

# ON BUILDING OPEN SOURCE PROGRAMS

A FEW SOMEWHAT DISJOINT COMMENTS

Dirk Eddebuettel

Invited Talk, Gretl Conference 2021

3 Jun 2021

[https://dirk.eddebuettel.com/papers/gretlconf\\_building\\_jun2021.pdf](https://dirk.eddebuettel.com/papers/gretlconf_building_jun2021.pdf)

## Today's Talk

- Gretl (and Gretl from Debian's View)
- A Little Docker
- The Action around GitHub Actions
- Open Build Service

## QUICK BIO FOR CONTEXT

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The screenshot shows the TileDB website homepage. At the top, there is a navigation bar with the [tile]DB logo and links for Products, Applications, Blog, Updates, Documentation, and Github. On the right side of the navigation bar, there are links for Login and a Sign up button. The main content area has a dark blue background. On the left, the heading "The Universal Data Engine" is displayed in white. Below the heading, there are four lines of text: "Beyond tables to any complex data", "Beyond SQL to any tool", "Beyond organizations to planet-scale sharing", and "Beyond clusters to serverless compute". To the right of this text is a 3D isometric grid of blue squares. Below the text and grid, there are two buttons: "Sign up" and "Docs". Underneath these buttons are two news items, each with a small icon and a right-pointing arrow: "New podcast on the TileDB universal data engine" and "New blog post on TileDB in Machine Learning". Below the main content area, there is a section titled "TileDB is a Universal Data Engine" in bold. Underneath this title, there is a paragraph: "Store, analyze and share any data (beyond tables), with any API or tool (beyond SQL) at planet-scale (beyond clusters)". At the bottom of this section, there is a row of logos for various integrations: PySpark, R, Databricks, Snowflake, Google Cloud, Amazon Redshift, Databricks, Spark, MongoDB, PDAI, GDAI, and pandas.

[tile]DB Products ▾ Applications ▾ Blog Updates Documentation Github Login [Sign up](#)

## The Universal Data Engine

Beyond tables to any complex data  
Beyond SQL to any tool  
Beyond organizations to planet-scale sharing  
Beyond clusters to serverless compute

[Sign up](#) [Docs](#)

[New podcast on the TileDB universal data engine](#) >

[New blog post on TileDB in Machine Learning](#) >

### TileDB is a Universal Data Engine

Store, analyze and share any data (beyond tables), with any API or tool (beyond SQL) at planet-scale (beyond clusters)

- Open Source (plus Service) as a business
- Earlier 20+ years as a Quant in Finance (coming in as Econometrician)
- Some relevant experience on different tools and approaches
- Influenced by 'commonly seen' best practices:
  - incremental changes
  - continued integration
  - test, test, test

## Academic

- (Adjunct) Clinical Professor, University of Illinois
  - teaching [STAT 447](#), a Data Science Programming Methods class

## Open Source

- Debian developer
  - since 1995, currently maintaining about 170+ packages (including `gretl`)
- R contributor / package author
  - since 2002, author / maintainer of 60+ CRAN packages, R Foundation Board Member
- R Project co-founder
  - Docker for R, including official 'r-base' image

# GRET

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## Key Points

- Really impressive breadth of build features
- Really thorough use of build tools
- Broad reach of build targets and platforms
- Impressive continued development over many years
- Creation of a lively community supporting Gretl
- Using a well-understand and widely-used copyleft license
- My one claim to fame ...
- ... may have been to suggest to Allin to add a reader for R data



# DEBIAN (AND GRETL)

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DDPO: Dirk Eddebuettel — Debian Quality Assurance - Google Chrome

qa.debian.org/developer.php?login=edd@debian.org

About Debian Getting Debian Support Developers' Corner

debain / debian quality assurance

### Packages overview for Dirk Eddebuettel

Dirk Eddebuettel <edd@debian.org> — Bugs: [open](#) [RC](#) [all](#) [submitted](#) [ISSUE](#) — Reports: [Dashboard](#) [Build](#) [Lintian](#) [Debian](#) [Patches](#) [GUCX](#) [Jazzer](#) [Contributors](#) [Resolves](#) [Patches](#)

main (179)

