xstatR: an Environment for Running R and XLISP-STAT in Docker Containers UseR! 2019

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Outline

Why XLISP-STAT?

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Integrating R and XLisp-Stat

Two dockerized environment have been created for integrating R and XLisp-Stat.

xstatR
: for embedding R into XLisp-Stat using the R dynamic library

RXLisp
: for embedding XLisp-Stat into R using the XLisp-Stat dynamic library

`xstatR` was originally presented by Jim Harner with programming support by Jun Tan in the 2009 Directions in Statistical Computing (DSC) Workshop held in Copenhagen.

RXLisp was developed by Duncan Temple Lang in 2002.

xstatR: Linking via the R dynamic library

`xstatR` is designed for the user who wants the full XLisp-Stat environment with extensions for advanced dynamic graphics and a full R environment both accessible by a command-line interface with X11 support.

- Allows for a natural interface for software written in C
- Calls R directly
- Does not depend on other software, except for R
- Needs no setup or configuration
- Compile R with the –enable-R-shlib option
- Recompile xlispstat after upgrading R (if necessary)

RXLisp: Linking via the XLisp-Stat dynamic library

`RXLisp` is designed for an R user who wants access to the dynamic graphics of XLisp-Stat using the syntax of R.

- Loads XLisp into R as an R package
- Implements a subset of XLisp-Stat, e.g., callbacks not currently supported
- Allows an R interface to XLisp-Stat (with an optional XLisp interface)
- Requires little knowledge of XLisp-Stat except the functions of interest

What is Docker?

Docker containers provides a platform for running `xstatR` and `RXLisp`.

The two principal Docker entities are:

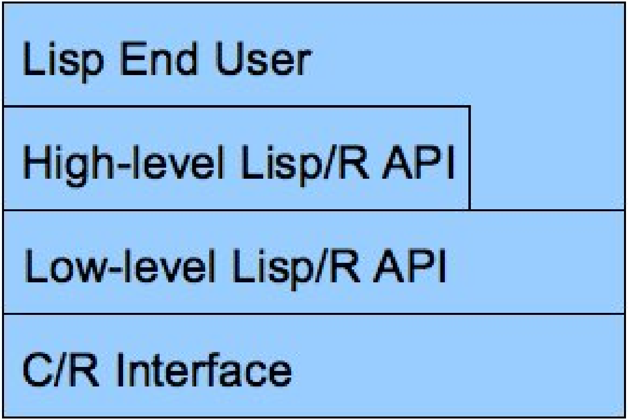
- **Image:** an executable package that includes everything needed to run an application
- **Container:** a runtime instance of an image

The image contains the code, configuration files, environmental variables, libraries, and the runtime. A container is an image with state, i.e., a user process.

The `xstatR` and `RXLisp` images provide complete, immutable solutions for embedding R in XLisp-Stat or embedding XLisp-Stat in R, respectively.

A Layered Structure

- C/R Interface
- Low level Lisp/R API
- High level Lisp/R API



C/R Interface

- The C/R interface is a thin wrapper of the embedded R API.
- The C/R interface avoids name conflicts between xlispstat and R
- R functions are mapped to C-based R interface macros/functions in xlispstat
- The C/R layer is invisible to users of xlispstat

Low Level Lisp/R API

- Developed in C for communicating with the external C interface in R
- Provides basic functions for allowing the Lisp user to access R
- Requires the user to take care of details, e.g., data synchronization between Lisp and R
- Designed for developers and advanced users
- Used as a platform for xlispstat packages, e.g., xstatR, that require the flexible use of R

High Level Lisp/R API

- Developed in Lisp
- Communicates with the low-level C macros/functions
- Provides convenient functions based on the embedded R environment
- Hides the embedded R environment from the user
- Is customizable and extendible, e.g., the user can customize the mapping between an R object and a Lisp object

Data type mapping

- Data type mapping needs to be dealt with in bridging/interface software
- One-to-one mapping is the ideal situation
- Due to the rich data structures in Lisp and R and their flexibility, no such mapping exists

A possible solution

- Convert simple data types, e.g., vectors of scalers.
- Returns a reference to R objects rather than converting complex data types
- Depends on the user to retrieve information from the R object references
- Used by R interface packages such as JRI and RServe

Problems of this method

- R objects need to be locked to avoid garbage collection
- User is responsible for releasing R objects
- Proper access methods to the object references are needed

Our strategy

- Use a generic structure to represent R objects
- Copy the data into this structure, ignoring unrecognized components
- Unlock the R object by default after all information is copied
- Assign R objects to variable names to retain them in memory, if persistence is needed

The generic structure representing R objects

- A list of length one or three
- The first element is the data part
- The second and third elements, for R objects with attributes, are the attribute names and the attribute values
- Attribute name list is a list of strings
- Attribute value list provides the corresponding values of the named attributes
- Data part is either an array of scalars/strings, etc., or (recursively) a list of generic structures

Current Implementation

- Many complicated structures are (currently) copied without special handling, e.g., `lm` objects.
- This structure is not convenient for direct use.
- The generic structure is a good foundation for building highly flexible conversions to meet users' needs, e.g., as has been implemented for data frames.

Low Level C Functions

- `(callR "`*`R statement`*`")`
  Parse and evaluate an R statement. The evaluation result will be copied into a generic structure and returned to the user.
- `(saveToR "`*`rName`*`", `*`lispObj`*`)`
  Save the value of `lispObj` into the embedded R environment (the value has to be encoded into the generic structure).

