

Random regression model

Model description

This example is given by Schaeffer & Dekkers: Random regressions in animal models for test-day production in dairy cattle (Proc. 5th WCGALP, 18:443-446, 1994).

The single trait random regression animal model has the form:

$$\mathbf{y} = f_1(\mathbf{p}, \mathbf{DIM}) + \mathbf{X}\mathbf{b} + f_2(\mathbf{a}, \mathbf{DIM}) + \mathbf{e},$$

where,

\mathbf{y} is vector of milk yield observations,

$f_1(\mathbf{p}, \mathbf{DIM})$ is fixed general regression function,

\mathbf{b} is vector of fixed herd times test-day interaction effects,

\mathbf{X} is design matrix to link observations to appropriate fixed effects,

$f_2(\mathbf{a}, \mathbf{DIM})$ is random additive genetic regression function, and

\mathbf{e} is random residual vector.

The fixed regression function has form

$$f_1(\mathbf{p}, DIM) = DIM \cdot p_1 + \ln(305/DIM)p_2$$

and the random regression function f for animal i has form

$$f_2(\mathbf{a}_i, DIM) = a_{i,1} + DIM \cdot a_{i,2} + \ln(305/DIM) \cdot a_{i,3}.$$

It is assumed that $\text{var}(\mathbf{a}) = \mathbf{A} \otimes \mathbf{G}_0 = \mathbf{G}$, $\text{var}(\mathbf{e}) = \mathbf{I}\sigma_e^2 = \mathbf{R}$ and $\text{cov}(\mathbf{a}, \mathbf{e}) = \text{cov}(\mathbf{e}, \mathbf{a}) = \mathbf{0}$, where \mathbf{G}_0 is 3×3 -matrix of variance and covariance components for random animal effects and \mathbf{A} is the numerator relationship matrix.

The variance components are

$$\mathbf{G}_0 = \begin{bmatrix} 44.791 & -0.133 & 0.351 \\ -0.133 & 0.073 & -0.010 \\ 0.351 & -0.010 & 1.068 \end{bmatrix}$$

and $\sigma_e^2 = 100$.

Input files

Datafile:

The data file contains information on the data to be analyzed together with class and regression variables for the model. The data file can be in free format (columns are separated by at least one space) or in binary format.

Each record, i.e., line in a free format file, has been divided to two parts: 1) Integer number columns and 2) real number columns. Columns of real numbers are always after the integer number columns.

RRM.dat

1	1	1	73.0	1.4298500	26.0
2	1	1	123.0	0.9081270	23.0
3	1	1	178.0	0.5385280	21.0
1	2	1	34.0	2.1939499	29.0
2	2	1	84.0	1.2894900	18.0
3	2	1	139.0	0.7858380	8.0
4	2	1	184.0	0.5053760	1.0
1	3	2	8.0	3.6408701	37.0
2	3	2	58.0	1.6598700	25.0
3	3	2	113.0	0.9929240	19.0
4	3	2	158.0	0.6577170	15.0
5	3	2	218.0	0.3358170	11.0
2	4	3	5.0	4.1108699	44.0
3	4	3	60.0	1.6259700	29.0
4	4	3	105.0	1.0663500	22.0
5	4	3	165.0	0.6143660	14.0
6	4	3	215.0	0.3496740	8.0
4	5	3	14.0	3.0812500	35.0
5	5	3	74.0	1.4162500	23.0
6	5	3	124.0	0.9000300	17.0
5	6	4	31.0	2.2863200	28.0
6	6	4	81.0	1.3258600	22.0
6	3	4	268.0	0.1293250	7.0

Column 1: Herd x Test-day (integer)

Column 2: Animal ID (integer)

Column 3: Block code (integer)

Column 4: Covariable for regression effect, days in milk (real)

Column 5: Covariable for regression effect, $\ln(305/\text{days in milk})$ (real)

Column 6: Milk yield (real)

Pedigree file:

All the pedigree information must be given in the pedigree file. Each animal in the pedigree must have a record with four integers of which the fourth integer is optional.