Source Package	Bugs		Version					Ubuntu	VCS	Builds	Lintian E+W	Deb check	Plu parts	GI Rep	Popcon	Watch
	All	RC	oldstable	stable	testing	unstable	exp									
abind	-	-	1.4-5-1	1.4-5-1.2	1.4-5-2	-	1.4-5-2	Git	1x ✓	✓	✓	X	✓	1354	1.4-5	
acepack	-	-	1.4-1-1	1.4-1-2	-	-	1.4-1-2	-	22x ✓	0+2	✓	X	✓	732	1.4-1	
beancounter	7	-	0.8-10	Excuse	0.8-10	-	0.8-10 4 bugs	-	1x ✓	0+5	✓	✓	✓	24	-	
boot	-	-	1.3-18-2	1.3-20-2	1.3-27-1	1.3-28-1	1.3-27-1 30 bugs	Git	1x ✓ 1x ✓	✓	✓	X	✓	6735	1.3-28	
cairodevice	1	-	2.23-2	2.25-2	2.28-2-1	-	2.28-2-1 2 bugs	Git	22x ✓	0+1	T U	X	✓	338	2.28.2	
car	-	-	2.14-1	3.0-2-1	3.0-10-1	-	3.0-10-1	Git	1x ✓	0+1	✓	X	✓	892	3.0-10	
chron	-	-	2.3-49-1	2.3-53-1	2.3-56-1	-	2.3-56-1	Git	22x ✓	0+1	✓	X	✓	779	2.3-56	
cluster	-	-	2.0-5-1	2.0-7-1-1	2.1-1-1	2.1-2-1	2.1-1-1 1 bug	Git	22x ✓ ██████████100%	✓	✓	X	✓	6791	2.1-2	
codetools	-	-	0.2-15-1	0.2-16-1	0.2-18-1	-	0.2-18-1	Git	1x ✓	✓	✓	X	✓	6744	0.2-18	
date	-	-	1.2-36-1	1.2-38-1	1.2-39-1	-	1.2-39-1 1 bug	Git	22x ✓	✓	✓	X	✓	331	1.2-39	
dbi	-	-	0.5-1-1 1.0-0-1-100%?	1.0-0-2	1.1-1-1	-	1.1-1-1	Git	1x ✓	✓	✓	X	✓	1053	1.1-1	
dsharder	4	-	3.31-1-7	3.31-1-2-1	-	-	3.31-1-2-1	Git	██████████5%	0+3	✓	MA	✓	327	-	
effects	-	-	3.1-2-1 4.0-1-1-100%?	4.1-0-1	4.2-0-1	-	4.2-0-1	Git	1x ✓	0+1	✓	X	✓	322	4.2-0	
ess	-	-	18-10-1	18-10-2-1	18-10-2-2	-	18-10-2-2 8 bugs (1.94%)	Git	1x ✓	0+1	S T U	✓	✓	618	18-10-2	
fashionoptions	-	-	3010-79-2	3042-82-1	3042-82-1	-	3042-82-1	-	22x ✓	0+3	✓	X	✓	85	3042-82	
fassets	-	-	3011-83-2	3042-84-1	3042-84-1	-	3042-84-1	-	22x ✓	0+4	✓	X	✓	300	3042-84	
Releases	79	-	3042-87-3	3042-88-3	3042-89-1-1	-	3042-89-1-1	Git	22x ✓	0+4	✓	X	✓	336	3042-89-1	

## Per Maintainer

- very dense display
- each package per row
- version status per release
- issue count
- build status
- QA check status
- [qa.debian.org/developer.php?login=edd@debian.org](https://qa.debian.org/developer.php?login=edd@debian.org)

# PACKAGE (TRACKER) VIEW

The screenshot shows the 'gretl' package page on the Debian Package Tracker. The page is titled 'gretl GNU Regression, Econometric & Time-Series Library'. It features several sections: 'general' with source, version, maintainer, arch, std-ver, and VCS; 'action needed' with a list of issues and their severity; 'bugs' with a summary of bugs by severity; 'versions' with a table of stable, testing, unstable, and experimental versions; 'testing migrations' with a list of migration events; 'news' with a list of news items; 'versioned links' with links for different versions; 'binaries' with a list of binary packages; and 'links' with various utility links. The page also includes a search bar and navigation links like 'Register | Log in | Subscribe'.

