SW4 2.01 QUICK START INSTALL GUIDE

*Note: the information shared within this install guide was compiled from the listed websites below, the SW4 Installation Guide and SW4 README files. This installation was performed on macOS Monterey V12.4, Intel Core i5.

key: websites, `shell terminal commands`

Introduction to the UNIX System

The UNIX system usually offers a variety of shell types. Some of the common ones are bash, csh, zsh, ksh, tcsh. The terminal is a program that is used to interact with a shell interface, similar to how the Chrome browser is an interface for various websites.

The UNIX system prompts user entry from the command line. Commands vary from shell type. Some common commands include:

⇒ `cd` - takes you to your home directory
⇒ `cd ..` - takes you back one directory
⇒ `cd <directory-name>` - changes directories
⇒ `echo` - returns typed entry in the shell
⇒ `date` - displays the current time and date
⇒ `pwd` - prints the current working directory you are in
⇒ `ls` - prints a list of every file within the current directory you are in
⇒ `~` - the tilde represents a short cut for your home directory
⇒ `mkdir` - creates a directory
⇒ `mv` - moves one or more files or directories from one place to another.
⇒ `touch` - creates a new, empty file
⇒ `cp` - This command is used to copy files or group of files or directory.

As you can probably guess, there are dozens of commands that you can use. For this installation guide, we will only use a few of these useful commands. While entering commands in your terminal, it's a good idea to copy and paste whenever you can. The terminal, just like any other compiler, can be very picky with spaces and syntax.

If needed, the below video can provide more information on the UNIX system:

⇒ https://www.youtube.com/watch?v=OAAdLMZvk1I&t=647s

1. Download SW4 Software

To download the SW4 software, you'll need to first log into CIG (Geodynamics). This process can be done by either creating an ORCID account or creating an account for CIG. You can do this here:

- ⇒ ORCID: https://orcid.org/register
- ⇒ CIG: https://geodynamics.org/register?return=Lw==

Log into your newly created account, and download the SW4 software:

- ⇒ Software
- ⇒ Download
- ⇒ SW4
- ⇒ View Link (HTM)
- ⇒ Download - *sw4-v2.01.zip*

2. Installing Compilers, Tools and Third-party Libraries

First things first - to successfully build SW4 on your system, it is necessary to install some compilers, management system tools, and third-party libraries.

Homebrew

Homebrew is a package and environment management system that simplifies the installation of software on macOS, as well as Linux. Homebrew installs the stuff you need that Apple, or your Linux system didn't. To download, paste this into your bash shell terminal window (to make sure you are in a bash shell, simply type "bash" into your terminal):

⇒

```
/bin/bash -c "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/HEAD/install.sh)"
```

The above command will download the software straight from the internet. The script will explain what the Homebrew software will do, will pause before it does it, and will walk you through the process. For more information on Homebrew, please see the website:

