

How to install Firedrake

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1 Firedraka 安装

需要计算机网络环境正常, 否则请参考 无网络安装

1.1 Ubuntu

下载安装脚本 `firedrake-install` 然后运行即可

```
curl -O https://raw.githubusercontent.com/firedrakeproject/firedrake/master/scripts/firedrake-install
python3 firedrake-install
```

查看安装帮助

```
python3 firedrake-install -h
```

1.1.1 Real Int32

```
python3 firedrake-install --slepc --disable-ssh --documentation-dependencies --remove-build-files
```

1.1.2 Complex Int64

```
PETSC_CONFIGURE_OPTIONS='--download-scalapack --download-mumps' \
python3 firedrake-install --petsc-int-type int64 --complex --slepc \
--disable-ssh --documentation-dependencies --remove-build-files
```

1.2 Windows

安装 WSL (适用于 Linux 的 Windows 子系统, Windows Subsystem for Linux). 默认情况下, 安装的系统为 Ubuntu.

1.2.1 WSL 安装

<https://docs.microsoft.com/zh-cn/windows/wsl/install>

1.2.2 Firedrake 安装

按照 Ubuntu 安装方式

1.3 Mac

先安装 Homebrew (<https://brew.sh/>), 然后使用 Homebrew 安装 python3, 之后类似于 Ubuntu 直接安装 firedrake

1.4 Linux Server

若服务器不能访问网络, 请参考下节: 无网络安装.

1.4.1 Spack I

Firedrake 团队提供了基于 Spack (HPC 上的包管理器) 安装的方式.

详见: <https://github.com/firedrakeproject/firedrake-spack>

1.4.2 Spack II

使用 spack 安装依赖包, 然后类似于 Ubuntu 方式安装 (需要禁用包管理器: `--no-package-manager`)

可参考如下脚本:

<https://raw.githubusercontent.com/lrtfm/notes-for-firedrake/main/scripts/spack-firedrake.py>

1.4.3 Docker

可以使用 Firedrake 团队构建的镜像

<https://hub.docker.com/u/firedrakeproject>.

2 无网络安装

若需在无网络访问的工作站上安装 firedrake, 需要使用 spack 的镜像功能.

假设本地可以 git 访问 github. 下面我们以安装软件在 `$HOME/opt` 目录为例.

注: 下面多行命令块中各行之间使用了 `&& \` 连接, 直接拷贝多行到终端输入回车即可.

Reference:

1. spack install:

- https://spack.readthedocs.io/en/latest/getting_started.html#installation

2. spack mirror:

- <https://spack.readthedocs.io/en/latest/mirrors.html#mirror-environment>
- <https://spack.readthedocs.io/en/latest/mirrors.html#mirror-files>

3. firedrake spack:

- <https://github.com/firedrakeproject/firedrake-spack>
- <https://hackmd.io/@TzVnFeL0TMCb3FaAi9qYBA/ByaRskMQ5>

2.1 本地

2.1.1 创建安装目录

```
mkdir $HOME/opt
```

2.1.2 下载安装 spack

```
cd $HOME/opt && \  
git clone -c feature.manyFiles=true https://github.com/spack/spack.git && \  
source $HOME/opt/spack/share/spack/setup-env.sh
```

注: 添加下面命令到文件 `$HOME/.bashrc` 中, 用于添加 spack 的 shell 支持, 使得每次开启终端都可以使用 spack.

```
source $HOME/opt/spack/share/spack/setup-env.sh
```

2.1.3 打包 spack 文件, 用于服务器安装

```
tar -czvf spack.tar.gz spack
```

2.1.4 下载 firedrake-spack 仓库

```
cd $HOME/opt && \  
git clone https://github.com/lrtfm/firedrake-spack.git && \  
git checkout tmp-fix-petsc-ptscotch
```

2.1.5 打包 firedrake-spack 文件, 用于服务器安装

```
tar -czvf firedrake-spack.tar.gz firedrake-spack
```

