

# How to install Cadnano on macOS

## Getting started

This chapter describes how to set up and configure your local **macOS** desktop or laptop so you can begin designing DNA origami nanostructures with **Cadnano**. If you have a PC, please see the **Windows** version of this document. This tutorial matches how we set up our own machines in the Douglas Lab as of September 2018.

When we refer to **Cadnano1**, we mean two separate “legacy” versions of Cadnano. The first is **cadnano v0.2.3** which supports honeycomb-lattice designs, and the second is **cadnanoSQ v0.2.4**, which supports square-lattice designs). **Cadnano1** was written in the ActionScript language (similar to JavaScript) for the **Adobe AIR** platform. **Cadnano2** is the Python port of Cadnano1. It uses **PyQt5**, a library that provides Python bindings for **Qt** (pronounced “cute”), a cross-platform GUI framework, which replace the function of Adobe AIR.

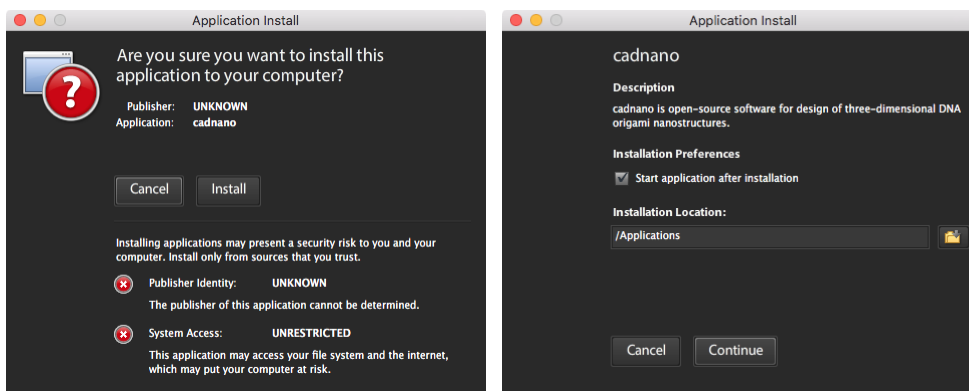
We find that it is useful to have a more than one copy of **Cadnano** available on your system. For example, you might want to open two versions of a design and edit them side-by-side. Also, while an OS update may often cause one version to stop working, it is rare that both will break simultaneously.

### ~ Notation styles for this document ~

URLs = blue clickable links	<a href="http://bionano.ucsf.edu/">http://bionano.ucsf.edu/</a>
Programs and packages = bold	<b>cadnano2</b>
Terminal commands = gray monospace font	<code>python main.py</code>
Button or tab = bold with brackets	<b>[Clone a repository]</b>
Important notes = bold red	<b>Don't forget this</b>

## Step 1. Install both honeycomb and square-lattice versions of Cadnano1

1. Install **Adobe AIR** from: <https://get.adobe.com/air/>
2. Download **cadnano** and **cadnanoSQ** from <http://cadnano.org/legacy>
3. Double-click each installers and follow the instructions. You should see an Application Install dialog window. Don't worry about the warning, it just means that we didn't pay a tax to become a known publisher. When you proceed, you can choose to add a desktop shortcut, or install in a different location.



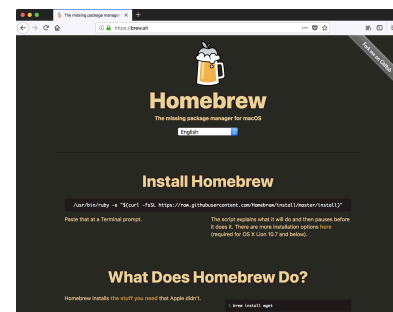
## Step 2. Install Homebrew

**Homebrew** is a package manager for macOS, and allows for easy **python3** installation. (Optional: Homebrew can install GUI applications too! See: [Cask](#))

1. Open a **Terminal** (the app can be found by typing `terminal` into Spotlight search, or navigating via Finder to `/Applications/Utilities/Terminal`).
2. Open a web browser and visit the URL <https://brew.sh/>
3. Copy & paste the “Install Homebrew” command into the **Terminal**, it will be something like:

```
/usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"
```