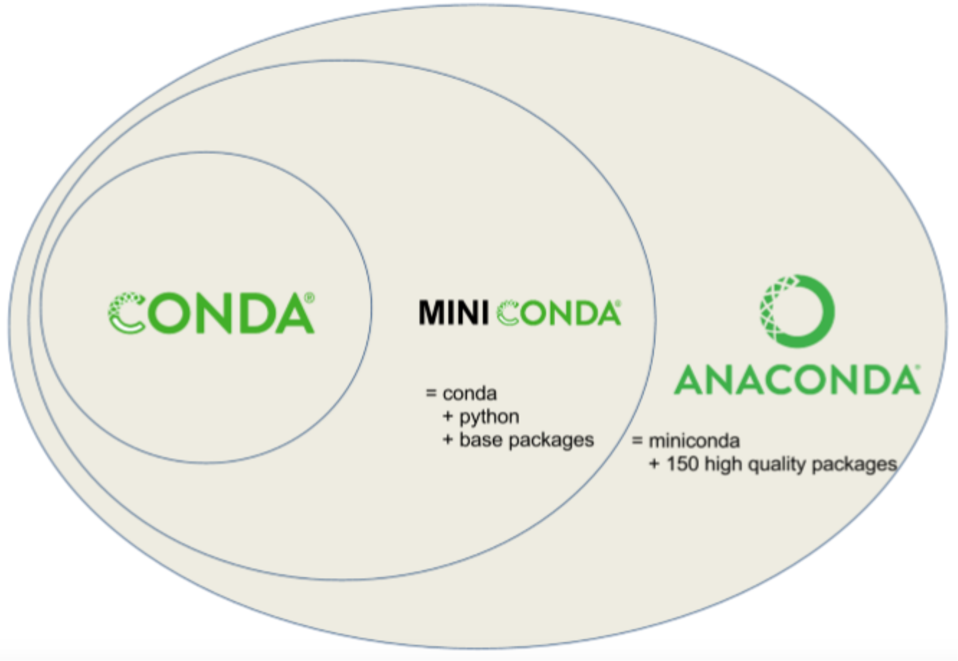
- ⇒ https://brew.sh/

Conda

Conda is a package and environment management system that runs on all systems. Although Conda was created for Python programs, Conda can work for any language. Depending on your needs, you can either download

Anaconda, Miniconda or Conda. Below you can see a breakdown for each. Download the latest versions here:

⇒ https://www.anaconda.com/products/distribution#Downloads



Source: Planemo documentation

GNU Make

GNU Make is a tool which enables you to build and install your packages without knowing the fancy details. You can check the version of make on your system with the command:

```
⇒ make -v
```

If you don't have GNU make installed on your system, you can download the latest version here:

⇒ http://ftp.gnu.org/gnu/make

GNU Installation

To start, manually move the make directory into your sw4-2.01 directory. Next, cd into your make directory in your terminal:

```
⇒ cd ~/sw4-2.01/make-4.3
⇒ brew install make
⇒ export PATH="/usr/local/opt/make/libexec/gnubin:$PATH"
```

To see if you installed correctly, check your version:

```
⇒ make -v
```

LAPACK and BLAS Libraries

These libraries provide basic mathematical functionality and come pre-installed on many machines. If you do not think this is the case for your system, you can download the latest versions here:

- ⇒ BLAS: http://www.netlib.org/blas
- ⇒ LAPACK: http://www.netlib.org/lapack

LAPACK and BLAS Installation

To compile all Fortran files in your terminal, cd to the BLAS directory and execute the command using make:

```
⇒ make
```

To rename the created library, execute:

```
⇒ mv blas_UNIX.a libblas.a
```

After creating the library called “libblas.a”, copy that file to your library directory by executing the following command:

```
⇒ sudo cp libblas.a /your/local/library/path
```

The above directory can be replaced by any library path in your system (wherever you'd like to store the libraries).

The "sudo" command runs an elevated prompt in your terminal without the need to change your identity. The BLAS package should now be installed.

Now we can switch to the LAPACK directory; cd to the LAPACK directory and follow the same commands:

```
⇒ make
```

Create a library called “lapack_MACOS.a” and copy the file to your library folder by executing:

```
⇒ sudo cp liblapack.a /your/local/library/path
```

MPI-2 Libraries

SW4 uses the message passing interface (MPI) standard for communication on parallel distributed memory machines. Open-source implementations Mpich-2 and OpenMPI provide support for this message passing. Note that the MPI-2 library must be installed even if you are only building SW4 for a single core system.

OpenMPI

MPI stands for Message Passing Interface. Written by the MPI Forum, a large committee comprised of a cross-section between industry and research representatives. MPI is a standardized API typically used for parallel and/or distributed computing. You can download the latest version here:

⇒ https://www.open-mpi.org/software/ompi/v4.1/

OpenMPI Installation

To start, manually move the OpenMPI directory into your sw4-2.01 directory. Next, cd into your OpenMPI directory in your terminal:

```
⇒ cd ~/sw4-2.01/openmpi-4.1.4
⇒ ./configure --prefix=/usr/local
```

Be patient, this command will create a LOT of output...

```
⇒ make all install
```

The OpenMPI configure script tests for many different libraries, not all of which are expected to succeed. You'll see errors and warnings about various operating-system specific tests that are not aimed for the operating system you are running. These are all normal, expected, and nothing to be concerned about.

If configure finishes successfully, it will generate a lot of Makefiles throughout the OpenMPI directory.

