Introduction to Multilevel Modeling using MLwin version 2.02:

Fitting a two-level model¹

1. Introduction

The data set you will use has been selected from a much larger data set produced by the Junior School Project (JSP) (Mortimer et al, 1989). This was a longitudinal study of an age cohort of 2000 pupils (level 1) who entered junior school age 7 and left in 1984 aged 11. The JSP pupils attended 48 primary schools (level 2) selected randomly from the 636 primary schools maintained by the Inner London Education Authority.

In this data modelling task the pupil outcome measure (called the 'response' variable) is a score for mathematics at age 9 (MATHS5; that is year 5 of the National Curriculum) and the single predictor (explanatory) variable is the mathematics score at age 7 (MATHS3; that is year 3 of the National Curriculum). We are interested in discovering – via data modelling - the size, nature and extent of the school effect on progress in mathematics.

We will consider the following models:

- Model 1. A random intercepts 'null' model with Maths5 as the response. No predictor/explanatory variables apart from the Constant (ie representing the intercept) which is allowed to vary randomly across schools and with the levels defined as pupils (level 1) in schools (level 2);
- Model 2. A random intercepts model. Model 1 with also the pre-test score as an explanatory variable (Maths3);
- Model 3. A random intercepts/slopes model. Model 2 with also the parameter associated with Maths3 being allowed to vary randomly across schools; that is random slopes as well as intercepts.

For any multilevel model there is a basic sequence of procedures which we will follow:

- data input: sorting, creating the constant term (normally called 'cons');
- model specification: response, predictors (explanatory variables), level, terms for the fixed and random part;
- estimation: the fitting of the specified model by a chosen procedure;
- examining the estimates and values such as standard errors
- estimating the residuals at each level for diagnosis of model problems and sometimes to make substantive interpretations;
- graphing the results both to look at estimate residuals and predictions from the estimated model
- model re-specification and the cycle begins over again.

2. Data input and manipulation

Here is a recommended sequence:

Data input File on Main Menu ASCII text file input

¹ Updated and adapted from task created by Kelvyn Jones, School of Geographical Sciences, University of Bristol.

Columns: c1-c5 File: jsp.dat OK

Name columns

Data manipulation on main menu

Names

C1	School	Enter
C2	Pupil	Enter
C3	Math3	Enter
C4	Math5	Enter
C5	Male	Enter

Naming categories

Highlight 'male' Categories

0: Female 1: Male

Save the worksheet

File on Main Meun Save worksheet as: jsp.ws

Remember to write down the complete filename you have used.

Sorting the data: pupils within schools

Data manipulation on main menu

Sort

Increase number of keys to 2

Choose 'School' as the highest key [slowest changing] Choose 'Pupil' as the lowest key [fastest changing] Highlight 'School' to 'male' Same as input Add to Action List Execute

Close Sort Window

Check data and save sorted worksheet

Data Manipulation on Main Menu

View or Edit data

Select View and Highlight 'School' to 'male' to select columns to view OK

Resize window to see all 5 columns

goto li	ne 1	view <u>H</u> elp F	ont		
	school(953)	pupil(953)	math3(953)	math5(953)	male(953)
1	1	1	23	23	female 🗖
2	1	3	22	39	male
3	1	4	14	32	male
4	1	6	16	11	female
5	1	7	17	26	male
6	1	8	21	28	female
7	1	11	32	32	female
8	1	13	25	27	female
9	1	14	29	36	female
10	1	15	34	33	female 👻

Some questions: 1

Has pupil 1 in school 1 made progress; what about pupil 4, and 15?

If it looks correct -

File on Main Menu

Save (as jsp.ws) Yes to overwrite

There is a final variable we have to create before we can begin modelling the data – the 'constant' variable. The 'constant' variable takes the value of 1 for every pupil (ie is a vector of 1's) and is used to estimate the intercept term in the regression equation. There are many ways of doing this but you must ensure that there is 1 for each and every pupil. The simplest way to achieve this is:

Data manipulation on the Main Menu

Generate Vector Constant Vector Output column: c6 Number of copies: 953 Value: 1 Generate Close window

The Generate vector just before Generate is clicked should look like:

-Tyj	pe of vector- Constant ve	ctor C Sequence	e C Repeated Sequence
Outp Num Valu	ut column ber of copies e	C6 953 1	
	<u>H</u> elp	<u>G</u> enerate	Random numbers

6	cons		<u>R</u> efresh	<u>C</u> ategories	<u>H</u> elp	
	Name	n	missing	min	тах	
1	school	953	0	1	50	
2	pupil	953	0	1	1399	
3	math3	953	0	4	36	
4	math5	953	0	5	40	
5	male	953	0	0	1	
6	cons	953	0	1	1	
7	C7	0	0	0	0	•

Name c6 as 'cons'. The revised top of the worksheet should look like:

After saving the revised data you are ready for modelling. Close the Names and the View data windows, you will not need them for the time being.

3. Model 1: two-level 'null' random intercepts

Specifying the model

The most straightforward way to specify the model is through the equations window which you will find under model on the main screen. Clicking on equations (main menu – model) will bring up the following rather uninspiring screen which is the heart of the programme. Here models are specified and estimates displayed. It is also possible to specify models in the command window and to see the equations displayed here.

🗿 Equal	tions							
$y \sim N$	(XB, <u>c</u>	<u>)</u>						
$y = \beta$	0 ^X 0							
<u>N</u> ame	<u>F</u> onts	+	-	Add <u>T</u> erm	<u>E</u> stimates	Nonlinear	Clear	Notation

Ignoring the bottom tool bar for a moment; the equations are as follows:

у	is the response;
N	indicates a normal distribution for a fixed part XB and a random part Ω ;
β_0	is the first fixed part estimate to be specified and x_0 is the first predictor variable to be specified.
red	is significant as it indicates that the variable and the parameter associated with it has not yet been specified.

To specify the response, click on either of the y's and complete the pop up menu as follows:

у	math5	[replaces none]
N levels:	2	[that is 2 levels school (j) and pupil (i); replaces none]
Level 2(j):	School	[j is higher level unit]

Level 1 (i)	Pupil	[i is lower level unit]
Done		

To specify the predictor to be a constant in the random intercepts 'null' model; click on either β_0 or x_0 ; complete the pop-up menu as follows:

Х	cons	[replaces none]
Tick	fixed part	[includes β_0]
Tick	j School	[allows β_0 parameter to vary at level 2]
Tick	i Pupil	[allows β_0 parameter to vary at level 1]

This completes the specification and the revised screen shows the variables and parameters have changed from red to black indicating that specification is complete.