## Package View

- version, maintainer, issues (by severity)
- links to builds logs (see below) and more
- version log
- binaries
- [tracker.debian.org/pkg/gretl](https://tracker.debian.org/pkg/gretl)

Tracker - Changelog - Bugs - packages.d.o - Source

Package(s):  Suite:

Compact mode  Co-maintainers

Architecture	Version	Status	For	Buildid	State	Section	Logs	Actions
all	2021a-1	Installed	134d 2h 28m	x86-conova-01		math	old   all (1)	giveback
amd64	2021a-1	Installed	134d 1h 59m	x86-csail-01		math	old   all (1)	giveback
arm64	2021a-1	Installed	134d 1h 59m	arm-conova-02		math	old   all (1)	giveback
armel	2021a-1	Installed	134d 1h 29m	hasse		math	old   all (1)	giveback
armhf	2021a-1	Installed	134d 1h 39m	hoiby		math	old   all (1)	giveback
i386	2021a-1	Installed	134d 2h 29m	x86-gmet-01		math	old   all (1)	giveback
mips64el	2021a-1	Installed	134d 29m	mipsel-manda-04		math	old   all (1)	giveback
mipsel	2021a-1	Installed	133d 23h 10m	berlin		math	old   all (1)	giveback
ppc64el	2021a-1	Installed	134d 2h 29m	ppc64el-unicamp-01		math	old   all (1)	giveback
s390x	2021a-1	Installed	134d 2h 28m	zani		math	old   all (1)	giveback
alpha	2021a-1	Installed	134d 11m	electro		math	old   all (1)	giveback
hppa	2021a-1	Installed	97d 15h 13m	phantom2		math	old   all (1)	giveback
hurd-i386	2021a-1	Failed	134d 1h 37m	ironforge	uncompiled	math	old   all (1)	giveback
ia64	2021a-1	BD-Uninstallable	134d 2h 53m		uncompiled	math	old   no log	giveback
kfreebsd-amd64	2021a-1	BD-Uninstallable	134d 2h 53m		out-of-date	math	old   no log	giveback
kfreebsd-i386	2021a-1	BD-Uninstallable	134d 2h 53m		out-of-date	math	old   no log	giveback
m68k	2021a-1	Installed	133d 23h 13m	vs92		math	old   all (1)	giveback
powerpc	2021a-1	Installed	134d 2h 13m	kapitsa		math	old   all (1)	giveback
ppc64	2021a-1	Installed	133d 16h 43m	blaauw2		math	old   all (1)	giveback
riscv64	2021a-1	Build-Attempted	12d 1h 5m	rv-mullvad-01	uncompiled	math	old   all (2)	giveback
sh4	2021a-1	BD-Uninstallable	134d 2h 52m		out-of-date	math	old   no log	giveback
sparc64	2021a-1	BD-Uninstallable	134d 2h 52m		out-of-date	math	old   no log	giveback
x32	2021a-1	Installed	134d 2h 12m	x32-do-02		math	old   all (1)	giveback

**Failing reason for gretl on hurd-i386:**

```
> ./configure: Line 21423: test: syntax error: `-'lblas' unexpected
```

**Tail of log for gretl on hurd-i386:**

## Build Release

- by architecture
- showing official and 'candidate' architectures
- links to build logs
- [buildd.debian.org/status/package.php?p=gretl](https://buildd.debian.org/status/package.php?p=gretl)

# BUILD STATUS - 'EXPERIMENTAL'

Tracker - Changelog - Bugs - packages.d.o - Source

Package(s):  Suite:

