Summary of Results from Diagnostic Test Project

Regression Model:

We first fitted linear models of exam result given diagnostic test score for each course to determine whether there was any relationship between the two variables. The linear models are:

ILA Exam Result = 10.35146 + 0.77310 * Diagnostic Test

CAP Exam Result = 5.2347 + 0.69049 * Diagnostic Test

PPS Exam Result = 10.5345 + 0.7874 * Diagnostic Test

We found that there is significant evidence to suggest that exam result is associated with diagnostic test (at the 0.1% level) in all three courses. We found this model to be a good fit to the data when checking variance and normality assumptions.

We used this regression model to generate prediction intervals for exam performance given diagnostic test scores and also created a graph showing the probability of passing the course (or passing by 60% and achieving a grade B) given a certain diagnostic test score.

We also ran these analyses on the MSE and MfP1 course data and obtained similar results with strong evidence that exam result was associated with diagnostic test score.

Tutorial Attendance:

For each course we fitted a linear model of exam result against tutorial attendance to determine whether there was any association. The linear models are given below:

ILA Exam Result = 24.263 + 4.319 * Tutorial Attendance

CAP Exam Result = 24.251 + 3.368 * Tutorial Attendance

PPS Exam Result = 36.4865 + 3.6725 * Tutorial Attendance

We found that there is significant evidence (at the 0.1% level) to suggest that exam result is associated with tutorial attendance across all three courses.

Since exam result across all three specialist maths courses seemed to be correlated with high tutorial attendance we also fitted a model to all subjects who attended 9 or 10 of their tutorials. With this adjusted regression model we have also generated prediction intervals around the adjusted model which assumes “full” tutorial attendance.

Combined Model:

We were then able to fit a linear model incorporating both tutorial attendance and diagnostic test. We found that both variables were highly significant (at the 0.1% level) in the regression and so neither could be disregarded.

ILA Exam Result = -17.24385 +3.4543 * Tutorial Attendance + 0.7271 * Diagnostic Test

CAP Exam Result = -11.1559 + 2.2799 * Tutorial Attendance + 0.6507 * Diagnostic Test

PPS Exam Result = 8.6228 + 3.1184 * Tutorial Attendance + 0.7059 * Diagnostic Test

We found that these combined linear models reduced the residual standard error of our previous regression models as seen below.

Residual Standard Errors:

Course	Original Regression with only diagnostic	Regression with both variables	Adjusted regression (9/10 Tutorials)
ILA	16.2	14.99	13.89
CAP	15.3	14.68	14.7
PPS	17.15	16.03	13.03

Gender

There was no significant difference between male and female performance in the ILA or CAL exams however overall there was a significant difference (at the 5% level) between male and female performance in the PPS exam.

We then re ran our test using just the maths cohort (i.e. those studying all three 1st year maths courses) to check that this difference was not due to the fact we had different students sitting ILA and CAL. We found that our results were the same and with the same set of students there was a significant difference in PPS exam mark but the difference was not significant in ILA or CAL.

Next we looked at the difference between males and females in each quartile of the data. We calculated the proportions of males and females in each quartile, finding as expected that the difference was considerable in PPS.

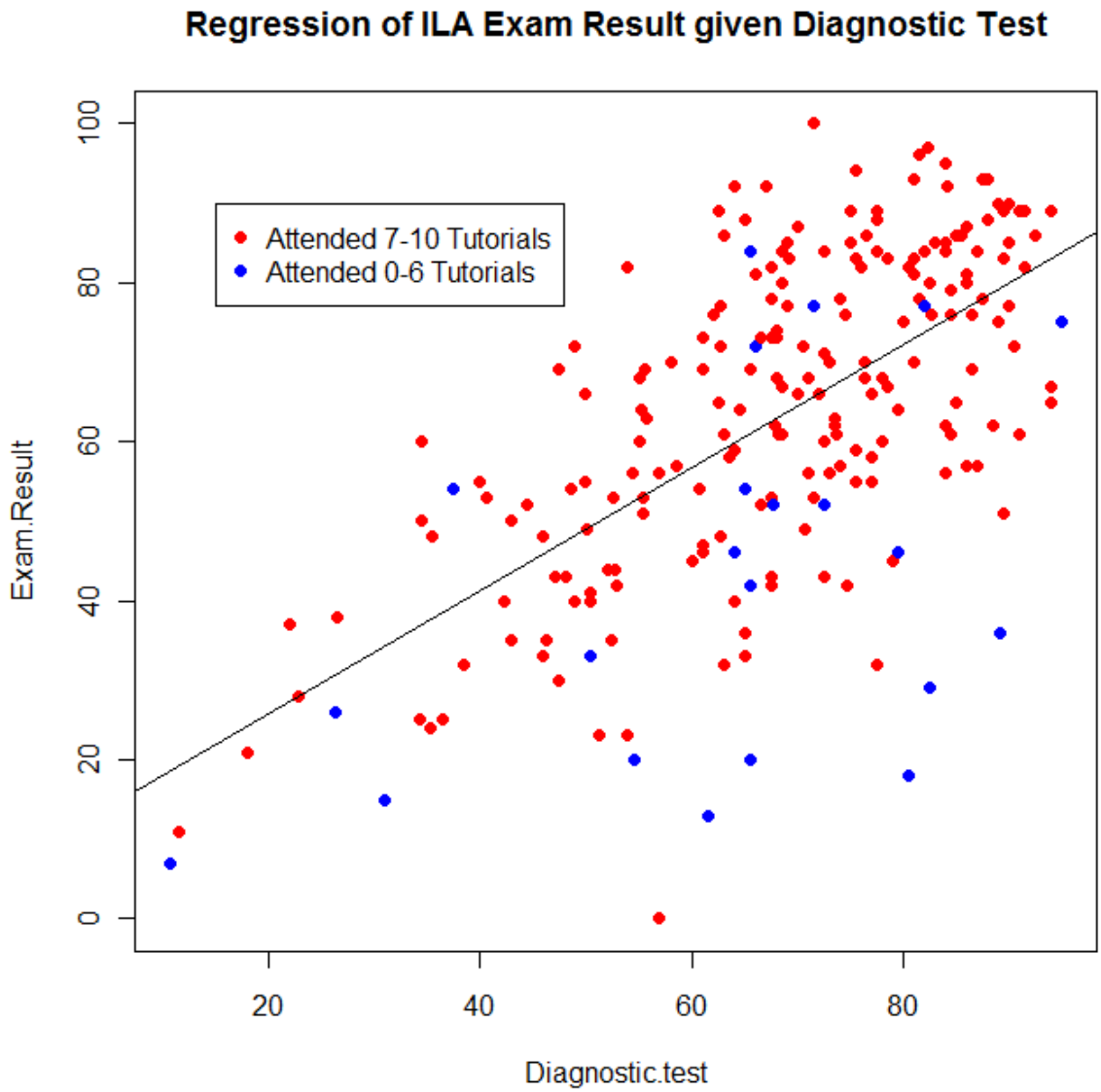
Domicile

- We found EU students to be performing significantly better than Scottish and Overseas students across all three courses.
- Scottish students are performing significantly worse in ILA than RUK students however the difference is not significant in CAP or PPS.

Tariff

When splitting the cohort into those who studied A-Level and those who studied Highers we found the following results:

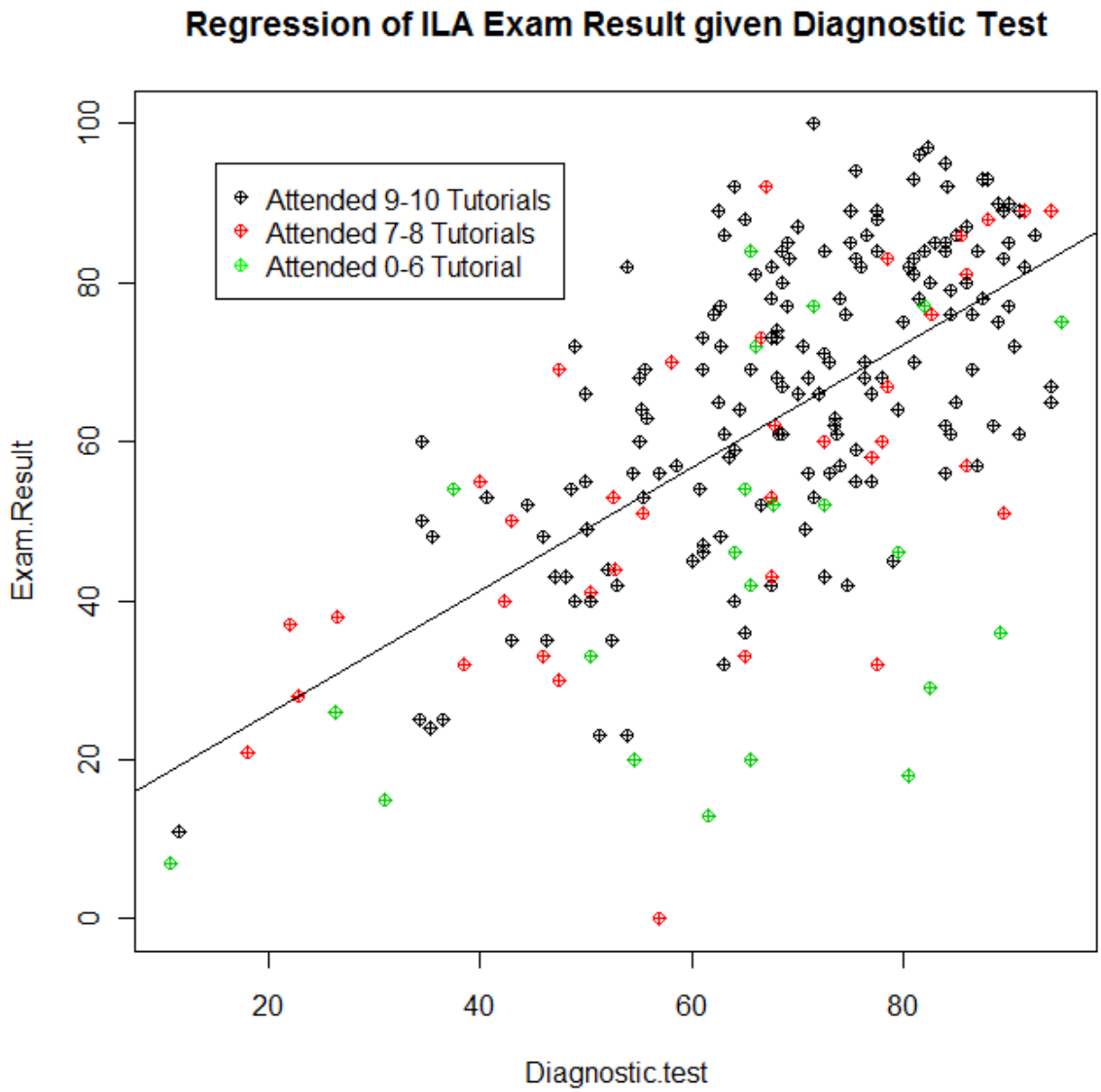
- There is a significant difference (at the 1% level) in exam result across all three specialist maths courses between those who studied only Higher and those who continued on to study Advanced Higher.
- There was no significant difference between students studying one A-Level and those studying two A-Levels except in the CAP exam where there was a significant difference at the 1% level.
- We did not have enough data on international students to investigate their qualifications.

