Welcome to the 23nd post in the *rationally reasonable R rants* series, or *R*4 for short. Today’s post was motivated by an exchange on the [r-devel list](https://stat.ethz.ch/mailman/listinfo/r-devel) earlier in the day, and a few subsequent off-list emails.

[Roger Koenker](http://www.econ.uiuc.edu/~roger/) posted [a question](https://stat.ethz.ch/pipermail/r-devel/2019-August/078258.html): how to best debug an issue arising only with gfortran-9 which is difficult to get hold off on his macOS development platform. Some people followed up, and I [mentioned](https://stat.ethz.ch/pipermail/r-devel/2019-August/078261.html) that I had good success using [Docker](https://www.docker.com/), and particularly our [Rocker](https://www.rocker-project.org/) containers—and [outlined a quick mini-tutorial](https://stat.ethz.ch/pipermail/r-devel/2019-August/078261.html) (which had one mini-typo lacking the imporant slash in -w /work). Roger and I followed up over a few more off-list emails, and by and large this worked for him.

So what follows below is a jointly written / edited ‘mini HOWTO’ of how to deploy [Docker](https://www.docker.com/) on macOS for debugging under particular toolchains more easily available on Linux. Windows and Linux use should be very similar, albeit differ in the initial install. In fact, I frequently debug or test in Docker sessions when I do not want to install on my Linux host system. Roger sent one version (I had also edited) [back to the list](https://stat.ethz.ch/pipermail/r-devel/2019-August/078269.html). What follows is my final version.

**Debugging with Docker: Getting Hold of Particular Compilers**

*Context: The* [*quantreg package*](https://cran.r-project.org/package=quantreg) *was seen exhibiting errors when compiled with gfortran-9. The following shows how to use gfortran-9 on macOS by virtue of Docker. It is written in Roger Koenker’s voice, but authored by Roger and myself.*

With extensive help from Dirk Eddelbuettel I have installed docker on my mac mini from

<https://hub.docker.com/editions/community/docker-ce-desktop-mac>

which installs from a dmg in quite standard fashion. This has allowed me to simulate running R in a Debian environment with gfortran-9 and begin the process of debugging my ancient rqbr.f code.

Some further details:

**Step 0: Install Docker and Test**

Install Docker for macOS following [this Docker guide](https://hub.docker.com/editions/community/docker-ce-desktop-mac). Do some initial testing, e.g.

docker --version

docker run hello-world

**Step 1: Download r-base and test OS**

We use the plainest Rocker container rocker/r-base, in the aliased form of the official Docker container for, *i.e.* r-base. We first ‘pull’, then test the version and drop into bash as second test.

docker pull r-base # downloads r-base for us

docker run --rm -ti r-base R --version # to check we have the R we want

docker run --rm -ti r-base bash # now in shell, Ctrl-d to exit

**Step 2: Setup the working directory**

We tell Docker to run from the current directory and access the files therein. For the work on [quantreg package](https://cran.r-project.org/package=quantreg) this is projects/rq for RogerL

cd projects/rq

docker run --rm -ti -v ${PWD}:/work -w /work r-base bash

This put the contents of projects/rq into the /work directory, and starts the session in /work (as can be seen from the prompt).

Next, we update the package information inside the container:

root@90521904fa86:/work# apt-get update

Get:1 http://cdn-fastly.deb.debian.org/debian sid InRelease [149 kB]

Get:2 http://cdn-fastly.deb.debian.org/debian testing InRelease [117 kB]

Get:3 http://cdn-fastly.deb.debian.org/debian sid/main amd64 Packages [8,385 kB]

Get:4 http://cdn-fastly.deb.debian.org/debian testing/main amd64 Packages [7,916 kB]

Fetched 16.6 MB in 4s (4,411 kB/s)

Reading package lists... Done

**Step 3: Install gcc-9 and gfortran-9**

root@90521904fa86:/work# apt-get install gcc-9 gfortran-9

Reading package lists... Done

Building dependency tree

Reading state information... Done

The following additional packages will be installed:

cpp-9 gcc-9-base libasan5 libatomic1 libcc1-0 libgcc-9-dev libgcc1 libgfortran-9-dev

libgfortran5 libgomp1 libitm1 liblsan0 libquadmath0 libstdc++6 libtsan0 libubsan1

