Centering and Interactions: The Training Data

A random sample of 150 technical support workers were first given a test of their technical skill and knowledge, and then randomly assigned to one of three training programmes. Six weeks later, their performance was assessed.

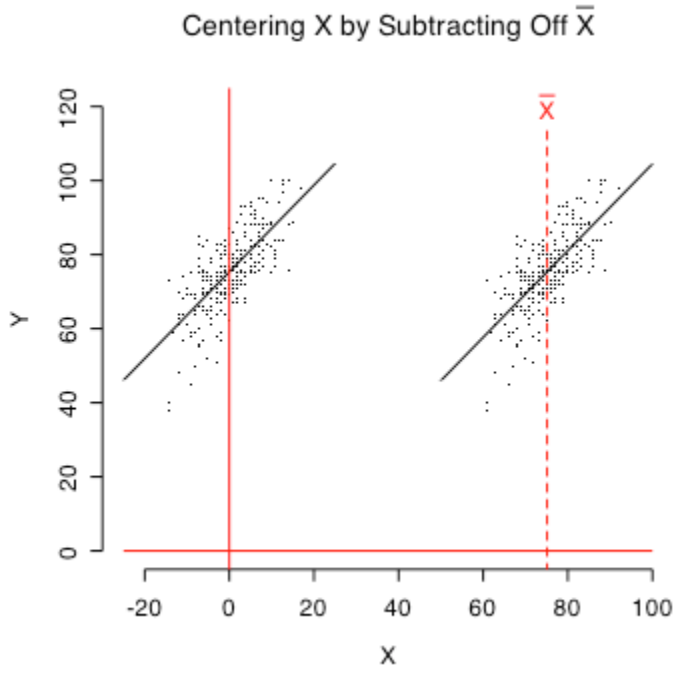
training.data

```
      group Skill Performance
  1       1    83          60
  2       1    81          57
  3       1    78          51
  4       1    70          53
  5       1    95          72
  6       1    81          58
  7       1    68          39
  8       1    74          53

...

147       3    71          36
148       3    75          44
149       3    77          38
150       3    73          44
```

