eirt - Item Response Theory Assistant for Excel

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Contents

Chapter 1

Introduction

The *eirt* program is an add-in for *Excel* that does Item Response Theory estimations. This program is restricted to the case where the latent variable (the ability) is unidimensional and follow the normal distribution, and the number of possible response (the options) is finite. This type of item include the binary case, the multiple choice case and the graded case.

The list of supported models includes the logistics models with one, two and three parameters for the binary data, the nominal response model for the multiple choice data, and the graded response model for the graded data.

The estimation of the item parameters is done by the maximum marginal likelihood estimator or by the Baye modal estimator. In addition, two non-parametrics estimators are supported; the kernel estimator and the penalized maximum marginal likelihood estimator. The abilities are estimated by the expected a posteriori estimator.

The *eirt* program uses the numerical routines from the *libirt* library (`http://libirt.sf.net`) also available in *rirt* a *R* package (`http://www.r-project.org`).

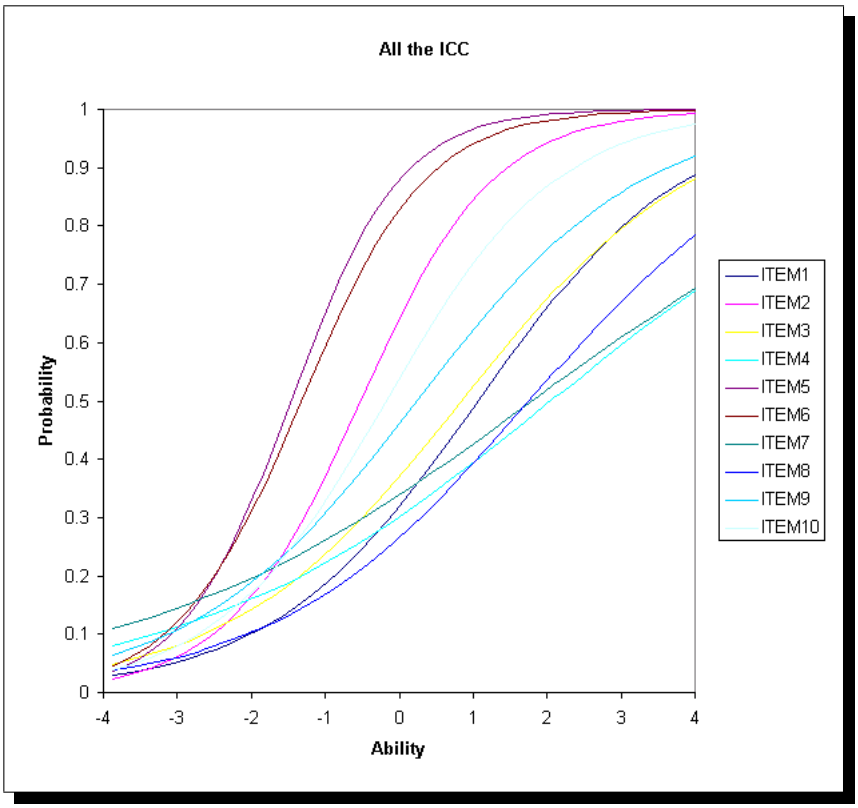

Figure 1.1: Example of Item Characteristic Curves.

Chapter 2

Installation

The *eirt* program is available for download at `http://sourceforge.net/project/showfiles.php?group_id=164538&package_id=186544`. The installation program is named **eirt-1.0.0.exe** where 1.0.0 is the version number.

The **installation program** first ask to select the **installation language**. Select **english** and click on the **ok** button. If another language is selected, it will also be used in the program. It is possible to change the **display language** after the installation with the **settings** tools(see the chapter 4).

For the rest of the installation, you can keep the default value. Near the end of the installation, an *Excel* macro is run to install the program into *Excel* menu. It is necessary then to accept the **macro activation**.

Chapter 3

Assistant usage

Before using the assistant, you have to start *Excel* and open the worksheet where your data is. Then you navigate into the **tools** menu, go to the **eirt** sub-menu and choose the **start the assistant** option.

