Testing in Python

Robust Automation for Professionals

Noah Gift & Alfredo Deza

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Noah Gift and Alfredo Deza

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Introduction

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About the cover

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Chapter 1: Configuring the environment

Noah Gift

Creating a local development environment that is simple, repeatable, and powerful is an essential first step to developing a testable software project. This technique is also a skill that translates to any future software development project.

Setting up and using Git

Source control is a mandatory part of any professional software project. There are many types of version control available including subversion[1], mercurial[2] and git[3]. The most popular of these is `git`.

Git can be standalone, or as part of a hosted solution. Two popular solutions for hosting git projects include: Github[4] and Gitlab[5].

Setup and use Github

To set up and use Github, you need a Github account and internet access. The minimal steps to start are:

1. Create a repository, for example, `hello`.
2. Add an SSH key to your Github account[6].
3. Clone the repository locally, for example:

Clone a repo

```
git clone git@github.com:paiml/hello.git
```

4. Create a change and push it. This process would be an example of a good first change (inside the cloned repo).

[1] https://subversion.apache.org/
[2] https://www.mercurial-scm.org/
[3] https://git-scm.com/
[4] https://github.com/
[5] https://about.gitlab.com/
[6] https://help.github.com/en/github/authenticating-to-github/adding-a-new-ssh-key-to-your-github-account

Clone a repo

```
echo "# hello" >> README.md
git add README.md
git commit -m "adding name of repo to README"
git push
```

Setting up and using Virtualenv

Surprise, the Python standard library includes a module called venv[7]. A virtual environment solves a significant problem in Python. It isolates the Python interpreter to a specific directory. In this example, a virtual environment works in a user's home directory.

Create Hello World Virtual Environment in Python

```
python3 -m venv ~/.hello
```

To use this "virtual environment," it needs to be activated.

Activate Hello World Virtual Environment in Python

```
source  ~/.hello/bin/activate
```

Using a repeatable convention to create virtual environments

Conventions are a powerful way to simplify complex software engineering tasks in a series of easy to remember steps. A convention-based workflow with virtual environments can also dramatically simplify using them. Here is a simple convention to use:

1. Create a virtual environment with a `~/.[reponame]` format

This process removes the decision about where to put the virtual environment and what to name it. If your git repository is called `hello`, then you would run the following command:

```
python3 -m venv ~/.hello
```

Note that the `.` makes the virtual environment invisible. This process will prevent your home directory overflowing with virtual environments when you open it in a GUI or list the contents with `ls -l`.

2. Create an alias in your Bash or ZSH environment.

With ZSH, the config file to edit would be `~/.zshrc` in Bash, it would be `~/.bashrc`. Inside of this config file add the following:

[7] https://docs.python.org/3/tutorial/venv.html

Create an alias for Git repo and virtual environment

```
## Hello repo
alias hello="cd ~/hello && source ~/.hello/bin/activate"
```

The next time you open your default shell, this alias will be available. Here is an example of what this workflow looks like on my ZSH environment, which uses a package called oh-my-zsh[8].

Use alias that performs `cd` and activates `hello` virtual environment

```
 hello
(.hello)  hello git:(master)
(.hello)  hello git:(master) which python
/Users/noahgift/.hello/bin/python
```

This convention-based workflow, if followed, makes a tedious and error-prone process easy to remember.

Installing packages and dependencies

There are several strategies available to install packages and dependencies. These are pip[9], conda[10] and docker format[11] containers. The most common is `pip`. Let's focus on that.

There is a convention to use with `pip` that will make you more productive.

1. Always use `pip` inside a virtual environment or a container.

Let's walk through a few scenarios:

- **Scenario A**: If you are using Google Colab notebooks[12], doing a pip install is fine since it is running in a container behind the scenes. Additionally, this is a managed environment designed for Python development, and the libraries are up to date for you. This notebook is a unique but useful environment. You could install it as follows: `!pip install pandas`. The `!` allows shell commands to run in a Jupyter notebook.
- **Scenario B**: If you provision an AWS Cloud9[13] development environment, this first thing you should do is create a virtual environment before you begin work. The native Amazon Linux or Ubuntu operating system needs to be isolated from what you want to do for a particular development task.

[8] https://ohmyz.sh/
[9] https://pip.pypa.io/en/stable/user_guide/
[10] https://docs.conda.io/en/latest/
[11] https://www.docker.com/
[12] https://colab.research.google.com/
[13] https://aws.amazon.com/cloud9/

- **Scenario C**: If you are developing a new project on your laptop, say an OS X laptop, you should use a virtual environment. This process will isolate your project from whatever installation occurs on the system.