Suggested packages:

gcc-9-locales gcc-9-multilib gcc-9-doc libgcc1-dbg libgomp1-dbg libitm1-dbg libatomic1-dbg

libasan5-dbg liblsan0-dbg libtsan0-dbg libubsan1-dbg libquadmath0-dbg gfortran-9-multilib

gfortran-9-doc libgfortran5-dbg libcoarrays-dev

The following NEW packages will be installed:

cpp-9 gcc-9 gfortran-9 libgcc-9-dev libgfortran-9-dev

The following packages will be upgraded:

gcc-9-base libasan5 libatomic1 libcc1-0 libgcc1 libgfortran5 libgomp1 libitm1 liblsan0

libquadmath0 libstdc++6 libtsan0 libubsan1

13 upgraded, 5 newly installed, 0 to remove and 71 not upgraded.

Need to get 35.6 MB of archives.

After this operation, 107 MB of additional disk space will be used.

Do you want to continue? [Y/n] Y

Get:1 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libasan5 amd64 9.1.0-10 [390 kB]

Get:2 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libubsan1 amd64 9.1.0-10 [128 kB]

Get:3 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libtsan0 amd64 9.1.0-10 [295 kB]

Get:4 http://cdn-fastly.deb.debian.org/debian testing/main amd64 gcc-9-base amd64 9.1.0-10 [190 kB]

Get:5 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libstdc++6 amd64 9.1.0-10 [500 kB]

Get:6 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libquadmath0 amd64 9.1.0-10 [145 kB]

Get:7 http://cdn-fastly.deb.debian.org/debian testing/main amd64 liblsan0 amd64 9.1.0-10 [137 kB]

Get:8 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libitm1 amd64 9.1.0-10 [27.6 kB]

Get:9 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libgomp1 amd64 9.1.0-10 [88.1 kB]

Get:10 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libgfortran5 amd64 9.1.0-10 [633 kB]

Get:11 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libcc1-0 amd64 9.1.0-10 [47.7 kB]

Get:12 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libatomic1 amd64 9.1.0-10 [9,012 B]

Get:13 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libgcc1 amd64 1:9.1.0-10 [40.5 kB]

Get:14 http://cdn-fastly.deb.debian.org/debian testing/main amd64 cpp-9 amd64 9.1.0-10 [9,667 kB]

Get:15 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libgcc-9-dev amd64 9.1.0-10 [2,346 kB]

Get:16 http://cdn-fastly.deb.debian.org/debian testing/main amd64 gcc-9 amd64 9.1.0-10 [9,945 kB]

Get:17 http://cdn-fastly.deb.debian.org/debian testing/main amd64 libgfortran-9-dev amd64 9.1.0-10 [676 kB]

Get:18 http://cdn-fastly.deb.debian.org/debian testing/main amd64 gfortran-9 amd64 9.1.0-10 [10.4 MB]

Fetched 35.6 MB in 6s (6,216 kB/s)

debconf: delaying package configuration, since apt-utils is not installed

(Reading database ... 17787 files and directories currently installed.)

Preparing to unpack .../libasan5\_9.1.0-10\_amd64.deb ...

Unpacking libasan5:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../libubsan1\_9.1.0-10\_amd64.deb ...

Unpacking libubsan1:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../libtsan0\_9.1.0-10\_amd64.deb ...

Unpacking libtsan0:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../gcc-9-base\_9.1.0-10\_amd64.deb ...

Unpacking gcc-9-base:amd64 (9.1.0-10) over (9.1.0-8) ...

Setting up gcc-9-base:amd64 (9.1.0-10) ...

(Reading database ... 17787 files and directories currently installed.)

Preparing to unpack .../libstdc++6\_9.1.0-10\_amd64.deb ...

Unpacking libstdc++6:amd64 (9.1.0-10) over (9.1.0-8) ...

Setting up libstdc++6:amd64 (9.1.0-10) ...

(Reading database ... 17787 files and directories currently installed.)

Preparing to unpack .../0-libquadmath0\_9.1.0-10\_amd64.deb ...

Unpacking libquadmath0:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../1-liblsan0\_9.1.0-10\_amd64.deb ...