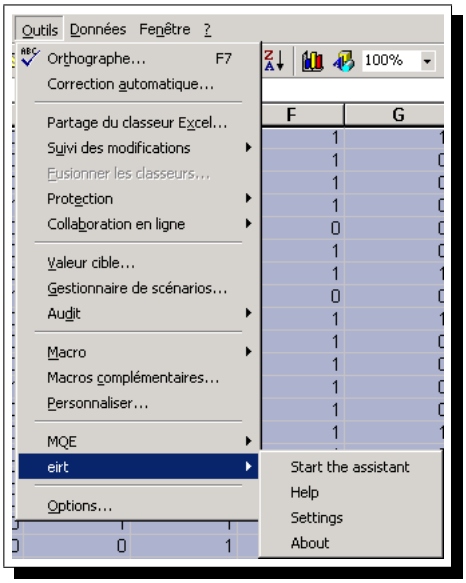

Figure 3.1: Starting the assistant.

The *eirt* program is an assistant like program with four step. At each step, the program gives a brief instruction, you give the information asked and then click on the **next** button. At the end of this process a report is generated.

At any step of the assistant, you can click on the **back** button to go at the previous step, on the **cancel** button to stop the program, or on the **help** button

to get help.

3.1 Step 1 : the data selection

The first step of the assistant is the data selection. The goal of this step is simply to enter the position of the data into the worksheet.

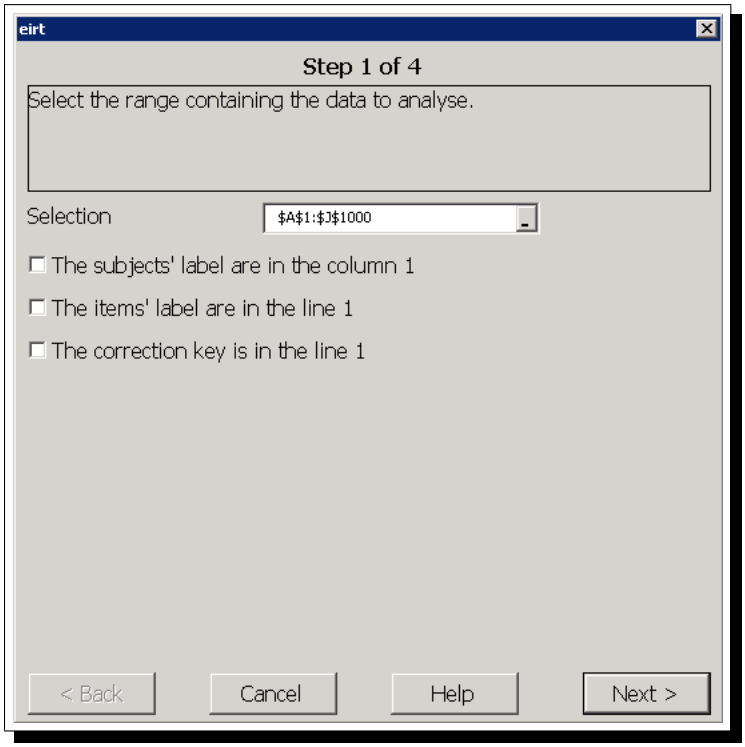

Figure 3.2: Data selection.

If before the start of the assistant a range is already selected, it is automatically used. If the selected range isn't the right one, you have to click on the **selection** and select a new range.

If the selected range contains the **subject labels** in the first column, the **item labels** in the first row or the **correction key** in the next row, then check the appropriate box.

3.2 Step 2 : the data type definition

The second step of the program is to define the **data type**. This step allow you to define how your data is coded and has an effect on which models are

available in the next step.

