

## R.FUZ PROGRAMS

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### I. INTRODUCTION

r.fuz programs have been developed for integrating fuzzy treatments in the GRASS GIS environment, and more specifically for introducing spatial fuzzy rule-based modelling. The fuzzy package consists of a set of three modules.

First, the program **r.fuz.set** is used to fuzzify existing raster maps, i.e. to assign to a raster layer one or several linguistic (fuzzy) variables, each one being defined by a group of fuzzy sets. The second module, **r.fuz.map**, allows the user to create some basic fuzzy information such as spatial distribution of membership function values, fuzzy set intersection maps, etc. Lastly, the third program, **r.fuz.rule**, is the spatial fuzzy rule model : it operates on each pixel of several input raster layers to produce an output raster map according to a set of inference rules. These rules, which can be considered as the result of an expert knowledge, are coded in the following way (for example) :

**IF** ( [map1 is low] **AND** [map2 is medium] ) **THEN** [map3 is high]

A full description of flags, parameters and inputs of the commands can be found using the **g.manual** command in the GRASS environment.

Due to the history of the package development, these programs operate under GRASS4 environment. Unfortunately, they are not planned to be upgraded towards GRASS5 for a short while !

### II. DIRECTORY STRUCTURE

The r.fuz programs are stored in the r.fuzzy directory whose the structure is described as follows (in this case, the architecture is based on Linux) :

```

-Obj.linux--
-data-----
      |
      | -include---
-fuzzy-----| -lib-----| -LIB.linux-
      |         | -src-----| -OBJ.linux-
-htm-----
-man-----| -man4-----
r.fuzzy-   | -OBJ.linux-
-r.fuz.map--| -cmd-----| -OBJ.linux-
      |         | -inter-----| -OBJ.linux-
      |         | -OBJ.linux-
-r.fuz.rule-| -cmd-----| -OBJ.linux-
      |         | -inter-----| -OBJ.linux-
      |         | -OBJ.linux-
-r.fuz.set--| -cmd-----| -OBJ.linux-
      |         | -inter-----| -OBJ.linux-
-Gmakefile
-README.sdw
-README.txt
-README.rtf
-clean.sh

```

### Directory list

- OBJ.linux directory : all of the OBJ.linux directories contain the object modules resulting of the compilation in a Linux architecture ;
- data directory : it contains ASCII files (fuzzy variables, rules) which can be used in the spearfish database in order to test the commands ;
- fuzzy directory : it contains the fuzzy library source files (src), include files (include) and library binary (lib). The library libfuzzy.a is used at the time of r.fuz program linking ;
- htm directory : in the future, it will contain the manual information in html format ;
- man directory : it contains the man information of the r.fuz programs. The source code is under man4 ;
- r.fuz.set, r.fuz.map and r.fuz.rule directories : these directories contain the program codes in the two user's modes for each command : interactive (inter) or command (cmd).

### File list

- Gmakefile : the GRASS makefile, which can be found at each level of the global file structure, contains the required information for compiling and building binaries ;

- clean.sh : it is a Bourne shell script for cleaning the whole r.fuzzy directory by deleting the .o , .a , LIB. , and OBJ. elements according the user's request ;
- README.sdw, README.rtf and README.txt : this present file in StarOffice5.2 , RTF and text formats.

### III. INSTALL

In the case you get the package in tar.gz format, installation requires the following steps :

- copy r.fuzzy.tar.gz in GRASS src.incoming directory ;
- run the commands **gunzip r.fuzzy.tar.gz** and **tar xvf r.fuzzy.tar** ; the r.fuzzy directory structure must be the same as described above ;
- run the command **gmake4.2** (or similar) that you are used to compile GRASS programs. The binaries are directly copied in the \$GISBASE/etc/bin/contrib/cmd and \$GISBASE/etc/bin/contrib/inter directories. The compilation step has been successfully tested on Linux (RedHat 6.0) and Sun (Solaris2.6) (see corresponding configuration files in Annexe 1 and 2)
- copy the r.fuzzy/man/man4 files in the GRASS source man/man4 directory ; in the directory GRASS source man, run the command **gmake4.2** (or similar) to install g.manual pages ;
- the first time a user runs **r.fuz.set**, a directory named fuzzy is created under the current MAPSET. So, for handling fuzzified raster maps with the g.copy, g.rename and g.remove commands, you have to update the element\_list file in \$GISBASE/etc directory by adding a record such as fuzzy:fuzzy at the end of the cell paragraph (see Annexe 3).