Unpacking liblsan0:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../2-libitm1\_9.1.0-10\_amd64.deb ...

Unpacking libitm1:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../3-libgomp1\_9.1.0-10\_amd64.deb ...

Unpacking libgomp1:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../4-libgfortran5\_9.1.0-10\_amd64.deb ...

Unpacking libgfortran5:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../5-libcc1-0\_9.1.0-10\_amd64.deb ...

Unpacking libcc1-0:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../6-libatomic1\_9.1.0-10\_amd64.deb ...

Unpacking libatomic1:amd64 (9.1.0-10) over (9.1.0-8) ...

Preparing to unpack .../7-libgcc1\_1%3a9.1.0-10\_amd64.deb ...

Unpacking libgcc1:amd64 (1:9.1.0-10) over (1:9.1.0-8) ...

Setting up libgcc1:amd64 (1:9.1.0-10) ...

Selecting previously unselected package cpp-9.

(Reading database ... 17787 files and directories currently installed.)

Preparing to unpack .../cpp-9\_9.1.0-10\_amd64.deb ...

Unpacking cpp-9 (9.1.0-10) ...

Selecting previously unselected package libgcc-9-dev:amd64.

Preparing to unpack .../libgcc-9-dev\_9.1.0-10\_amd64.deb ...

Unpacking libgcc-9-dev:amd64 (9.1.0-10) ...

Selecting previously unselected package gcc-9.

Preparing to unpack .../gcc-9\_9.1.0-10\_amd64.deb ...

Unpacking gcc-9 (9.1.0-10) ...

Selecting previously unselected package libgfortran-9-dev:amd64.

Preparing to unpack .../libgfortran-9-dev\_9.1.0-10\_amd64.deb ...

Unpacking libgfortran-9-dev:amd64 (9.1.0-10) ...

Selecting previously unselected package gfortran-9.

Preparing to unpack .../gfortran-9\_9.1.0-10\_amd64.deb ...

Unpacking gfortran-9 (9.1.0-10) ...

Setting up libgomp1:amd64 (9.1.0-10) ...

Setting up libasan5:amd64 (9.1.0-10) ...

Setting up libquadmath0:amd64 (9.1.0-10) ...

Setting up libatomic1:amd64 (9.1.0-10) ...

Setting up libgfortran5:amd64 (9.1.0-10) ...

Setting up libubsan1:amd64 (9.1.0-10) ...

Setting up cpp-9 (9.1.0-10) ...

Setting up libcc1-0:amd64 (9.1.0-10) ...

Setting up liblsan0:amd64 (9.1.0-10) ...

Setting up libitm1:amd64 (9.1.0-10) ...

Setting up libtsan0:amd64 (9.1.0-10) ...

Setting up libgcc-9-dev:amd64 (9.1.0-10) ...

Setting up gcc-9 (9.1.0-10) ...

Setting up libgfortran-9-dev:amd64 (9.1.0-10) ...

Setting up gfortran-9 (9.1.0-10) ...

Processing triggers for libc-bin (2.28-10) ...

root@90521904fa86:/work# pwd

Here filenames and versions reflect the Debian repositories as of today, August 5, 2019. While minor details may change at a future point in time, the key fact is that we get the components we desire *via a single call* as the Debian system has a well-honed package system

**Step 4: Prepare Package**

At this point Roger removed some dependencies from the package quantreg that he knew were not relevant to the debugging problem at hand.

**Step 5: Set Compiler Flags**

Next, set compiler flags as follows:

root@90521904fa86:/work# mkdir ~/.R; vi ~/.R/Makevars

adding the values

CC=gcc-9

FC=gfortran-9

F77=gfortran-9

to the file. Alternatively, one can find the settings of CC, FC, CXX, … in /etc/R/Makeconf (which for the Debian package is a softlink to R’s actual Makeconf) and alter them there.

**Step 6: Install the Source Package**

Now run

R CMD INSTALL quantreg\_5.43.tar.gz

which uses the gfortran-9 compiler, and this version did reproduce the error initially reported by the CRAN maintainers.

**Step 7: Debug!**

With the tools in place, and the bug reproduces, it is (just!) a matter of finding the bug and fixing it.

And that concludes the tutorial.