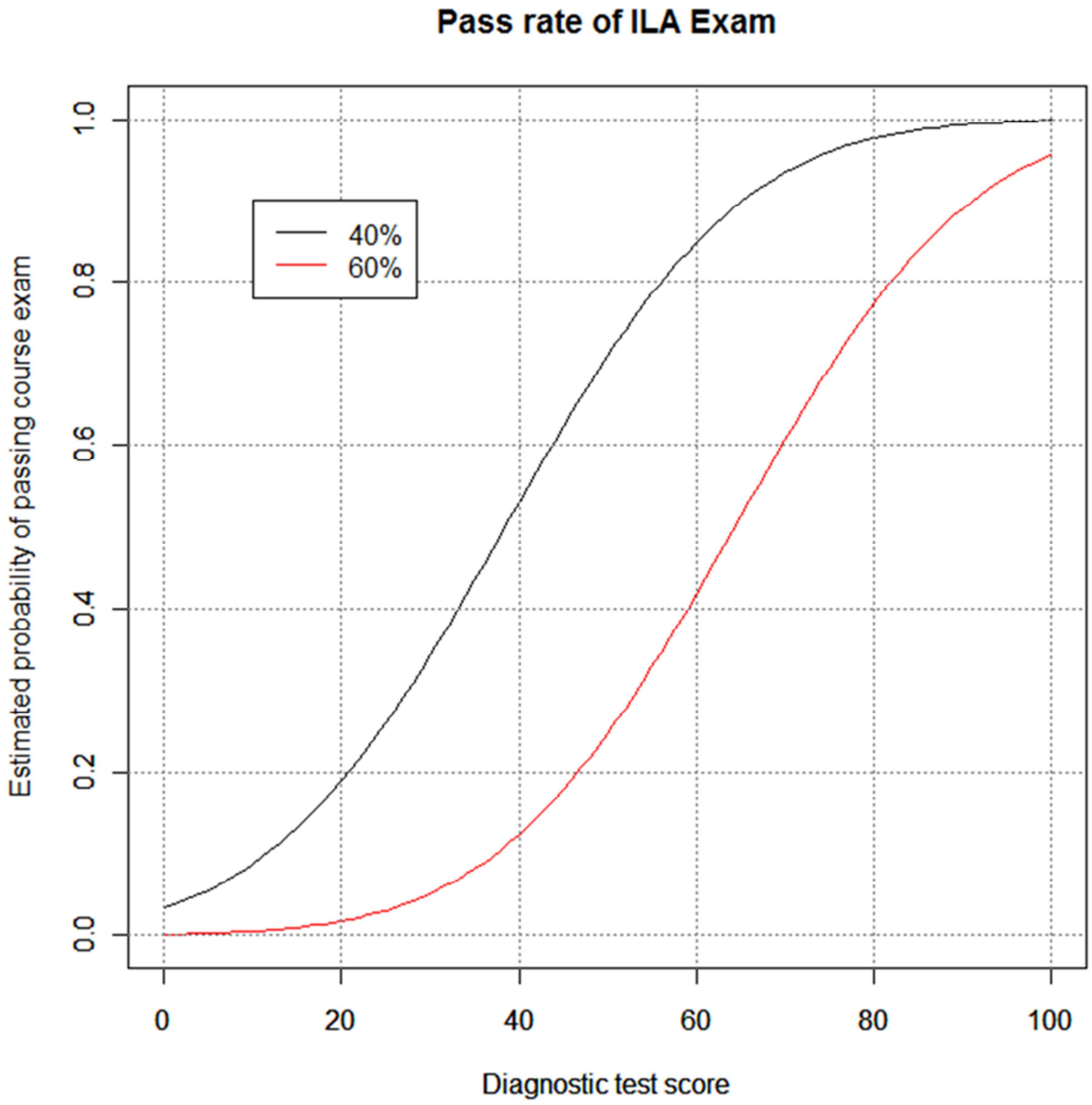


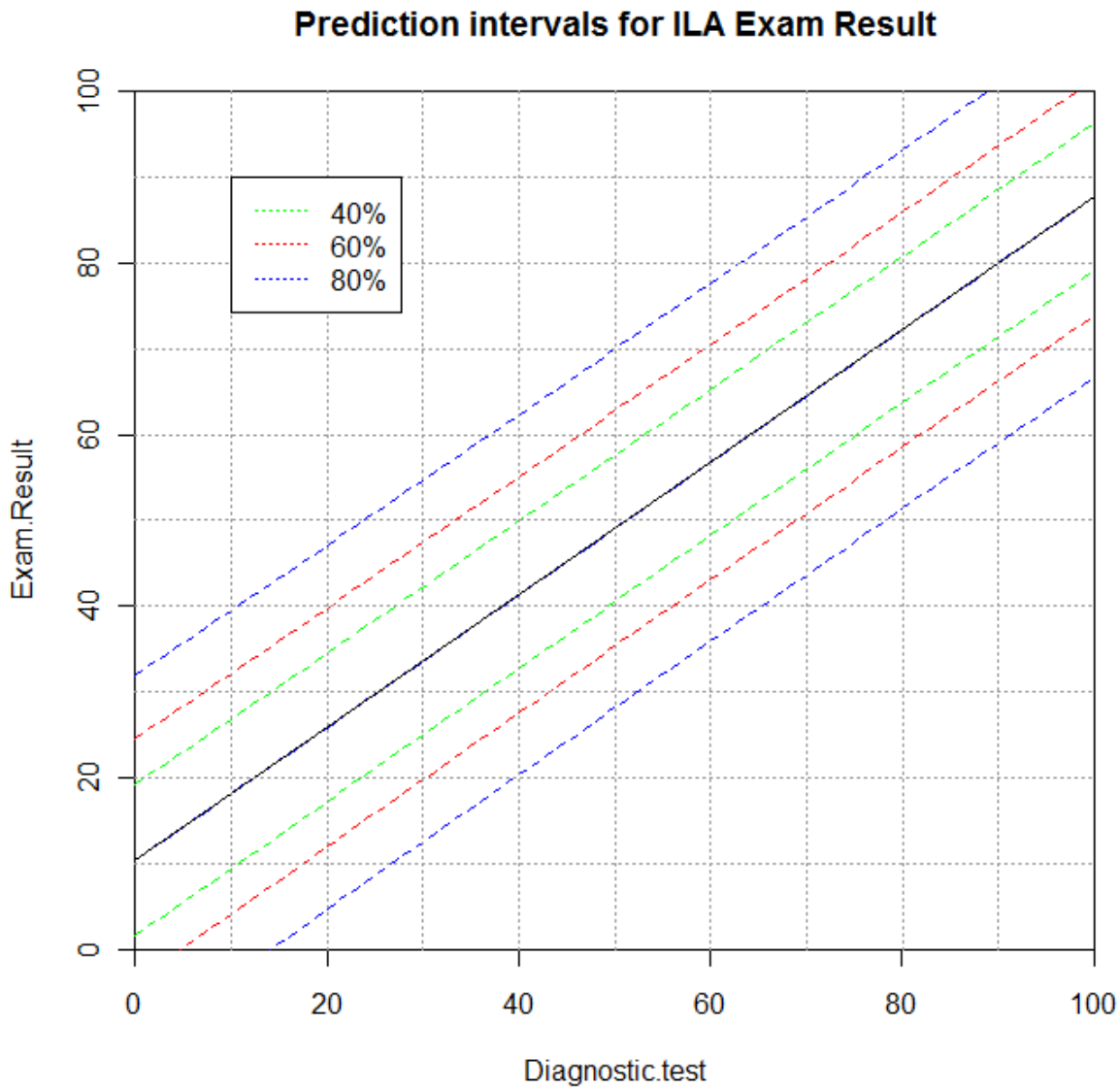
Model:

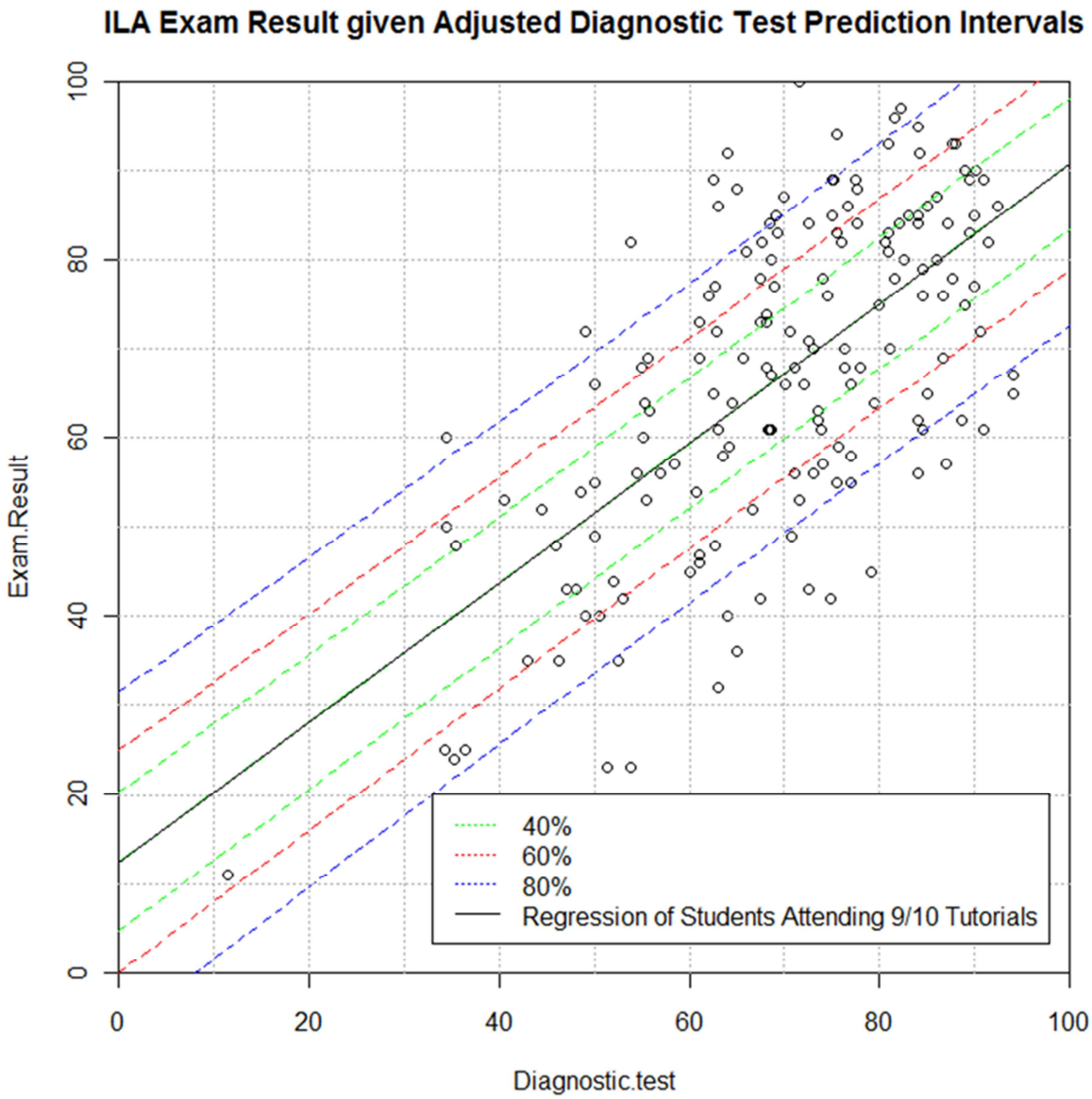
ILA Exam Result = 10.35146 + 0.77310*Diagnostic Test