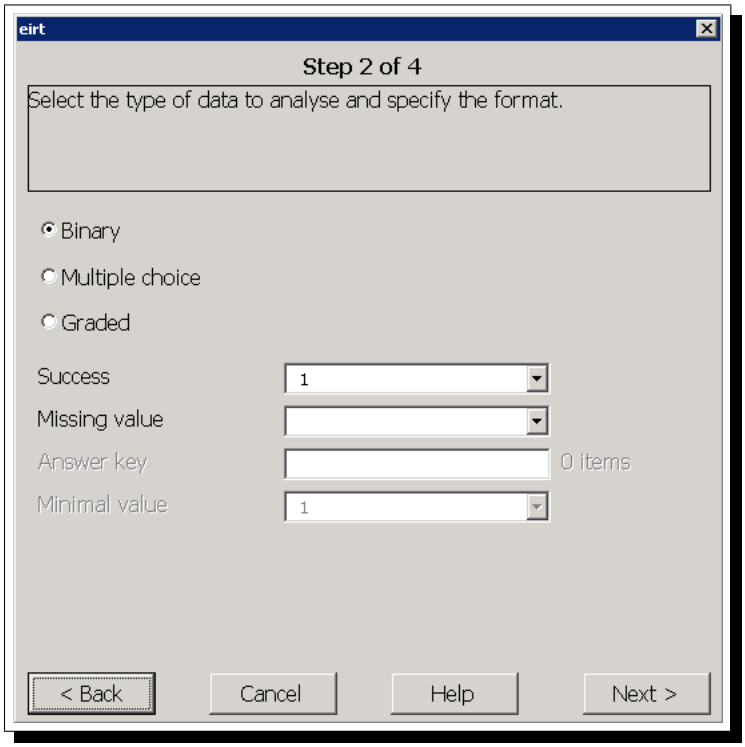

Figure 3.3: Definition of the data type.

In all the case you have to give how the **missing values** are coded. This value can be a number, a string or left empty, in which case the empties cells will be taken as missing values.

3.2.1 Binary type

If all the item have only the same two options, you should choose the **binary type** that gives access to the univariate logistic models and make a simpler report. In this case you also have to give how the **succes** are coded. This value can be a number or a string. All the responses different from this value and different of a missing value is assumes to be a failure.

3.2.2 Multiple choice type

If some items have more than two options and each item has only one good option, you have to choose the **multiple choice type**. In this case you also have to give the **correction key**. The values in this field have to be comma separated

and contains no spaces. To help you input the correction key, its length is displayed. If the corrction key is in the selected range and the appropriate box was checked in the first step, then the key is already into this field.

3.2.3 Graded type

If some items have more than two options, the response to all items are integers, and a bigger response mean a bigger ability, then you have to choose the **graded type**. In this case you also have to give the **minimal** value common to all the items.

3.3 Step 3 : the model or method choice

The third step of the program is the **model** choice. Depending on the data type, some models are unavailables.

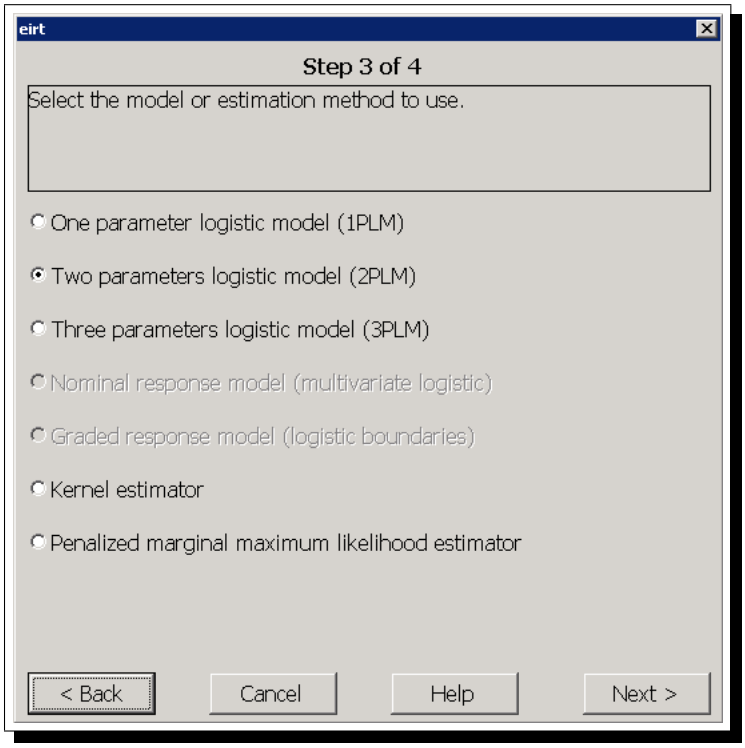

Figure 3.4: Model choice.