2. In a new project, use a `requirements.txt` file. If the project deploys somewhere, it is a best practice to `freeze` the currently installed versions: `pip freeze > requirements.txt` and then install using `pip install -r requirements.txt`.

3. Run `make install` with `pip`. This snippet is an example of `Makefile`.

`Makefile` contents

```
install:
    pip install --upgrade pip &&\
        pip install -r requirements.txt
```

If this convention follows on all projects, it dramatically reduces the chance something will go wrong in installing software with `pip`. Additionally, there is little to remember to install software; a user runs `make install`.

Setup Visual Code code

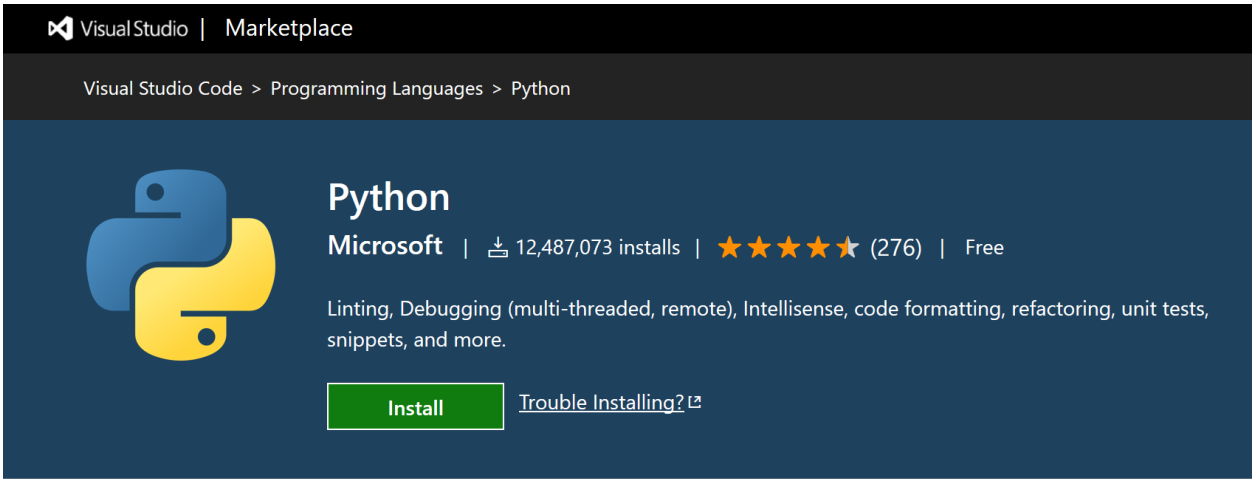
Having a reliable source code editor can dramatically improve the efficiency of software development. The Visual Studio Code[14] is one of the most popular editors for Python projects for a reason, it works! These are the steps to installing and using the Visual Studio Code toolkit.

1. Download the version for your platform[15].

Visual Studio Code has a version that works for Windows, Linux (Debian, Ubuntu, Red Hat, Fedora, and SUSE) and OS X. This is a significant advantage off the bat. You can use the same editor for any operating system.

2. Install the Visual Studio Code Python extension[16].

[14] https://code.visualstudio.com/
[15] https://code.visualstudio.com/#alt-downloads
[16] https://marketplace.visualstudio.com/items?itemName=ms-python.python



Python Visual Studio Code Extension

3. Install the correct Python interpreter for your operating system. This interpreter should be higher than Python 3.7 or later.

- If you are on Windows, you can install from the official Python Windows page[17].
- If you are on OS X, you should do a `brew install python3`. You should NOT use the install Python that comes with OS X. You will need to install Homebrew[18] if you haven't installed it. Note you can also upgrade the version of Python by using `brew upgrade python`.