2.1.6 添加该仓库到 spack

```
spack repo add firedrake-spack
```

2.1.7 检查 spack 安装情况

现在运行 `spack info py-firedrake` 查看 firedrake-spack 仓库是否添加成功

```
$ spack info py-firedrake  
PythonPackage:  py-firedrake  
  
Description:  
  Firedrake is an automated system for the portable solution of partial  
  differential equations using the finite element method (FEM)  
  
Homepage: https://firedrakeproject.org  
  
Preferred version:  
  develop      [git] https://github.com/firedrakeproject/firedrake.git on branch master  
  
Safe versions:
```

develop

[git] https://github.com/firedrakeproject/firedrake.git on branch master

Deprecated versions:

None

Variants:

Name [Default]	When	Allowed values	Description
=====	====	=====	=====
64-bit-indices [off]	--	on, off	Install PETSc using 64bit indices
build_system [python_pip]	--	python_pip	Build systems supported by the package
complex [off]	--	on, off	Install Firedrake in complex mode
minimal-petsc [off]	--	on, off	Build PETSc with minimal packages for Firedrake
slepc [off]	--	on, off	Install SLEPc and slepc4py

Build Dependencies:

eigen	mpi	py-cython	py-h5py	py-mpi4py	py-pip	py-pyadjoint	py-scipy
libspatialindex	petsc	py-fiat	py-islpy	py-numpy	py-pkgconfig	py-pyop2	py-setuptools
libsupermesh	py-cachetools	py-finat	py-matplotlib	py-petsc4py	py-progress	py-requests	py-slepc4py

Link Dependencies:

eigen libspatialindex libsupermesh mpi petsc python slepc

Run Dependencies:

eigen	petsc	py-finat	py-mpi4py	py-pip	py-pyop2	py-scipy	py-t
libspatialindex	py-cachetools	py-h5py	py-nbval	py-pkgconfig	py-pytest	py-setuptools	py-u
libsupermesh	py-cython	py-islpy	py-numpy	py-progress	py-pytest-xdist	py-slepc4py	py-v
mpi	py-fiat	py-matplotlib	py-petsc4py	py-pyadjoint	py-requests	py-sympy	pyth

当前 \$HOME/opt 目录文件如下:

```
$ ls -lha
total 214M
drwxrwxr-x 4 z2yang z2yang 112 Oct 30 15:17 .
drwxrwxr-x 3 z2yang z2yang 47 Oct 30 15:02 ..
drwxrwxr-x 5 z2yang z2yang 204 Oct 30 15:16 firedrake-spack
-rw-rw-r-- 1 z2yang z2yang 211K Oct 30 15:17 firedrake-spack.tar.gz
drwxrwxr-x 10 z2yang z2yang 4.0K Oct 30 15:17 spack
-rw-rw-r-- 1 z2yang z2yang 214M Oct 30 15:15 spack.tar.gz
```

2.2 工作站

2.2.1 创建安装目录

```
mkdir $HOME/opt
```

2.2.2 上传文件

使用 ftp 等工具上传本地的 firedrake-spack.gz 和 spack.tar.gz 到服务器的 \$HOME/opt 目录.

2.2.3 解压安装 spack

```
cd $HOME/opt && \
tar -zxvf spack.tar.gz && \
source $HOME/opt/spack/share/spack/setup-env.sh
```

注 1: 添加下面命令到文件 `$HOME/.bashrc` 中, 用于添加 spack 的 shell 支持, 使得每次开启终端都可以使用 spack.

```
source $HOME/opt/spack/share/spack/setup-env.sh
```

注 2: 某些工作站上 `/tmp` 目录内容没有执行权限, 需要更改 spack 的构建目录配置如下:

```
mkdir -p $HOME/.spack && \
cat > $HOME/.spack/config.yaml <<EOF
config:
  build_stage:
    - \${user_cache_path}/stage
EOF
```

2.2.4 解压安装 firedrake-spack 仓库

```
cd $HOME/opt && \
tar -zxvf firedrake-spack.tar.gz && \
spack repo add firedrake-spack
```

