Introduction to R and computing for Quantitative Fisheries Science

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Why programming?

"Can one be a good data analyst without being a half-good programmer? The short answer to that is, 'No'. The long answer to that is, 'No!'."

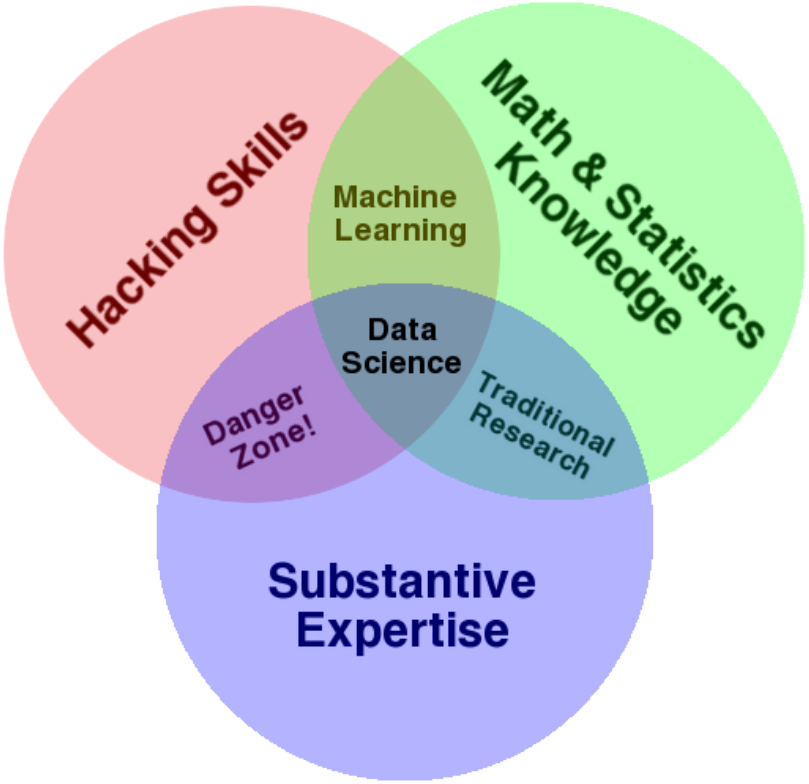
– Frank Harrell, 1999 S-PLUS User Conference, New Orleans (October 1999)

But this should be easy

"Managing fisheries is hard: it's like managing a forest, in which the trees are invisible and keep moving around"

- Professor John Shepherd

Data analyst



What is R

- Data analysis and statistics environment
- Interpreted computer language
- Open-source software project
- Active community of developers and practicioners
- Current version: 3.1.0 (2014-04-10) – "Spring Dance"

Why R?

R is

- awesome
- free (both speech and beer)
- a community
- the *lingua franca*
- a language and an environment
- integrates with other tools
- a way to reproducible research

OSS = Peer review

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POLICYFORUM

COMPUTATIONAL SCIENCE

Troubling Trends in Scientific Software Use

"Blind trust" is dangerous when choosing software to support research.

Lucas N. Joppa,[1*] Greg McInerny,[12] Richard Harper,[1] Lara Salido,[3] Kenji Takeda,[1] Kenton O'Hara,[1] David Gavaghan,[2] Stephen Emmott[1]

Software pervades every domain of science (*1*–*3*), perhaps nowhere more decisively than in modeling. In key scientific areas of great societal importance, models and the software that implement them define both how science is done and what science is done (*4*, *5*). Across all science, this dependence has led to concerns around the need for open access to software (*6*, *7*), centered on the reproducibility of research (*1*, *8*–*10*). From fields such as high-performance computing, we learn key insights and best practices for how to develop, standardize, and implement software (*11*). Open and systematic approaches to the development of software are essential for all sciences. But for many scientists this is not sufficient. We across all disciplines that are dependent upon a computational approach.