PROJ

PROJ is a generic coordinate transformation software that transforms geospatial coordinates from one coordinate reference system (CRS) to another. This includes cartographic projections as well as geodetic transformations. Download the latest version of PROJ here:

⇒ https://proj.org/download.html#download

PROJ Installation

To start, manually move the PROJ directory into your sw4-2.01 directory. Next, cd into your PROJ directory in your terminal:

```
⇒ cd ~/sw4-2.01/proj-9.0.1
⇒ conda install -c conda-forge proj
⇒ conda install -c conda-forge proj-data
```

Euclid E-tree Library (optional)

The Euclid Project allows the capability to perform physical simulations by computing directly on databases. The Euclid E-tree Library software is available for download here:

⇒ http://www.cs.cmu.edu/~euclid/euclid3-latest.tar.gz

Euclid Installation

This package contains the programs and specifications of building the CVM E-tree database for the Los Angeles basin. There are three directories:

⇒ libsrc - contains the E-tree library source code programs.
⇒ examples - contains example programs demonstrating how to use the E-tree library.
⇒ cvm - contains the programs and specifications of building CVM E-tree database for the Los Angeles basin.

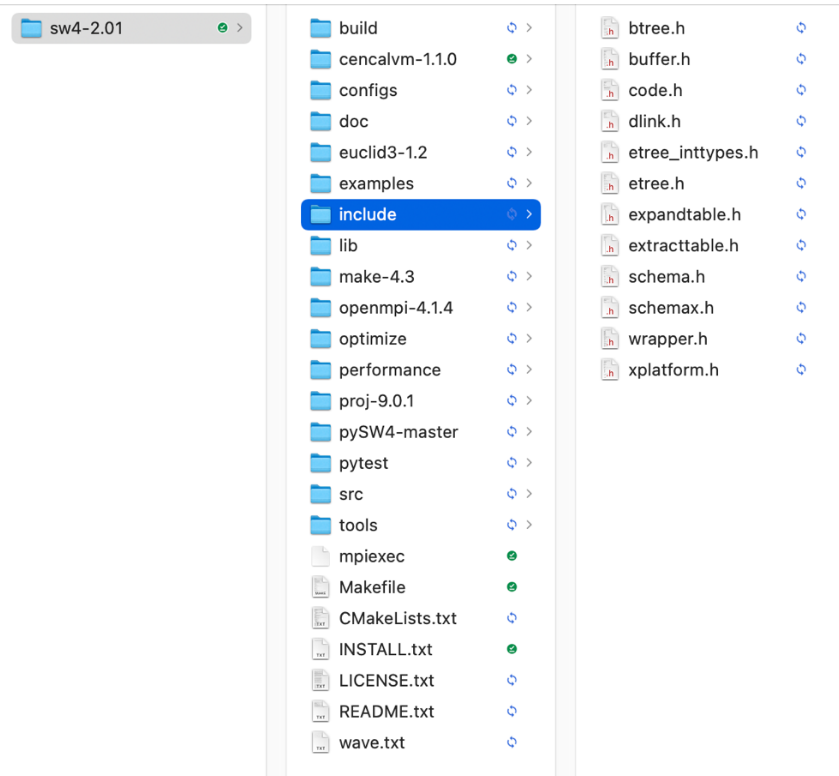
To start, move the Euclid directory you just downloaded into your sw4-2.01 directory. Next, create two directories within sw4-2.01 (you can do this manually or through your terminal):

```
⇒ mkdir include
⇒ mkdir lib
```

The Euclid Library must be installed by explicitly copying all include files (.h) to the include directory and all libraries to the lib directory:

```
⇒ cd euclid3-1.2/libsrc
⇒ make
⇒ cp *.h ${~/sw4-2.01}/include
⇒ cp libetree.* ${~/sw4-2.01}/lib
```