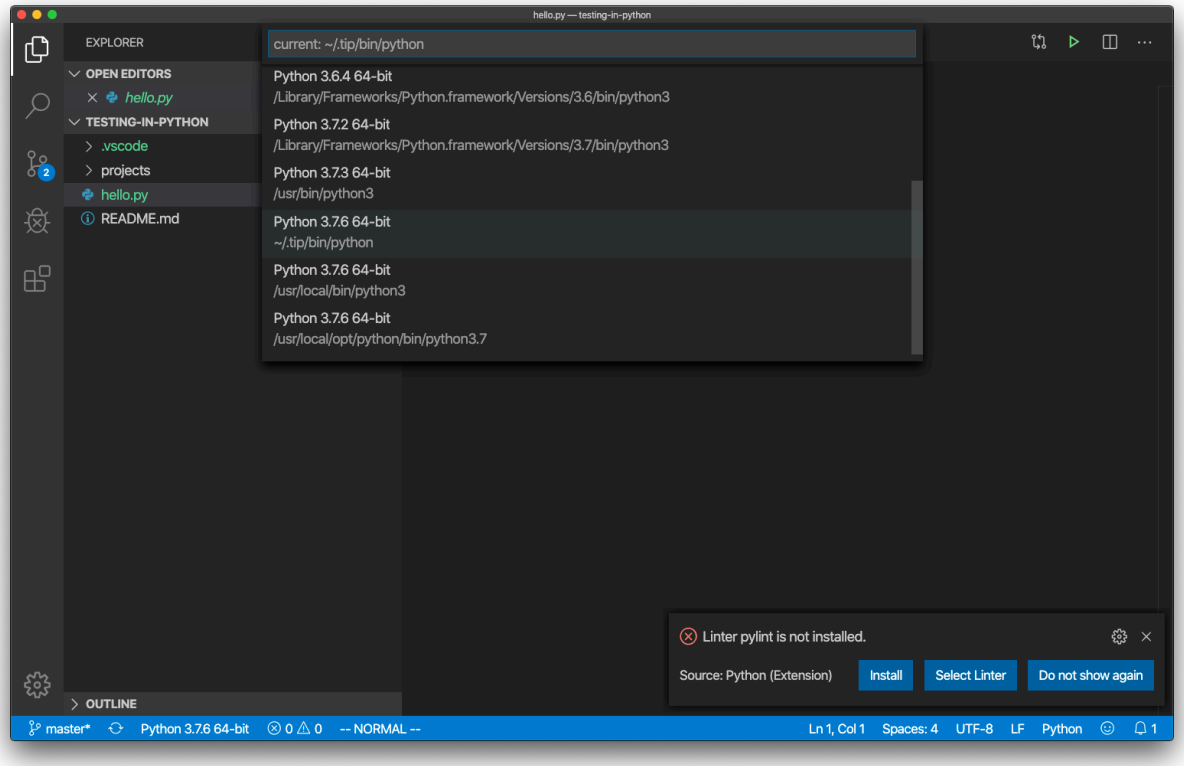
brew upgrade example

```
(.tip) > brew upgrade python
==> Upgrading 1 outdated package:
python 3.7.5 -> 3.7.6_1
==> Upgrading python
Warning: Building python from source:
  The bottle needs the Apple Command Line Tools to be installed.
  You can install them, if desired, with:
    xcode-select --install
```

- If you are on Linux, you may want to upgrade to a specific version of Python using the native package management system. If `pip` needs to install, you can install it with `get-pip.py`[19].

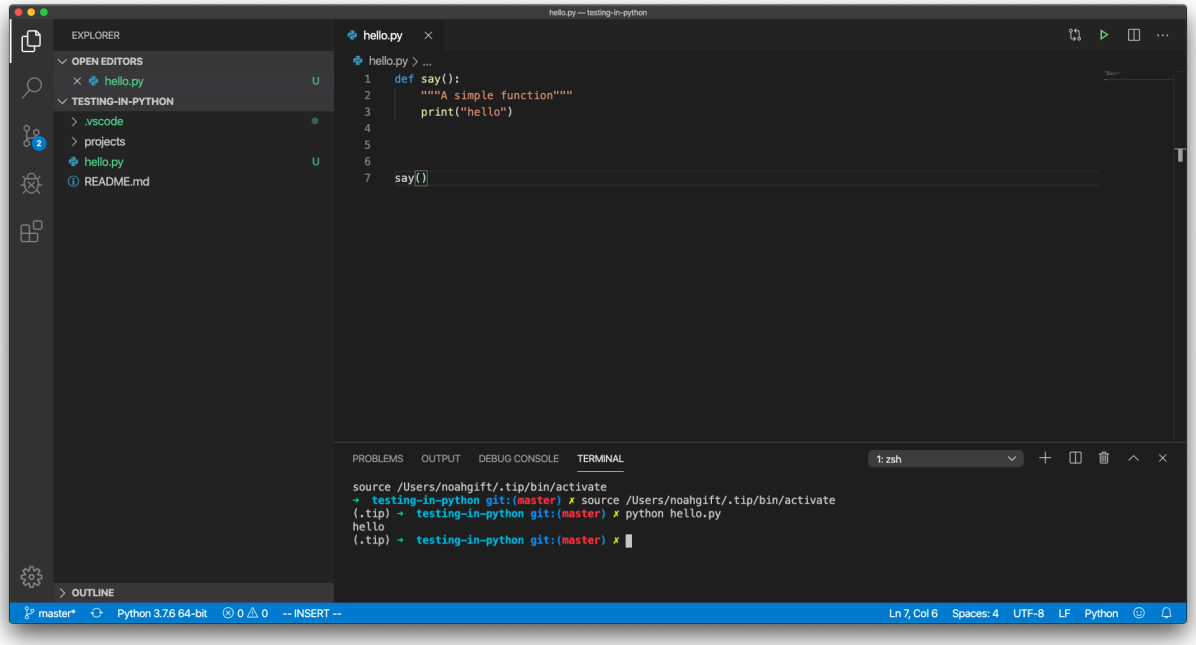
4. Use the virtual environment setup instructions described early in the chapter to `activate` a virtual environment. Next, launch visual studio code inside the activated environment: `code .`. This step will start Visual Studio code within your virtual environment. Note, it is essential to double-check that Visual Studio Code has the correct interpreter. It toggles as shown.