3.3.1 The one parameter logistic model

The **one parameter logistic model** is available only if the data type is **binary**. In this model each item has only one parameter, the **threshold** (or **difficulty**). The **slope** parameter (or **discrimination**) is fixed to a constant for all the items.

3.3.2 The two parameters logistic model

The **two parameters logistic model** is available only if the data type is **binary**. In this model each item has two parameters, the **threshold** and the **slope**.

3.3.3 The three parameters logistic model

The **three parameters logistic model** is available only if the data type is **binary**. In this model each item has three parameters, the **threshold**, the **slope** and the **asymptote** (or **guessing**). This model is harder to fit and gives greater estimation errors.

3.3.4 The nominal response model

The **nominal response model** is available if the data type is **multiple choice** or **graded**. Each option of each item has two parameters, the **threshold** and the **slope**. Unlike the **graded response model**, no order is forced on the options. If the data type is **graded**, then the value of the options is used only for the initialisation and to compute the item characteristic curves.

3.3.5 The graded response model

The **graded response model** isa vailable only if the data type is **graded**. Each option of each item has one parameter, the **threshold**, and a common parameter to the item, the **slope**. The order of the options is forced.

3.3.6 The kernel estimator

The **kernel estimator** is available for all data types. With this estimator, no model is imposed to the data and the curves are obtained by smoothing with the Nadaraya-Watson estimator. This method is also used in the *Testgraf* program by J.O. Ramsay.

3.3.7 The penalized maximum marginal likelihood estimator

The **penalized maximum marginal likelihood estimator** is available for all data types. This method is a tradeoff between the logistics models and the data.

3.4 Step 4 : the report options

The fourth and last step of the program is the choice of the elements to include in the report. Some elements such as **all the data points from the plots**, the **ability estimates** or the **test of local independance** can take a lot of pages in the report, it is recommended to activate them only if necessary.

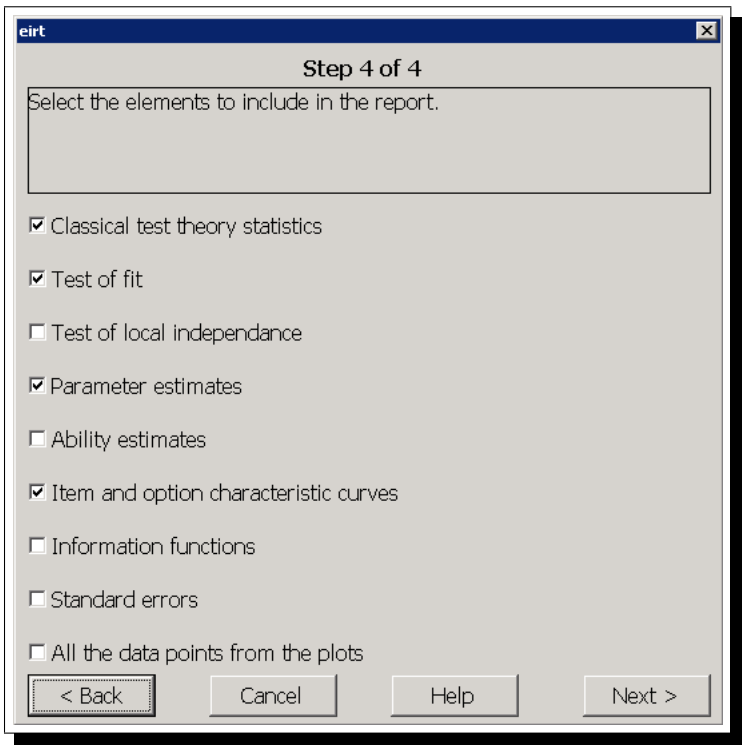

Figure 3.5: The report options.

After this step, the estimation process begin. While the estimation is running, *Excel* will not be usable. The time of the estimation depends on the number of subject and item, the model and the computer speed. For a few thousands subject and ten items, the estimation should not take more than ten seconds for binaries items and two or three minutes for five options items on a recent computer.