Residual Standard Error: 16.2


Regression of ILA Exam Result given Diagnostic Test
Attended 9-10 Tutorials
Attended 7-8 Tutorials
Attended 0-6 Tutorial
Exam.Result
Diagnostic.test
0
20
40
60
80
100
20
40
60
80


Pass rate of ILA Exam
Estimated probability of passing course exam
0.0
0.2
0.4
0.6
0.8
1.0
40%
60%
0
20
40
60
80
100
Diagnostic test score

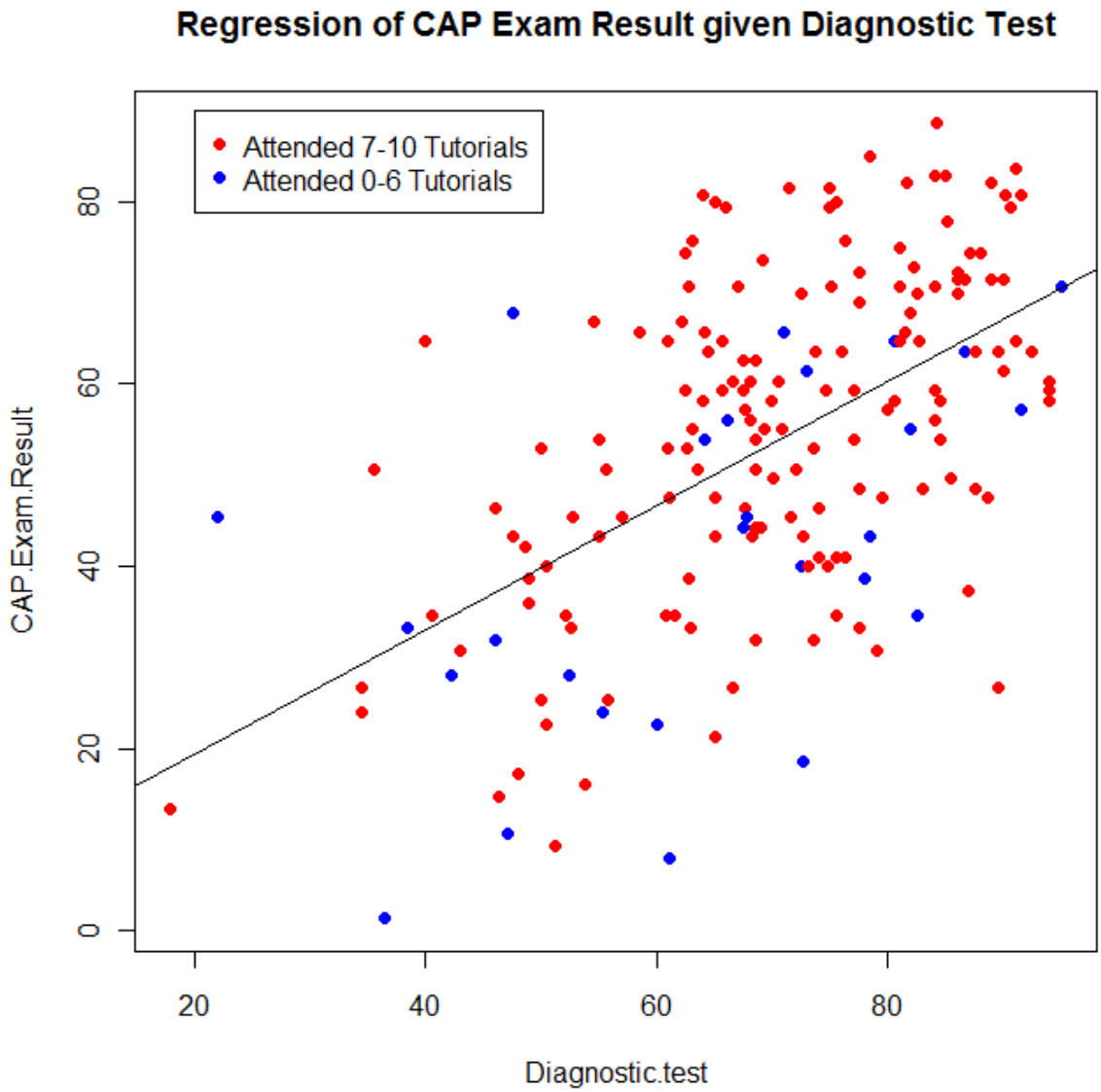

Prediction intervals for ILA Exam Result
40%
60%
80%
Exam.Result
Diagnostic.test
0
20
40
60
80
100



Model:

ILA Exam Result = 12.4231 + 0.7836*Diagnostic test

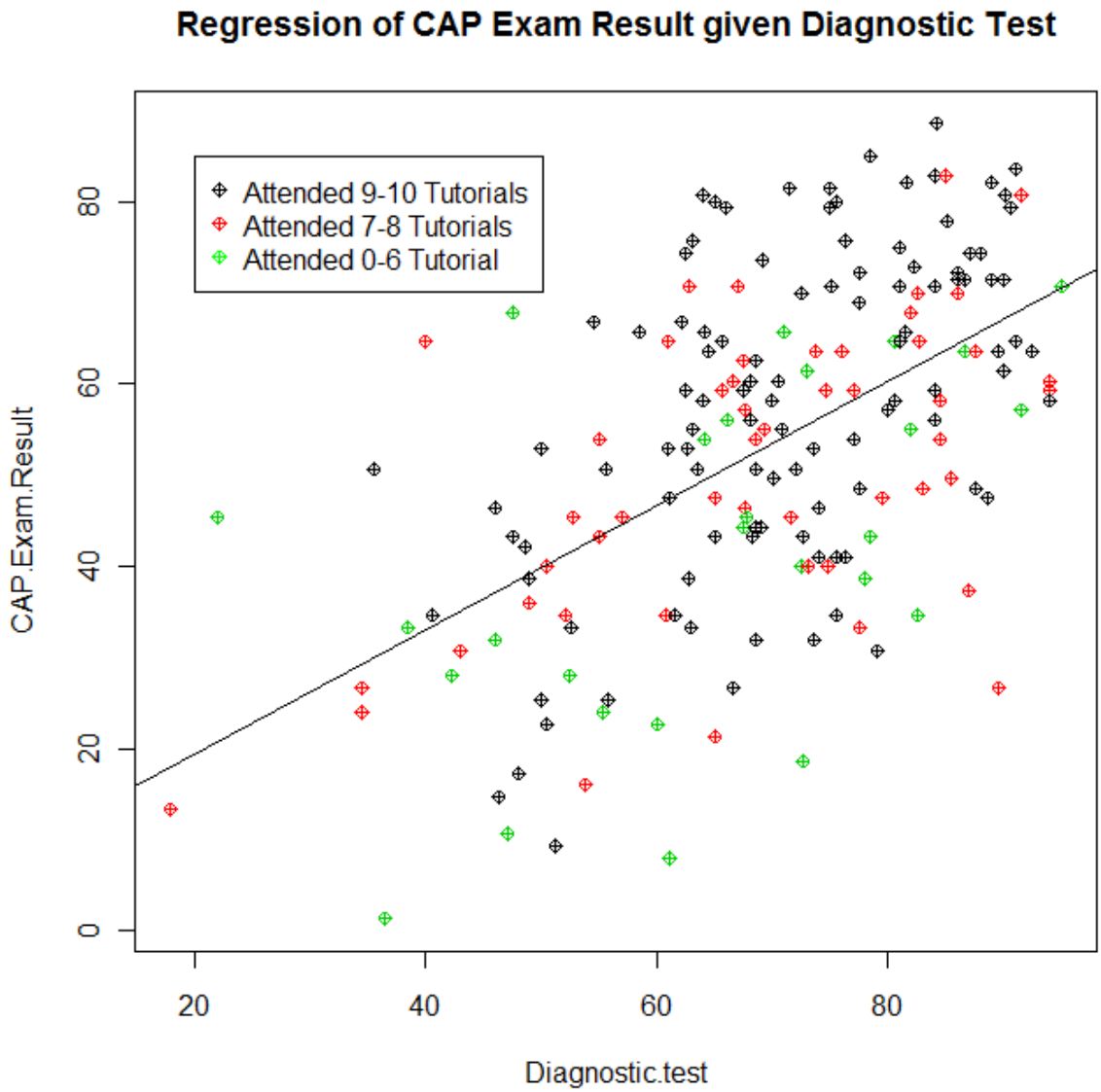
Residual Standard Error = 13.89

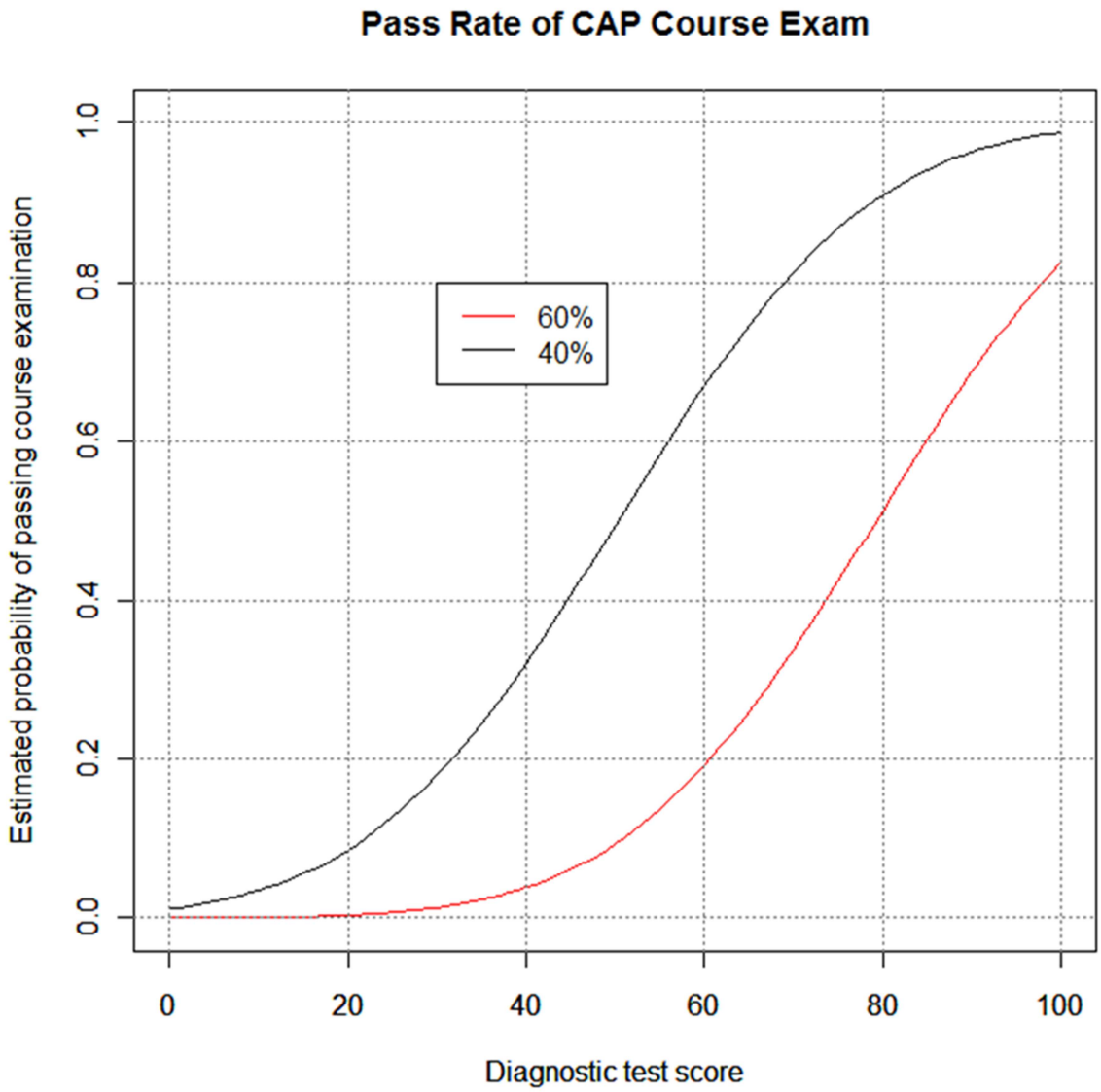


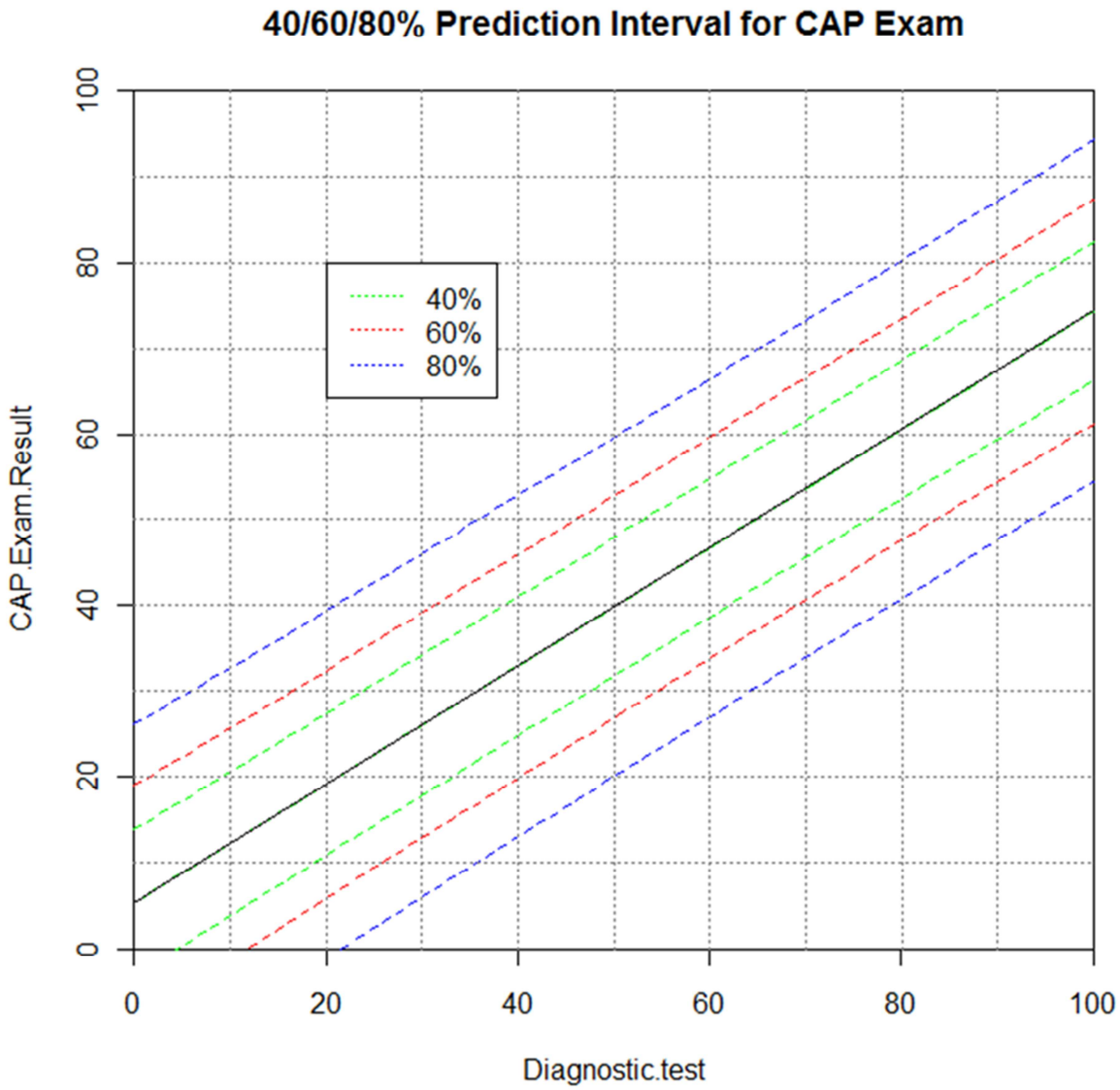
Model:

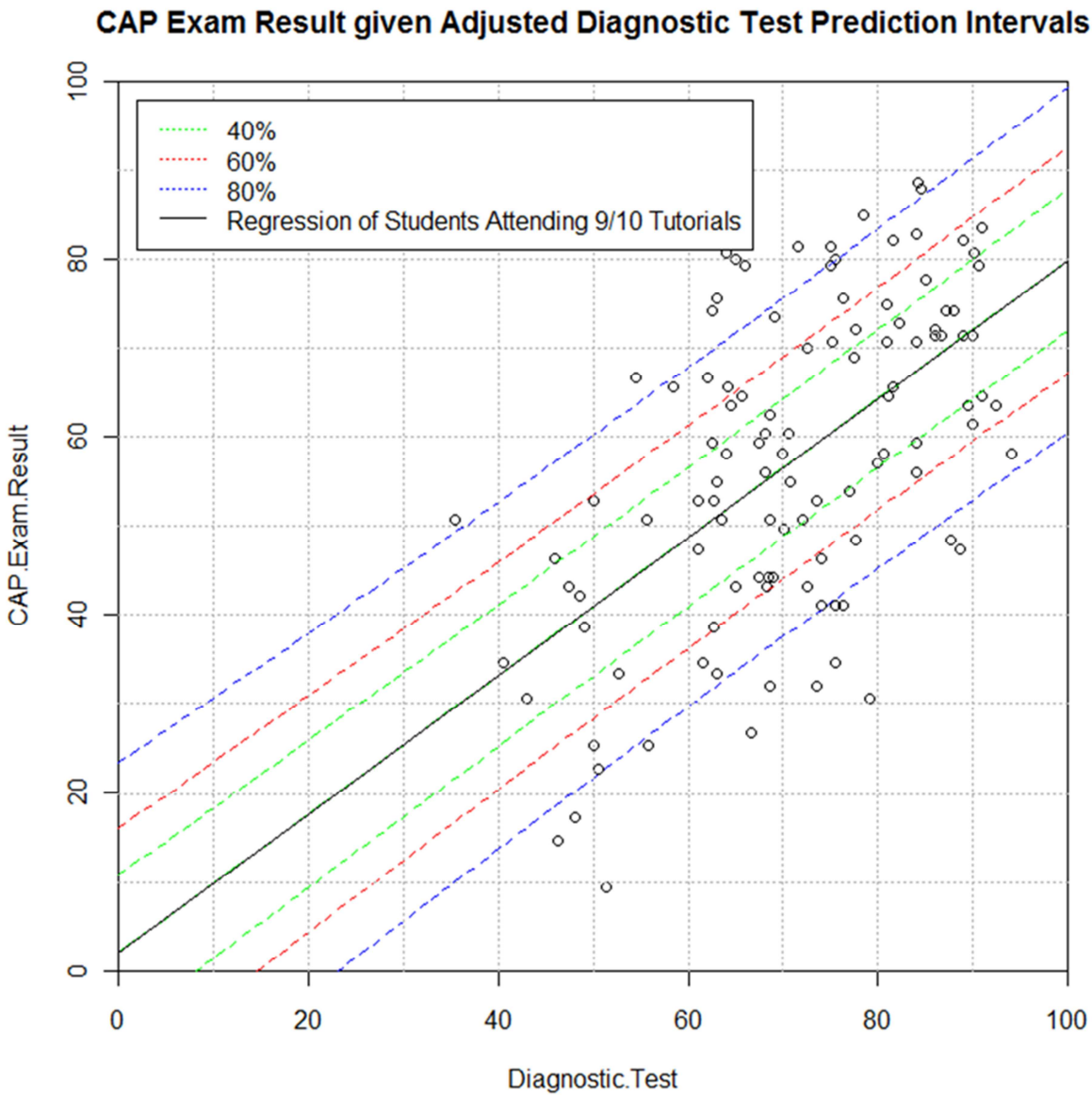
CAP Exam Result = 5.2347 + 0.69049*Diagnostic Test