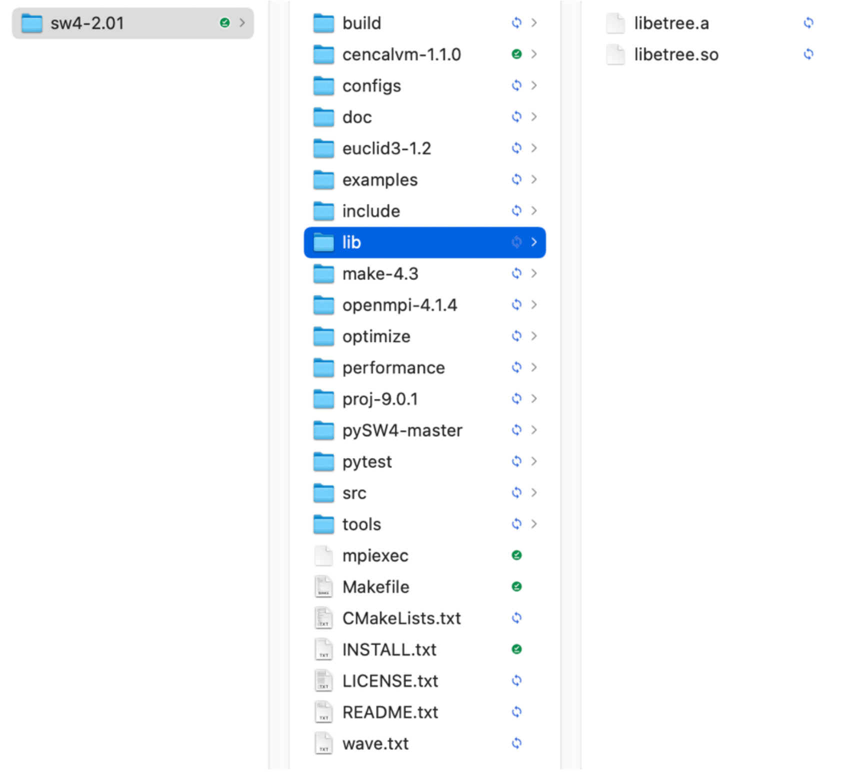
Your include and lib directories should look like this after moving the files:



sw4-2.01

build
cencalvm-1.1.0
configs
doc
euclid3-1.2
examples
include
lib
make-4.3
openmpi-4.1.4
optimize
performance
proj-9.0.1
pySW4-master
pytest
src
tools
mpiexec
Makefile
CMakeLists.txt
INSTALL.txt
LICENSE.txt
README.txt
wave.txt

btree.h
buffer.h
code.h
dlink.h
etree_inttypes.h
etree.h
expandtable.h
extracttable.h
schema.h
schemax.h
wrapper.h
xplatform.h



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mpiexec
Makefile
CMakeLists.txt
INSTALL.txt
LICENSE.txt
README.txt
wave.txt

libetree.a
libetree.so

To build the Euclid package, the first thing you need to do is to build the E-tree Library:

⇒ Manually enter the `~/sw4-2.01/euclid3-1.2/libsrc` directory.
⇒ Open the file Makefile with an editor or compiler, modify the variable according to your operating system, and resave the file.
⇒ `cd ~/sw4-2.01/euclid3-1.2`
⇒ `gmake`

You may optionally choose to build the example programs for building the CVM E-tree database for the Los Angeles basin. The steps are similar to building the E-tree library except you will use the `~/sw4-2.01/euclid3-1.2/cvm` directory:

⇒ Manually enter `~/sw4-2.01/euclid3-1.2/cvm` directory.
⇒ Open the README file with an editor or compiler. This is important. The instructions in the README file will direct you to set the variables correctly in the Makefile. Make sure to resave after you edit.
⇒ Modify the variables in the Makefile properly as instructed.
⇒ Build the programs and E-tree database as per the instructions.

CENCALVM Library (optional)

The USGS 3-D Geologic and Seismic Velocity Models of the San Francisco Bay Area region provide a three-dimensional view of the geologic structure and physical properties of the region down to a depth of 45 km (28 miles). This software library is required to query the seismic velocity model for physical properties. You can download the latest version here:

⇒ https://github.com/usgs/earthquake-cencalvm/releases

CENCALVM Installation

⇒ To start, manually move the CENCALVM directory into your sw4-2.01 directory. Within your terminal, cd into your CENCALVM directory.
⇒ `cd ~/sw4-2.01/cencalvm-1.1.0`
⇒ Next, the provided `setup.sh` script only works if you are using a bash shell. If you are using a different shell, you will need to alter how the environment variables are set in `setup.sh`, similar to the E-tree library.
⇒ `source setup.sh`

The source command is used to read a file and treat its content as a set of commands to execute. After this command, you should get: " Ready to run cencalvmquery." in your terminal.

*You will need to either source the `setup.sh` script each time you open a new bash shell (terminal) window or manually add the environment variables to your shell setup script (for example,`.bashrc`).