🖥 Equations					
$math5_{ij} \sim N(XB, \Omega)$					
$math5_{ij} = \beta_{0ij} cons$					
Name Fonts + - Add Term Estimates Nonlinear Clear	Notation				

Pressing the + button on the bottom toolbar increases the detail; pressing + again will bring more detail. You should now see the full algebraic specification of the model. Pressing – reduces the detail, clicking Fonts allow the fonts to be changed in terms of size and type.

Equations	- U ×
$math5_{ij} \sim N(XB, \Omega)$	-
$math5_{ij} = \beta_{0ij} cons$	
$\beta_{0ij} = \beta_0 + u_{0j} + e_{0ij}$	
$\begin{bmatrix} u_{0j} \end{bmatrix} \sim \mathbf{N}(0, \ \Omega_u) : \ \Omega_u = \begin{bmatrix} 2 \\ \sigma_{u0} \end{bmatrix}$	
$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim \mathbf{N}(0, \ \Omega_e) \ : \ \Omega_e = \begin{bmatrix} \sigma_{e0}^2 \end{bmatrix}$	_ _
Name Fonts + - Add Term Estimates Nonlinear Clear	Notation

To produce a model that is easier to interpret click on the Name button and then the Notation button (tick subscripts as names) to get the following display

🖥 Equations						
$\mathrm{math5}_{pupil,\ school} \sim \mathrm{N}(XB,\ \Omega)$						
math5 $_{pupil, \ school} = eta_{0pupil, \ school} \mathbf{cons}$						
$eta_{0 pupil, \ school} = eta_0 + u_{0 \ ochool} + e_{0 \ pupil, \ school}$						
$\begin{bmatrix} u_{0school} \end{bmatrix} \sim \mathbf{N}(0, \ \Omega_u) : \ \Omega_u = \begin{bmatrix} 2 \\ \sigma_{u0}^2 \end{bmatrix}$						
$\begin{bmatrix} e_{0pupil, school} \end{bmatrix} \sim N(0, \ \Omega_{e}) \ : \ \Omega_{e} = \begin{bmatrix} 2 \\ \sigma_{e0}^{2} \end{bmatrix}$	- -					
Name Fonts + - Add Term Estimates Nonlinear Clear	Notation					

Before proceeding to estimation it is a good idea to check the hierarchy with the following sequence:

Model on main Menu

Hierarchy viewer

🖥 Hierarchy viewer				
Summary	-		(9
level range tota				
school (school) 148 48		Option	ns <u>H</u> elp	
pupii (pupii,) 163 95.				
J				
Details				
L2 ID: 1, school = 1 of 48	L2 ID: 2, school = 2 of 48	L2ID: 3, school = 3 of 48	L2ID: 4, school = 4 of 48	L2 ID: 5, school = 5 of 48
N1 26	N1 11	N1 14	N1 24	
L2 ID: 6, school = 6 of 48	L2ID: 7, school = 7 of 48	L2 ID: 8, school = 8 of 48	L2 ID: 9, school = 9 of 48	L2 ID: 11, school = 10 of 48
N1 18	N1 11	N1 27	N1 21	N1 11
L2 ID: 12, school = 11 of 48	L2 ID: 13, school = 12 of 48	L2 ID: 14, school = 13 of 48	L2 ID: 15, school = 14 of 48	L2 ID: 16, school = 15 of 48
N1 23	N1 22	N1 13	N1 7	N1 16
L2 ID: 17, school = 16 of 48	L2ID: 18, school = 17 of 48	L2 ID: 19, school = 18 of 48	L2 ID: 20, school = 19 of 48	L2 ID: 21, school = 20 of 48
N1 6	N1 18	N1 14	N1 13	N1 28
L2 ID: 22, school = 21 of 48	L2 ID: 23, school = 22 of 48	L2 ID: 24, school = 23 of 48	L2 ID: 25, school = 24 of 48	L2 ID: 26, school = 25 of 48
N1 14	N1 18	N1 21	N1 14	N1 20
L2 ID: 27, school = 26 of 48	L2 ID: 28, school = 27 of 48	L2 ID: 29, school = 28 of 48	L2 ID: 30, school = 29 of 48	L2 ID: 31, school = 30 of 48
N1 22	N1 15	N1 13	N1 27	N1 35
L2 ID: 32, school = 31 of 48	L2 ID: 33, school = 32 of 48	L2 ID: 34, school = 33 of 48	L2 ID: 35, school = 34 of 48	L2 ID: 36, school = 35 of 48
N1 23	N1 44	N1 27	N1 16	N1 28
L2 ID: 37, school = 36 of 48	L2 ID: 38, school = 37 of 48	L2 ID: 39, school = 38 of 48	L2 ID: 40, school = 39 of 48	L2 ID: 41, school = 40 of 48
N1 17	N1 12	N1 14	N1 10	N1 10
L2 ID: 42, school = 41 of 48	L2ID: 44, school = 42 of 48	L2 ID: 45, school = 43 of 48	L2 ID: 46, school = 44 of 48	L2 ID: 47, school = 45 of 48
N1 41	N1 5	N1 11	N1 15	N1 33
L2 ID: 48, school = 46 of 48 N1 63	L2 ID: 49, school = 47 of 48 N1 22	L2 ID: 50, school = 48 of 48 N1 14		

It is possible to see the number of pupils in each and every (higher-level) school. Close the windows when you have examined the structure and it is the same as shown. Any problems are likely to be a result of incorrect sorting. Notice that there are 48 schools, number 10 and 43 are not in our sample.

Estimating the model

Before estimating begins, click on estimates in the lower tool bar twice (on equations window). The blue values are to be ignored, as they are not the converged values. To start estimation click the START button at the top of the screen – watch the screen at the bottom as the fixed and random parameters are estimated school by school and the gauge tanks are filled, and as the iteration counter increases.

As the parameters converge on a stable value, the coefficients in the Equations window will turn green. The letters IGLS next to STOP inform you that the default overestimation procedure is being used: iterative generalised least squares. When they are all green the overall model has converged. For model 1, the following estimates are derived:

膏 Equations - 🗆 × math $5_{pupil, school} \sim N(XB, \Omega)$ math $5_{pupil, school} = \beta_{0pupil, school} cons$ $\beta_{0pupil, school} = 30.501(0.387) + u_{0school} + e_{0pupil, school}$ $\begin{bmatrix} u_{0school} \end{bmatrix} \sim \mathbf{N}(0, \ \Omega_u) : \ \Omega_u = \begin{bmatrix} 4.861(1.455) \end{bmatrix}$ $\begin{bmatrix} e_{0pupil, school} \end{bmatrix} \sim N(0, \Omega_e) : \Omega_e = \begin{bmatrix} 39.420(1.852) \end{bmatrix}$ -2*loglikelihood(IGLS Deviance) = 6262.661(953 of 953 cases in use)• Name Fonts Add Term Estimates Nonlinear Clear Notation Responses Help

The terms in the Equations window represent parameter estimates with their estimated standard errors in brackets; the log-likelihood is a measure of badness of fit, 953 out of 953 cases in use means there are no missing values in our data.