4. Press RETURN when prompted. You may need to enter your password to install **Xcode Command Line Tools** or fix file permissions.



```
shawn ~ $ /usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"
=> This script will install:
/usr/local/bin/brew
/usr/local/share/doc/homebrew
/usr/local/share/man/man1/brew.1
/usr/local/share/zsh/site-functions/_brew
/usr/local/etc/bash_completion.d/brew
/usr/local/Homebrew
=> The following existing directories will be made group writable:
/usr/local/bin
=> The following existing directories will have their owner set to shawn:
/usr/local/bin
=> The following existing directories will have their group set to admin:
/usr/local/bin
=> The following new directories will be created:
/usr/local/etc
/usr/local/include
/usr/local/lib
/usr/local/sbin
/usr/local/share
/usr/local/var
/usr/local/opt
/usr/local/share/zsh
/usr/local/share/zsh/site-functions
/usr/local/Cellar
/usr/local/Caskroom
/usr/local/Homebrew
/usr/local/Frameworks
=> The Xcode Command Line Tools will be installed.

Press RETURN to continue or any other key to abort
=> /usr/bin/sudo /bin/chmod u+rwx /usr/local/bin
[Password:
```

## Step 3. Install Python3

1. Once **Homebrew** is successfully installed, type the following command to install python3:

```
brew install python3
```

```
shawn ~ $ brew install python3
=> Installing dependencies for python: gdbm, openssl, readline, sqlite, xz
=> Installing python dependency: gdbm
=> Downloading https://homebrew.bintray.com/bottles/gdbm-1.18.high_sierra.bottl
##### 100.0%
=> Pouring gdbm-1.18.high_sierra.bottle.tar.gz
📦 /usr/local/Cellar/gdbm/1.18: 20 files, 584.4KB
=> Installing python dependency: openssl
=> Downloading https://homebrew.bintray.com/bottles/openssl-1.0.2p.high_sierra.
##### 100.0%
=> Pouring openssl-1.0.2p.high_sierra.bottle.tar.gz
=> Caveats
A CA file has been bootstrapped using certificates from the SystemRoots
keychain. To add additional certificates (e.g. the certificates added in
the System keychain), place .pem files in
  /usr/local/etc/openssl/certs

and run
  /usr/local/opt/openssl/bin/c_rehash

openssl is keg-only, which means it was not symlinked into /usr/local,
because Apple has deprecated use of OpenSSL in favor of its own TLS and crypto l
ibraries.
```

2. If successful, you should be able to launch **python3** from the terminal by simply typing:

```
python3
```

```
shawn ~ $ python3
Python 3.7.0 (default, Aug 22 2018, 15:22:33)
[Clang 9.1.0 (clang-902.0.39.2)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> 
```

## Step 4. Set up a virtual environment

We highly recommend using virtual environments for managing cadnano installations, and Python projects in general.

Why use virtual environments? Normally, when you install **Python** modules from the **Terminal**, you are directly changing your system-wide configuration. However, some programs have different installation requirements that cannot easily co-exist, for example two different release versions of the same program. Virtual environments mitigate this problem by creating self-contained folders to manage custom sets of Python modules, and providing a set of **Terminal** commands to easily switch between different configurations to make it *seem* like you're just working in a normal environment. The approach helps protect your system configuration since you avoid modifying it directly. And, if a virtualenv configuration gets messed up, you can easily delete it and start over.