[17] https://docs.python.org/3.7/using/windows.html
[18] https://brew.sh/
[19] https://pip.pypa.io/en/stable/installing/#installing-with-get-pip-py



Python interpreter

Also, note that this same interpreter can be selected to test the code as shown.



Python interpreter

Here is the example code for you to test on your own. Paste parts of the code to see how linting, syntax highlighting, and auto-completion works.

A Hello World Function to Try in Visual Studio code

```
def say():
    """A simple function"""
    print("hello")

say()
```

Setup and use Vim

A kitchen has many types of knives. There is a steak knife to cut food like a steak while eating. There is a Chef's Knife that may be very high quality, large and expensive. Its use is for tasks the require power, like chopping an onion. A paring knife solves problems of precision. One example use case of a paring knife is to peel a tomato.

Likewise, `vim`, the editor serves a particular purpose. It is an editor that is ubiquitous, and it makes many tasks simple to solve. Every developer needs a little vim in their software kitchen.

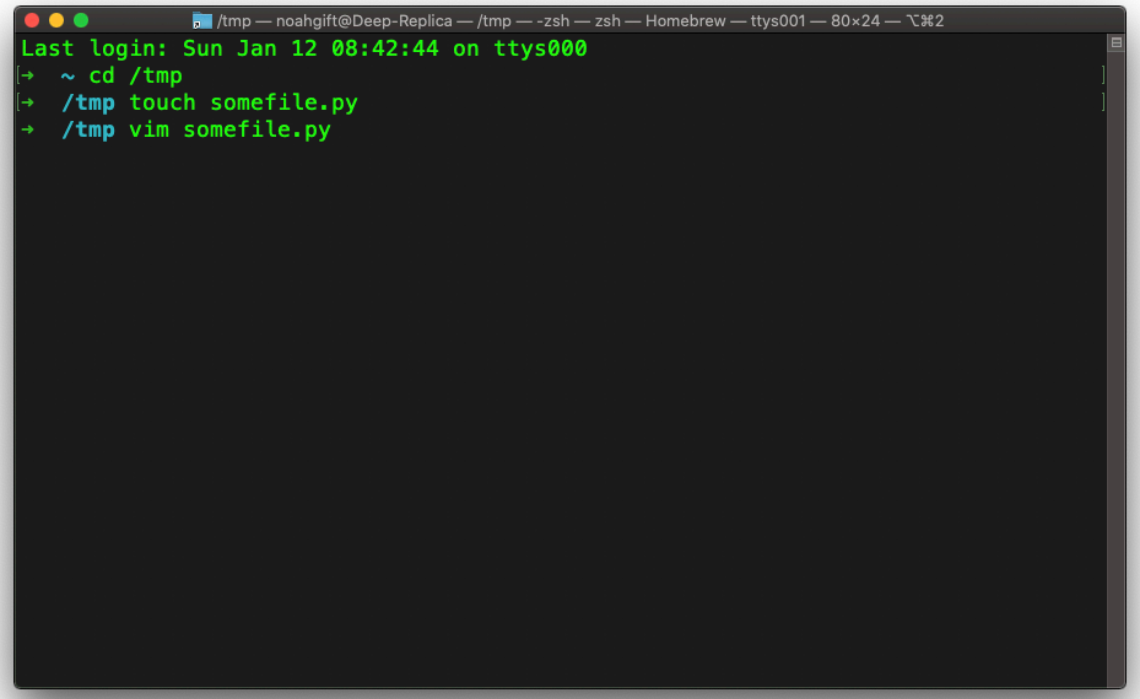
Install Vim

The `vim` program preinstalls on many machines. If `vim` is not available, you refer to the download instructions from the official vim website[20].

