Chapter 17
Partial Order and Software

17.1 Software Available

Halfon (2006) reviews available software. We summarize and update the review for the convenience of the reader:

RANA, Pavan (2003)
DART, Manganaro et al. (2008)
PRORANK, Pudenz (2005) and Voigt et al. (2006)
CORRELATION, Sørensen et al. (2005)
WHASSE, Bruggemann et al. (1999)
POSAC, Shye (1994) and Borg and Shye (1995); see also http://ca.huji.ac.il/bf/hudap-Info.pdf
POSET, Patil et al. (2009, personal communication (POSET-ranking))
PyHasse, Bruggemann et al. (2008a, b), Bruggemann and Voigt (2009), and Voigt et al. (2008a, b)
VB-RAPID, Joshi et al. (2010)

If formal concept analysis is included then the list above can be extended; see the home page: http://www.upriss.org.uk/fca/fcasoftware.html:

TOSCANA, see Vogt and Wille (1995a, b)
CONIMP-variants, see Burmeister (1997)
CONEXP1.3, see Yevtushenko (2000), http://sourceforge.net/projects/conexp

17.2 Brief Characterization of Some of the Software

Some software packages may be presented briefly. The selection is subjective and does not reflect any quality or importance.

PRORANK (programming language: JAVA): Still under development, intends to include multivariate statistics as far as possible. It already has tools to edit the graphics and to handle subsets of objects and indicators. In comparison with the software WHASSE, data handling is greatly facilitated.

R. Brüggemann, G.P. Patil, *Ranking and Prioritization for Multi-indicator Systems*, Environmental and Ecological Statistics 5, DOI 10.1007/978-1-4419-8477-7_17,

CORRELATION (programming language: DELPHI): The very idea is to examine two partial orders and how far a "correlation" can be found on the basis of these two posets.

WHASSE (programming language: DELPHI): Includes down sets, antagonism, object selection wizards, matrix W, linear extensions and applications to calculate rank frequency distributions, averaged ranks and mutual probabilities, and CAM (called P(IB)). WHASSE is professionally programmed, has a well-developed graphical user interface, and can be delivered as a stand-alone package, i.e., it is not necessary to use Internet for installing the software.

DART (programming language C++): Includes multivariate procedures like PCA and KMEANS clustering and several functions to provide linear orders and also has some facilities for posetic approaches.

POSAC: In SYSTAT.

POSET (programming language: C++): Development at Penn State Center for Statistical Ecology and Environmental Statistics. It provides linear ranks on the basis of linear extensions.

PyHasse (programming language: PYTHON): Major software used in the monograph. Therefore, we describe PyHasse in more detail later (Section 17.3).

VB-RAPID (VISUAL BASIC): Developed by Joshi et al. (2010). It is described in more detail in Section 17.4.

17.3 PyHasse

17.3.1 Overview

PyHasse is based on the free downloadable PYTHON programming software, version 2.6. PYTHON programs can be used on different platforms and under different operating systems; there are many specific and powerful free downloadable libraries available.

Graphical user interfaces (GUIs) can be programmed by Tkinter, which is available together with PYTHON and is based on Tk/Tcl. PYTHON supports testing and can be considered as an "experimental software," allowing the programmer to quickly gain experience in programming work and, more important, to test and efficiently program new theoretical tools.

17.3.2 General Principles of PyHasse

First of all, PyHasse should be considered as a test version. It actually consists of more than 30 programs (called "modules") and is still pretty dynamically under development. An overview with status of March 2009 can be found in Bruggemann and Voigt (2009).

The modules are independently written programs, so new ideas can be easily programmed without having to take care of already used variable names. All modules are related to two libraries, written by Bruggemann, which contain basic procedures and basic classes of object-oriented programming: rmod2 and raioop2. Some modules have interfaces by which results can be interchanged.

One of the modules is “pyhassemenue7,” the central platform from where general information can be obtained (for example a tutorial) and from where actual interesting modules can be selected.

The appearance of the modules (i.e., their user interfaces) is similar as far as possible. Each module has a “help” function. This help function informs about

- aim of the module,
- prerequisites (especially how to handle Excel® data files as input),
- usage (or steps),
- known bugs or difficulties, and
- recommended example files (provided with the PyHasse software).

In many cases, there is also an “about” button, which informs about the status of the module and gives background information, for example, about important literature.