Download the velocity model database files:

⇒ https://www.usgs.gov/programs/earthquake-hazards/science/3-d-geologic-and-seismic-velocity-models-san-francisco-bay
⇒ USGSBayAreaVM-08.3.0.etree.gz
⇒ USGSBayAreaVMExt-08.3.0.etree.gz
⇒ MD5SUMS_GZIPPED (Verifies the integrity of the compressed files)
⇒ MD5SUMS (Verifies the integrity of the uncompressed files)

Check the integrity of the database files you just downloaded, before and after uncompressing:

```
⇒ md5sum -c MD5SUMS_GZIPPED
⇒ md5sum -c MD5SUMS
```

3. Installing SW4 with CMake

```
⇒ cd ~/sw4-2.01
⇒ mkdir build
⇒ cd build
⇒ cmake [options] ..
```

The *two dots* after cmake [options] are essential and instructs the installer to look in the parent directory for the CMakeLists.txt file. The cmake command searches for the necessary libraries and other dependencies, then creates makefiles that are appropriate for your system.

Next, enter the make command to compile and link SW4 using these makefiles.

```
⇒ make
```

When installed successfully, you should be greeted with an enthusiastic welcome message from your terminal:

```
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```
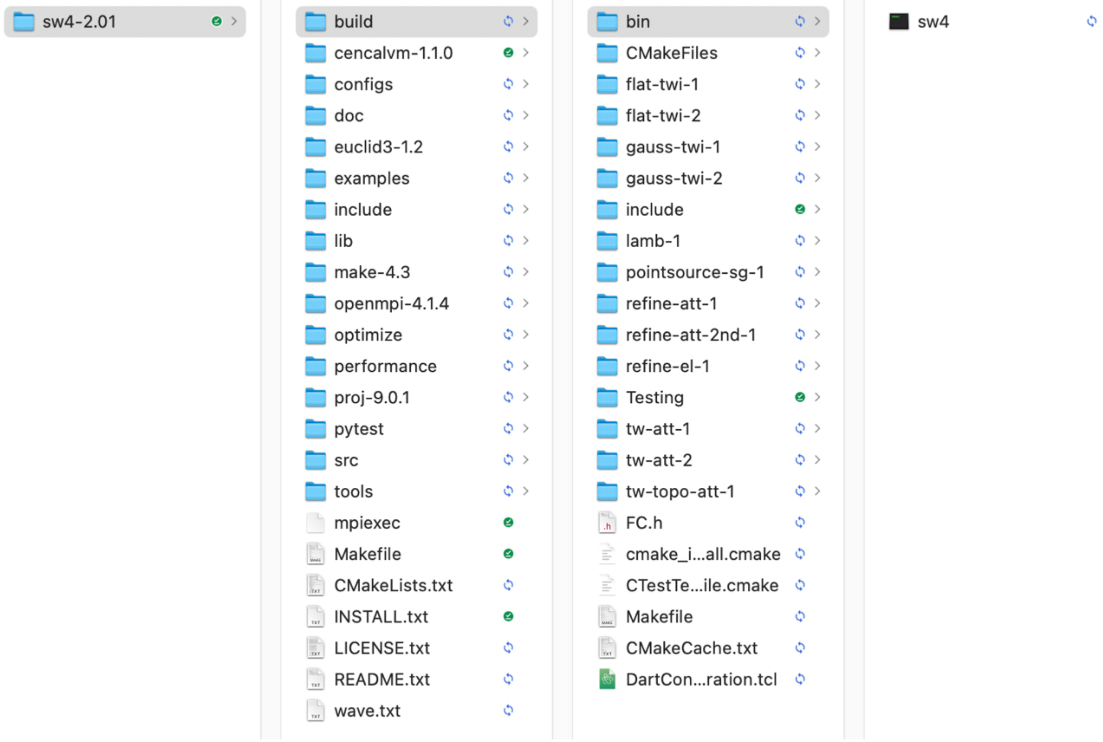

Success! You did a great job.

Cmake will put the SW4 executable in the `~/sw4-2.01/build/bin` directory.

After SW4 is successfully installed, your directory system should look like this:



sw4-2.01

build
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Makefile
CMakeLists.txt
INSTALL.txt
LICENSE.txt
README.txt
wave.txt

bin
CMakeFiles
flat-twi-1
flat-twi-2
gauss-twi-1
gauss-twi-2
include
lamb-1
pointsource-sg-1
refine-att-1
refine-att-2nd-1
refine-el-1
Testing
tw-att-1
tw-att-2
tw-topo-att-1
FC.h
cmake_i...all.cmake
CTestTe...ile.cmake
Makefile
CMakeCache.txt
DartCon...ration.tcl

sw4