Examples

```
(setf y-list (callR "rnorm(50)"))
(setf y (first y-list))
(histogram y)
(saveToR "y" y-list)
```

High level functions: converting R objects

- A prototype, `Rengine-proto`, was built to ease the process of calling R.
- `Rengine-proto` directly supports the xstatR package, but can be used by any xlispstat package.
- The user can determine how to convert an R object based on its class name, dimension, etc.
- `Rengine-proto` currently includes loading data from R, saving an xstatR dataset to an R data frame, etc.

List of major methods

- `(send R :call "statement" &key asis)`
  Parse and evaluate a R statement.
  asis is a boolean value indicating whether to bypass the conversion process or not
- `(send R :save "rName" lispObj &key attr attrNames)`
  Save a lisp object to R. Attributes and names can be attached
- `(send R :save-dataset "rName" lispObj &key cols rows)`
  Save a dataset or part of a dataset as data frame in R

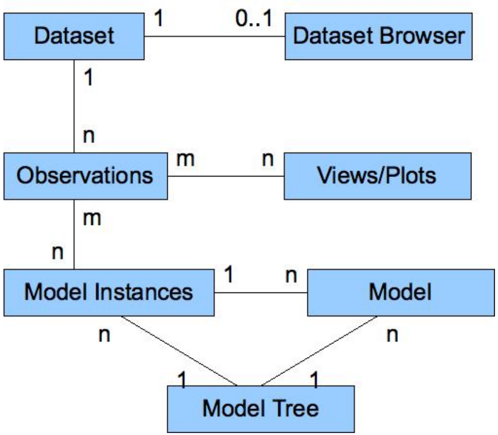
Examples

```
(setf iris (send R :data "iris"))
(send R :save-dataset "iris.data" iris
:cols '(SEPAL.LENGTH SEPAL.WIDTH)
:rows (iseq 1 10))
(send R :call "ls()")
(setf x (send R :call "iris.data"))
```

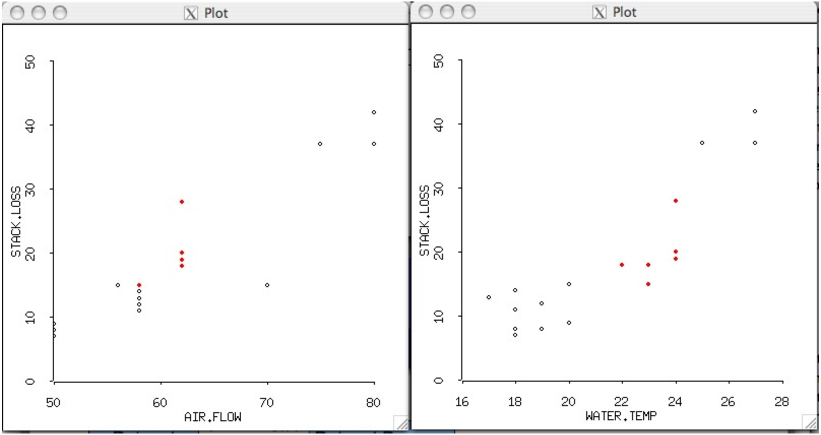
The xstatR package

- A lisp package used for dynamic graphics, data modeling, and multivariate analysis
- Dataset objects are defined in terms of observation objects
- Virtual datasets are constructed to encapsulate derived variables from model or other statistical objects
- Observations are objects viewable in different graphs
- Point state, color, and symbol are properties of the observation
- Changes in an observation value or property is immediately updated in its linked views
- R acts as a computational engine using the Lisp/R bridge

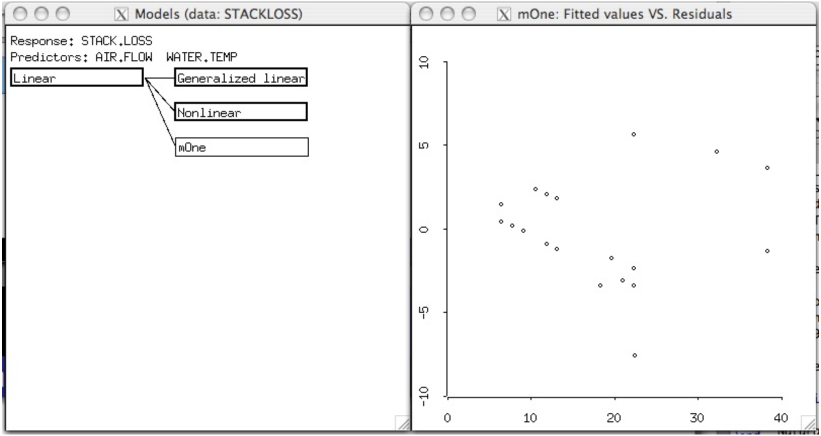
Partial Overview



Linked plots



Modeling Tree



More about virtual datasets for models

- Models generate derived variables from the original model variables.
- The newly generated data often need to be combined with the original dataset, e.g., to plot residuals against a predictor.
- SAS/JMP add (optionally) derived variables from models to the same dataset and the user soon loses track of which derived variables go with which model.
- R generates (optionally) named model and summary objects and the user soon loses track of the underlying models/summaries.
- Virtual datasets combined with tree-based model visualizations provide a solution.

Currently working on...

- Virtual datasets combine the "variables" in a dataset with the "derived variables" from a model object
- The dataset browser shows the virtual dataset by clicking on the statistical object view, e.g., a model view
- Virtual datasets support linking, e.g., for model diagnostic plots
- Virtual model datasets combined with a model tree recursively allow model comparisons