Surveying Species Distribution Modelers

We surveyed scientists across a single domain, species distribution modeling (SDM) (*15*) [see supplementary materials for details]. This strategic targeting separates our analysis from previous efforts in important ways, allowing an analysis spanning computational skill sets, while addressing the interplay between models and computation. Our ~400 respondents ranged from those who "find it difficult to use software" to those "very experienced and very technical." Asking people to first identify with a scientific domain and addressing models and software through that

used "click-and-run" software with easy-to-manipulate user interfaces and dropped to 11% for those who used "syntax-driven" platforms. Further, 7, 9, and 18% of scientists cited "the developer is well-respected," "personal recommendation," and "recommendation from a close colleague," respectively, as reasons for using software. Only 8% claimed they had validated software against other methods as a primary reason for choice; 79% expressed a desire to learn additional software and programming skills.

Many of these scientists rely on the fact that the software has appeared in a peer-reviewed article, recommendations, and personal opinion, as their reason for adopting software. This is scientifically misplaced, as the software code used to conduct the science

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Author	Free Software Foundation
Version	3
Publisher	Free Software Foundation, Inc.
Published	29 June 2007
DFSG compatible	Yes[1]
FSF approved	Yes[2]
OSI approved	Yes[3]
Copyleft	Yes[2][4]
Linking from code with a different license	No (except for linking GNU AGPLv3 with GNU GPLv3 – see section)
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CRAN

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Contributed Packages

Available Packages

Currently, the CRAN package repository features 4555 available packages.

Table of available packages, sorted by date of publication

Table of available packages, sorted by name

Installation of Packages

Please type `help("INSTALL")` or `help("install.packages")` in R for information on how to install packages from this repository. The manual R Installation and Administration [PDF] (also contained in the R base sources) explains the process in detail.

CRAN Task Views allow you to browse packages by topic and provide tools to automatically install all packages for special areas of interest. Currently, 31 views are available.

Package Check Results

All packages are tested regularly on machines running Debian GNU/Linux, Fedora and Solaris. Packages are also checked under Mac OS X and Windows, but typically only on the day the package appears on CRAN.

The results are summarized in the check summary (some timings are also available). Additional details for Windows checking and building can be found in the Windows check summary.

Writing Your Own Packages

The manual Writing R Extensions [PDF] (also contained in the R base sources) explains how to write new packages and how to contribute them to CRAN.

Repository Policies

The manual CRAN Repository Policy [PDF] describes the policies in place for the CRAN package repository.

Related Directories

cran.r-project.org/bin/windows/contrib/checkSummaryWin.html

0:9

Task views

Blog with Knitr and Je... | Welcome | Travelling... | iagomosqueira/ICESSAI | Home - TCSAI2012 | Oráculo manual y art... | The Comprehensive R...