1. If you don't already have virtual environments set up, first, run this command from the **Terminal**:

```
pip3 install virtualenvwrapper
```

```

shawn ~ $ pip3 install virtualenvwrapper
Collecting virtualenvwrapper
  Downloading https://files.pythonhosted.org/packages/2b/8c/3192e10913ad945c0f0fcb17e9b2679434a28ad58ee31ce0104cba3b1154/virtualenvwrapper-4.8.2-py2.py3-none-any.whl
Collecting virtualenv (from virtualenvwrapper)
  Downloading https://files.pythonhosted.org/packages/b6/30/96a02b2287098b23b875bc8c2f58071c35d2efe84f747b64d523721dc2b5/virtualenv-16.0.0-py2.py3-none-any.whl (1.9MB)
    100% |#####| 1.9MB 1.5MB/s
Collecting stevedore (from virtualenvwrapper)
  Downloading https://files.pythonhosted.org/packages/a1/d9/93a975469c53a9ee85de9ec0deb12345aa777748b4c263860668592344fe/stevedore-1.29.0-py2.py3-none-any.whl
Collecting virtualenv-clone (from virtualenvwrapper)
  Downloading https://files.pythonhosted.org/packages/6d/c2/dccb5ccf599e0c5d1eea6acb058af7a71384f9740179db67a9182a24798/virtualenv_clone-0.3.0-py2.py3-none-any.whl
Collecting pbr!=2.1.0,>=2.0.0 (from stevedore->virtualenvwrapper)
  Downloading https://files.pythonhosted.org/packages/69/1c/98cba002ed975a91a0294863d9c774cc0ebe38e05bbb65e83314550b1677/pbr-4.2.0-py2.py3-none-any.whl (100kB)
    100% |#####| 102kB 2.4MB/s
Collecting six>=1.10.0 (from stevedore->virtualenvwrapper)
  Downloading https://files.pythonhosted.org/packages/67/4b/141a581104b1f6397bfa78ac9d43d8ad29a7ca43ea90a2d863fe3056e86a/six-1.11.0-py2.py3-none-any.whl

```

Installing **virtualenvwrapper** will also install its dependencies, including the **virtualenv** package.

- Virtualenvwrapper is invoked as a shell script to temporarily set up your environment. Because virtual environments work directly on the **Terminal**, we need to make sure that it runs every time you open a Terminal window. We do so by adding some lines to your **.bash\_profile** with the following command:

```

cat <<END >> ~/.bash_profile
export WORKON_HOME=$HOME/.venvs
VIRTUALENVWRAPPER_PYTHON=/usr/local/bin/python3
source /usr/local/bin/virtualenvwrapper.sh
END

```

- Optional: If you'd like to set your command prompt so the style matches the coloring in this document, you can also copy the first two lines from <https://gist.github.com/sdouglas/324d2a6e760a301c1d85> into your **~/.bash\_profile** using **nano** (or the editor of your choice):

```
nano ~/.bash_profile
```

- Next, open a new **Terminal** window. If everything worked, you should see **virtualenvwrapper.sh** run for the first time and create 12 files. The next time you open th **Terminal** it should just look like the normal command prompt.

```

Last login: Sat Sep 15 18:40:31 on ttys002
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/premkproject
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/postmkproject
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/initialize
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/premkvirtualenv
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/postmkvirtualenv
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/prermvirtualenv
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/postrmvirtualenv
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/predeactivate
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/postdeactivate
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/preactivate
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/postactivate
virtualenvwrapper.user_scripts creating /Users/shawn/.venvs/get_env_details

```

## Step 5. Create a virtualenv and install Cadnano2 dependencies: PyQt5 and networkx

**PyQt5** is required to run **Cadnano2**, similar to Adobe AIR for **Cadnano1**. The **networkx** package is used to handle some of the graph algorithms for the original version of the Autobreak plugin. We won't be using that feature, but it's easier to just install the dependency for now. We will be using **pip**, a command-line python package installer.

1. Let's create our first virtual environment in preparation for installing **cadnano2**:

```
mkvirtualenv cn2
```

The new virtualenv will automatically activate upon creation, and you should see its name in parentheses at the start of your prompt, something like “(cn2) username ~ \$” if you are working in your home directory.

2. Now we can install the **cadnano2** dependencies **PyQt5** and **networkx** inside the “cn2” virtualenv that we just created. First install **PyQt5** using the following command:

```
pip install PyQt5==5.10.1
```

The “==5.10.1” part forces the installation of a specific version of **PyQt5**. We have found that the latest version of PyQt5 (version 5.11.2, as of September 2018) can cause some runtime errors, but 5.10.1 should work fine.

3. Install **networkx** using the following command:

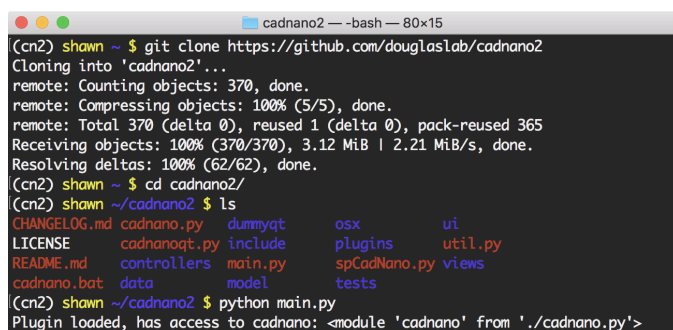
```
pip install networkx
```

The above commands from steps 2 and 3 should output messages about downloading and installing the corresponding packages, similar to what we saw above when installing **virtualenvwrapper**. If you see warnings about upgrading **pip** to the newest version, you can ignore them. Or, follow the instructions if you wish.