RRM.ped

1	9	7	1
2	10	8	1
3	9	2	2
4	10	8	3
5	11	7	3
6	11	1	4
7	0	0	8
8	0	0	8
9	0	0	8
10	0	0	8
11	0	0	8

Column 1: Animal ID

Column 2: Sire ID

Column 3: Dam ID

Column 4: Block code

Variance component file:

The variance components file has variances and covariances for all the random effects in the model. The variance component file has a line for each (co)variance. Order of lines in the file is irrelevant.

RRM.var

1	1	1	44.791
1	2	1	-0.133
1	3	1	0.351
1	2	2	0.073
1	2	3	-0.010
1	3	3	1.068
2	1	1	100.000

Column 1: Random effect number (integer)

Column 2: Row index (integer)

Column 3: Column index (integer)

Column 4: (Co)variance value (real)

Command file:

CLIM instructions for a random regression model analysis. Everything beyond '#' sign is considered as a comment.

RRM.clm

```
TITLE " RANDOM REGRESSION, L.Schaeffer & J.Dekkers (1994) "
DATAFILE RRM.dat
INTEGER HTD animal blk-var # Integer column names
REAL DIM ln305DIM & # Covariables
      milk_yd # Milk yield

PEDFILE RRM.ped # Pedigree file
PEDIGREE G am # Genetics associated with animal code: am=animal model

PARFILE RRM.var # Variance component file

PRECON b f # Preconditioner: b=block diagonal, f=full block

DATASORT BLOCK=blk-var PEDIGREECODE=animal

MODEL
      milk_yd = DIM ln305DIM HTD G(1 DIM ln305DIM| animal)
```

Solution files

Structure of the formatted solution files depends on the model. Therefore, explanation of the content of those files is given in the printout of the particular run of the program.

MiX99-solver program has been run by command `mix99s -s`, meaning that in all parts of the program default values are used.

"Solreg"-file contains solutions for general regressions.

Trt	Reg-No	Solution	Trait	Covariable
1	1	-.49839E-01	MILK_YD	DIM
1	2	5.2910	MILK_YD	LN305DIM

Column 1: Trait number

Column 2: Regression number within trait

Column 3: Solution

Column 4: Name of trait

Column 5: Name of covariable

"Solfix"-file contains solutions for fixed effects.

Fact.	Trt	Level	N-Obs	Solution	Factor	Trait
1	1	1	3	19.950	HTD	MILK_YD
1	1	2	4	20.374	HTD	MILK_YD
1	1	3	4	20.610	HTD	MILK_YD
1	1	4	4	19.728	HTD	MILK_YD
1	1	5	4	18.605	HTD	MILK_YD
1	1	6	4	17.852	HTD	MILK_YD

Column 1: Factor number

Column 2: Trait number

Column 3: Level code

Column 4: Number of observations

Column 5: Solution

Column 6: Name of factor

Column 7: Name of trait

"Solani"-file contains solutions for genetic animal effect.

1	1	3	-0.44275	0.36870E-01	-0.36889E-01
2	1	4	0.26984	-0.66036E-01	0.32232E-01
3	0	6	-0.72869	0.68316E-02	-0.47905E-01
4	0	5	1.1019	-0.53655E-02	0.76730E-01
5	0	3	-0.16256	0.69338E-02	-0.14854E-01
6	0	2	-0.48274	0.16646E-01	-0.37701E-01
7	2	0	-0.98701E-01	0.13336E-01	-0.10279E-01
8	2	0	0.45726	-0.23801E-01	0.36320E-01
9	2	0	-0.62851	0.35026E-01	-0.47890E-01
10	2	0	0.45726	-0.23801E-01	0.36320E-01
11	2	0	-0.18727	-0.76207E-03	-0.14493E-01

Column 1: Animal ID

Column 2: Number of descendants

Column 3: Number of observations

Column 4: Solution for trait 1 milk_yd and factor animal

Column 5: Solution for trait 1 milk_yd and factor DIM(animal)

Column 6: Solution for trait 1 milk_yd and factor ln305DIM(animal)