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ggplot2

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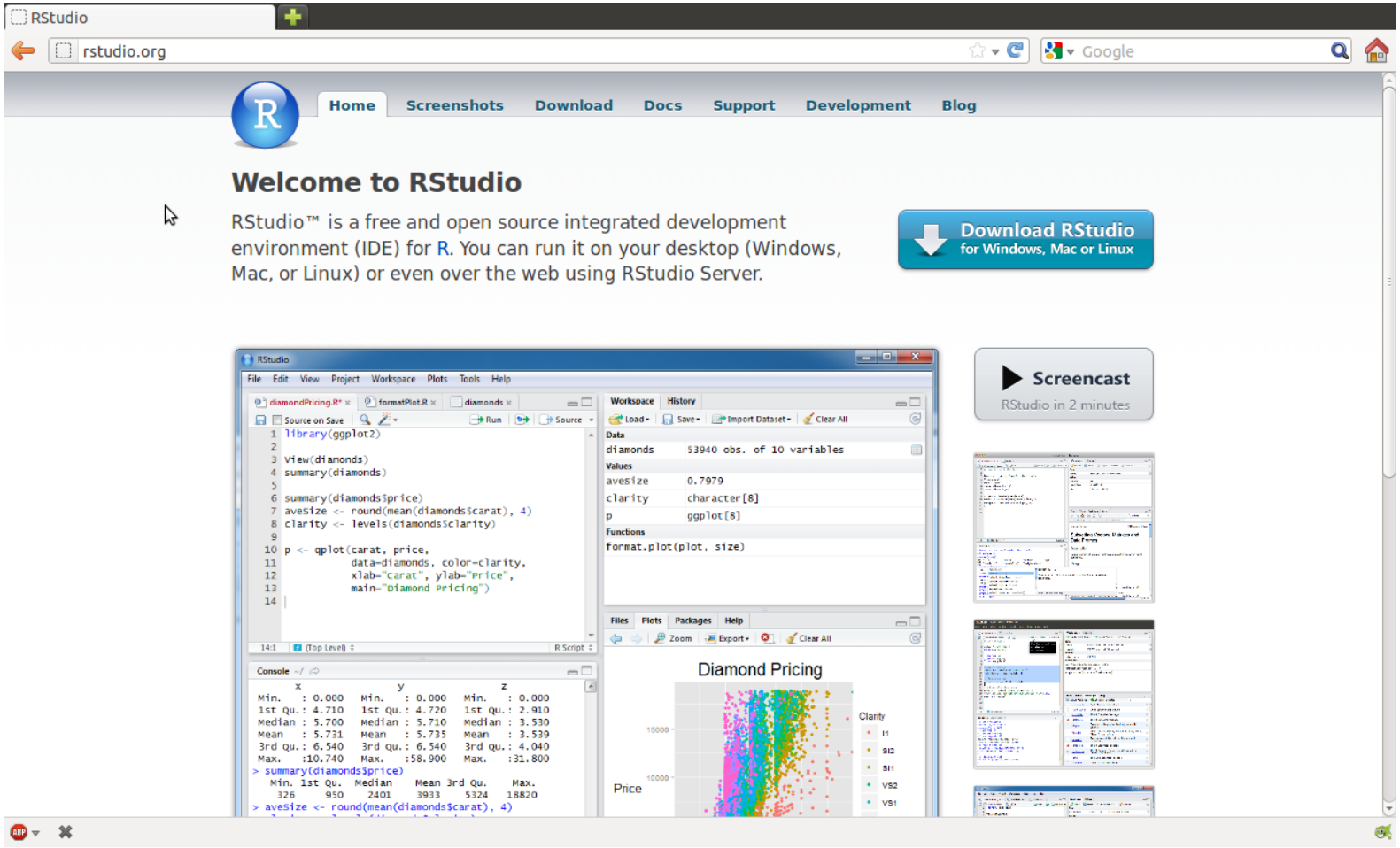
CRAN Task Views

Bayesian	Bayesian Inference
ChemPhys	Chemometrics and Computational Physics
ClinicalTrials	Clinical Trial Design, Monitoring, and Analysis
Cluster	Cluster Analysis & Finite Mixture Models
DifferentialEquations	Differential Equations
Distributions	Probability Distributions
Econometrics	Computational Econometrics
Environmetrics	Analysis of Ecological and Environmental Data
ExperimentalDesign	Design of Experiments (DoE) & Analysis of Experimental Data
Finance	Empirical Finance
Genetics	Statistical Genetics
Graphics	Graphic Displays & Dynamic Graphics & Graphic Devices & Visualization
HighPerformanceComputing	High-Performance and Parallel Computing with R
MachineLearning	Machine Learning & Statistical Learning
MedicalImaging	Medical Image Analysis
Multivariate	Multivariate Statistics
NaturalLanguageProcessing	Natural Language Processing
OfficialStatistics	Official Statistics & Survey Methodology
Optimization	Optimization and Mathematical Programming
Pharmacokinetics	Analysis of Pharmacokinetic Data
Phylogenetics	Phylogenetics, Especially Comparative Methods
Psychometrics	Psychometric Models and Methods
ReproducibleResearch	Reproducible Research
Robust	Robust Statistical Methods
SocialSciences	Statistics for the Social Sciences
Spatial	Analysis of Spatial Data
Survival	Survival Analysis
TimeSeries	Time Series Analysis

RStudio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Welcome to RStudio
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Price
Clarity