Some questions: 2What does 30.501 represent?And 4.861; and is it significantly different from zero? And 39.42?Does it appear that student achievement varies between schools?What is overall mean?30.5What is overall mean?30.5What is total variation around this mean?4.86 + 39.42What proportion of the variance is at the school level (ie attributable to the school)?4.86/ (4.86 + 39.42) = 11%What are likely bounds of variation on schools (ie confidence interval)? Assuming normality?95% of schools lie $30.5 \pm 1.96 *$ sqrt (level 2 variance); that is between 34.8 and 26.2

Estimating Residuals and Graph of Residuals

The next stage is to examine the residuals. One useful procedure is to estimate the level-2 residuals, their ranks and produce a caterpillar plot to see which are significantly different from the overall model. The sequence is:

Model on Main Menu

Residuals

Change 1.0 to 1.96 SD (comparative) of residual [to get standard errors of residuals]Tick only 'Ranks of residuals to'[untick all other options]Change level to 2:schools[replace 1:pupil; to get school level residuals]Click set columns[to get output columns]Calculate[to estimate]

Don't close down the windows. The completed screen should look like:

🖥 Residuals	
Settings Plots	
Cutput Columns	
start output at	300 Set columns
residuals to	C300
1.96 SD(comparative) of residual to	C301
standardised(diagnostic) residuals to	C302
normal scores of residuals to	
normal scores of standardised residuals	
ranks of residuals to	C303
deletion residuals	
🔲 🔲 leverage values	
🔲 🗖 Influence values	
Calculate weighted residuals	٢
level: 2:school 💌 Calc	Help

The columns where requested values are to be stored are shown. To view the values you can either use the view data window, or use the command interface to print them out. We chose the latter; the sequence is;

Data Manipulation on Main Menu Command interface Type the command in lower left hand box Print c300 c303 [Level 2 residual and rank] Press enter

	C300	C303
N =	48	48
1	-3.7826	2.0000
2	-0.49765	20.000
3	1.5372	40.000
4	-1.7136	9.0000
5	0.87883	32.000
6	0.037677	24.000
7	1.2816	37.000
8	-0.10038	22.000
9	0.77229	31.000
10	-0.65464	18.000
11	-0.88464	15.000
12	-0.83096	17.000
13	-1.3033	10.000
14	2.4153	45.000
15	-1.8671	8.0000
16	0.92097	33.000
17	-0.57512	19.000
18	1.2206	35.000
19	0.49685	29.000
20	-2.5208	5.0000
21	-1.2670	11.000
22	-0.99642	13.000
23	2.6617	46.000
24	1.2658	36.000
25	0.67528	30.000
26	-0.067084	23.000
27	-3.8734	1.0000
28	-2.0139	6.0000
29	0.38381	28.000
30	4.0935	48.000
31	-0.85249	16.000
32	-1.0178	12.000
33	2.2921	44.000
34	0.082354	25.000
35	3.6548	47.000
36	0.97511	34.000
37	1.3421	38.000
38	-0.40763	21.000
39	-3.3689	4.0000
40	1.8217	42.000
41	-1.9047	7.0000
42	0.34291	26.000
43	-3.4804	3.0000
44	1.7519	41.000
45	2.2007	43.000
46	-0.93598	14.000
47	0.36467	27.000
48	⊥.4468	39.000

Some questions: 3

What is the highest achieving school; what does a pupil on average achieve there? What is the lowest achieving school; what does a pupil on average achieve there?

The extremes 'add' and 'take-away' 4.1 and -3.9; corresponding to likely 95% confidence interval

Close the command interface and the output window, before proceeding

Return to the residuals window and select:

Plot tab

Click residuals +/- 1.96 SD x rank [on single plots section at top of screen] Apply

Note that D10 is the default graph display for this plot.



This gives a caterpillar plot, which plots each residual with its 95% confidence band against rank.



Some questions: 3 What are the high and low achieving schools? Click on the graph and use the Identify Points tab

What determines confidence band? Hint: click on one with wide band and look at hierarchy

Before proceeding close the Residuals and Graph Display.

Making predications and drawing varying relation plots

The next task is to make predictions of Math5 score in each school and then to plot them on a customised graph.

Model on Main Menu Predictions

The top screen needs to be completed by choosing items from the middle screen; the bottom buttons control the form of the results and where they are going to be put.

predictions			
y nupil. school	$_{l} = \hat{\beta}_{0school} \mathbf{co}_{l}$	ns	
1 7 7	• • • • • • • • • • • • • • • • • • • •		
variable	cons		
fixed	$\boldsymbol{\beta}_0$		
level 2	U _{Oschool}		
level 1	е _{Орирії, school}		
· · · · · · · · · · · · · · · · · · ·			<u>ا ا</u>
<u>Fonts</u> <u>N</u> ame	e <u>C</u> alc <u>H</u> elp	output from prediction to	c7 🔻
1.0 S.E.of		▼ output to	-

Here is the completed screen to derive the predicted mean Math5 for each school; the level-1 residuals remain greyed out and the results are stored in column 7, which is currently unused. Clicking on an item toggles it in and out of the equation. Calculate needs to be pressed to make the calculations. Nothing appears to happen but if you View the data you will see that a set of predications has been made and put in column 7.

Next bring up the Customised graphics window (Graph on main menu). Currently the D10 graphic display is in operation as this set was used to produce the caterpillar residual plot. Change this to D1.

Choose	y is c7	[math5 predictions on y axis]
	x is math3	[plot against math3 on x axis; but remember math3 not yet in
		model]
	Group is school	[to get a line of predictions for each school]
	Plot type is line and Apply	d point

Here is the customised setting screen as it should be before pressing Apply:

💦 Cus	Customised graph : display 1, data set 1					
D1	D1 🔽 Apply Labels Del data set Help 🔽 autosort on x					
ds #	Y	x		-Details for for data set number (ds#) 1		
1	c7	math3		plot what? plot style position error bars other		
2						
3				У c7 💌 X math3 💌		
4				Siter group		
5				niter <u>[none]</u> group school v		
6				plot type line interview		
7						
8						
9						
10			-			
	'	•				

To add titles to the resultant graph – right click on graph display. Here is the graph after titles have been added:



That completes the first model, save the worksheet as model1.ws, which will include the model equations, graphs and estimates, after giving the name Yhat1 to column 7. Close all windows except the equations window.