2.2.5 准备 firedrake 安装环境

1. 创建环境

```
FIREDRAKE_ENV_NAME=firedrake-complex-int64 && \
spack env create -d $FIREDRAKE_ENV_NAME && \
spack env activate -p $FIREDRAKE_ENV_NAME && \
spack -e $SPACK_ENV config add concretizer:unify:true
```

2. 添加软件包 (可根据需要添加或删减)

```
spack add py-firedrake@develop%gcc +64-bit-indices+complex ^mpich ^openblas \
^petsc+mumps+scalapack+int64+complex+libyaml+parmmg+mmg \
^hypra+complex+int64+superlu-dist && \
spack add py-pygmsh py-meshio py-tqdm py-pyyaml
```

注: `^mpich` 和 `^openmpi` 均测试出错, 但直接运行并行代码正常, 为什么?

3. 运行 concretize (spack 计算软件依赖关系)

```
spack concretize -f 2>&1 | tee $SPACK_ENV/spack-firedrake-concretize.log
```

4. 查看 \$SPACK_ENV 目录, 有如下内容

```
$ ls -la $SPACK_ENV
total 620
drwxrwxr-x 3 z2yang z2yang 118 Oct 30 16:01 .
drwxrwxr-x 5 z2yang z2yang 147 Oct 30 15:33 ..
drwxrwxr-x 4 z2yang z2yang 89 Oct 30 16:01 .spack-env
-rw-rw-r-- 1 z2yang z2yang 54343 Oct 30 16:01 spack-firedrake-concretize.log
-rw-rw-r-- 1 z2yang z2yang 572917 Oct 30 16:01 spack.lock
-rw-rw-r-- 1 z2yang z2yang 457 Oct 30 16:01 spack.yaml
```

2.2.6 本地创建镜像文件上传服务器

通过 `spack.lock` 文件在本地创建 `firedrake` 环境, 构建镜像, 并上传服务器.

1. 下载 `spack.lock` 文件到本地.
2. (本地) 运行如下命令创建镜像 (创建镜像需要 10min 左右)

```
cd $HOME/opt && \  
spack env create -d firedrake-mirror-env spack.lock && \  
spack env activate -p ./firedrake-mirror-env && \  
time spack mirror create -a -d spack-firedrake-mirror 2>&1 | tee creat-mirror.logs
```

结束后会有如下输出

```
==> Summary for mirror in file:///home/z2yang/z2yang/local/opt/spack-firedrake-mirror  
==> Archive stats:  
    0    already present  
   244    added  
    0    failed to fetch.  
  
real    10m56.048s  
user    1m1.559s  
sys     0m13.604s
```

如果有失败的, 需要先删除缓存, 重新创建镜像:

```
spack clean -ds && \  
time spack mirror create -a -d spack-firedrake-mirror 2>&1 | tee creat-mirror.logs
```

3. (本地) 打包镜像

```
tar -czvf spack-firedrake-mirror.tar.gz spack-firedrake-mirror
```

4. 上传镜像

使用 `ftp` 工具上传 `spack-firedrake-mirror.tar.gz` 到服务器上 `$HOME/opt` 目录

5. (服务器) 解压镜像

```
tar -xzvf spack-firedrake-mirror.tar.gz
```

6. (服务器) 添加镜像路径到 `spack`

```
cat > $HOME/.spack/mirrors.yaml <<EOF  
mirrors:  
  local_filesystem: file://$HOME/opt/spack-mirror-firedrake  
EOF
```

7. (工作站) 查看镜像是否添加成功, 运行 `spack mirror lsit` 应该有如下信息

```
$ spack mirror list  
local_filesystem    file://<your-home-path>/opt/spack-mirror-firedrake  
spack-public        https://mirror.spack.io
```