17.3.3 List of Modules

In PyHasse, three types of modules are available:

M: Basic PyHasse Analysis Tool
D: Simple versions of decision support systems
H: Supporting modules (interfaces, tutorial writers) (Table 17.1)

Table 17.1 PyHasse modules, alphabetically sorted (status November 2009)

	Name	Main tasks	Class	Remark
1	antag2.py	Which pair of attributes leads to the maximal Sep(X_1, X_2)	M	
2	avrank4.py	Canonical order based on lattice theoretical method. Module avrank4.py is mainly based on the free software lcell of Wienand (2005, 2006). See also Morton et al. (2006, 2009)	M	For a broader background, see also Chapter 9
3	avs6.py	Changes of attribute values: Which consequences	M	Will be replaced in the near future by pooc
4	cap6.py	Comparative acquisition profile	M	
5	concord2.py	Concordance analysis	H	
6	covi2.py	Reads interactively cover information, generates a Hasse diagram, and translates it into graphviz format	H	

Table 17.1 (continued)

	Name	Main tasks	Class	Remark
7	covreader4	Reads information from an external cover matrix	H	
8	dahp4	The weights for super-attributes are found by the AHP procedure of Saaty (1994)	M	A comparison with weights obtained from other methods is of interest; however, we leave it for future work
9	dds8.py	Calculation of dominance diagrams	M	
10	Disco2.py	Discordance–concordance analysis	D	
11	discretiz1.py	Performs a discretization, transformed data matrix is available for mainHD16	H	
12	fuzzyHD12.py	Fuzzy partial order analysis	M	
13	genlinext1.py	If the number of objects is less than 10, then the averaged ranks and the height frequency matrix are calculated very fast. Height frequency plots for selected objects are available	H	
14	graphviz1.py	Reads information from cover matrix (available from, e.g., mainHD16 and provides the Hasse diagram in graphviz format)	H	
15	hdgt4	Some graph theoretical information of the Hasse diagram. Provides averaged ranks by extended local partial order model version (Bruggemann and Carlsen, 2011)	M	
16	HDsimpl1	Quick access to the Hasse diagram from a data matrix	H	
17	hpor1.py	Hierarchical partial order analysis. Based on averaged ranks form of groups of attributes; Carlsen (2008)	M	
18	interval4.py	Analysis by m^2-order and inclusion order of the intervals	M	
19	linagg6.py	Monte Carlo Simulation of the rank of an index, randomly selecting the weights	M	

Table 17.1 (continued)

	Name	Main tasks	Class	Remark
20	linext_play2.py	Reads in linear extensions and calculates their intersection	H	
21	LPOMstruct1.py	Reads in characteristics of a Hasse diagram and calculates the average heights	H	
22	mainHD19.py	Hasse diagram, down sets, up sets, intervals, minimum spanning trees, linear extensions after Bubley Dyer, LPOM, chain statistics	M	The most important tool
23	mutprobavrk.py	Reads in characteristics of a Hasse diagram and calculates mutual ranking probabilities	H	
24	optimsim5.py	Which attribute subset makes a partial order most similar to a given one	M	Will be replaced in the near future
25	oreste6.py	If preferences of $a > b$, vs $b > a$ are known then a graphical characterization of the decision situation is given	D	
26	owa3.py	Aggregation to superindicators applying fuzzy concepts; Yager (1993)	M	
27	palg4.py	Application of p-algorithm	M	
28	pir3.py	Information about PyHasse texts	H	
29	pooc3	Attribute-related sensitivity	M	Will be upgraded in the near future
30	POTanalysis1	Module mainHD19 is simplified to fit into pyhassemenue7	H	
31	prom6	PROMETHEE (simplified)	D	
32	pyHasse_progr1.py	Information about PyHasse modules	H	
33	pyhassemenue7.py	Information platform and access to the modules of PyHasse	H	
34	randomdm2.py	Generates random data matrices	H	
35	sensi11.py	Attribute-related sensitivity analysis	M	
36	sep3.py	Calculates which set of attributes is common for X_1 and X_2 such that for all $x \in X_1, y \in X_2, x > y$; common for X_1 and X_2, such that for all $x \in X_1, y \in X_2, x < y$; common for X_1 and X_2, such that for all $x \in X_1, y \in X_2, x = y$	M	sepanal2.py with many more tools replaced sep3.py (July 2010)