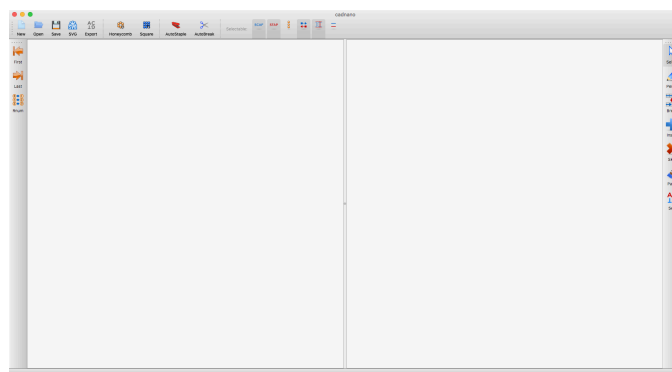
## Step 6: Install Cadnano2 by cloning the source git repository

1. Finally, we can clone the latest version of **cadnano2**, and run it.

```
git clone https://github.com/douglaslab/cadnano2
cd cadnano2
python3 main.py
```



```
cadnano2 --bash -- 80x15
(cn2) shawn ~ $ git clone https://github.com/douglaslab/cadnano2
Cloning into 'cadnano2'...
remote: Counting objects: 370, done.
remote: Compressing objects: 100% (5/5), done.
remote: Total 370 (delta 0), reused 1 (delta 0), pack-reused 365
Receiving objects: 100% (370/370), 3.12 MiB | 2.21 MiB/s, done.
Resolving deltas: 100% (62/62), done.
(cn2) shawn ~ $ cd cadnano2/
(cn2) shawn ~/cadnano2 $ ls
CHANGELOG.md  cadnano.py    dummyqt      osx          ui
LICENSE       cadnanoqt.py include      plugins      util.py
README.md     controllers  main.py     spCadNano.py views
cadnano.bat   data        model       tests
(cn2) shawn ~/cadnano2 $ python main.py
Plugin loaded, has access to cadnano: <module 'cadnano' from './cadnano.py'>
```



Hopefully, the **cadnano2** window launched!

## Step 7: Running Cadnano2 in a new Terminal window

Once you have your virtual environment set up, open a new **Terminal** and run the following:

```
workon cn2
cd ~/cadnano2
python3 main.py
```

If you installed or moved cadnano2 somewhere other than your home directory, you'll need to adapt the command to navigate there.

Note that you only need to follow steps 5 and 6 once to setup the **virtualenv** and download the **cadnano2** source. After that, you only need to activate or deactivate the **cn2** virtualenv as needed. Note that the “python3 main.py” command will not work until you activate the **cn2** virtualenv.

In general, to re-activate your **cn2** virtual environment, you use the **workon** command, e.g.

```
workon cn2
```

To switch back to your normal non-virtual environment, just open a new **Terminal** or use the **deactivate** command:

```
deactivate
```

## Step 8: Create a Cadnano2 alias

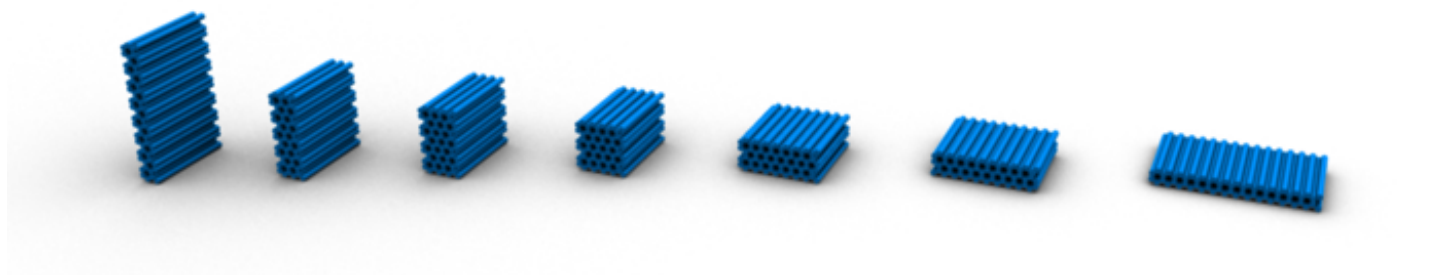
You may wish to add the following line to your **.bash\_profile** to create an alias to run all three commands together:

```
alias cadnano2='workon cn2 && cd ~/cadnano2 && python main.py'
```