Residual Standard Error: 15.3


Regression of CAP Exam Result given Diagnostic Test
Attended 9-10 Tutorials
Attended 7-8 Tutorials
Attended 0-6 Tutorial
CAP.Exam.Result
0
20
40
60
80
20
40
60
80
Diagnostic.test


Pass Rate of CAP Course Exam
Estimated probability of passing course examination
0.0
0.2
0.4
0.6
0.8
1.0
60%
40%
0
20
40
60
80
100
Diagnostic test score

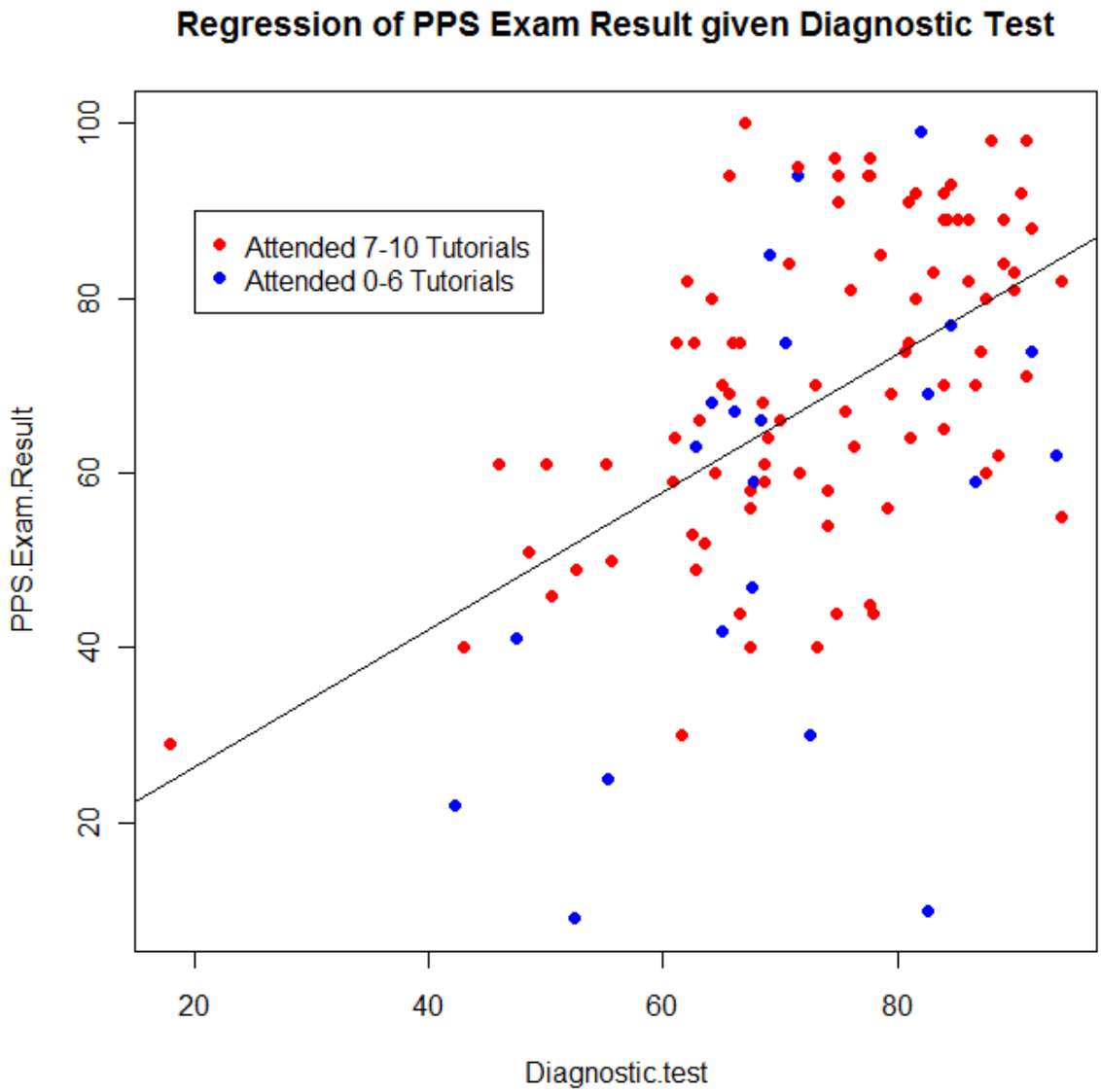

40/60/80% Prediction Interval for CAP Exam
CAP.Exam.Result
Diagnostic.test
40%
60%
80%
0
20
40
60
80
100



Model:

CAP Exam Result = 2.0691 + 0.7787*Diagnostic test

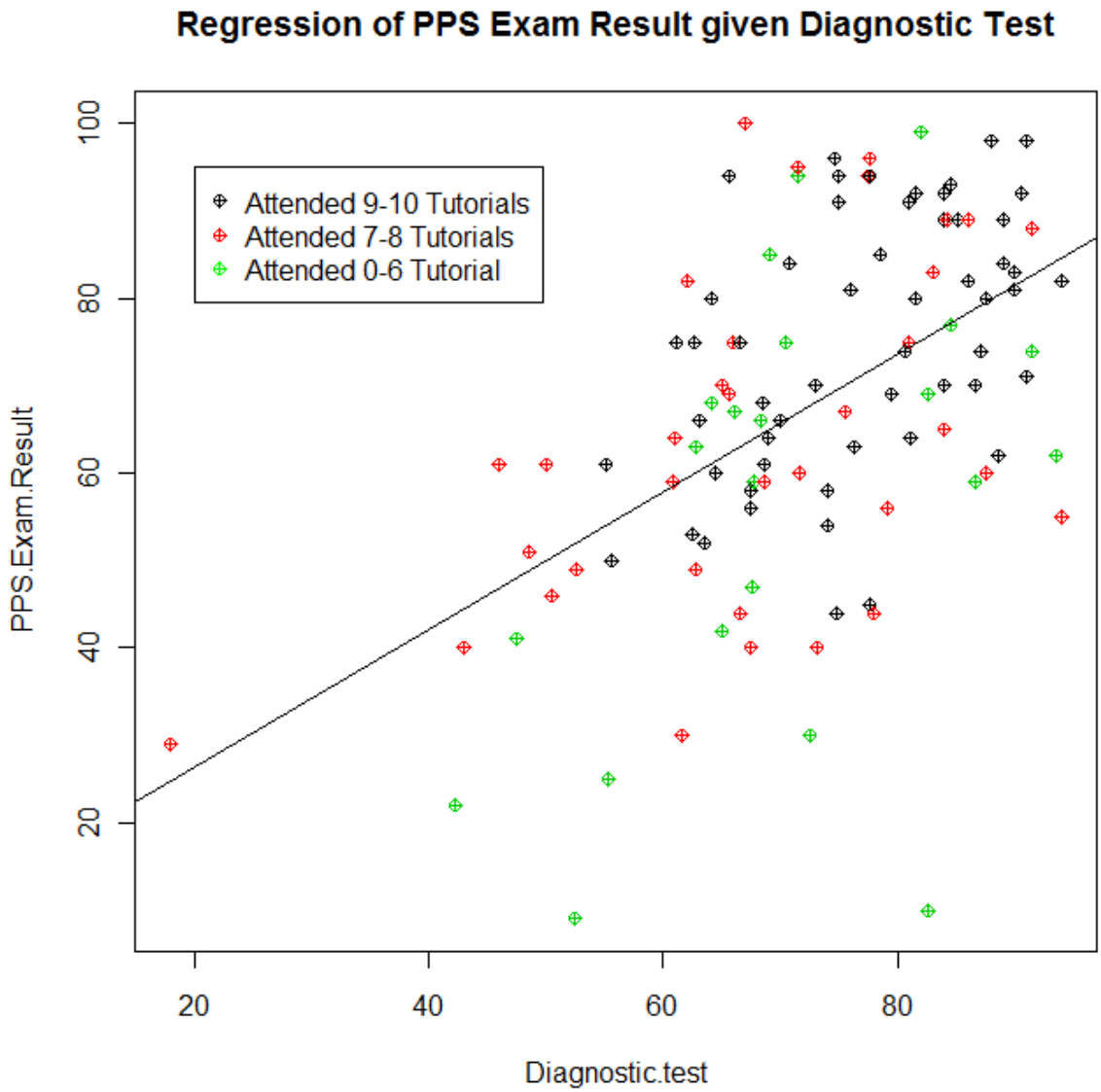
Residual Standard Error = 14.7

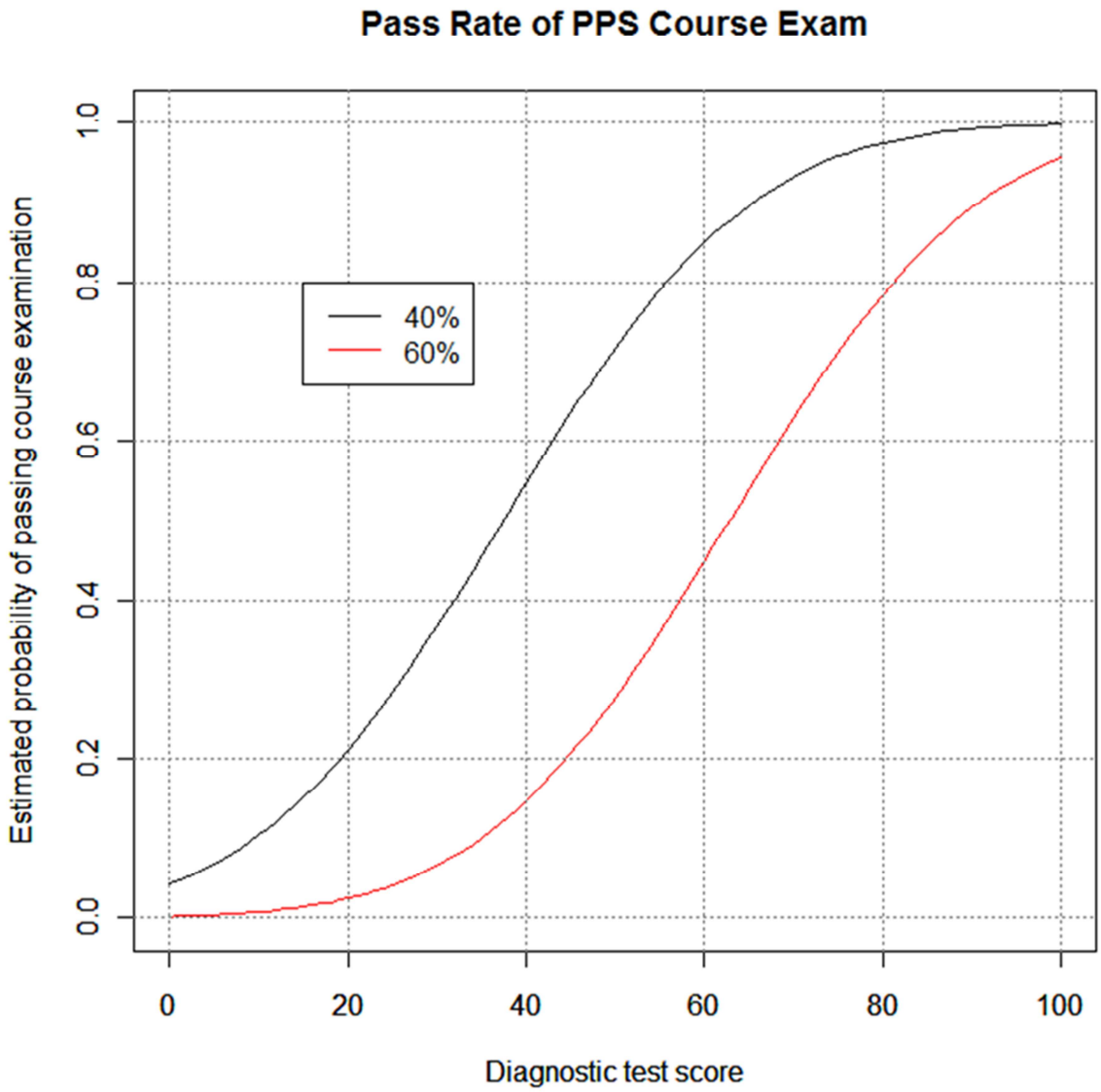


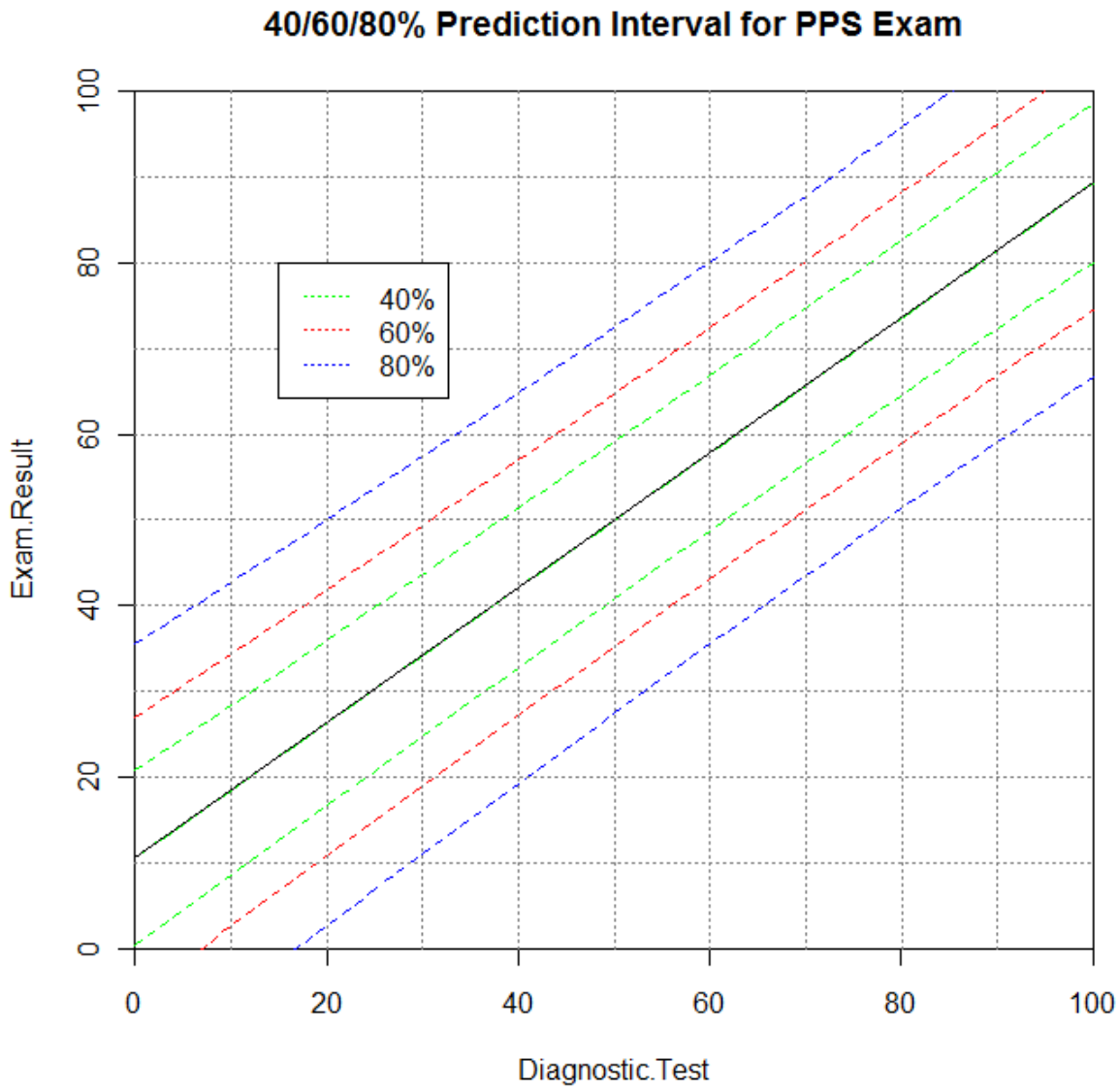
Model:

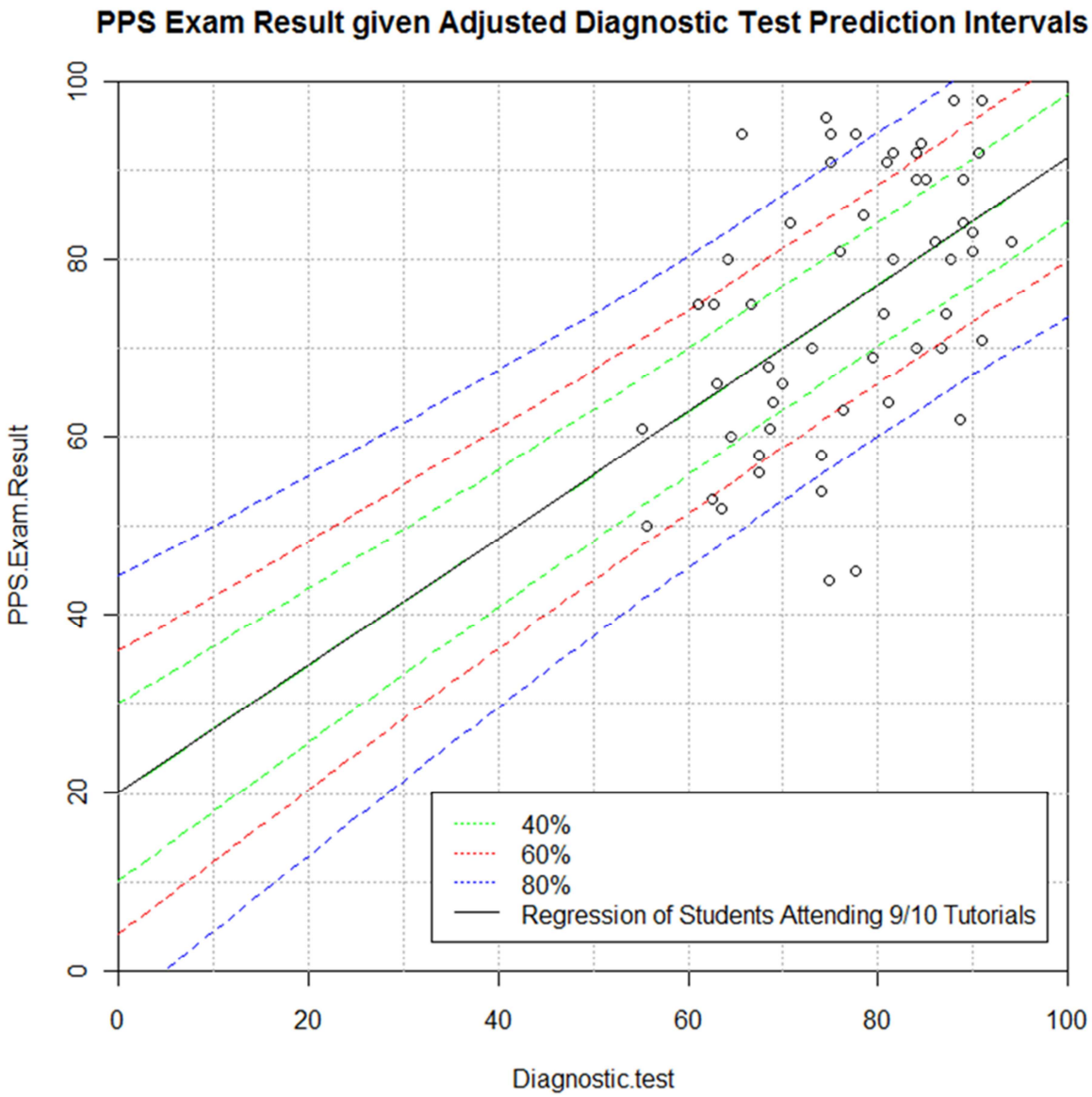
PPS Exam Result = 10.5345 + 0.7874*Diagnostic Test

Residual Standard Error: 17.15


Regression of PPS Exam Result given Diagnostic Test
Attended 9-10 Tutorials
Attended 7-8 Tutorials
Attended 0-6 Tutorial
PPS.Exam.Result
Diagnostic.test
20
40
60
80
100


Pass Rate of PPS Course Exam
Estimated probability of passing course examination
0.0
0.2
0.4
0.6
0.8
1.0
40%
60%
0
20
40
60
80
100
Diagnostic test score


40/60/80% Prediction Interval for PPS Exam
Exam.Result
Diagnostic.Test
40%
60%
80%
0
20
40
60
80
100