Use Vim

Mastering `vim` can take years, but there is a minimalistic approach to be effective immediately. This process is a convention to follow:

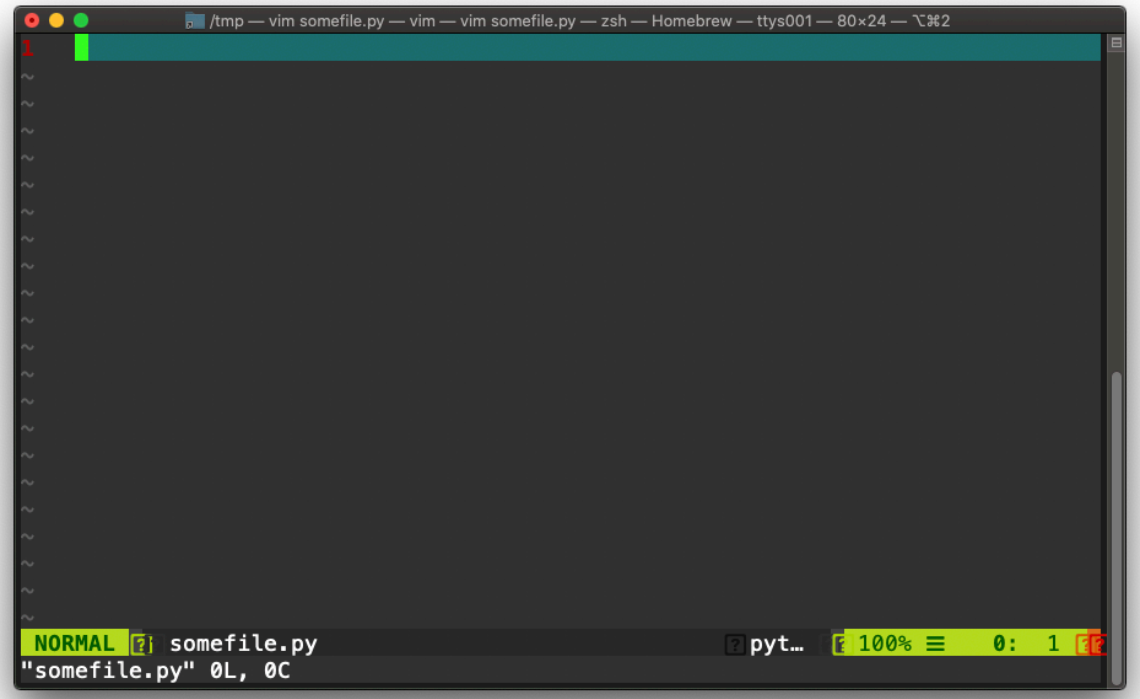
1. Create a file: `touch somefile.py`
2. Edit the file in vim: `vim somefile.py`