3.4.1 The classical test theory statistics

Check this box to have the **classical test theory statistics**, such as the **item means** (or **difficulties**), the **item correlation** (or **discriminations**), and **Cronbach's alpha**.

3.4.2 The test of fit

Check this box to have the **test of fit** global and for each item by likelihood ratio.

3.4.3 The test of local independance

Check this box to have the **test of local independance** of each item pairs by likelihood ratio.

3.4.4 The item parameters

Check this box to have the **item parameters**. This element is not available for the non-parametric methods.

3.4.5 The ability estimates

Check this box to have the **ability estimates** of each subject.

3.4.6 The item and option characteristic curves

Check this box to have the plot of each **item and option characteristic curves**.

3.4.7 The information functions

Chech this box to have the **information functions** plots.

3.4.8 The standard errors

Check this box to have the **standard errors** of all the estimates.

3.4.9 All the data points from the plots

Check this box to have all the data necessary to create the given plots.

3.5 The report

Once the estimation process is finish, a new worksheet is created in the current *Excel* file. This sheet is named **eirt** follow by a number and contains the report. Before quiting *Excel*, you have to **save** the file if you want to keep the report. If you make more than one report and want to delete some of them, you have to select them, navigate in the **edit** menu and choose the **delete a sheet** option.

Classical test theory statistics

Number of subject	Number of item	Number of missing response	Score's mean	Score's standard deviation	Cronbach's Alpha
1000	10	0	4.854	1.985	0.503

Item	Mean (difficulty)	Standard deviation	Correlation (discrimination)
ITEM1	0.335	0.472	0.208
ITEM2	0.614	0.487	0.295
ITEM3	0.380	0.485	0.204
ITEM4	0.308	0.462	0.134
ITEM5	0.819	0.385	0.275
ITEM6	0.777	0.416	0.268
ITEM7	0.344	0.475	0.108
ITEM8	0.280	0.449	0.162
ITEM9	0.464	0.499	0.208
ITEM10	0.533	0.499	0.256

Estimation summary

Data source	Range '$A$1:$J$1000' in sheet 'Feuil1' of file 'example.xls'
Method	Baye's modal estimator (BME)
Model	Two parameters logistic model (2PLM)

No item were ignored by the estimation process.

All the items converged.

Figure 3.6: Report example.

3.5.1 The classical test theory statistics

- The **number of subject**.
- The **number of item**.
- The **number of missing value**.
- The **score mean**.
- The **score standard deviation**.
- The **Cronbach's alpha**.
- The **mean (difficulty)** of each item.
- The **standard deviation** of each item.
- The **correlation (discrimination)** of each item.

3.5.2 The estimation summary

- The **data source**.
- The **estimation methode**.
- The **model** if applicable.
- The **smoothing parameter** if applicable.
- The number of item **ignored** by the estimation.
- The number of item that didn't **converged**.

3.5.3 The test of fit

- The **Chi-square** statistics, global and for each item.
- The number of **degree of freedom**, global and for each item.
- The **p-value**, global and for each item. The row is in red if this value is less than 0.05.

3.5.4 The test of local independance

- The **Chi-square** statistics for each item pair.
- The number of **degree of freedom** for each item pair.
- The **p-value** for each item pair. The row is in red if this value is less than 0.05.

3.5.5 The item parameter

- The **slope** (a) of each item and option if applicable.
- The **threshold** (b) of each item and option if applicable.
- The **asymptote** (c) of each item and option if applicable.
- The **standard error** (**s.e.**) of each parameter if selected in step 4.

3.5.6 The ability estimates

- The **ability** of each subject.
- The **standard error** (**s.e.**) of each ability if selected in step 4.

3.5.7 The item and option characteristic curves

- A plot of the item characteristic curve **ICC** of each item.
- A plot of the option characteristic curve **OCC** of each option if applicable.

3.5.8 The information functions

- A plot of all the **information functions**.

3.5.9 All the data points from the plots

- The data points used for the **ICC** plots if applicable.
- The data points used for the **OCC** plots if applicable.
- The data points used for the **information functions** plots if applicable.

3.5.10 The pages header and footer

If the report is printed, the header and footer contains the program version, the data file name, the date and time and the page number.