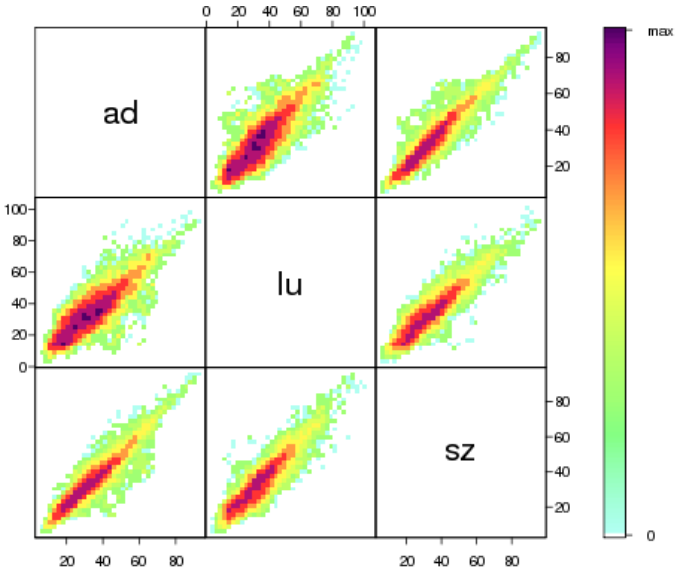
Basic features

- Numerous procedures (algebra, matrix, stats)
- Named storage (everything is an object)
- Functions
- Classes and methods (S3, S4)
- Special values (`NA, NaN, Inf, NULL`)
- Logical objects and boolean algebra
- `basic_features.R`

What else can it do?

- Data handling and storage
- Matrix algebra
- Regular expressions
- Statistics!
- OOP
- Programming
- Graphics

Eye candy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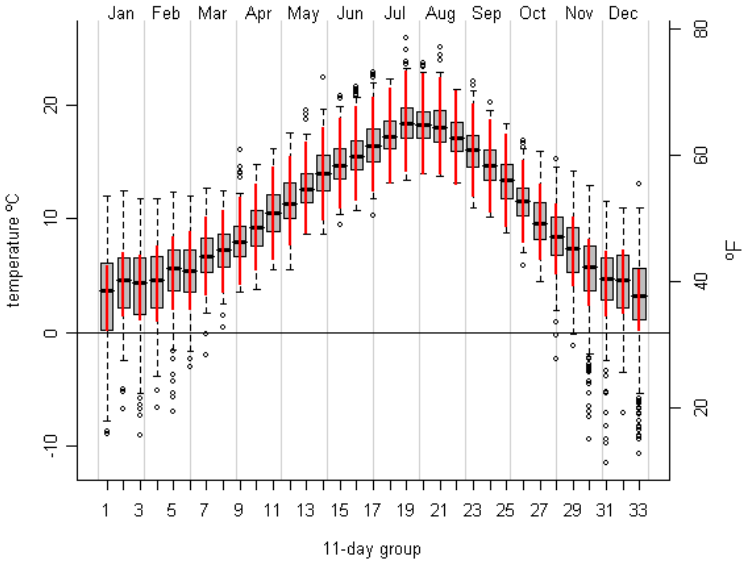
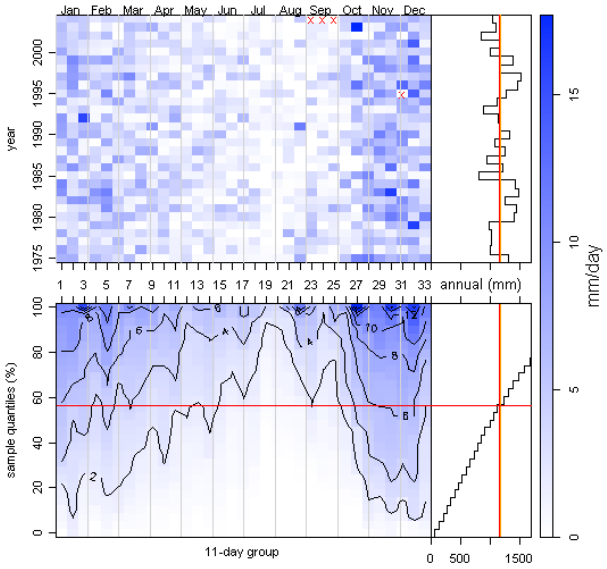
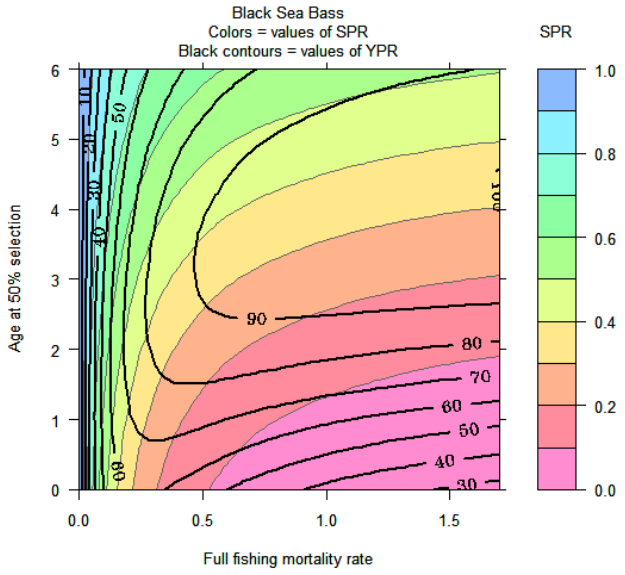
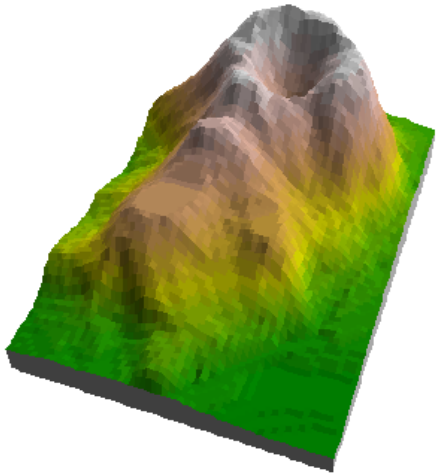