4. Model 2: two-level random intercepts model (with a centred predictor: math3)

Specifying and estimating the model

We now want to see what happens when we take account of Math3, that is we are modelling *progress* not achievement. It may well be that schools are markedly different in their intake, and this may be the underlying reason for differing school achievement.

The first thing we have to do is to centre the predictor variable around a convenient value. Use the Basic Statistics window to find that the mean is 25 for Math3. Use the calculate window (or the command window) to create a new variable:

c8 = 'math3' - 25

and name c8 with the heading 'Math3-25'. Save the revised worksheet as model2.ws. Return to the equations window. To include the new variable in the fixed part of the model, click on Add Term on the bottom toolbar and specify the variable 'math3-25 by clicking on it from the list. Then click Done.



The initial estimate is zero and the model has to be estimated. By clicking on More in the top toolbar, estimation will progress from the current estimates; START restarts the estimation from the beginning. After some iterations the model will converge when all the estimates turn green.

 $\begin{array}{|c|c|c|c|c|} \hline \textbf{N} \textbf{Equations} & \textbf{I} \textbf{Clear N(XB, \Omega)} \\ \hline \textbf{math} \textbf{5}_{pupil, school} \sim \textbf{N}(XB, \Omega) \\ \hline \textbf{math} \textbf{5}_{pupil, school} = \beta_{0pupil, school} \textbf{cons} + 0.604(0.032) \textbf{math} \textbf{3} - 25_{pupil, school} \\ \beta_{0pupil, school} = 30.265(0.344) + u_{0school} + e_{0pupil, school} \\ \hline \textbf{[} u_{0school} \textbf{]} \sim \textbf{N}(0, \ \Omega_{u}) : \ \Omega_{u} = \textbf{[} 3.975(1.146) \textbf{]} \\ \hline \textbf{[} e_{0pupil, school} \textbf{]} \sim \textbf{N}(0, \ \Omega_{e}) : \ \Omega_{e} = \textbf{[} 28.349(1.332) \textbf{]} \\ -2*loglikelihood(IGLS Deviance) = 5952.730(953 \text{ of } 953 \text{ cases in use}) \end{array}$

Some questions: 4 What do the estimates represent? 30 265 (remember Math3 is centred at 25) 0.604 the general rate of progress across all schools 3.975 is there still variation between schools after taking account of math3? 28.349 has pupil level variance changed? Partitioning the variance A: Original Variance from null model: 4.861 + 39.24 = 44.28B: Total residual variance from model 2: 3.975 + 28.349 = 32.224Proportion of original variance accounted for by 'Math3' = (B-A)/A=(32.224 - 44.28)/44.28= 27% total variance in pupil outcome accounted for Proportion of remaining variance still unaccounted for at school level =3.975/(3.975+28.349)= 12 % (ie 12% of remaining variance is attributable to schools) What are likely bounds of variation on schools (ie confidence interval)? Assuming normality 95% of schools lie 30.3 ± 1.96 * sqrt (level 2 variance); that is between 34.2 and 26.4 That is typical child starts with 25 score on math3: then progress is typically to 30.3 math5 score but in top 2.5% of schools the average progress is to 34.2 math5 score and in bottom 2.5% of schools the average progress is to 26.4 math5 score.

Notice that with 1 extra explanatory variable the loglikelihood/deviance has decreased from to 6263 to 5952 with a single parameter.

Residuals and graph of residuals

Model on Main Menu

Residuals

Start output at c310 Change 1.0 to 1.96 standard errors Tick all types of residuals Level 2: schools Click Set columns Click Calculate [not to overwrite existing columns/residuals] [to get 95% confidence intervals]

[replace 1:pupil; to get school level residuals] [to get all output columns] [to estimate]

🗿 Residuals	_ 🗆 🗵
Settings Plots	
Output Columns start output at	310 Set columns
residuals to	C310
1.96 SD(comparative) of residual to	C311
standardised(diagnostic) residuals to	C312
rormal scores of residuals to	C313
normal scores of standardised residuals	C314
ranks of residuals to	C315
deletion residuals	C316
leverage values	C317
✓ Influence values	C318
Calculate weighted residuals	۳
level: 2:school 💌 Calc	Help

Data manipulation on Main Menu Command interface Print c300 c303 c310 c315

This gives the following data in the out put window Model 1: c300: school residuals c303: rank Model 2: c310: school residuals c315: rank