There are 2 SAS programs. `training1.sas` illustrates some statistical ideas and SAS details. `training2.sas` is more focused on analyzing the data. Recall the idea of centering covariates at the mean.



```
/* training1.sas */
title 'Centering and Interactions (Customer Support Training)';

/* FIRST, DEMONSTRATE CENTERING THE SMART WAY, AND CREATION OF INTERACTION
   TERMS. */

data support;
     infile '/folders/myfolders/training.data' firstobs=2;
     input id Group Skill Performance;
     cskill = skill;
     label cskill = 'Skill Minus Mean'; /* Center it below in proc standard  */

proc standard out=support2 mean=0; /* Could also say std=1 to standardize */
     var cskill;

proc means;
     var skill cskill;

data support3;
     set support2;
     if group=. then g1=.;
        else if group=1 then g1=1;
        else g1=0;
     if group=. then g2=.;
        else if group=2 then g2=1;
        else g2=0;
     g1skill = g1*skill; g2skill = g2*skill;
     g1cskill = g1*cskill; g2cskill = g2*cskill;

/* NOW VERIFY THAT CENTERING AFFECTS ONLY THE INTERCEPTS, AND THAT FOR AN
   EQUAL SLOPES MODEL, PROC GLM GIVES THE SAME RESULTS WHETHER THE
   COVARIATE IS CENTERED OR NOT. */

proc reg;
     title2 'Equal slopes uncentered with proc reg';
     model performance = skill g1 g2;
     Group: test g1=g2=0;

proc reg;
     title2 'Equal slopes Centered with proc reg';
     model performance = cskill g1 g2;
     Group: test g1=g2=0;

proc glm;
     title2 'Equal slopes uncentered with proc glm';
     class group;
     model performance = skill group;
     lsmeans group / pdiff  adjust=bon;

proc glm;
     title2 'Equal slopes Centered with proc glm';
     class group;
     model performance = cskill group;
     lsmeans group / pdiff  adjust=bon;
```

```
/* NOW THE MODEL INCLUDES AN INTERACTION, ALLOWING FOR UNEQUAL
   SLOPES. COMPARE RESULTS WITH THE COVARIATE CENTERED AND UNCENTERED. THE
   MORAL OF THE STORY IS THAT YOU CAN GET WHAT YOU WANT EITHER WAY IF YOU KNOW
   WHAT YOU'RE DOING, BUT IT CAN BE EASIER WITH CENTERED IVs. */

proc reg;
     title2 'Unequal Slopes Uncentered with proc reg';
     model performance = skill g1 g2 g1skill g2skill;
     GroupAtZero: test g1=g2=0;
     Interaction: test g1skill=g2skill=0;
     GroupAtMean: test g1 + 75*g1skill = g2 + 75*g2skill = 0;
     Group1vs2AtMean: test g1 + 75*g1skill = g2 + 75*g2skill;

proc reg;
     title2 'Unequal Slopes Centered with proc reg';
     model performance = cskill g1 g2 g1cskill g2cskill;
     GroupAtMean: test g1=g2=0;
     Group1vs2AtMean: test g1=g2;
     Interaction: test g1cskill=g2cskill=0;

/* HERE, WE SEE THAT WHEN PROC GLM TESTS A CATEGORICAL INDEPENDENT VARIABLE
   IN THE PRESENCE OF COVARIATES, IT IS TESTING FOR DIFFERENCES BETWEEN
   INTERCEPTS. THIS IS TRUE EVEN IF THE MODEL HAS AN INTERACTION BETWEEN
   THE CATEGORICAL VARIABLE AND THE COVARIATE(S). WHEN THE COVARIATES ARE
   UNCENTERED, THIS IS SELDOM WHAT YOU WANT, AND YOU NEED TO WATCH OUT. */

proc glm;
     title2 'Unequal slopes uncentered with proc glm';
     class group;
     model performance = skill group skill*group;
     lsmeans group / pdiff  adjust=bon;

proc glm;
     title2 'Unequal slopes Centered with proc glm';
     class group;
     model performance = cskill group cskill*group;
     lsmeans group / pdiff  adjust=bon;
```

The MEANS Procedure

Variable	Label	N	Mean	Std Dev	Minimum
Skill		150	75.0000000	7.0320455	58.0000000
cskill	Skill Minus Mean	150	0	7.0320455	-17.0000000

Variable	Label	Maximum
Skill		95.0000000
cskill	Skill Minus Mean	20.0000000

Just display parameter estimates for centered and uncentered data. R^2, overall F tests and tests for Group are identical.

Equal slopes uncentered with proc reg
Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-19.51425	4.70654	-4.15	<.0001
Skill	1	0.76152	0.06229	12.23	<.0001
g1	1	13.12694	1.06923	12.28	<.0001
g2	1	7.33355	1.06891	6.86	<.0001

Equal slopes Centered with proc reg
Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	37.59984	0.75589	49.74	<.0001
cskill	Skill Minus Mean	1	0.76152	0.06229	12.23	<.0001
g1		1	13.12694	1.06923	12.28	<.0001
g2		1	7.33355	1.06891	6.86	<.0001

For this equal slopes model, output from proc glm is identical whether the covariate is centered or uncentered. Just show least squares means.

Group	Performance LSMEAN	LSMEAN Number
1	50.7267741	1
2	44.9333870	2
3	37.5998389	3

Group	x_2	x_3	$E(Y\|\mathbf{x})$
1	1	0	$(\beta_0 + \beta_2) + (\beta_1 + \beta_4)x_1$
2	0	1	$(\beta_0 + \beta_3) + (\beta_1 + \beta_5)x_1$
3	0	0	$\beta_0 + \beta_1 x_1$

```
proc reg;
     title2 'Unequal Slopes Uncentered with proc reg';
     model performance = skill g1 g2 g1skill g2skill;
     GroupAtZero: test g1=g2=0;
     Interaction: test g1skill=g2skill=0;
     GroupAtMean: test g1 + 75*g1skill = g2 + 75*g2skill = 0;
     Group1vs2AtMean: test g1 + 75*g1skill = g2 + 75*g2skill;
```