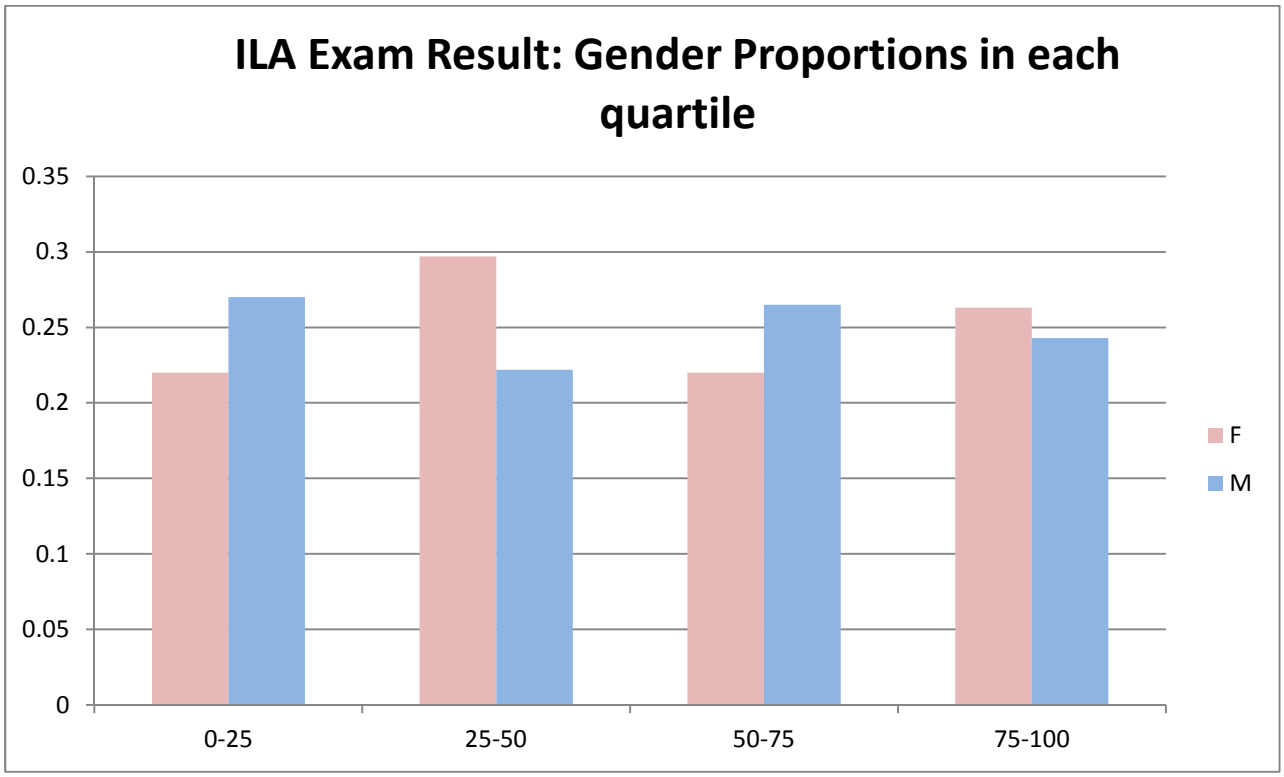


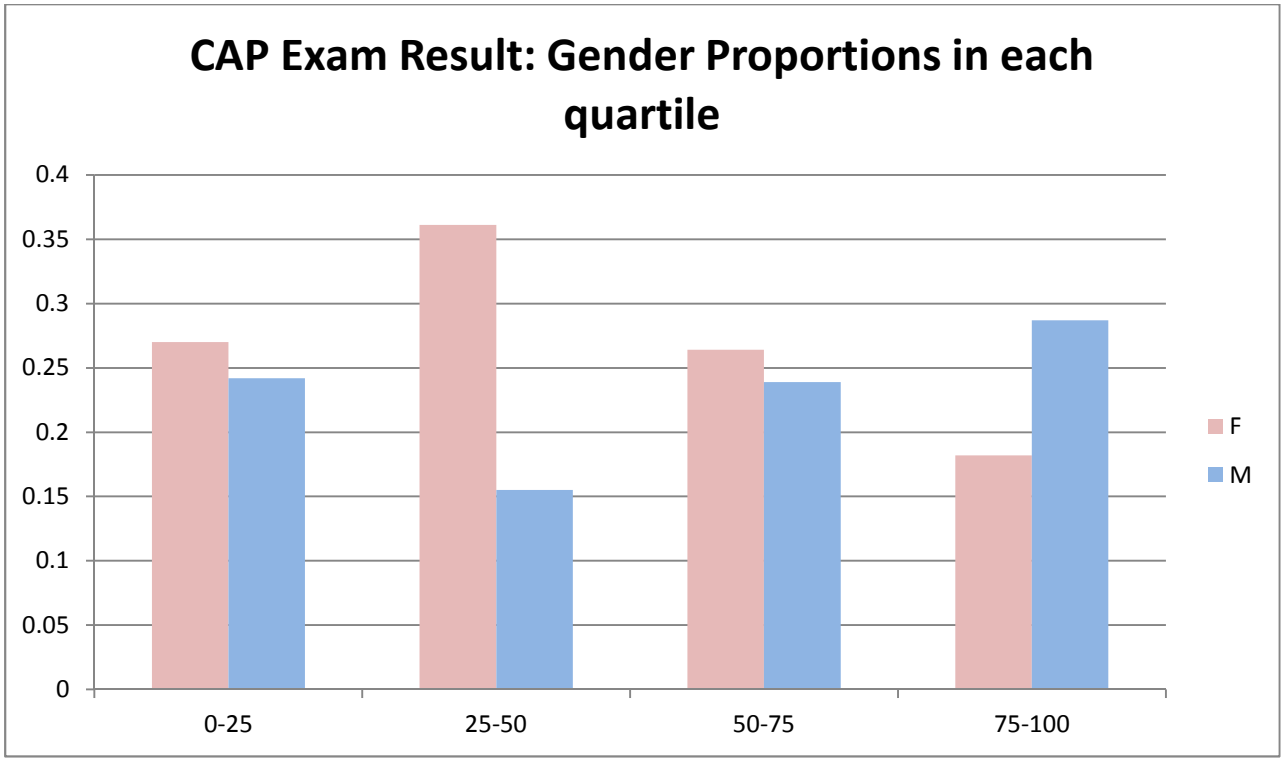
Model:

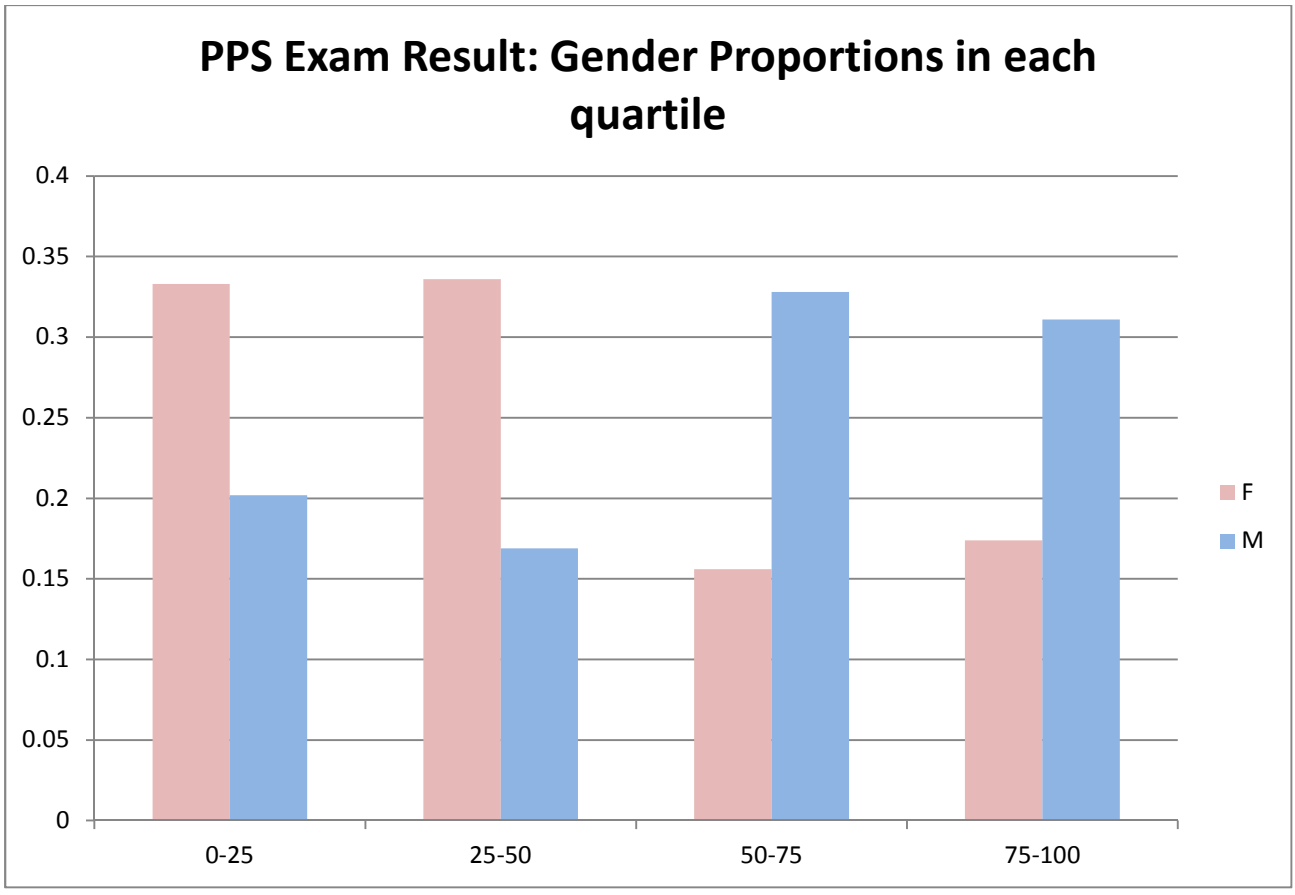
PPS Exam Result = 20.0833 + 0.7137*Diagnostic test