Chapter 4

Settings

Before you can change the **settings** of *eirt*, you have to start *Excel*. Then you navigate into the **tools** menu, go to the **eirt** sub-menu and choose the **settings** option. If you are satisfied with your changes, click on the **ok** button and you changes are applied and saved.

4.1 The language

Under this tab you can change the **display language** of the program.

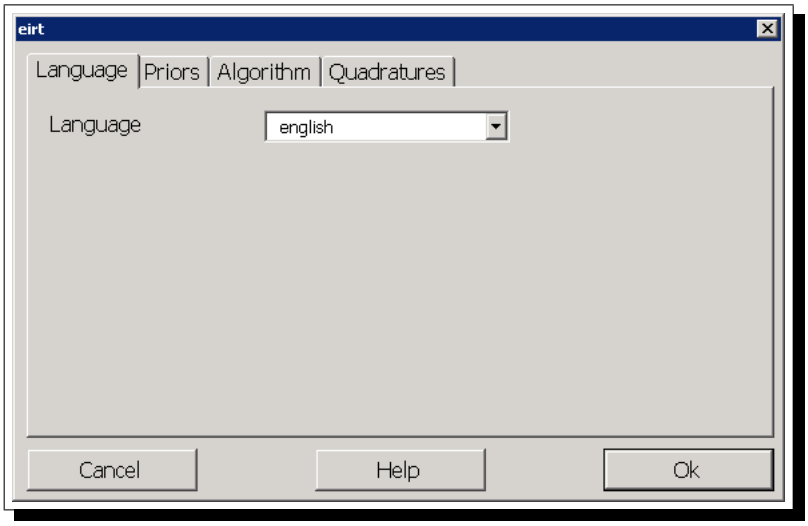

Figure 4.1: Language settings.

4.2 The priors

Under this tab you can change the **prior distributions**. These parameters are applicable only for the binary logistic model.

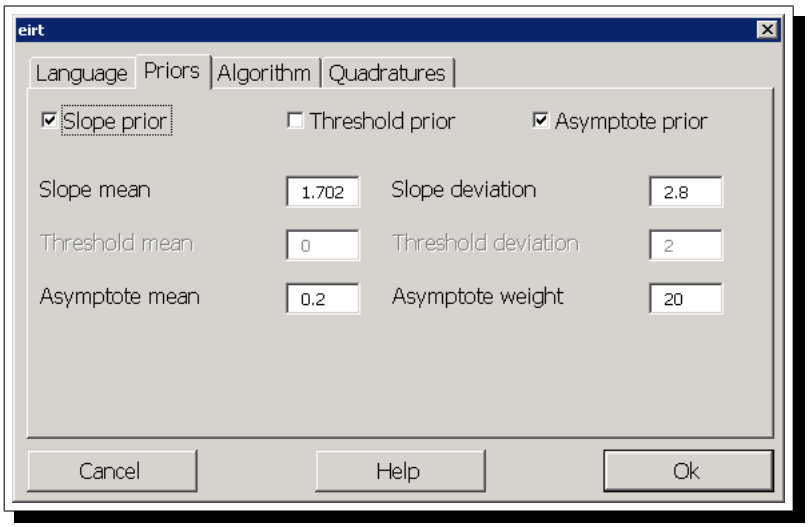

Figure 4.2: Priors settings.

4.2.1 The slope prior

Check this box to use a log-normal distribution on the slope parameter. This option is recommended to correct the Heywood cases. If this option is activated, you can also change the **slope mean** and **slope standard deviation**.

4.2.2 The threshold prior

Check this box to use a normal distribution on the threshold parameter. If this option is activated, you can also change the **threshold mean** and **threshold standard deviation**.

4.2.3 The asymptote prior

Check this box to use a beta distribution on the asymptote parameter. If this option is activated, you can also change the **asymptote mean** and **asymptote weight**.

4.3 The algorithm

Under this tab you can change some parameters of the **algorithms** used.