Table 17.1 (continued)

	Name	Main tasks	Class	Remark
37	simi4.py	Proximity analysis of two partial orders, test for inclusion of two partial orders, set of edges corresponding to the symmetric difference of any two partial orders	M	In testing phase
38	stability3.py	Calculates stability fields and hot spots	M	
39	zetareader1	Reads in an external zeta matrix, calculation of mutual probability after De Loof et al. (2008a)	H	

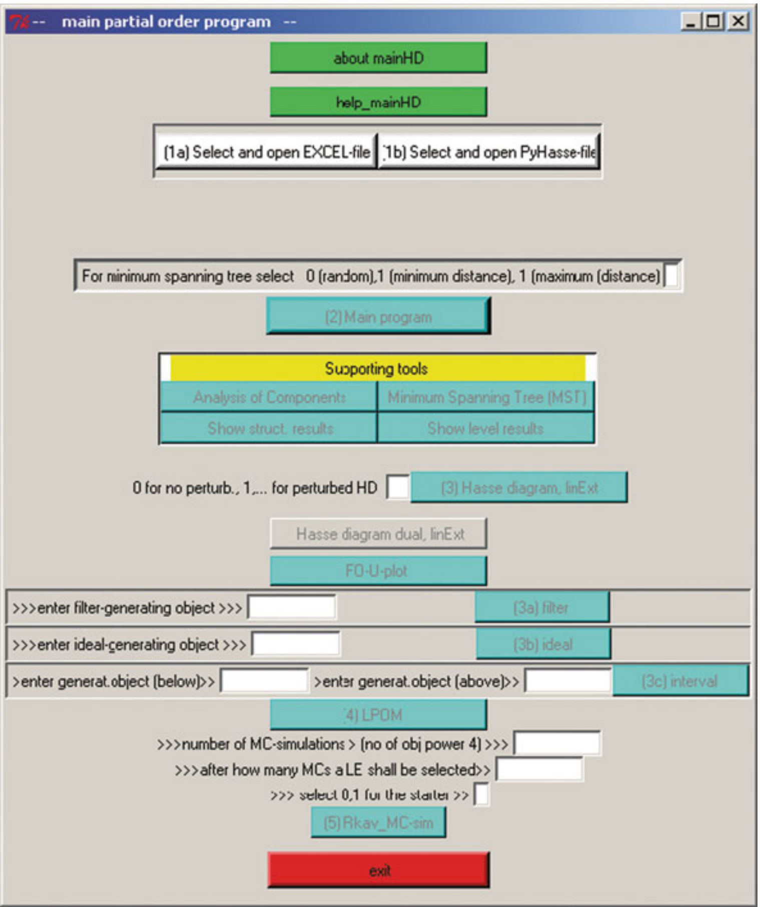

Fig. 17.1 Graphical user interface of mainHD19.py

The module mainHD19 is the main working module and can be used to analyze transformed data matrices of the modules discretiz1.py and palg4.py. Additionally mainHD19 provides data formats such that the graph theoretical program graphviz (see http://4webmaster.de/wiki/Graphviz-Tutorial) can be applied to obtain readable directed graphs. The user interface of mainHD19.py is shown in Fig. 17.1.

There are four areas in the graphical user interface:

1. informal part and the access to different data
2. characteristics of a poset can be obtained as well as the Hasse diagrams
3. navigation within a Hasse diagram
4. linear or weak orders by LPOM or Bubley Dyer algorithm

Some buttons are only activated if the needed information is provided.

Table 17.2 lists the use of PyHasse in the theoretical part of the monograph.