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
temperature °C
°F
11-day group

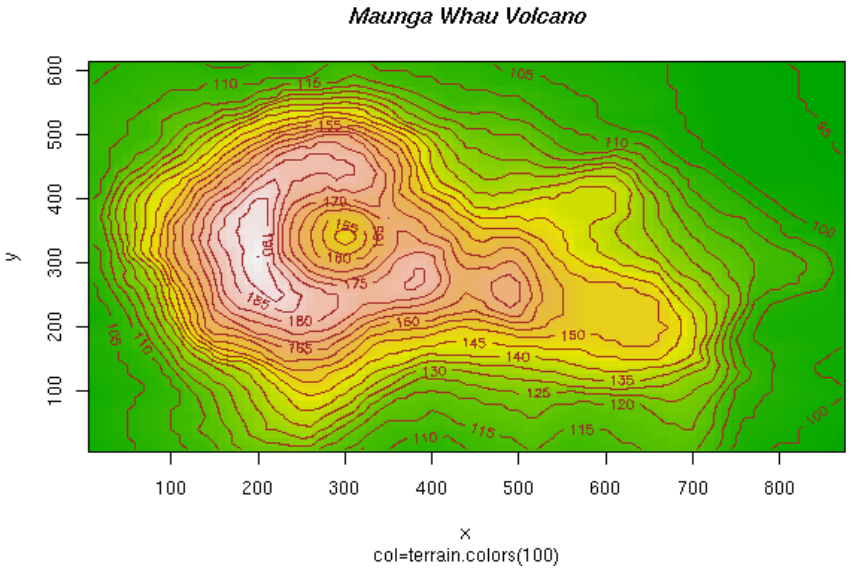
Eye candy


Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
year
annual (mm)
sample quantiles (%)
11-day group
mm/day


Black Sea Bass
Colors = values of SPR
Black contours = values of YPR
SPR
Age at 50% selection
Full fishing mortality rate

Eye candy





What doesn't it do

- No DB, but connections (SQL, NoSQL, Spreadsheets)
- No GUI, but IDE & GUI toolsets - CLI
- Slow, but C/C++, HPC
- No commercial support, but community
- Think for you