Unequal Slopes Uncentered with proc reg

The REG Procedure
Model: MODEL1
Dependent Variable: Performance

Number of Observations Read	150
Number of Observations Used	150

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	9194.71754	1838.94351	67.38	<.0001
Error	144	3929.82246	27.29043		
Corrected Total	149	13125			

Root MSE	5.22402	R-Square	0.7006
Dependent Mean	44.42000	Adj R-Sq	0.6902
Coeff Var	11.76052		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-1.79639	8.41130	-0.21	0.8312
Skill	1	0.52395	0.11235	4.66	<.0001
g1	1	-21.30069	11.75037	-1.81	0.0720
g2	1	-10.37307	11.17456	-0.93	0.3548
g1skill	1	0.45954	0.15622	2.94	0.0038
g2skill	1	0.23742	0.14870	1.60	0.1125

Unequal Slopes **Uncentered** with proc reg

The REG Procedure

Test GroupAtZero Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	44.88509	1.64	0.1967
Denominator	144	27.29043		

Test Interaction Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	118.07192	4.33	0.0150
Denominator	144	27.29043		

Test GroupAtMean Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	2171.92438	79.59	<.0001
Denominator	144	27.29043		

Test Group1vs2AtMean Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	820.33666	30.06	<.0001
Denominator	144	27.29043		

Group	x_2	x_3	$E(Y\|\mathbf{x})$
1	1	0	$(\beta_0 + \beta_2) + (\beta_1 + \beta_4)x_1$
2	0	1	$(\beta_0 + \beta_3) + (\beta_1 + \beta_5)x_1$
3	0	0	$\beta_0 + \beta_1 x_1$

```
proc reg;
     title2 'Unequal Slopes Centered with proc reg';
     model performance = cskill g1 g2 g1cskill g2cskill;
     GroupAtMean: test g1=g2=0;
     Group1vs2AtMean: test g1=g2;
     Interaction: test g1cskill=g2cskill=0;
```

```
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                     Unequal Slopes Centered with proc reg

                               The REG Procedure
                                 Model: MODEL1
                           Dependent Variable: Performance

                         Number of Observations Read         150
                         Number of Observations Used         150


                                Analysis of Variance

                                          Sum of           Mean
Source                     DF            Squares         Square    F Value    Pr > F

Model                       5         9194.71754     1838.94351      67.38    <.0001
Error                     144         3929.82246       27.29043
Corrected Total           149              13125


                 Root MSE              5.22402    R-Square     0.7006
                 Dependent Mean       44.42000    Adj R-Sq     0.6902
                 Coeff Var            11.76052


                               Parameter Estimates

                                        Parameter     Standard
Variable     Label                DF     Estimate        Error  t Value  Pr > |t|

Intercept    Intercept             1     37.50006      0.74029    50.66    <.0001
cskill       Skill Minus Mean      1      0.52395      0.11235     4.66    <.0001
g1                                 1     13.16456      1.04631    12.58    <.0001
g2                                 1      7.43335      1.04596     7.11    <.0001
g1cskill                           1      0.45954      0.15622     2.94    0.0038
g2cskill                           1      0.23742      0.14870     1.60    0.1125
```

Unequal Slopes Centered with proc reg

The REG Procedure
Model: MODEL1

Test GroupAtMean Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	2171.92438	79.59	<.0001
Denominator	144	27.29043		

Test Group1vs2AtMean Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	820.33666	30.06	<.0001
Denominator	144	27.29043		

Test Interaction Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	118.07192	4.33	0.0150
Denominator	144	27.29043		

	Uncentered with proc reg	Centered with proc reg
GroupAtZero	F = 1.64	
Interaction	F = 4.33	F = 4.33
GroupAtMean	F = 79.59	F = 79.59
Group1vs2AtMean	F = 30.06	F = 30.06