2.2.7 安装 Firedrake

1. 运行 develop 命令以避免一些错误

```
spack develop py-firedrake@develop && \  
spack develop libsupermesh@develop && \  
spack develop petsc@develop && \  
spack develop chaco@petsc && \  
spack develop py-fiat@develop && \  
spack develop py-finat@develop && \  
spack develop py-islpy@develop && \  
spack develop py-petsc4py@develop && \  
spack develop py-pyadjoint@develop && \  
spack develop py-pyop2@develop && \  
spack develop py-coffee@develop && \  
spack develop py-loopy@develop && \  
spack develop py-cgen@develop && \  
spack develop py-codepy@develop && \  
spack develop py-genpy@develop && \  
spack develop py-tsfc@develop && \  
spack develop py-ufl@develop
```

2. 安装

在服务器端运行下面命令安装（第一次安装需要等待一段时间 1-2hour, 中间可能会失败, goog luck!）

```
spack concretize -f 2>&1 | tee $SPACK_ENV/spack-firedrake-develop.log && \  
time spack install --fail-fast --show-log-on-error \  
--log-file $SPACK_ENV/spack-firedrake-install.log
```

最后几行输出如下:

```
[+] /home/z2yang/z2yang/server2/opt/spack/opt/spack/linux-ubuntu22.04-cascadelake/gcc-11.3.0/py-firedrake-dev  
==> Updating view at /home/z2yang/z2yang/server2/opt/firedrake-complex-int64/.spack-env/view  
  
real    184m44.242s  
user    836m56.348s  
sys     97m42.901s
```

3. 取消激活环境

```
despacktivate
```

会有如下 Warning 忽略即可

```
$ despacktivate  
==> Warning: Skipping reversal of unreversable operation<class 'spack.util.environment.UnsetEnv'> PETSC_ARCH  
==> Warning: Skipping reversal of unreversable operation<class 'spack.util.environment.UnsetEnv'> PETSC_ARCH  
==> Warning: Skipping reversal of unreversable operation<class 'spack.util.environment.UnsetEnv'> PETSC_ARCH  
==> Warning: Skipping reversal of unreversable operation<class 'spack.util.environment.UnsetEnv'> PETSC_ARCH
```

2.2.8 使用

1. 激活环境


```
cd $HOME/opt && \  
spack env activate -p $FIREDRAKE_ENV_NAME
```

2. 测试

```
cd $SPACK_ENV/py-firedrake && \  
pytest tests/regression/ -k "poisson_strong or stokes_mini or dg_advection"
```

3 Colab 上尝试 Firedrake

Colab 是 Colaboratory 的简称, (可以看作是在线版 Jupyter, 浏览器中编写和执行 Python 代码)

FEM on Colab 支持在 Colab 上安装 FEniCS, FEniCSx, Firedrake, NGSolve, gmsh

3.1 导入 Package

3.1.1 Firedrake

大概 3 分钟

```
try:  
    import firedrake  
except ImportError:  
    !wget "https://fem-on-colab.github.io/releases/firedrake-install-real.sh" \  
      -O "/tmp/firedrake-install.sh" && bash "/tmp/firedrake-install.sh"  
    import firedrake
```

3.1.2 Gmsh

```
try:  
    import gmsh  
except ImportError:  
    !wget "https://fem-on-colab.github.io/releases/gmsh-install.sh" \  
      -O "/tmp/gmsh-install.sh" && bash "/tmp/gmsh-install.sh"  
    import gmsh
```

3.2 示例

<https://colab.research.google.com/drive/1gM3zMWtSkH7XyDi1yJL76BPFnOJjSdYh?usp=sharing>

4 问题求助

官方文档:

- <https://www.firedrakeproject.org/documentation.html>

Github 仓库 (issues and discussions):

- <https://github.com/firedrakeproject/firedrake>

- <https://github.com/firedrakeproject/firedrake/issues>
- <https://github.com/firedrakeproject/firedrake/discussions>

Slack 讨论组:

- <https://firedrakeproject.herokuapp.com/>

邮件列表:

- <https://mailman.ic.ac.uk/mailman/listinfo/firedrake>

5 其他有限元工具

- [FEniCSx](#)
- [NgSolve](#)
- [deal.II](#)
- [libMesh](#)
- [FreeFEM](#)
- [Dune](#)