N = 48 48 48 48 48 1 -3.7826 2.0000 -2.6157 5.0000 2 -0.49765 20.000 -0.21464 23.000 3 1.5372 40.000 0.87949 36.000 4 -1.7136 9.0000 -2.0311 7.0000 5 0.87883 32.000 -0.22142 22.000 6 0.037677 24.000 -0.12780 25.000 7 1.2816 37.000 1.5606 40.000 8 -0.10038 22.000 0.26056 27.000 9 0.77229 31.000 -1.8780 8.0000 12 -0.83096 17.000 -0.14164 24.000 13 -1.3033 10.000 -0.76421 13.000 14 2.4153 45.000 0.45405 31.000 15 -1.8671 8.0000 -0.28410 20.000 16 0.92097 33.000 0.45405 31.000		C300	C303	C310	C315
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	N =	48	48	48	48
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1	-3.7826	2.0000	-2.6157	5.0000
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2	-0.49765	20.000	-0.21464	23.000
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	3	1.5372	40.000	0.87949	36.000
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	4	-1.7136	9.0000	-2.0311	7.0000
60.03767724.000 -0.12780 25.00071.281637.0001.560640.0008 -0.10038 22.0000.2605627.00090.7722931.000 -1.8780 8.000010 -0.65464 18.000 0.75171 34.00011 -0.88464 15.000 -0.77298 12.00012 -0.83096 17.000 -0.14164 24.00013 -1.3033 10.000 -0.76421 13.000142.415345.000 0.69202 33.000142.415345.000 -0.25611 17.00016 0.92097 33.000 -0.45410 20.00017 -0.57512 19.000 -0.28410 20.000181.220635.000 1.0052 38.00019 0.49685 29.000 -0.43571 19.00020 -2.5208 5.0000 -3.0554 2.000021 -1.2670 11.000 -1.5689 9.000022 -0.99642 13.000 -0.57769 16.00023 2.6617 46.000 2.9306 44.000 241.265836.000 1.3776 39.00025 0.67528 30.000 -3.3681 1.0000 26 -0.067084 23.000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 -2.875	.5	0.87883	32.000	-0.22142	22.000
0 0 1.2816 $37,000$ 1.5206 $40,000$ 8 -0.10038 22.000 0.26056 27.000 9 0.77229 31.000 -1.8780 8.0000 10 -0.65464 18.000 0.75171 34.000 11 -0.88464 15.000 -0.77298 12.000 12 -0.83096 17.000 -0.14164 24.000 13 -1.3033 10.000 -0.76421 13.000 14 2.4153 45.000 0.69202 33.000 15 -1.8671 8.0000 -0.55611 17.000 16 0.92097 33.000 -0.43405 31.000 17 -0.57512 19.000 -0.43571 19.000 20 -2.5208 5.0000 -0.43571 19.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 31 -0.85249 16.000 0.42203 30.000 31 -0.85249 16.000 -2.8753 3.0000 <	6	0 037677	24 000	-0 12780	25 000
1.2010 $3.1.000$ 1.2000 1.0000 4.0000 9 0.77229 31.000 -1.8780 8.0000 10 -0.65464 18.000 0.75171 34.000 11 -0.88464 15.000 -0.77298 12.000 12 -0.83096 17.000 -0.14164 24.000 13 -1.3033 10.000 -0.76421 13.000 14 2.4153 45.000 0.69202 33.000 15 -1.8671 8.0000 -0.55611 17.000 16 0.92097 33.000 -0.55611 17.000 16 0.92097 33.000 -0.28410 20.000 17 -0.57512 19.000 -0.28410 20.000 17 -0.57512 19.000 -0.43571 19.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 30.000 0.98509 37.000 26 -0.67784 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 29 0.38381 28.000 1.3776 39.000 30 -0.85249 16.000 -0.63784 14.000 34 0.082354 25.000 -0.63784 14.000 <	7	1 2816	37 000	1 5606	40 000
0 0.77229 31.000 -1.8780 8.0000 10 -0.65464 18.000 0.75171 34.000 11 -0.83096 17.000 -0.77298 12.000 12 -0.83096 17.000 -0.77298 12.000 13 -1.3033 10.000 -0.76421 13.000 14 2.4153 45.000 0.69202 33.000 14 2.4153 45.000 -0.55611 17.000 16 0.92097 33.000 -0.48410 20.000 17 -0.57512 19.000 -0.28410 20.000 18 1.2206 35.000 -0.43571 19.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 24 1.2584 45.000 3.0525 47.000 31 -0.85249 16.000 -0.63784 45.000 32 -1.0178 12.000 -1.3651 10.000 32 -2.0139 6.0000 -1.3267 11.000	, 8	-0 10038	22 000	0.26056	27 000
3 + 0.7229 31.000 -1.07570 34.000 $10 - 0.65464$ 18.000 -0.77298 12.000 $11 - 0.88464$ 15.000 -0.77298 12.000 $12 - 0.83096$ 17.000 -0.14164 24.000 $13 - 1.3033$ 10.000 -0.76421 13.000 $14 2.4153$ 45.000 0.69202 33.000 $15 - 1.8671$ 8.0000 -0.55611 17.000 $16 0.92097$ 33.000 0.45405 31.000 $17 - 0.57512$ 19.000 -0.28410 20.000 $18 1.2206$ 35.000 1.0052 38.000 $19 0.49685$ 29.000 -3.0554 2.0000 $20 - 2.5208$ 5.0000 -3.0554 2.0000 $21 - 1.2670$ 11.000 -1.5689 9.0000 $22 - 0.99642$ 13.000 -0.57769 16.000 $23 2.6617$ 46.000 2.9306 44.000 $24 1.2658$ 36.000 1.7952 42.000 $25 0.67528$ 30.000 0.33708 28.000 $27 - 3.8734$ 1.0000 -2.8753 3.0000 $29 - 3.8381$ 28.000 1.3776 39.000 $30 - 4.0935$ 48.000 3.0525 47.000 $31 - 0.85249$ 16.000 -0.63784 14.000 $32 - 2921$ 44.000 3.0222 46.000 $34 - 0.04763$ 21.000 -1.3267 11.000 $31 - 0.85249$ 16.000 -2.8756 45.000 $31 - 0.85249$ 16.000	G	0.10030	31 000	-1 8780	2 / . 000
10 -0.88464 15.000 -0.77128 12.00012 -0.83096 17.000 -0.77428 12.000 13 -1.3033 10.000 -0.76421 13.000 14 2.4153 45.000 0.69202 33.000 15 -1.8671 8.0000 -0.55611 17.000 16 0.92097 33.000 0.45405 31.000 17 -0.57512 19.000 -0.28410 20.000 18 1.2206 35.000 1.0052 38.000 19 0.49685 29.000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.33708 28.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0222 46.000 31 -0.85249 16.000 -0.63784 14.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 38 -0.40763 21.000 $-1.$	10	-0 65/6/	18 000	0 75171	34 000
11 -0.83096 17.000 -0.74256 12.00012 -0.83096 17.000 -0.76421 13.00013 -1.3033 10.000 -0.76421 13.00014 2.4153 45.000 0.69202 33.000 15 -1.8671 8.0000 -0.55611 17.000 16 0.92097 33.000 0.45405 31.000 17 -0.57512 19.000 -0.28410 20.000 18 1.2206 35.000 1.0052 38.000 19 0.49685 29.000 -0.435711 19.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.33708 28.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 <	11	0 00464	15.000	0.77200	12 000
12 -0.83036 17.000 -0.76421 13.000 13 -1.3033 10.000 -0.76421 13.000 14 2.4153 45.000 0.69202 33.000 15 -1.8671 8.0000 -0.55611 17.000 16 0.92097 33.000 0.45405 31.000 17 -0.57512 19.000 -0.28410 20.000 18 1.2206 35.000 1.0052 38.000 19 0.49685 29.000 -0.435711 19.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 34 -0.9354 25.000 -1.3651 10.000 34 0.082354 25.000 -0.63784 44.000 32.2921 44.000 3.0222 46.000 34 0.082354 25.000 -2.5776 6.0000 34 0.082354 25.000 -2.5776 6.0000 38 -0.40763 21.000 -2.8256 4.0000 38 <td>10</td> <td>-0.00404</td> <td>17.000</td> <td>-0.77298</td> <td>12.000</td>	10	-0.00404	17.000	-0.77298	12.000
13 -1.3033 10.000 -0.70421 13.000 14 2.4153 45.000 0.69202 33.000 15 -1.8671 8.0000 -0.55611 17.000 16 0.92097 33.000 0.45405 31.000 17 -0.57512 19.000 -0.28410 20.000 18 1.2206 35.000 -3.0554 2.0000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 2.921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 41 -1.9047 7.0000 -0.45035 18.000 38 -0.40763 21.000 -0	12	-0.03090	10.000	-0.14104	24.000
142.413343.000 0.69202 33.00015 -1.8671 8.0000 -0.55611 17.000 16 0.92097 33.000 0.45405 31.000 17 -0.57512 19.000 -0.28410 20.000 18 1.2206 35.000 1.0052 38.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.38708 28.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 -1.3267 11.000 38 -0.40763 21.000 -1.3267 11.000 38 -0.40763 21.000 -0.2856	11	-1.3033 2.4152	10.000	-0.76421	13.000
15 -1.8071 8.0000 -0.53611 17.000 16 0.92097 33.000 0.45405 31.000 17 -0.57512 19.000 -0.28410 20.000 18 1.2206 35.000 1.0052 38.000 19 0.49685 29.000 -0.435711 19.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 -1.3267 11.000 39 -3.3689 4.0000 -2.8256 21.000 41 -1.9047 7.0000 $-$	14	2.4153	45.000	0.69202	33.000