Compact mode  Co-maintainers

Architecture	Version	Status	For	Buildid	State	Section	Logs	Actions
all	2021b-1	Installed	25d 2h 29m	x86-grnet-02		math	old   all (1)	giveback
amd64	2021b-1	Installed	25d 2h 29m	x86-csail-01		math	old   all (1)	giveback
arm64	2021b-1	Installed	25d 2h 18m	arm-arm-04		math	old   all (1)	giveback
armel	2021b-1	Installed	25d 1h 34m	hoiby		math	old   all (1)	giveback
armhf	2021b-1	Installed	25d 2h 18m	arm-conova-01		math	old   all (1)	giveback
i386	2021b-1	Installed	25d 2h 29m	x86-grnet-01		math	old   all (1)	giveback
mips64el	2021b-1	Installed	25d 1h 59m	mipsel-manda-05		math	old   all (1)	giveback
mipsel	2021b-1	Installed	25d 38m	mipsel-aql-02		math	old   all (1)	giveback
ppc64el	2021b-1	Installed	25d 2h 29m	ppc64el-unicamp-01		math	old   all (1)	giveback
s390x	2021b-1	Installed	25d 2h 29m	zani		math	old   all (1)	giveback
alpha	2021b-1	Installed	24d 5h 36m	imago		math	old   all (1)	giveback
hppa	2021b-1	Installed	25d 1h 2m	panama		math	old   all (1)	giveback
hurd-i386	2021b-1	Installed	25d 2h 12m	mahler		math	old   all (1)	giveback
ia64 ↓	2021b-1	BD-Uninstallable	25d 2h 42m		uncompiled	math	old   no log	giveback
kfreebsd-amd64 ↓	2021b-1	BD-Uninstallable	25d 2h 42m		uncompiled	math	old   no log	giveback
kfreebsd-i386 ↓	2021b-1	BD-Uninstallable	25d 2h 42m		uncompiled	math	old   no log	giveback
m68k	2021b-1	Installed	24d 23h 31m	m68k-gandi-02		math	old   all (1)	giveback
powerpc	2021b-1	Installed	25d 2h 2m	blaauw		math	old   all (1)	giveback
ppc64	2021b-1	Installed	25d 2h 1m	blaauw2		math	old   all (1)	giveback
riscv64 ↓	2021b-1	Build-Attempted	25d 1h 51m	rv-r44-01	uncompiled	math	old   all (2)	giveback
sh4 ↓	2021b-1	BD-Uninstallable	25d 2h 41m		uncompiled	math	old   no log	giveback
sparc64 ↓	2021b-1	BD-Uninstallable	25d 2h 41m		uncompiled	math	old   no log	giveback
x32	2021b-1	Installed	25d 2h 1m	x32-do-01		math	old   all (1)	giveback

**Dependency installability problem for [gretl](#) on ia64:**

```
gretl build-depends on missing:
gnuplot-x11:i64
```

**Dependency installability problem for [gretl](#) on kfreebsd-amd64:**

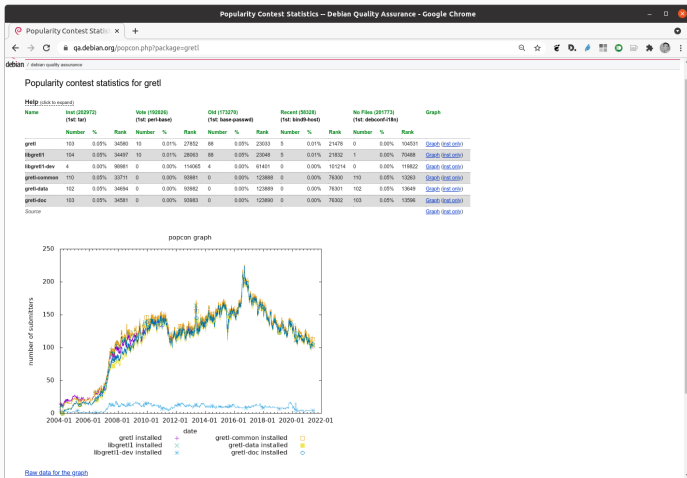
## Build of Experimental

- again by architecture
- showing official and 'candidate' architectures
- links to build logs
- [buildd.debian.org/status/package.php?p=gretl&suite=experimental](https://buildd.debian.org/status/package.php?p=gretl&suite=experimental)

The screenshot shows the website for 'gretl-reproducible-builds.org' with the URL 'tests.reproducible-builds.org/debian/rb-pkg/unstable/amd64/gretl.html'. The page title is 'gretl - reproducible builds result - Google Chrome'. The main content area displays details for the 'gretl' package, including its source, binary, architecture, and version (2021a-1). It lists the source code location and provides checksums for various architectures (amd64, i386, armhf) and distributions (experimental, unstable, bullseye, buster, stretch). The 'amd64' section is highlighted, showing the package is available in 'unstable' and 'bullseye'. The 'amd64' section also lists the build architecture, kernel version, build date, and build path. The 'amd64' section lists the build architecture, kernel version, build date, and build path. The 'amd64' section lists the build architecture, kernel version, build date, and build path. The 'amd64' section lists the build architecture, kernel version, build date, and build path.