Compare tests based on Type III Sums of Squares from `proc glm`

Unequal slopes uncentered with proc glm

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Skill	1	4144.661016	4144.661016	151.87	<.0001
Group	2	89.770177	44.885088	1.64	0.1967
Skill*Group	2	236.143846	118.071923	4.33	0.0150

Unequal slopes Centered with proc glm

Source	DF	Type III SS	Mean Square	F Value	Pr > F
cskill	1	4144.661016	4144.661016	151.87	<.0001
Group	2	4343.848752	2171.924376	79.59	<.0001
cskill*Group	2	236.143846	118.071923	4.33	0.0150

	Uncentered with proc reg	Centered with proc reg
GroupAtZero	F = 1.64	
Interaction	F = 4.33	F = 4.33
GroupAtMean	F = 79.59	F = 79.59
Group1vs2AtMean	F = 30.06	F = 30.06

So `proc glm` is testing differences between intercepts, even when there is an interaction.

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Least Squares Means
Adjustment for Multiple Comparisons: Bonferroni

Group	Performance LSMEAN	LSMEAN Number
1	50.6646230	1
2	44.9334080	2
3	37.5000601	3

Least Squares Means for effect Group
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Performance

i/j	1	2	3
1		<.0001	<.0001
2	<.0001		<.0001
3	<.0001	<.0001	

And the multiple comparison tests of differences between least squares means are <u>not</u> follow-ups to the test for Group.