Create file

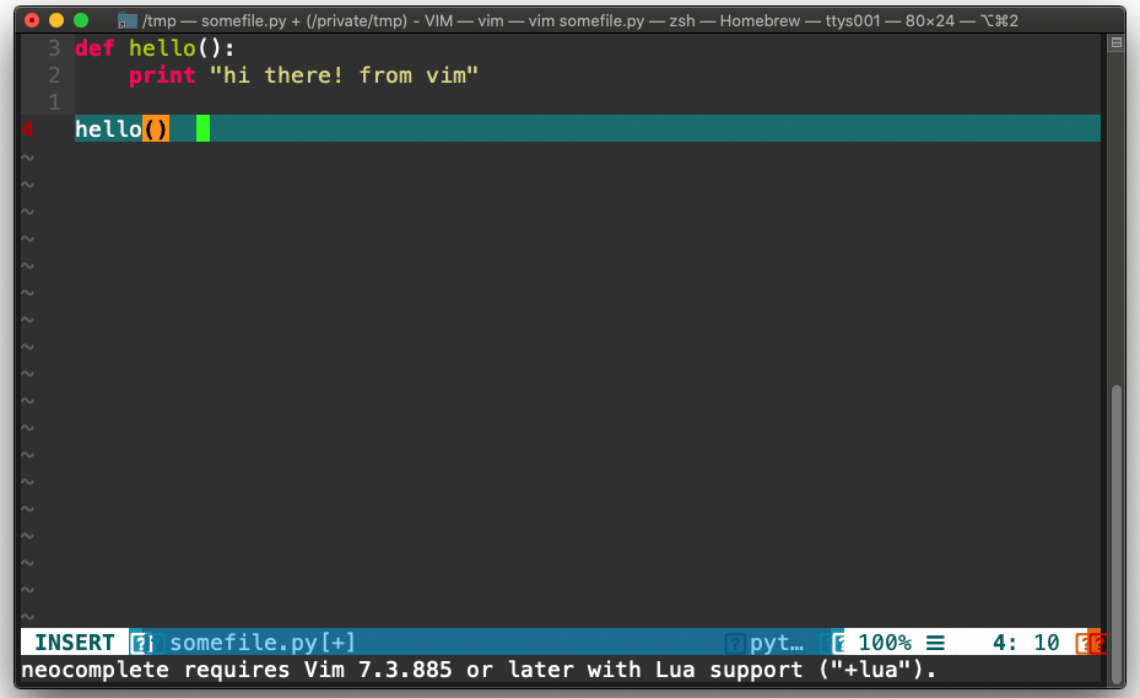
[20] https://www.vim.org/download.php

3. Switch to “insert mode” by pressing the key `i`. You will start in ‘normal’ mode.



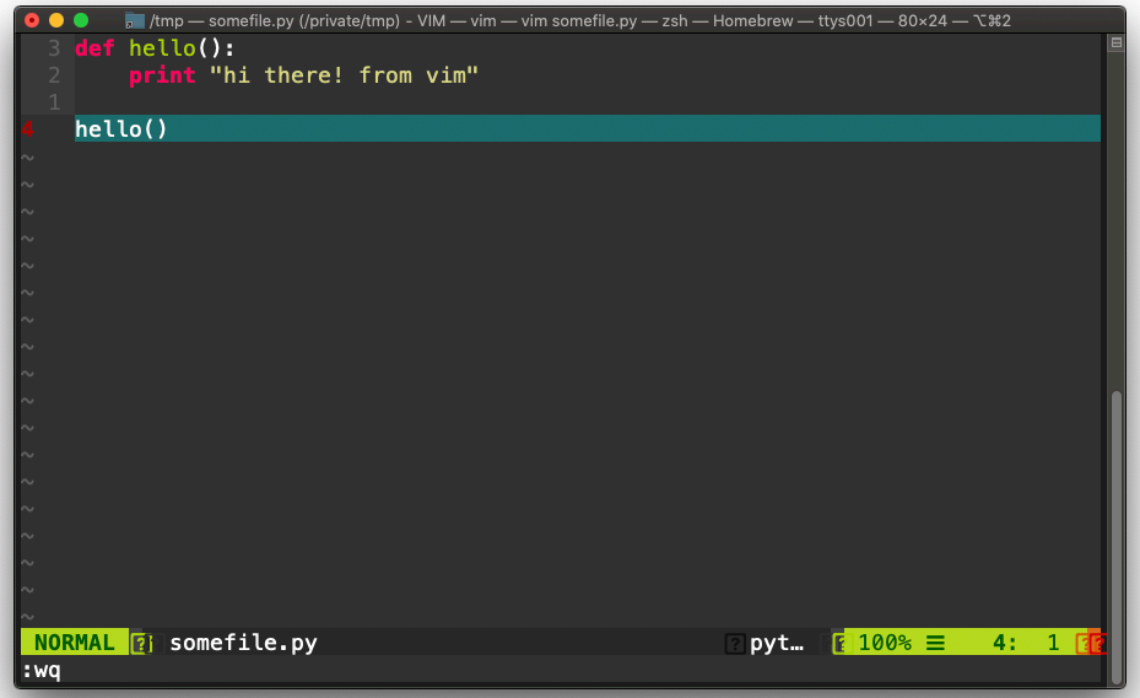
Insert mode

4. Edit the file.



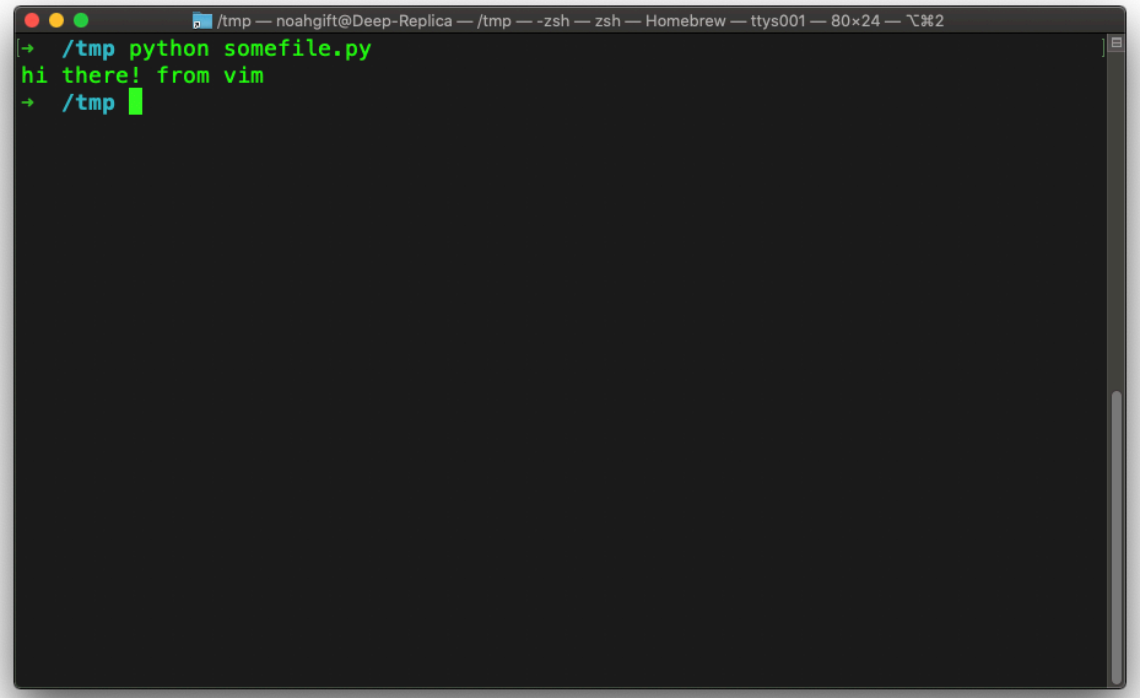
Edit file

5. Save the file by pressing Escape key and typing: `:wq`.



Save

6. Run the file.



Create file

If you get yourself in a mode that seems to be confusing, often the best way out is to press the Escape key. This step is the best way to solidify this knowledge; to do this workflow many times on many different types of machines. It will cement the learning.

Later feel free to get more advanced and learn new `vim` tricks, but first master the basics, and this will add an entirely new capability that will open up many workflows.

Setup Makefile

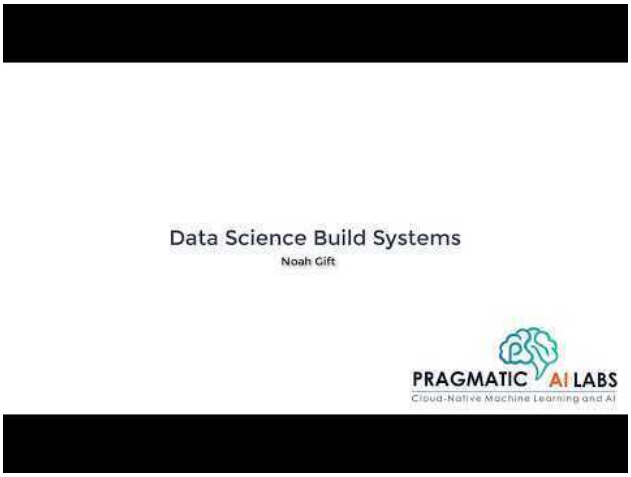
Just like `vim`, mastering `Makefiles` can take years, but a minimalistic approach provides immediate benefits. The main advantage of a `Makefile` is the ability to enforce a convention. If every time you work a project, you follow a few simple steps, it reduces the possibility of errors in building and testing a project.

A typical Python project improves by adding a `Makefile` with the following steps: `make setup`, `make install`, `make test`, `make lint` and `make all`.

Example Makefile

```
setup:
    python3 -m venv ~/.myrepo

install:
    pip install --upgrade pip &&\
        pip install -r requirements.txt

test:
    python -m pytest -vv --cov=myrepolib tests/*.py
    python -m pytest --nbval notebook.ipynb


lint:
    pylint --disable=R,C myrepolib cli web

all: install lint test
```

This example is from a tutorial repository called `myrepo`[21]. There is also an article about how to use it from CircleCI[22].



View this Video at https://www.youtube.com/watch?v=xYX7n5bZw-w[23].