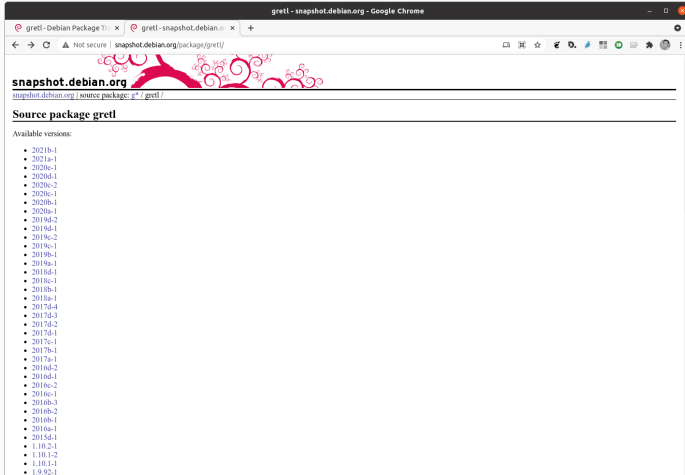
## Reproducible

- an aside but interesting
- initially Debian only
- now across distros
- important for trust in reproducibility
- ‘bit by bit’ identical
- [tests.reproducible-builds.org/debian/rb-pkg/unstable/amd64/gretl.html](https://tests.reproducible-builds.org/debian/rb-pkg/unstable/amd64/gretl.html)



## Popularity Context

- older *opt-in* initiative
- unclear statistical ‘survey properties’
- baseline is *e.g.* the glibc package at 200k
- [qa.debian.org/popcon.php?package=gretl](https://qa.debian.org/popcon.php?package=gretl)



## Snapshots

- useful (if little known)
- access to old source versions *and binaries*
- useful for comparison, regression testing, ...
- `snapshot.debian.org/package/gretl`

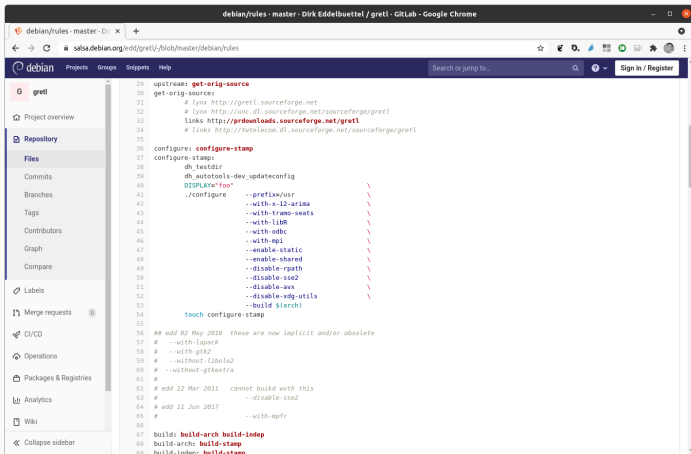


The screenshot shows the GitLab web interface for the 'gretl' project. The browser address bar shows 'salsa.debian.org/edd/gretl'. The page title is 'gretl' and the project ID is 29540. The project has 200 commits, 3 branches, 186 tags, 113.4 MB files, and 113.5 MB storage. The current commit is 'releasing package gretl version 2021b-1' by Dirk Eddelbuettel, authored 3 weeks ago. The commit message is 'releasing package gretl version 2021b-1'. The commit hash is 'ea847c8f'. The commit includes a README, GNU GPLv3 license, and a CHANGELOG. Below the commit, there is a table of packages:

Name	Last commit	Last update
addons	New upstream version 2021b	3 weeks ago
apidemo	New upstream version 2021b	3 weeks ago
cephes	New upstream version 2020d	9 months ago
cli	New upstream version 2021b	3 weeks ago
dcmf	Import Upstream version 1.10.2	2 years ago
debian	releasing package gretl version 2021b-1	3 weeks ago
doc	New upstream version 2021b	3 weeks ago
gui	New upstream version 2021b	3 weeks ago
lib	New upstream version 2021b	3 weeks ago

## Package Repo

- upstream plus packaging
- mostly internal and used by package builds
- but all packaging 'visible'
- [salsa.debian.org/edd/gretl](https://salsa.debian.org/edd/gretl)



```
29 upstream: get-orig-source
30 get-orig-source:
31     # lynx http://gretl.sourceforge.net
32     # lynx http://unc.dl.sourceforge.net/sourceforge/gretl
33     # links http://prdownloads.sourceforge.net/gretl
34     # links http://tutotecom.dl.sourceforge.net/sourceforge/gretl
35
36 configure: configure-stamp
37 configure-stamp:
38     dh_testdir
39     dh_autotools-dev_updateconfig
40     DESPLATE="foo" \
41     .configure \
42     --prefix=/usr \
43     --with-x-12-arma \
44     --with-trano-seats \
45     --with-libR \
46     --with-odbc \
47     --with-mpi \
48     --enable-static \
49     --enable-shared \
50     --disable-rpath \
51     --disable-sse2 \
52     --disable-avx \
53     --disable-xdg-utils \
54     --build $arch)
55     touch configure-stamp
56
57 ## edd 02 May 2010 these are now implicit and/or obsolete
58 # --with-lapack
59 # --with-gtk2
60 # --without-libole2
61 # --without-gtkextra
62 # edd 12 Mar 2011 cannot build with this
63 # --disable-sse2
64 # edd 11 Jun 2017
65 # --with-mpfr
66
67 build: build-arch build-indep
68 build-arch: build-stamp
69 build-indep: build-stamp
```

## Package Repo

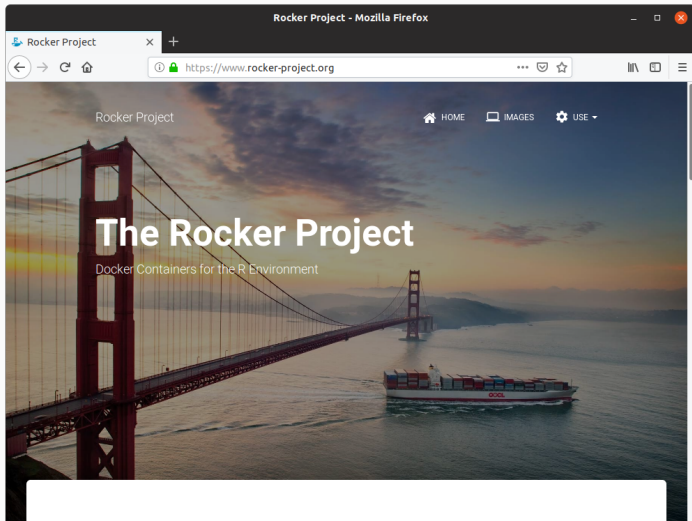
- all details of packaging a little overwhelming
- but at least starting point for mods
- [salsa.debian.org/edd/gretl/-/blob/master/debian/rules](https://salsa.debian.org/edd/gretl/-/blob/master/debian/rules)

# DOCKER

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## Key Points

- Big fan and early user/contributor
- Part of the Rocker Project offering different R containers
- Our rocker/r-base is also the official r-base
- Possibly way for gretl to just offer gretl contains
- With tagged releases: gretl:2021a, gretl:2021b, ...



## Rocker

- base containers used for derived containers
- 'versioned' container popular for snapshots
- now also ML flavours
- popular containers with over 500k downloads
- our rocker/r-base is official r-base
- [rocker-project.org](https://rocker-project.org)

## An Introduction to Rocker: Docker Containers for R

by Carl Boettiger, Dirk Eddebuetel

**Abstract** We describe the Rocker project, which provides a widely-used suite of Docker images with customized R environments for particular tasks. We discuss how this suite is organized, and how these tools can increase portability, scaling, reproducibility, and convenience of R users and developers.