With `proc glm`, you should almost always center the covariates if the model includes interactions between factors and covariates.

```
/* training2.sas */
options linesize=79 noovp formdlim=' ';
title 'Customer Support Training';

/* THIS PROGRAM IS FOCUSED ON UNDERSTANDING THE DATA. training1.sas WAS
   MORE ABOUT STATISTICAL IDEAS AND SOME SAS DETAILS */

data support;
     infile 'training.data' firstobs=2;
     input id Group Skill Performance;
     cskill = skill;
     label cskill = 'Skill Minus Mean'; /* Center it below in proc standard  */

proc standard out=support2 mean=0; /* Could also say std=1 to standardize */
     var cskill;

data support3;
     set support2;
     if group=. then g1=.;
        else if group=1 then g1=1;
        else g1=0;
     if group=. then g2=.;
        else if group=2 then g2=1;
        else g2=0;
     g1skill = g1*skill; g2skill = g2*skill;
     g1cskill = g1*cskill; g2cskill = g2*cskill;

/* EQUAL REGRESSIONS SAYS THAT THE THREE REGRESSION LINES ARE RIGHT ON TOP
   OF EACH OTHER. THAT IS, THERE ARE NO DIFFERENCES AMONG TRAINING
   PROGRAMMES FOR ANY SKILL LEVEL. THIS IS THE NULL HYPOTHESIS FOR THE
   EQUAL SLOPES MODEL, TOO.  */

proc reg data = support3;
     title2 'Test Equal Regressions (and equal slopes)';
     model performance = skill g1 g2 g1skill g2skill;
     EqualRegressions: test g1=g2=g1skill=g2skill = 0;
     Interaction: test g1skill=g2skill = 0;

proc iml;
     title2 'Proportion of remaining variation explained by';
     title3  'Unequal regressions and Unequal slopes';
      F = 41.74; s = 4; NminusP = 144; a1 = s*F/(NminusP + s*F);
      F = 4.33; s = 2; NminusP = 144; a2 = s*F/(NminusP + s*F);
      print "Unequal Regressions: " a1 ", Unequal Slopes: " a2;


/* LOOK TO SEE WHAT'S GOING ON. A CONVENIENT WAY TO GET THE THREE
   REGRESSIONS IS TO JUST FIT THEM DIRECTLY. ONLY THE ESTIMATED REGRESSION
   COEFFICIENTS ARE WHAT WE WOULD GET FROM A SINGLE REGRESSION MODEL WITH
   PRODUCT TERMS. EVERYTHING ELSE IS "WRONG." */

proc sort;
     by group;
proc reg;
     title2 'Separate regressions';
     model performance = skill;
     by group;  /* Data must be sorted by this varIale. */

/* LOOK AT A ROUGH PLOT OF THE REGRESSION LINES OVER THE RANGE OF THE
   DATA. OUTPUT FROM THE SEPARATE REGRESSIONS GIVES

   Group 1: Yhat = -23.09708 + 0.98349*X
   Group 2: Yhat = -12.16946 + 0.76137*X
   Group 3: Yhat = -1.79639  + 0.52395*X
```

```
   WHAT IS THE RANGE OF THE DATA? A REAL DATA ANALYSIS JOB
   WOULD START WITH DESCRIPTIVE STATISTICS AND YOU'D KNOW THIS ALREADY.  */

proc univariate;
     var skill;

/* CREATE A SAS DATA SET OF POINTS TO PLOT. THIS WOULD BE BETTER IN R. */

data pts;
     do skill = 60 to 95;
        group = 1; Yhat = -23.09708 + 0.98349*skill; output;
        group = 2; Yhat = -12.16946 + 0.76137*skill; output;
        group = 3; Yhat = -1.79639  + 0.52395*skill; output;
     end;
     label Yhat = 'Predicted Performance';

options pagesize=500;
proc print;
     title2 'Look at the data set pts';

options pagesize=35;
proc plot;
     title2 'Rough Plot of the Three Regression Lines';
     plot Yhat * skill = group; /* Plotting symbol is the value of group. */

/* ARE THE DIFFERENCES BETWEEN TRAINING PROGRAMMES SIGNIFICANT EVEN AT LOW
SKILL LEVELS? FROM PROC UNIVARIATE, MINIMUM IS 58 AND 25TH PERCENTILE IS 71. */

proc reg data = support3;
     title2 'Test group differences at lower skill levels';
     model performance = skill g1 g2 g1skill g2skill;
     DiffAt58: test g1 + 58*g1skill = g2 + 58*g2skill = 0;
     DiffAt71: test g1 + 71*g1skill = g2 + 71*g2skill = 0;
     /* 67 is the 10th percentile. */
     DiffAt67: test g1 + 67*g1skill = g2 + 67*g2skill = 0;
     /* 64 is the 5th percentile. */
     DiffAt64: test g1 + 64*g1skill = g2 + 64*g2skill = 0;
     Group1vs2At64: test g1 + 64*g1skill = g2 + 64*g2skill;
     Group1vs3At64: test g1 + 64*g1skill = 0;
     Group2vs3At64: test g2 + 64*g2skill = 0;

/* HOW MIGHT THESE RESULTS BE DESCRIBED IN PLAIN LANGUAGE? YOU DON'T HAVE
TO (AND SHOULD NOT) SAY EVERYTHING. HERE'S A POSSIBILITY.

"Average job performance depends on level of skill and technical
knowledge prior to training. Naturally, those with higher prior levels of
skill tend to perform better. Overall, average job performance was best for
employees receiving Training Programme 1, followed by 2 and 3 in that
order. The advantage of Programme 1 was greatest for those with higher
levels of prior skill, but was still apparent for those with relatively low
skill levels."

A HIGH-RESOLUTION PLOT OF THE THREE REGRESSION LINES WOULD BE GOOD, EVEN FOR
A NON-TECHNICAL AUDIENCE.

THERE ARE SOME MORE INTERESTNG ISSUES THAT COULD BE EXPLORED WITH THESE
DATA. ONE EXAMPLE IS TESTS OF PAIRWISE DIFFERENCES BETWEEN SLOPES. ANOTHER
ONE IS TO LOCATE THE EXACT SKILL LEVEL AT WHICH GROUP DIFFERNCES BECOME
CLEAR, TREATING ALL TESTS AS SCHEFFE FOLLOW-UPS TO THE INITIAL TEST OF
EQUAL REGRESSIONS. IT'S LIKELY NOT GOING TO BE AT THE 5TH PERCENTILE,
BECAUSE OF THE PENALTY FOR PROTECTING INFINITELY MANY TESTS AT A SINGLE
JOINT SIGNIFICANCE LEVEL. */
```