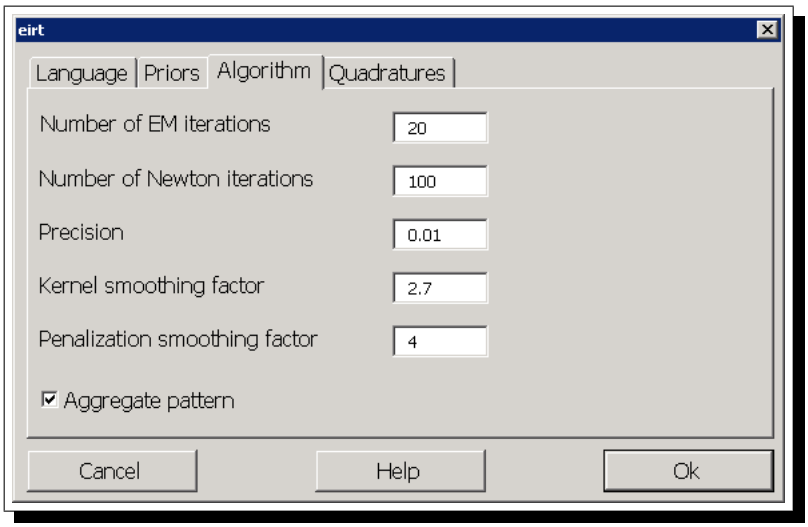

Figure 4.3: Algorithm settings.

4.3.1 The number of EM iteration

This option controls the **number of iteration** done by the EM (Expectation-Maximisation) algorithm of the maximum marginal likelihood estimators.

4.3.2 The number of Newton iteration

This option controls the maximal **number of iteration** done by the Newton algorithm (root finding) of the the maximum marginal likelihood estimators.

4.3.3 The precision

This option controls the **precision** seeked by the Newton algorithm (root finding) of the the maximum marginal likelihood estimators.

4.3.4 The kernel smoothing factor

This option controls the **bandwidth** used by the kernel estimator. This factor is multiplied to the number of subject to the -1/5 power. A greater bandwith give smoother and less steep curves.

4.3.5 The penalization smoothing factor

This option controls the quantity of **penalization** used by the penalized maximum marginal likelihood estimator. This factor is multiplied to the number of subject to the 1/5 power. More penalization give curves more like the logistic model.

4.3.6 The data aggregation

If this box is checked, the data are **aggregated** before the estimation. The estimation time is reduced and this dosen't changes the results. This option is recommended if the number of subject is greater than the number of item.

4.4 The quadratures

Under this tab you can change the **quadratures** used.

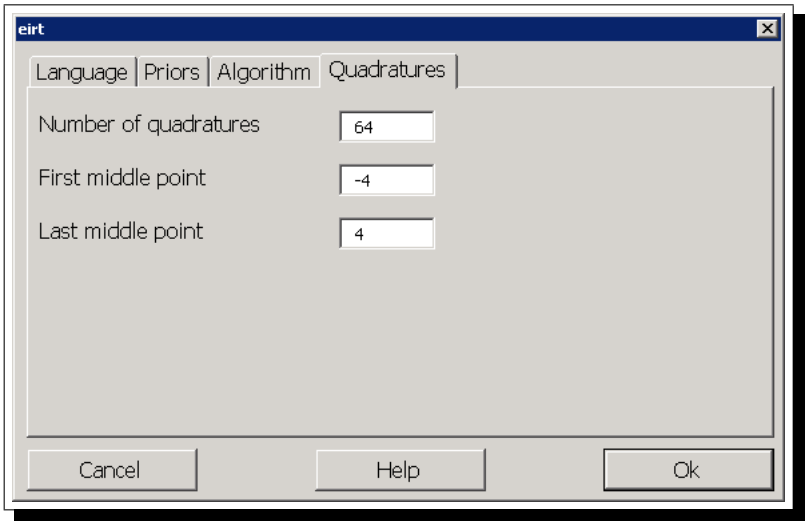

Figure 4.4: Quadratures settings.

4.4.1 The number of quadrature

This option controls the **number of quadrature** used to integrate the latent variable (the ability). This number has to be a power of 2 (16, 32, 64, 128, ...).

4.4.2 The first middle point

This option controls the **first middle point** of the quadratures.

4.4.3 The last middle point

This option controls the **last middle point** of the quadratures.

Chapter 5

Copyright

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