### Introduction

The Rocker project was launched in October 2014 as a collaboration between the authors to provide high-quality Docker images containing the R environment (Boettiger and Eddebuetel, 2014). Since that time, the project has seen both considerable uptake in the community and substantial development and evolution. Here we seek to document the project's objectives and uses.

### What is Docker?

Docker is a popular open-source tool to create, distribute, deploy, and run software applications using *containers*. Containers provide a virtual environment (see Clark et al. (2014) for an overview of common virtual environments) requiring all operating-system components an application needs to run. Docker containers are lightweight as they share the operating system kernel, start instantly using a layered filesystem which minimizes disk footprint and download time, are built on open standards that run on all major platforms (Linux, Mac, Windows), and provide an added layer of security by running an application in an isolated environment (Docker, 2015). Familiarity with a few key terms is helpful in understanding this paper. The term "container" refers to an isolated software environment on a computer. R users can think of running a container as analogous to loading an R package; a container is an active instance of a static Docker image. A Docker "image" is a binary archive of that software, analogous to an R binary package: a given version is downloaded only once, and can then be "run" to create a container whenever it is needed. A "Dockerfile" is a recipe, the source-code, to create a Docker image. Pre-built Docker images are publicly available through Docker Hub, which plays a role for central distribution similar to CRAN in our analogy. Development and contributions to the Rocker project focus on the construction, organization and maintenance of these Dockerfiles.

## Early Paper

- describes project
- and two (early) stacks
- [journal.r-project.org/archive/2017/RJ-2017-065/](http://journal.r-project.org/archive/2017/RJ-2017-065/)

## The Rockerverse: Packages and Applications for Containerisation with R

by Daniel Nüst, Dirk Eddelbuettel, Dom Bennett, Robrecht Cannoodt, Dav Clark, Gergely Daróczi, Mark Edmondson, Colin Fay, Ellis Hughes, Lars Kjeldgaard, Sean Lopp, Ben Marwick, Heather Nolis, Jacqueline Nolis, Hong Ooi, Karthik Ram, Noam Ross, Lori Shepherd, Péter Sólymos, Tyson Lee Swetnam, Nitesh Turaga, Charlotte Van Petegem, Jason Williams, Craig Willis, Nan Xiao

**Abstract** The Rocker Project provides widely used Docker images for R across different application scenarios. This article surveys downstream projects that build upon the Rocker Project images and presents the current state of R packages for managing Docker images and controlling containers. These use cases cover diverse topics such as package development, reproducible research, collaborative work, cloud-based data processing, and production deployment of services. The variety of applications demonstrates the power of the Rocker Project specifically and containerisation in general. Across the diverse ways to use containers, we identified common themes: reproducible environments, scalability and efficiency, and portability across clouds. We conclude that the current growth and diversification of use cases is likely to continue its positive impact, but see the need for consolidating the Rockerverse ecosystem of packages, developing common practices for applications, and exploring alternative containerisation software.

### Introduction

The R community continues to grow. This can be seen in the number of new packages on CRAN, which is still on growing exponentially (Hornik et al., 2019), but also in the numbers of conferences, open educational resources, meetings, unconferences, and companies that are adopting R, as exemplified by the useR! conference series<sup>1</sup>, the global growth of the R and R-Ladies user groups<sup>2</sup>, or the foundation and impact of the R Consortium<sup>3</sup>. These trends cement the role of R as the *lingua franca* of statistics, data

## Recent Paper

- recent ‘applications’ paper
- very broad overview
- [journal.r-project.org/archive/2020/RJ-2020-007/](https://journal.r-project.org/archive/2020/RJ-2020-007/)