The REG Procedure
Model: MODEL1
Dependent Variable: Performance

Number of Observations Read	150
Number of Observations Used	150

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	9194.71754	1838.94351	67.38	<.0001
Error	144	3929.82246	27.29043		
Corrected Total	149	13125			

Root MSE	5.22402	R-Square	0.7006
Dependent Mean	44.42000	Adj R-Sq	0.6902
Coeff Var	11.76052		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-1.79639	8.41130	-0.21	0.8312
Skill	1	0.52395	0.11235	4.66	<.0001
g1	1	-21.30069	11.75037	-1.81	0.0720
g2	1	-10.37307	11.17456	-0.93	0.3548
g1skill	1	0.45954	0.15622	2.94	0.0038
g2skill	1	0.23742	0.14870	1.60	0.1125

The REG Procedure
Model: MODEL1

Test EqualRegressions Results for
Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	4	1139.07990	41.74	<.0001
Denominator	144	27.29043		

Test Interaction Results for Dependent
Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	118.07192	4.33	0.0150
Denominator	144	27.29043		

Proportion of remaining variation explained by
Unequal regressions and Unequal slopes

a1	a2

Unequal Regressions: 0.5369179 , Unequal Slopes: 0.0567274

Separate regressions

---------- Group=1 ----------

The REG Procedure
Model: MODEL1
Dependent Variable: Performance

Number of Observations Read	50
Number of Observations Used	50

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2240.23137	2240.23137	102.94	<.0001
Error	48	1044.58863	21.76226		
Corrected Total	49	3284.82000			

Root MSE	4.66500	R-Square	0.6820
Dependent Mean	50.94000	Adj R-Sq	0.6754
Coeff Var	9.15784		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-23.09708	7.32694	-3.15	0.0028
Skill	1	0.98349	0.09693	10.15	<.0001

Separate regressions

---------- Group=2 ----------

The REG Procedure
Model: MODEL1
Dependent Variable: Performance

Number of Observations Read	50
Number of Observations Used	50

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1667.19066	1667.19066	49.87	<.0001
Error	48	1604.72934	33.43186		
Corrected Total	49	3271.92000			

Root MSE	5.78203	R-Square	0.5095
Dependent Mean	45.04000	Adj R-Sq	0.4993
Coeff Var	12.83754		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-12.16946	8.14248	-1.49	0.1416
Skill	1	0.76137	0.10782	7.06	<.0001

---------- Group=3 ----------

The REG Procedure
Model: MODEL1
Dependent Variable: Performance

Number of Observations Read	50
Number of Observations Used	50

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	593.57551	593.57551	22.25	<.0001
Error	48	1280.50449	26.67718		
Corrected Total	49	1874.08000			

Root MSE	5.16500	R-Square	0.3167
Dependent Mean	37.28000	Adj R-Sq	0.3025
Coeff Var	13.85460		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-1.79639	8.31626	-0.22	0.8299
Skill	1	0.52395	0.11108	4.72	<.0001

Skipping `proc univariate` output except for the quantiles ...

Quantile	Estimate
100% Max	95
99%	91
95%	87
90%	84
75% Q3	80
50% Median	74
25% Q1	71
10%	67
5%	64
1%	59
0% Min	58

