your `validate` function should return `True`.
- Run your program with `python numb3rs.py`. Type `255.255.255.255`, followed by Enter. Your `validate` function should return `True`.
- Run your program with `python numb3rs.py`. Type `512.512.512.512`, followed by Enter. Your `validate` function should return `False`.
- Run your program with `python numb3rs.py`. Type `1.2.3.1000`, followed by Enter. Your `validate` function should return `False`.
- Run your program with `python numb3rs.py`. Type `cat`, followed by Enter. Your `validate` function should return `False`.

### How to Test `test_numb3rs.py`

To test your tests, run `pytest test_numb3rs.py`. Try to use correct and incorrect versions of `numb3rs.py` to determine how well your tests spot errors:

- Ensure you have a correct version of `numb3rs.py`. Run your tests by executing `pytest test_numb3rs.py`. `pytest` should show that all of your tests have passed.
- Modify the `validate` function in the correct version of `numb3rs.py`. `validate` might, for example, only check whether the first byte of the IPv4 address is valid. Run your tests by executing `pytest test_numb3rs.py`. `pytest` should show that at least one of your tests has failed.
- Again modify the correct version of `numb3rs.py`. `validate` might, for example, mistakenly return `True` when the user inputs an incorrect IPv4 format. Run your tests by executing `pytest test_numb3rs.py`. `pytest` should show that at least one of your tests has failed.

You can execute the below to check your code using `check50`, a program that CS50 will use to test your code when you submit. But be sure to test it yourself as well!

```
check50 cs50/problems/2022/python/numb3rs
```

Green smilies mean your program has passed a test! Red frownies will indicate your program output something unexpected. Visit the URL that `check50` outputs to see the input `check50` handed to your program, what output it expected, and what output your program actually gave.

## How to Submit

In your terminal, execute the below to submit your work.

```
submit50 cs50/problems/2022/python/numb3rs
```