Table 17.2 Use of PyHasse in the theory part of the monograph

Sections	Figures	Topic	PyHasse module	Remark
4.2.5		Sensitivity measures	sensi11.py	
4.4.1		Stability and related graphs	snsi11.py	
5.2	Figure 5.3	Incomparabilities related to levels	mainHD16.py	Now (30 July 2010): mainHD19.py
5.4.2		Antagonistic attributes	antag2.py	Only analysis for pairs of attributes
5.5	Figure 5.20	Dominance	dds.8	
6.3		Discretization	discretiz1.py	
6.4		Fuzzy partial order	fuzzyHD12.py	
6.5		p-algorithm	palg4.py	
7.2.5	Figure 7.7	MC simulation	linagg6.py	
7.3		m^2 order, inclusion order	interval4.py	Now (30 July 2010) interval7.py
7.4.2		Comparability acquisition profile	cap6.py	
7.5		Stability fields	stability3.py	
9.3.3		Local partial order model	mainHD16.py	LPOMstruct1.py: interactive program
9.4		Bubley Dyer algorithm	mainHD19.py	
9.6		Lattice method	avrank4.py	
9.8.2	Figure 9.8	Mutual probability	mutprobavrk1.py	Interactive program
10.4		Concordance analysis	concord2.py	
10.6		Proximity analysis	simi4.py	Now (30 July 2010): simi5.py

17.4 RAPID

17.4.1 Standards

Under the auspices of the USNSF project for digital governance and hot spot geoinformatics for monitoring, etiology, early warning, and sustainable management and development at the Penn State Center for Statistical Ecology and Environmental Statistics, G.P. Patil, Principal Investigator, effort has been in progress for methodology and software development for ranking and prioritization information delivery (RAPID).

The software "RAPID" has been under development to clearly encompass features of some well-known programs and more, such as

- WHASSE
- POSET
- POSAC
- PyHasse

17.4.1.1 Steps of Developing RAPID

RAPID is developed in several steps. RAPID0 provides the Hasse diagram and basic tools to analyze it. RAPID1 will contain additional features arising from the partial order context.

Of most importance is that a tool of getting linear or weak orders out of a poset is available. The general concept is explained in Fig. 17.2.

There are several crucial steps:

a) The starter for the Monte Carlo Markov chain calculation (MCMC) after Bubley Dyer,
b) Sampling of the final subset of linear extensions, and
c) Defining conditions in the decision mark.

Especially (c) still uses some heuristics.

The programming language is VISUAL BASIC at present.

17.4.2 Modules and Facilities of VB-RAPID

In contrast to PyHasse, VB-RAPID 1 consists of one single program and the access to different tools of partial order follows by menus and submenus. The main menus are

File: Open and save data
Functions: Basic information about the data matrix

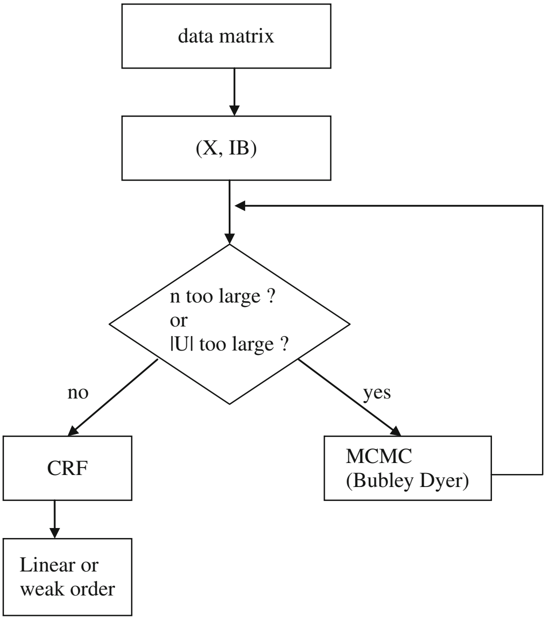

Fig. 17.2 RAPID-ranking, a combination of the Bubley Dyer and the cumulative rank frequency (CRF) algorithm; see Chapter 9

HASSE Diagram: Hasse diagram in two possible orientations
Results: Access to partial order tools (see below)
Help: Context specific help texts written in HTML

The menu "Results" pops up to the following submenu:

1. Level population
2. Cover matrix
3. Down sets and up sets
4. Intervals
5. Maximal, minimal, and isolated elements
6. Structural details (predecessors, successors, and incomparable elements)
7. Sensitivity, based on the matrix W (W(X,IB(i),IB(j)))
8. LPOM
9. D-matrix (which we did not consider in the monograph)
10. Minimum rank graph
11. Articulation points
12. Bubley Dyer simulation (combined with CRF)

Information in (3)–(5), (6), (8), (9), (11) is rendered in textual form, all others display a graphic additionally, like, e.g., in (12) height probability graphs.

In contrast to PyHasse, VB-RAPID provides a graphical editor (menu HASSE Diagram), by which the number of crossings can be manually reduced.

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