Look at the data set pts

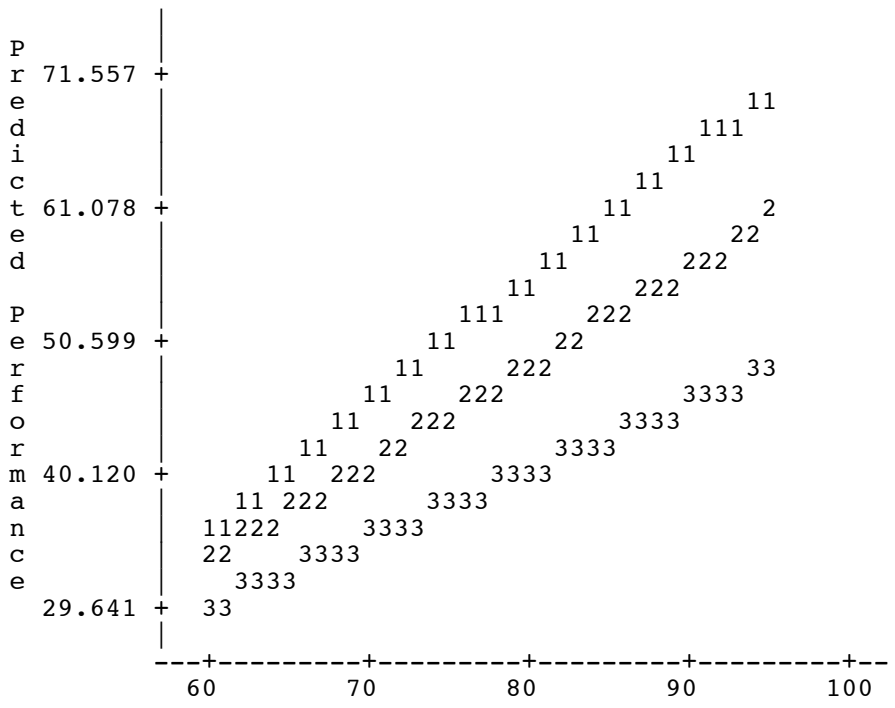
Obs	skill	group	Yhat
1	60	1	35.9123
2	60	2	33.5127
3	60	3	29.6406
4	61	1	36.8958
5	61	2	34.2741
6	61	3	30.1646
7	62	1	37.8793
8	62	2	35.0355
9	62	3	30.6885
10	63	1	38.8628
11	63	2	35.7969
12	63	3	31.2125
13	64	1	39.8463
14	64	2	36.5582
15	64	3	31.7364
16	65	1	40.8298
17	65	2	37.3196
18	65	3	32.2604
19	66	1	41.8133

Skipping ...

100	93	1	68.3675
101	93	2	58.6380
102	93	3	46.9310
103	94	1	69.3510
104	94	2	59.3993
105	94	3	47.4549
106	95	1	70.3345
107	95	2	60.1607
108	95	3	47.9789

Rough Plot of the Three Regression Lines

Plot of Yhat*skill. Symbol is value of group.



Test group differences at lower skill levels

The REG Procedure
Model: MODEL1
Dependent Variable: Performance

Number of Observations Read	150
Number of Observations Used	150

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	9194.71754	1838.94351	67.38	<.0001
Error	144	3929.82246	27.29043		
Corrected Total	149	13125			

Root MSE	5.22402	R-Square	0.7006
Dependent Mean	44.42000	Adj R-Sq	0.6902
Coeff Var	11.76052		

The REG Procedure
Model: MODEL1

Test DiffAt58 Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	49.76774	1.82	0.1651
Denominator	144	27.29043		

The REG Procedure
Model: MODEL1

Test DiffAt71 Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	1204.88567	44.15	<.0001
Denominator	144	27.29043		

The REG Procedure
Model: MODEL1

Test DiffAt67 Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	474.61887	17.39	<.0001
Denominator	144	27.29043		

The REG Procedure
Model: MODEL1

Test DiffAt64 Results for Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	227.79970	8.35	0.0004
Denominator	144	27.29043		

Test group differences at lower skill levels

The REG Procedure
Model: MODEL1

Test Group1vs2At64 Results for
Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	78.28716	2.87	0.0925
Denominator	144	27.29043		

Test group differences at lower skill levels

The REG Procedure
Model: MODEL1

Test Group1vs3At64 Results for
Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	448.28484	16.43	<.0001
Denominator	144	27.29043		

Test group differences at lower skill levels

The REG Procedure
Model: MODEL1

Test Group2vs3At64 Results for
Dependent Variable Performance

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	172.31830	6.31	0.0131
Denominator	144	27.29043		