## Annexe 1 : compilation head file for Linux architecture

```
# GRASS compilation head file for LINUX/Intel x86 architecture

CC                = gcc
FC                = g77
LEX               = lex -l
YACC              = yacc
ARCH              = linux

GISBASE           = /opt/grass421
UNIX_BIN          = /usr/local/unix_bin

DEFAULT_DATABASE =
DEFAULT_LOCATION =

# -fwritable-strings - for ps.map only
#COMPILE_FLAGS    = -O2 -m486 -fwritable-strings -DATT_386
# -DATT_386 added for i.in.erdas
COMPILE_FLAGS     = -O2 -m486 -DATT_386
LDFLAGS           = -Wl,-s

# debug flags:
#COMPILE_FLAGS    = -g -Wall -m486

XCFLAGS           = -D_NO_PROTO
XLDFLAGS          =
XINCPATH          = -I/usr/X11R6/include
XMINCPATH         = -I/usr/X11R6/include
XLIBPATH          = -L/usr/X11R6/lib
XTLIBPATH         = -L/usr/lib
XMLIBPATH         = -L/usr/lib
XLIB              = -lX11
XTLIB             = -lXt
XMLIB             = -lXm
XEXTRALIBS       =

TERMLIB           =
CURSES            = -lncurses $(TERMLIB)
MATHLIB           = -lm

#               LIBRULE = ar ruv $@ $?
#               LIBRULE = ar ruv $@ $?; ranlib $@
#               LIBRULE = ar ruv $@ $?; ar ts $@
#               LIBRULE = ar rc $@ `lorder $(OBJ) | tsort`
LIBRULE           = ar ruv $@ $?

USE_TERMIO        = -DUSE_TERMIO
USE_MTIO          = -DUSE_MTIO
USE_FTIME         = -DUSE_FTIME
DIGITFLAGS        = -DUSE_SETREUID -DUSE_SETPRIORITY
VECTLIBFLAGS      =
GETHOSTNAME       = -DGETHOSTNAME_OK
```

## Annexe 2 : compilation head file for Solaris architecture

```
CC                = gcc
FC                = g77
LEX              = lex
YACC             = yacc
ARCH            = solaris

GISBASE          = /opt/grass42/binary
UNIX_BIN         = /opt/grass42/src421/src/CMD/unix_bin

DEFAULT_DATABASE =
DEFAULT_LOCATION =

COMPILE_FLAGS    = -O
LDFLAGS          = -s -ldl

XCFLAGS          = -D_NO_PROTO
XLDFLAGS         =
XINCPATH         =
XMINCPATH        = -I/usr/dt/include
XLIBPATH         = -L/usr/openwin/lib
XTLIBPATH        = -L/usr/ucblib
XMLIBPATH        = -L/usr/lib -L/usr/dt/lib
XLIB             = -lX11
XTLIB            = -lXt
XMLIB            = -lXm
XEXTRALIBS      =

# TERMLIB         = -ltermib
# CURSES          = -lcurses $(TERMLIB)
TERMLIB          =
CURSES           = -ltermib
MATHLIB          = -lm

#                LIBRULE = ar ruv $@ $?
#                LIBRULE = ar ruv $@ $?; ranlib $@
#                LIBRULE = ar ruv $@ $?; ar ts $@
#                LIBRULE = ar rc $@ `lorder $(OBJ) | tsort`
LIBRULE          = ar ruv $@ $?

USE_TERMIO       = -DUSE_TERMIO
USE_MTIO         = -DUSE_MTIO
USE_FTIME        = -DUSE_FTIME
DIGITFLAGS      = -DUSE_SETREUID -DUSE_SETPRIORITY
VECTLIBFLAGS     =
GETHOSTNAME      = -DGETHOSTNAME_OK
```

### Annexe 3 : element\_list file in \$GISBASE/etc

```
# @(#)Element_List 2.4 12/2/87
# this file specifies the database elements that
# are processed by RENAME, REMOVE, COPY, and LIST
#
# format:
# main_element:alias:description:menu text
#   support_element:description
#
cell:rast:raster:raster files
  cellhd:header
  cats:category
  colr:color
  hist:history
  cell_misc:misc
  fuzzy:fuzzy
dig:vect:vector:binary vector files
  dig_att:attributes
  dig_plus:topology
  dig_cats:category
  dig_misc:misc
reg:point registration
icons:icon:icon:paint icon files
paint/labels:labels:label:paint label files
site_lists:sites:site list:site list files
windows:region:region definition:region definition files
group:group:imagery group:imagery group files
```