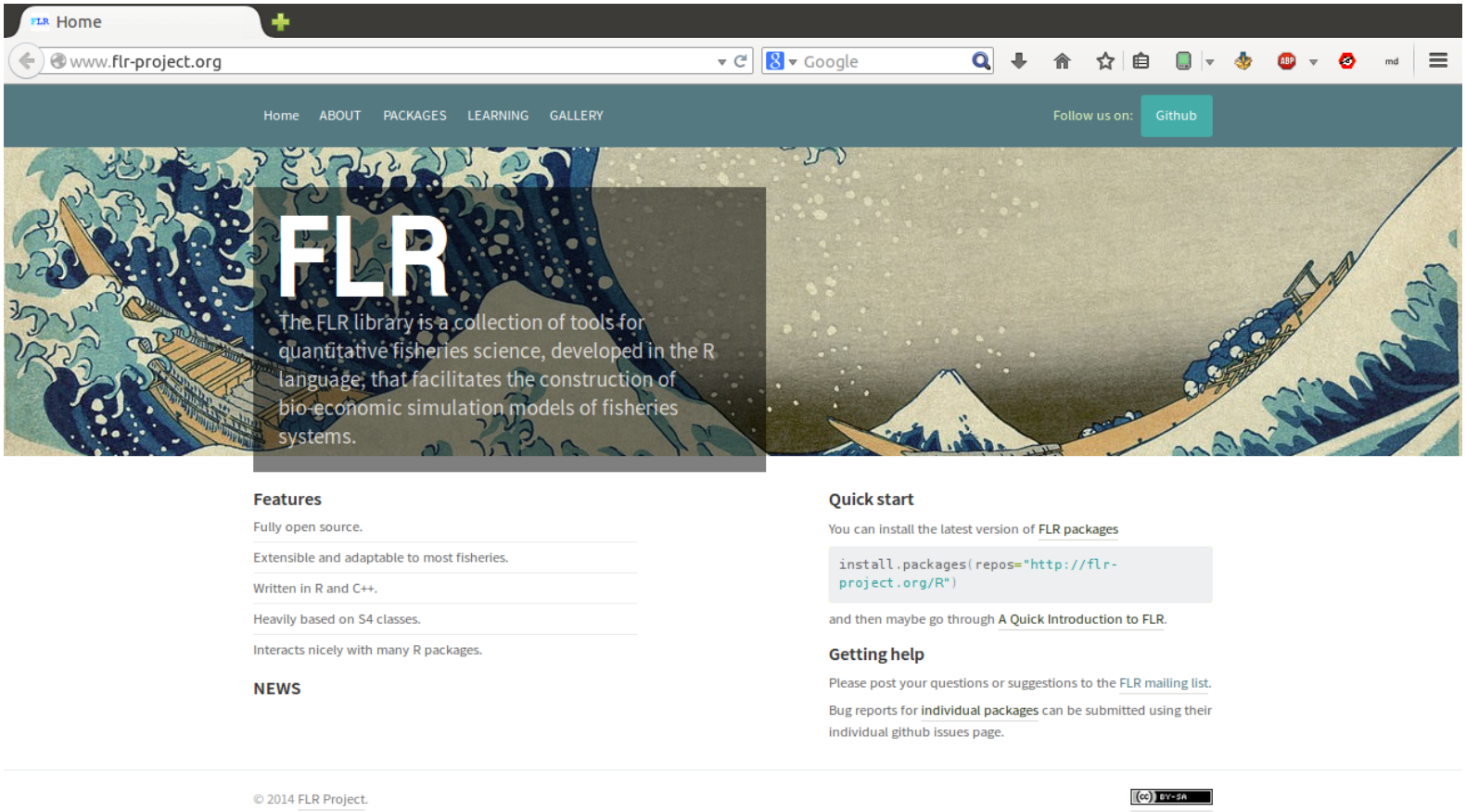
Help!

- Help for each function and data type
- ?mean
- ??mean
- ?help
- http://rseek.org
- stackoverflow, http://stackoverflow.com/questions/tagged/r
- Mailing lists

FLR

- Stock assessment and provision of management advice
  - Well tested, robust methods
  - Open to detailed inspection
- Data and model validation through simulation
- Risk analysis
- Capacity development & education
- Promote collaboration and openness in quantitative fisheries science
- Support the development of new models and methods
  - Extensible toolset
  - Links to other tools (ADMB, BUGS, . . .)

flr-project.org



Tools of the trade

- Version Control Systems
- Editors & IDEs
- Literate Programming
- Validation, Verification and Testing (VV&T)
- **Reproducible Research**

Sexy data analysis

Setting up R & RStudio

- http://cran.r-project.org
- http://rstudio.org