With the alias, you can just type the following command to launch the app:

```
cadnano2
```

Both honeycomb and square lattice designs are handled by the same version of **cadnano2**, so we are pretty much ready to start designing! You can click on the **[Honeycomb]** or **[Square]** button in the interface to get started, or visit <http://cadnano.org/gallery.html> to download some published DNA origami designs to open and play with.



# Additional Instructions

## Reporting Bugs

The **douglaslab/cadnano2** application is not bug free. You should get in the habit of saving your designs frequently, and reporting bugs when it crashes so we can make it more stable over time. Typically, you will get a Traceback in the **Terminal** window with some information about the line number and function that was executing when an exception was thrown.

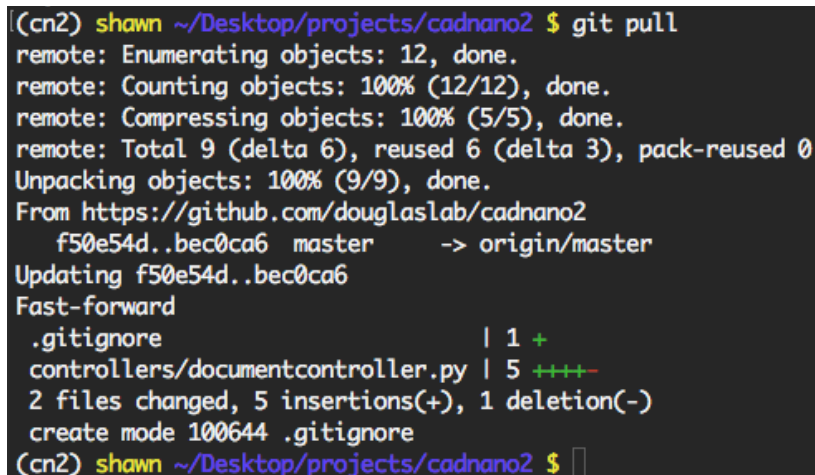
If you encounter this situation, please copy the full traceback and paste it into new “Issue” along with detailed steps to reproduce at <https://github.com/douglaslab/cadnano2/issues>. If you have any example files that will be useful in reproducing the bug, please upload them too.

If you poke around in the source code and think that you’ve fixed the bug, please submit a pull request along with your Issue. If we incorporate your fix, you will be added to the list of contributors.

## Updating Cadnano2 when it’s been patched

If you submit any bugs, hopefully, we will be able to patch the source code quickly. Once that is done, you’ll need to synchronize your local copy of **cadnano2** with the latest commit. You can do from the **Terminal** by navigating to the cadnano2 source path, and then performing a **git pull** command:

```
cd ~/cadnano2
git pull
```



```
(cn2) shawn ~/Desktop/projects/cadnano2 $ git pull
remote: Enumerating objects: 12, done.
remote: Counting objects: 100% (12/12), done.
remote: Compressing objects: 100% (5/5), done.
remote: Total 9 (delta 6), reused 6 (delta 3), pack-reused 0
Unpacking objects: 100% (9/9), done.
From https://github.com/douglaslab/cadnano2
   f50e54d..bec0ca6  master    -> origin/master
Updating f50e54d..bec0ca6
Fast-forward
 .gitignore                  | 1 +
 controllers/documentcontroller.py | 5 +++-
 2 files changed, 5 insertions(+), 1 deletion(-)
 create mode 100644 .gitignore
(cn2) shawn ~/Desktop/projects/cadnano2 $
```

Assuming you haven’t made any local changes to the source code in the master branch, any updates should download and you’ll see some output similar to the above screenshot. If there haven’t been any updates, you’ll see the message “Already up to date”.