Data Science Build Systems

The general idea is that a convention eliminates the need to think about what to do. For every project, there is a common way to install software, a common way to test software, and a common way to test and lint software. Just like `vim`, a `Makefile` build system is often already on a Unix or Linux

[21] https://github.com/noahgift/myrepo
[22] https://circleci.com/blog/increase-reliability-in-data-science-and-machine-learning-projects-with-circleci/

system. Even Microsoft uses the Linux operating system in Azure[24], and the result is that Linux is the preferred deployment target for most software.

Extending a Makefile for use with Docker Containers

Beyond the simple `Makefile`, it is also useful to extend it to do other things. An example of this is as follows:

Example Makefile for Docker and Circleci

```
setup:
    python3 -m venv ~/.container-revolution-devops

install:
    pip install --upgrade pip &&\
        pip install -r requirements.txt

test:
    #python -m pytest -vv --cov=myrepolib tests/*.py
    #python -m pytest --nbval notebook.ipynb

validate-circleci:
    # See https://circleci.com/docs/2.0/local-cli/#processing-a-config
    circleci config process .circleci/config.yml

run-circleci-local:
    # See https://circleci.com/docs/2.0/local-cli/#running-a-job
    circleci local execute

lint:
    hadolint demos/flask-sklearn/Dockerfile
    pylint --disable=R,C,W1203,W1202 demos/**/**.py

all: install lint test
```

A `Dockerfile` linter is called `hadolint`[25] checks for bugs in a `Dockerfile`. A local version of the CircleCI build system[26] allows for testing in the same environment as the SaaS offering. The minimalism is still present: `make install`, `make lint` and `make test`, but the `lint` step is complete and authoritative with the inclusion of `Dockerfile` as well as `Python` linting.