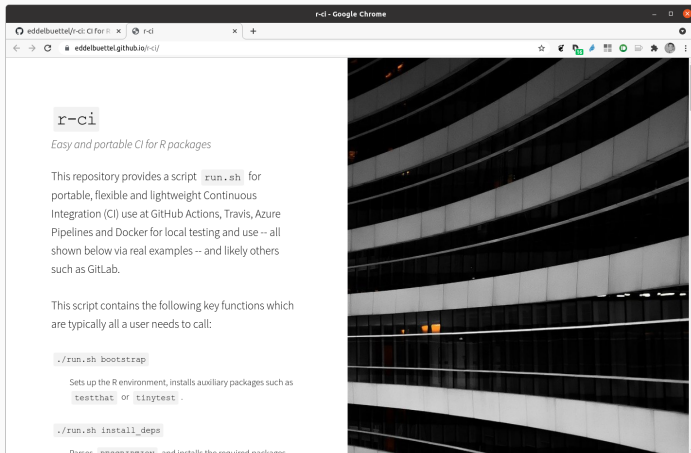
# GITHUB AND GITHUB ACTIONS

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## Status

- `git` won the distributed version control systems competition
- Will admit having been a slow-ish converter (maybe eight years ago)
- But am all in now and keep code, papers, websites, course notes, ... there
- **GitHub** has won the UI competition and is now synonymous to `git` for many
- Personally, I was not that much on the 'quit because of MSFT' train
- Not too concerned about **GitHub** for code: GitLab, Gitea.io, ... offer alternatives
- But I still really dislike vendor lock-in
- Which makes rather sceptical about the current craze of complicated and sophisticated GitHub Actions 'YAML' programming



## Features

- portable
- independent of CI host
- works GitHub, Azure, Travis
- likely works elsewhere
- simple, comprehensible
- “works for me”
- [eddelbuettel.github.io/r-ci/](https://eddelbuettel.github.io/r-ci/)

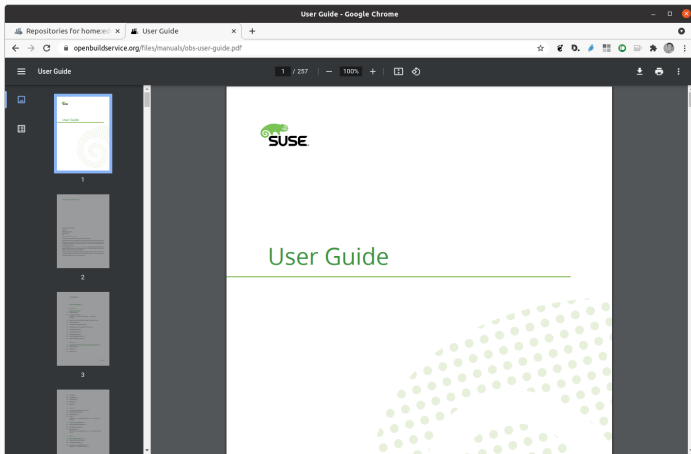
# OPENSUSE BUILD SERVICE

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The screenshot shows the openSUSE Build Service website in a Google Chrome browser. The page has a dark sidebar on the left with navigation options like 'All Projects' and 'Status Monitor'. The main content area features a 'Welcome to openSUSE Build Service' section with introductory text and a 'System Status' graph. The graph shows 'Busy workers' over time from May 27 to June 02, with a peak around 1500 workers. A 'News' section on the right contains several articles with timestamps like '1 day ago', '2 days ago', and '25 days ago'. The bottom of the page has a 'Latest Updates' section.

## OBS

- free service, no restrictions
- fairly resourceful
- started exploring / testing only recently
- [build.opensuse.org](https://build.opensuse.org)



## Manual

- one of the detailed documentation piece
- also available is a wiki
- plus a mailing list
- [openbuildservice.org/files/manuals/obs-user-guide.pdf](https://openbuildservice.org/files/manuals/obs-user-guide.pdf)

## Key Points

- New(ish) to me too
- Using it currently to experiment with the 3rd or 4th attempt at converting all / most CRAN packages into .deb binaries
- Build service for *multiple distro* and OSs, even windoze
- Free as in beer and cpu cycles, can be combined with GitHub and GitLab
- Pretty well documented: 250+ page pdf, wiki, responsive (low volume) mailing list
- Build releases and/or dev snapshots for OpenSUSE, Fedora, Debian, Ubuntu, ...
- This may be of interest to 'Team Gretl'

THANKS!

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# THANK YOU!

slides <https://dirk.eddelbuettel.com/presentations/>

web <https://dirk.eddelbuettel.com/>

mail [dirk@eddelbuettel.com](mailto:dirk@eddelbuettel.com)

github [@eddelbuettel](#)

twitter [@eddelbuettel](#)