16 0.92097 33.000 0.43405 31.000 17 -0.57512 19.000 -0.28410 20.000 18 1.2206 35.000 1.0052 38.000 19 0.49685 29.000 -0.43571 19.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.38708 28.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45	15	-1.86/1	8.0000	-0.55611	17.000
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	16	0.92097	33.000	0.45405	31.000
18 1.2206 35.000 1.0052 38.000 19 0.49685 29.000 -0.43571 19.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 -1.3267 11.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.8756 21.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -0.22	1/	-0.5/512	19.000	-0.28410	20.000
19 0.49685 29.000 -0.43571 19.000 20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -0.62486 21.000 43 -3.4804 3.0000 $-6.$	18	1.2206	35.000	1.0052	38.000
20 -2.5208 5.0000 -3.0554 2.0000 21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 -1.3651 10.000 32 -2.921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 41 -1.9047 7.0000 -0.45035 18.000 41 -1.9047 7.0000 -0.22856 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 -0.62480 15.000 44 <td>19</td> <td>0.49685</td> <td>29.000</td> <td>-0.43571</td> <td>19.000</td>	19	0.49685	29.000	-0.43571	19.000
21 -1.2670 11.000 -1.5689 9.0000 22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -2.5776 6.0000 41 -1.9047 7.0000 -0.45035 18.000 41 -1.9047 7.0000 -0.22856 21.000 42 0.34291 26.000 -0.22856 21.000 44 1.7519 41.000 -0.62480 15.000 44 <td>20</td> <td>-2.5208</td> <td>5.0000</td> <td>-3.0554</td> <td>2.0000</td>	20	-2.5208	5.0000	-3.0554	2.0000
22 -0.99642 13.000 -0.57769 16.000 23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 41 -1.9047 7.0000 -0.45035 18.000 41 -1.9047 7.0000 -0.22856 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 <td>21</td> <td>-1.2670</td> <td>11.000</td> <td>-1.5689</td> <td>9.0000</td>	21	-1.2670	11.000	-1.5689	9.0000
23 2.6617 46.000 2.9306 44.000 24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 34 0.082354 25.000 -0.63784 14.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 3.1995 48.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 <t< td=""><td>22</td><td>-0.99642</td><td>13.000</td><td>-0.57769</td><td>16.000</td></t<>	22	-0.99642	13.000	-0.57769	16.000
24 1.2658 36.000 1.7952 42.000 25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -0.22856 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 -0.62480 15.000 45 2.2007 43.000 1.6816 41.000 46 <td< td=""><td>23</td><td>2.6617</td><td>46.000</td><td>2.9306</td><td>44.000</td></td<>	23	2.6617	46.000	2.9306	44.000
25 0.67528 30.000 0.98509 37.000 26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -2.8256 4.0000 43 -3.4804 3.0000 -2.8256 4.0000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48	24	1.2658	36.000	1.7952	42.000
26 -0.067084 23.000 0.33708 28.000 27 -3.8734 1.0000 -2.8753 3.0000 28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -2.8256 4.0000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 <	25	0.67528	30.000	0.98509	37.000
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	26	-0.067084	23.000	0.33708	28.000
28 -2.0139 6.0000 -3.3681 1.0000 29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -0.22856 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 1.4468 39.000 0.67059 32.000	27	-3.8734	1.0000	-2.8753	3.0000
29 0.38381 28.000 1.3776 39.000 30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -0.22856 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 1.4468 39.000 0.67059 32.000	28	-2.0139	6.0000	-3.3681	1.0000
30 4.0935 48.000 3.0525 47.000 31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -2.8256 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 1.4468 39.000 0.67059 32.000	29	0.38381	28.000	1.3776	39.000
31 -0.85249 16.000 0.42203 30.000 32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 1.4468 39.000 0.67059 32.000	30	4.0935	48.000	3.0525	47.000
32 -1.0178 12.000 -1.3651 10.000 33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -2.8256 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 1.4468 39.000 0.67059 32.000	31	-0.85249	16.000	0.42203	30.000
33 2.2921 44.000 3.0222 46.000 34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -2.8256 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 1.4468 39.000 0.67059 32.000	32	-1.0178	12.000	-1.3651	10.000
34 0.082354 25.000 -0.63784 14.000 35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -2.8256 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 1.4468 39.000 0.67059 32.000	33	2.2921	44.000	3.0222	46.000
35 3.6548 47.000 2.9485 45.000 36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -0.22856 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 1.4468 39.000 0.67059 32.000	34	0.082354	25.000	-0.63784	14.000
36 0.97511 34.000 0.83096 35.000 37 1.3421 38.000 3.1995 48.000 38 -0.40763 21.000 -1.3267 11.000 39 -3.3689 4.0000 -2.5776 6.0000 40 1.8217 42.000 2.0989 43.000 41 -1.9047 7.0000 -0.45035 18.000 42 0.34291 26.000 -0.22856 21.000 43 -3.4804 3.0000 -2.8256 4.0000 44 1.7519 41.000 0.40773 29.000 45 2.2007 43.000 1.6816 41.000 46 -0.93598 14.000 -0.62480 15.000 47 0.36467 27.000 0.16175 26.000 48 1.4468 39.000 0.67059 32.000	35	3.6548	47.000	2.9485	45.000
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	36	0.97511	34.000	0.83096	35.000
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	37	1.3421	38.000	3.1995	48.000
39-3.36894.0000-2.57766.0000401.821742.0002.098943.00041-1.90477.0000-0.4503518.000420.3429126.000-0.2285621.00043-3.48043.0000-2.82564.0000441.751941.0000.4077329.000452.200743.0001.681641.00046-0.9359814.000-0.6248015.000470.3646727.0000.1617526.000481.446839.0000.6705932.000	38	-0.40763	21.000	-1.3267	11.000
401.821742.0002.098943.00041-1.90477.0000-0.4503518.000420.3429126.000-0.2285621.00043-3.48043.0000-2.82564.0000441.751941.0000.4077329.000452.200743.0001.681641.00046-0.9359814.000-0.6248015.000470.3646727.0000.1617526.000481.446839.0000.6705932.000	39	-3.3689	4.0000	-2.5776	6.0000
41-1.90477.0000-0.4503518.000420.3429126.000-0.2285621.00043-3.48043.0000-2.82564.0000441.751941.0000.4077329.000452.200743.0001.681641.00046-0.9359814.000-0.6248015.000470.3646727.0000.1617526.000481.446839.0000.6705932.000	40	1.8217	42.000	2.0989	43.000
420.3429126.000-0.2285621.00043-3.48043.0000-2.82564.0000441.751941.0000.4077329.000452.200743.0001.681641.00046-0.9359814.000-0.6248015.000470.3646727.0000.1617526.000481.446839.0000.6705932.000	41	-1.9047	7.0000	-0.45035	18.000
43-3.48043.0000-2.82564.0000441.751941.0000.4077329.000452.200743.0001.681641.00046-0.9359814.000-0.6248015.000470.3646727.0000.1617526.000481.446839.0000.6705932.000	42	0.34291	26.000	-0.22856	21.000
441.751941.0000.4077329.000452.200743.0001.681641.00046-0.9359814.000-0.6248015.000470.3646727.0000.1617526.000481.446839.0000.6705932.000	43	-3.4804	3.0000	-2.8256	4.0000
452.200743.0001.681641.00046-0.9359814.000-0.6248015.000470.3646727.0000.1617526.000481.446839.0000.6705932.000	44	1.7519	41.000	0.40773	29.000
46-0.9359814.000-0.6248015.000470.3646727.0000.1617526.000481.446839.0000.6705932.000	45	2.2007	43.000	1.6816	41.000
470.3646727.0000.1617526.000481.446839.0000.6705932.000	46	-0.93598	14.000	-0.62480	15.000
48 1.4468 39.000 0.67059 32.000	47	0.36467	27.000	0.16175	26.000
	48	1.4468	39.000	0.67059	32.000