[24] https://azure.microsoft.com/en-us/overview/linux-on-azure/
[25] https://github.com/hadolint/hadolint
[26] https://circleci.com/docs/2.0/local-cli/

Notes about installing `hadolint` and `circleci`: If you are on OS X you can `brew install hadolint` if you are on another platform follow the instructions from `hadolint`[27]/ To install the local version of `circleci` on OS X or Linux you can run `curl -fLSs https://circle.ci/cli | bash` or follow the official instructions for local version of the CircleCI build system[28]

Setup and Use ZSH/Bash

The shell environment of Bash or ZSH is a given for working with Python. As discussed previously, most deployment targets are now Linux. With the widespread adoption of containers, even Windows is now a Linux target. What is the format for authoring `Dockerfiles`? The format is largely Bash Commands[29]. Additionally, Bash[30] and ZSH[31] are largely compatible with a few small differences.

Use oh-my-zsh

Let's focus mainly on ZSH through the use of an open-source framework for ZSH called Oh My Zsh[32]. The way to install it via the following command:

```
sh -c "$(curl -fsSL https://raw.github.com/ohmyzsh/ohmyzsh/master/tools/install.sh)"
```

After installation, you will get many convenient features: automatic `cd` (you don't need to type anymore), enhanced shell completion, and environment context recognition. Notice the `zsh` prompt I am using the write the book.

```
(.tip) ›  testing-in-python-book git:(chapter1) □
```

The `oh-my-zsh` plugins allow for automatic recognition of the Python Virtual Environment as well as the fact that I am in a git repository and what branch I have.

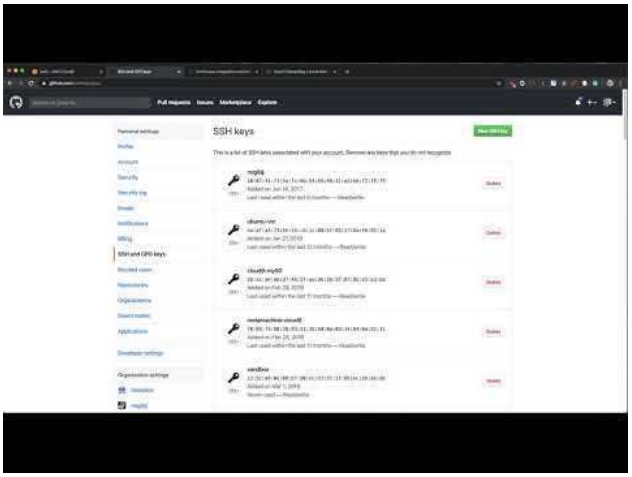
Using Cloud-based development environments

Just as many environments are Linux, it is also true that most deployment environments are in the cloud. Three of the largest cloud providers are: AWS[33], Azure[34] and GCP[35]. To write software that deploys on Cloud Computing environments, it often makes more sense to write, test, and build code in cloud-specific development environments. Let's discuss two of these environments.

[27] https://github.com/hadolint/hadolint
[28] https://circleci.com/docs/2.0/local-cli/
[29] https://docs.docker.com/engine/reference/builder/
[30] https://www.gnu.org/software/bash/
[31] https://en.wikipedia.org/wiki/Z_shell
[32] https://ohmyz.sh/
[33] https://aws.amazon.com/
[34] https://azure.microsoft.com/en-us/
[35] https://cloud.google.com/

AWS Cloud9

The AWS Cloud9 Environment[36] is an IDE that allows a user to write, run, and debug code (including serverless code in Python) in the AWS cloud. This step simplifies many workflows, including security and network bandwidth. You can watch a walkthrough video here that creates a new AWS Cloud9 environment.



View this Video at https://www.youtube.com/watch?v=4SIFF1PAMbw[37].

Setup CI Pipeline with AWS Cloud9 and CircleCI

GCP Cloud Shell

The GCP Cloud Shell[38] environment allows a user to develop software directly inside of the GCP ecosystem. This step is completely free and provides for many simplifications of cloud-based development tasks.

[36] https://aws.amazon.com/cloud9/
[38] https://cloud.google.com/shell/

Chapter 2: Testing Conventions

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Directories

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Tests outside of the package

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Tests inside of the package

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The most simple test possible

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The power of `assert`

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Pytest vs. Unittest

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Code Quality

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The people analytics of a team

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Churn

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Linting

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Flake8

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