Close the command interface and output windows and return to the Plots tab of the residuals window, choose the same plot as before to get the following caterpillar plot:



Some questions: 6

After taking account of pre-test, what can you say about the majority of schools? And hence league tables?

Making Predictions and drawing varying relations plots

Model on Main Menu Predictions

Complete the window as follows putting the revised school estimates to c9

apredictions			<u>- 0 ×</u>
y y pupil, school	$\hat{\beta}_{0school}$ cor	$ns + \hat{\beta}_1 math 3-25_{pup}$	ril. school
1 7 7 .,	•		
variable	cons	math3-25	pupil, school
fixed	$\boldsymbol{\beta}_0$	β_1	
level 2	U _{Oschool}		
level 1	e _{Opupil,} school		
•			Þ
Eonts Name	e <u>C</u> alc <u>H</u> elp	output from prediction to	c9 🔻
1.0 S.E.of		▼ output to	-

The residuals at level 1 **must** remain greyed out

[display graph set D1]
[sub-graph not to overwrite ds#1]
[type in c9 if not on list; revised math5 predictions on y-axis]
[plot against math3]
[to plot school lines]

Also on Plot' position' tab select position of graph ds#2

Mark X in col 2 and row 1	[original plot for model 1 in col 1 row 1]
Apply	

The Plot what screen should show that there are two sub-graphs in graph set display D1

히 Cus	🖡 Customised graph : display 1, data set 2				
D1	D1 Apply Labels Del data set Help autosort on x				
ds #	Y	X	Details for for data set number (ds#) 2		
1	yhat1	math3	plot what? plot style position error bar	s other	
2	c9	math3			
3			C9 💌 X math	3 🔽	
4			filter group		
5					
6			plot type ine+point		
7					
8					
9					
10					
		<u> </u>			



Model 3: a random-intercepts and random-slope model (fully random at level 2)

Specifying and estimating the model

Return to the equations window

Click on Math3-25 Tick school as well as fixed Click Done Click More [to get math3-25 variable pop-up menu] [to allow parameter to vary across schools] [to close window] [continue estimation, blue to green]



Some questions: 7

What do the estimates represent?

30.23 0.61 4.638 -0.348 0.035 27.206

What do you think the school lines will look like? Do you anticipate fanning in or out?

Residuals and graph of residuals

Model on Main Menu Residuals Start output at c320 [not to overwrite existing columns/residuals] Change 1.0 to 1.96 standard errors [to get 95% confidence bands] Tick all types of residuals Level 2: schools [replace 1:pupil; to get school level residuals] Click Set columns [to get all output columns] Click Calculate [to estimate] Return to residuals window Plot tab Click residuals +/- 1.96 SD x rank [on single plots pane] [to get two plots in D10] Apply

Two plots produced automatically



Some questions: 8		
What does top graph show?	Intercepts	
And bottom?	Slopes	

Notice that there are two columns for each and every residual and that residuals are in c320 - c321 and ranks in c330 - c33. To print out residuals:

Data manipulation Command interface Print c320 c330 c321 c331

	C320	C330	C321	C331
N =	48	48	48	48
1	-2.0744	8.0000	0.098642	35.000
2	0.15082	26.000	-0.038014	18.000
3	0.55224	33.000	-0.0068282	22.000
4	-2.4376	5.0000	0.20626	45.000
5	-0.23633	22.000	0.015039	26.000
6	0.33606	29.000	-0.067354	17.000
7	1.2918	37.000	-0.067740	16.000
8	0.067890	25.000	0.029201	27.000
9	-3.1320	3.0000	0.23388	46.000
10	0.47875	32.000	-0.010702	21.000
11	-1.0391	14.000	0.10915	37.000
12	0.31135	28.000	-0.083578	15.000
13	-0.75296	15.000	0.057591	32.000
14	1.2599	36.000	-0.10221	13.000
15	-0.65434	17.000	0.074478	33.000
16	-0.079283	24.000	0.033971	28.000
17	-0.20206	23.000	0.0082753	25.000
18	1.4933	39.000	-0.13783	10.000
19	-0.59096	18.000	0.047515	30.000
20	-3.0173	4.0000	0.17771	43.000
21	-1.7869	9.0000	0.13736	39.000
22	-1.2481	12.000	0.17126	42.000
23	3.1448	45.000	-0.24154	3.0000
24	2.4185	42.000	-0.23345	5.0000
25	1.2384	35.000	-0.11504	11.000
26	0.20623	27.000	0.0060090	24.000
27	-2.4239	7.0000	0.15366	40.000
28	-3.7080	1.0000	0.23911	47.000
29	1.3084	38.000	-0.093209	14.000
30	3.3874	47.000	-0.21041	7.0000
31	0.36306	30.000	-0.015948	20.000
32	-1.2331	13.000	0.051546	31.000
33	2.9468	44.000	-0.21368	6.0000
34	-1.4890	10.000	0.16521	41.000
35	3.4022	48.000	-0.24268	2.0000
36	1.1556	34.000	-0.10572	12.000
37	3.1609	46.000	-0.27432	1.0000
38	-1.3364	11.000	0.081526	34.000
39	-2.4344	6.0000	0.17968	44.000
40	2.5131	43.000	-0.20469	8.0000
41	-0.29547	21.000	-0.0029025	23.000
42	-0.49893	20.000	0.046242	29.000
43	-3.5870	2.0000	0.34222	48.000
44	0.45211	31.000	-0.028513	19.000
45	2.4009	41.000	-0.23636	4.0000
46	-0.74351	16.000	0.10310	36.000
47	-0.57301	19.000	0.12434	38.000
48	1.5333	40.000	-0.16021	9.0000

 Some questions: 9

 What does a pupil with a score of 25 achieve in school 8? 30.23 + 0.07In school 28? 30.23 - 3.71In school 35? 30.23 + 3.40

 What does a pupil with a score of 35 achieve in school 8? 30.23 + 0.07 + 10* (0.61 + 0.03)In school 28? 30.23 - 3.71 + 10* (0.61 + 0.24)In school 35? 30.23 + 3.40 + 10* (0.61 - 0.24)
 Close output and command interface. Save revised worksheet as model3.ws.

To get a covariance plot

Return to residuals window

Plots tab

Tick Residuals on pairwise pane Click Apply Click in graph Graph title model 3: covariance plot

[to get covariance plot]



Strong tendency for schools that are good for the average pupil (right in horizontal axis) to make comparatively less progress for higher ability pupils (bottom on vertical axis), estimated correlation is -0.87 (via Main menu Model -> Estimates table). But picture most clearly summarised by varying relation plots (see below).

🖥 Estimates		_1	٥×
+ - Level 2: s	chool 🔻 ±		elp
0	cons	math3-25	
cons	$\sigma_{u 0}^2$		
	4.638		
	(1.288)		
	4 .63 4		
	Corr: 1.000		
math3-25	σ _{u10}	σ ² _{u 1}	
	- 0.348	0.035	
	(0.118)	(0.017)	
	- 0.3 48	0.035	
	Corr: - 0.865	Corr: 1.000	

Predictions and varying relations plots

Model on Main Menu

Predictions

Click on Cons[to get all terms associated with Constant included]Click on Math3-25[to get all terms associated with Math3-5 included]Click on level-1 residuals associated with Cons to excludeOutput to c10[free column]Click Calculate[to estimate]

Name c10 as 'Yhat3' and save the revised worksheet.

apredictions		
y nunil school	$_{l} = \hat{\beta}_{0school} \mathbf{cor}$	$ns + \hat{\beta}_{1school}$ math 3-25 minit school
pupit, concor	,	, inter pape, one
variable	cons	math3-25 _{pupil, school}
fixed	$\boldsymbol{\beta}_0$	$\boldsymbol{\beta}_1$
level 2	U _{Oschool}	U _{1school}
level 1	e _{Opupil,} school	
•		Þ
<u>F</u> onts <u>N</u> ame	e <u>C</u> alc <u>H</u> elp	output from prediction to c10 💌
1.0 S.E.of		▼ output to ▼

To get two different kinds of varying relation graphs for model 3 follow instructions below.

Plot 3:

Graphics on Main Menu	
Customised graphs	
Switch to D1	[display graph set D1]
Click on right side to ds#3	[sub-graph not to overwrite ds#1 & ds#2]
y is Yhat3	
x is math3	[plot against math3 on x axis]
Group is school	[to plot predicted school lines]
Plot type is line+point	

Also on Plot' position' tab select position of graph ds#3

Mark X in col 1 and row 2 [original plot for model 1 in col 1 row 1] Apply

Plot 4:	
Still on graph set D1	
Click on right side to ds#4	[sub-graph not to overwrite ds#1, ds#2 & ds#3]
y is math5	[math5 observed scores on y axis]
x is math3	[plot against math3 on x axis]
Group is none	[to plot raw data]
Plot type is point	
Also on Plot' position' tab select pos	<i>tition of graph</i> ds#4
Mark X in col 2 and row 2 Apply	[original plot for model 1 in col 1 row 1]
Still on graph set D1	

till on graph set D1	
Click on right side to ds#5	[sub-graph ds#5 not to overwrite ds#1-4]
y is Yhat3	[revised math5 predictions on y-axis]
x is math3	[plot against math3 on x axis]
Group is school	[to plot predicted school lines]
Plot type is line	

Also on Plot' position' tab select position of graph ds#5 (overlaid on ds#4)

Mark X in col 2 and row 2 [original plot for model 1 in col 1 row 1] Apply

The Plot what screen should show that there are five sub-graphs in graph set display D1 (sub-graphs 4 & 5 are overlaid on top of each other to superimpose model 3 school lines on raw data for Plot 4):

히 Cus	tomised graj	ph:display 1	1, data set 5	×	
D1	D1 💌 Apply Labels Del data set Help 🔽 autosort on x				
ds #	Y	x	Details for for data set number (ds#) 5		
1	yhat1	math3	plot what? plot style position error bars other	וב	
2	yhat2	math3			
3	yhat3	math3	y Yhat3 ▼ × math3 ▼		
4	math5	math3	Elfar Inc.		
5	yhat3	math3	inter <u>none</u> v group school v		
6					
7					
8			_		
9					
10					
		•	• <u> </u>		

We can see from the four summary plots shown below that schools matter for the least able!



Some questions: 10 Butis there a ceiling effect? But.....are boy girl differences important? What about school-level variables? Etc etc

References

Mortimore, P., Sammons, P., Stoll, L., Lewis, D., and Ecob, R. (1989) School Matters, London, Open Books.

Sally Thomas Graduate School of Education University of Bristol

25th Oct 2007