Residual Standard Error: 13.03

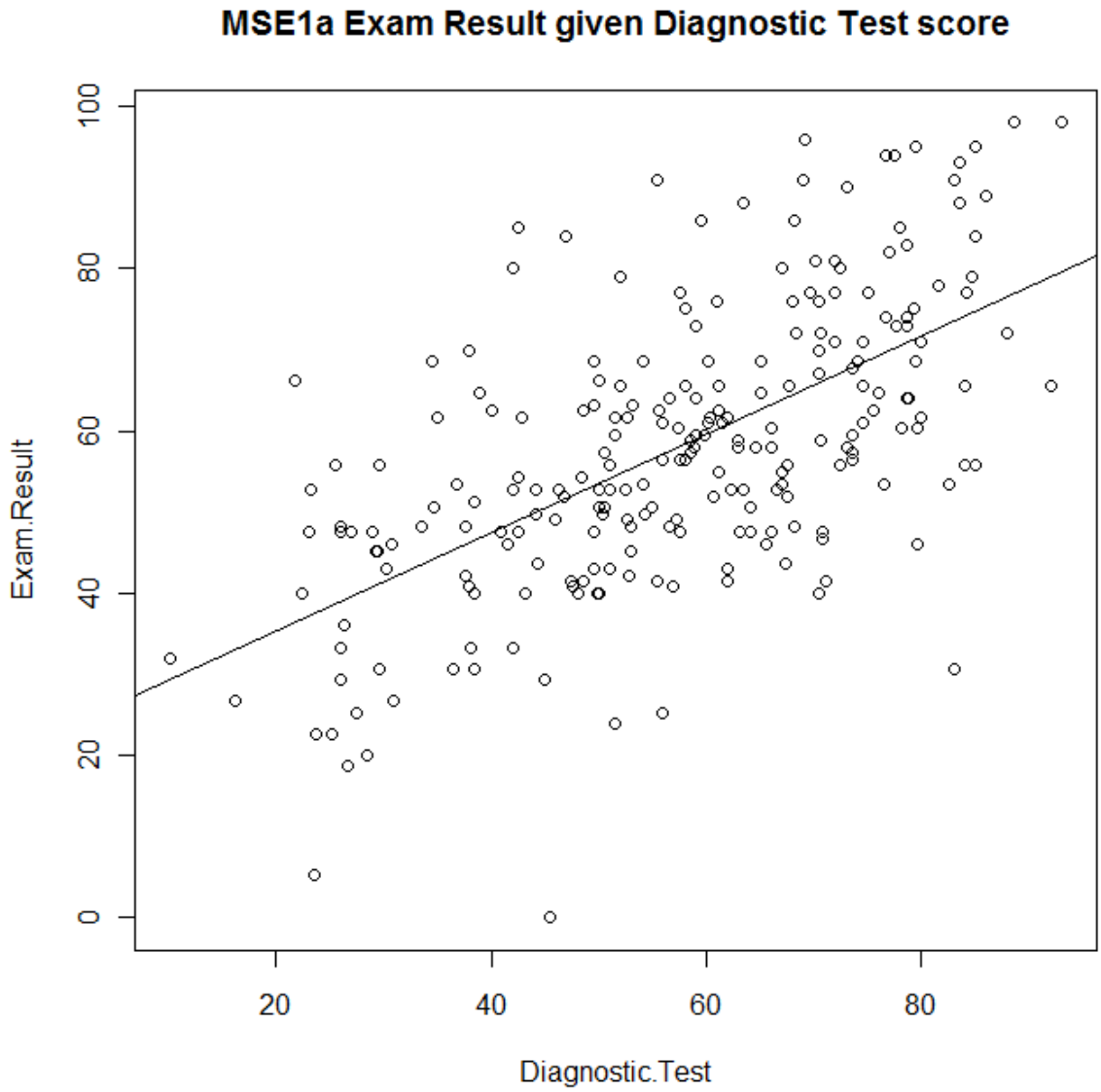
Gender Analysis




CAP Exam Result: Gender Proportions in each quartile
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0-25
25-50
50-75
75-100
F
M


PPS Exam Result: Gender Proportions in each quartile
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0-25
25-50
50-75
75-100
F
M

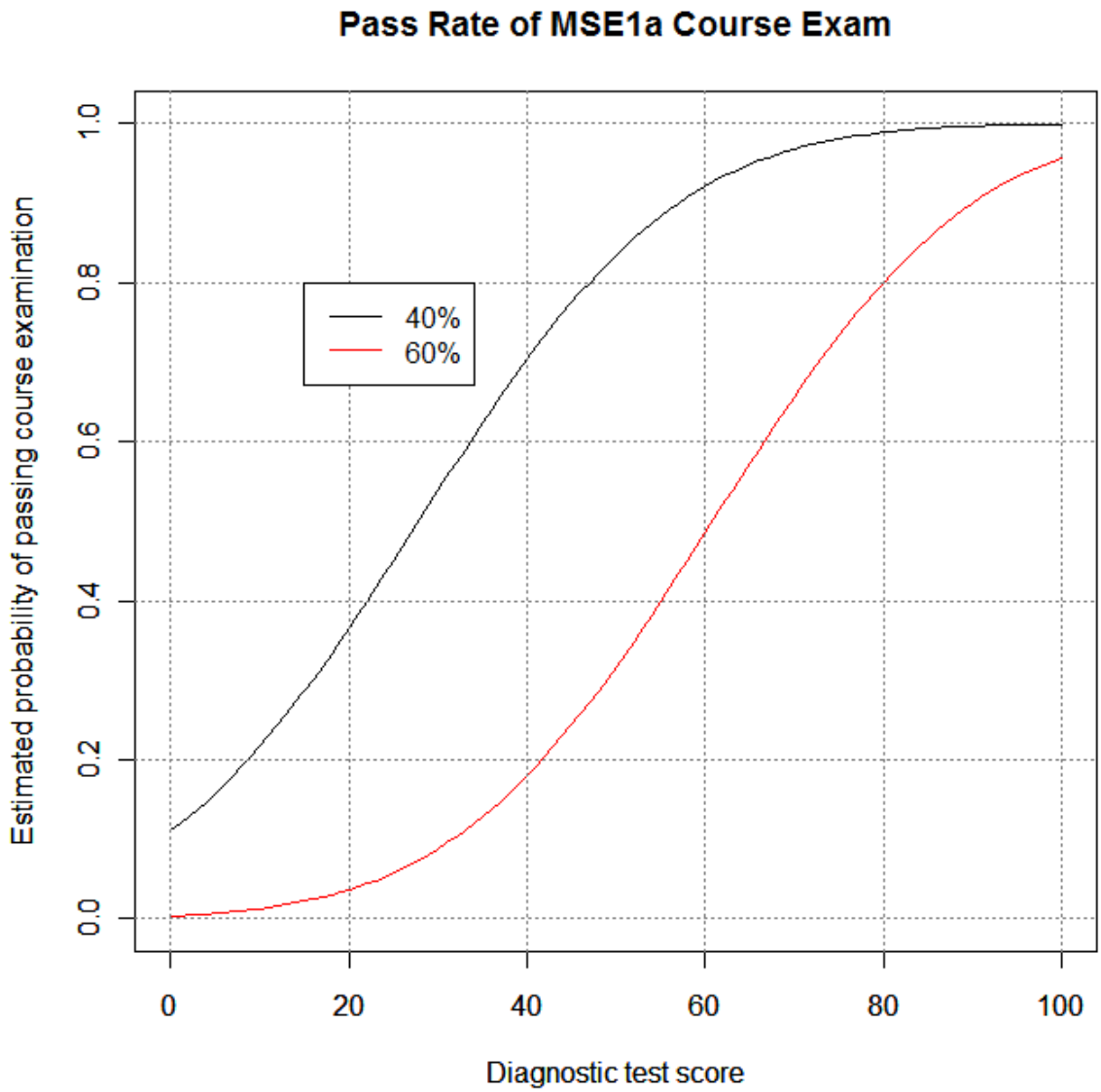
MSE Analysis

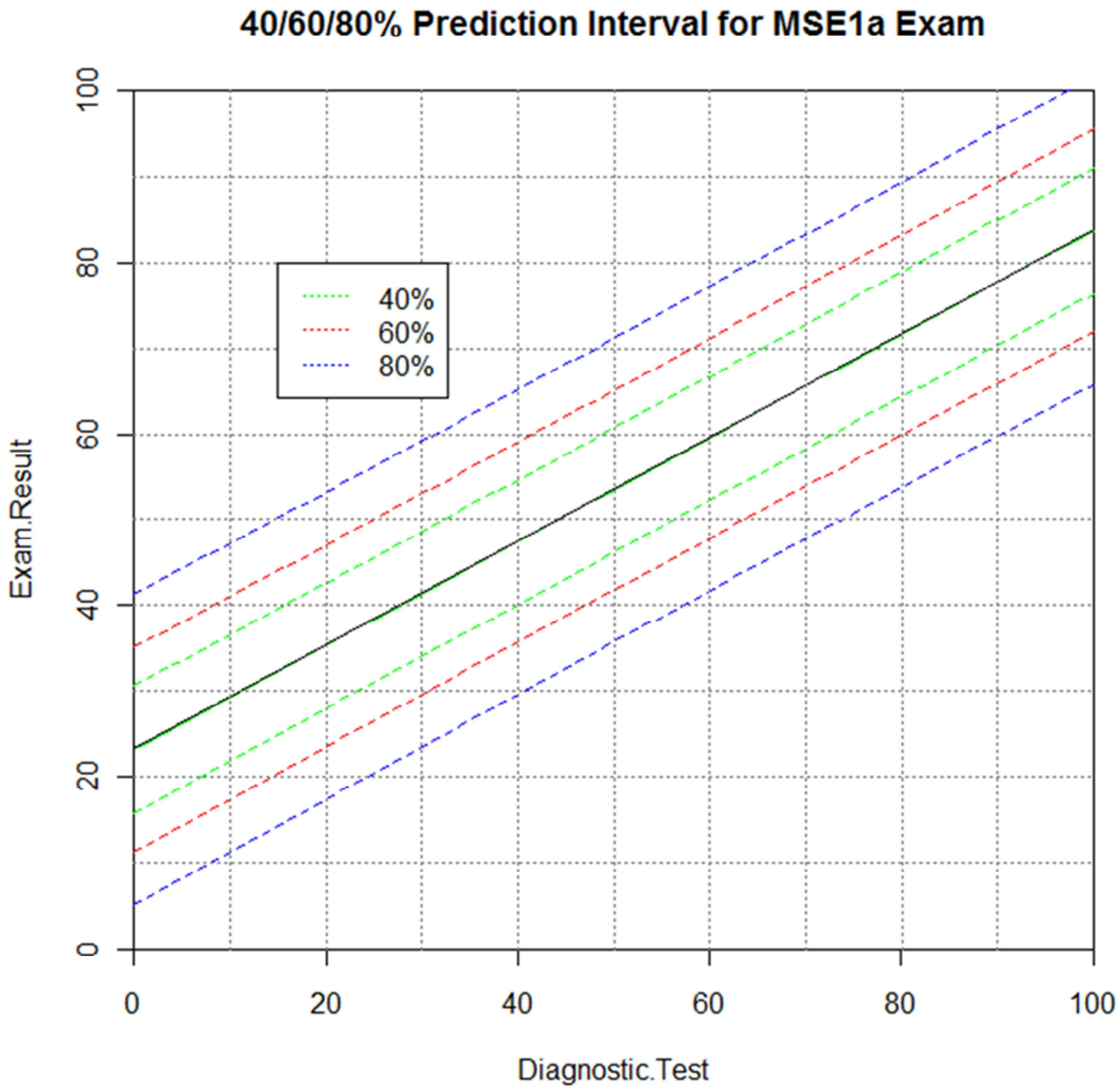


Model:

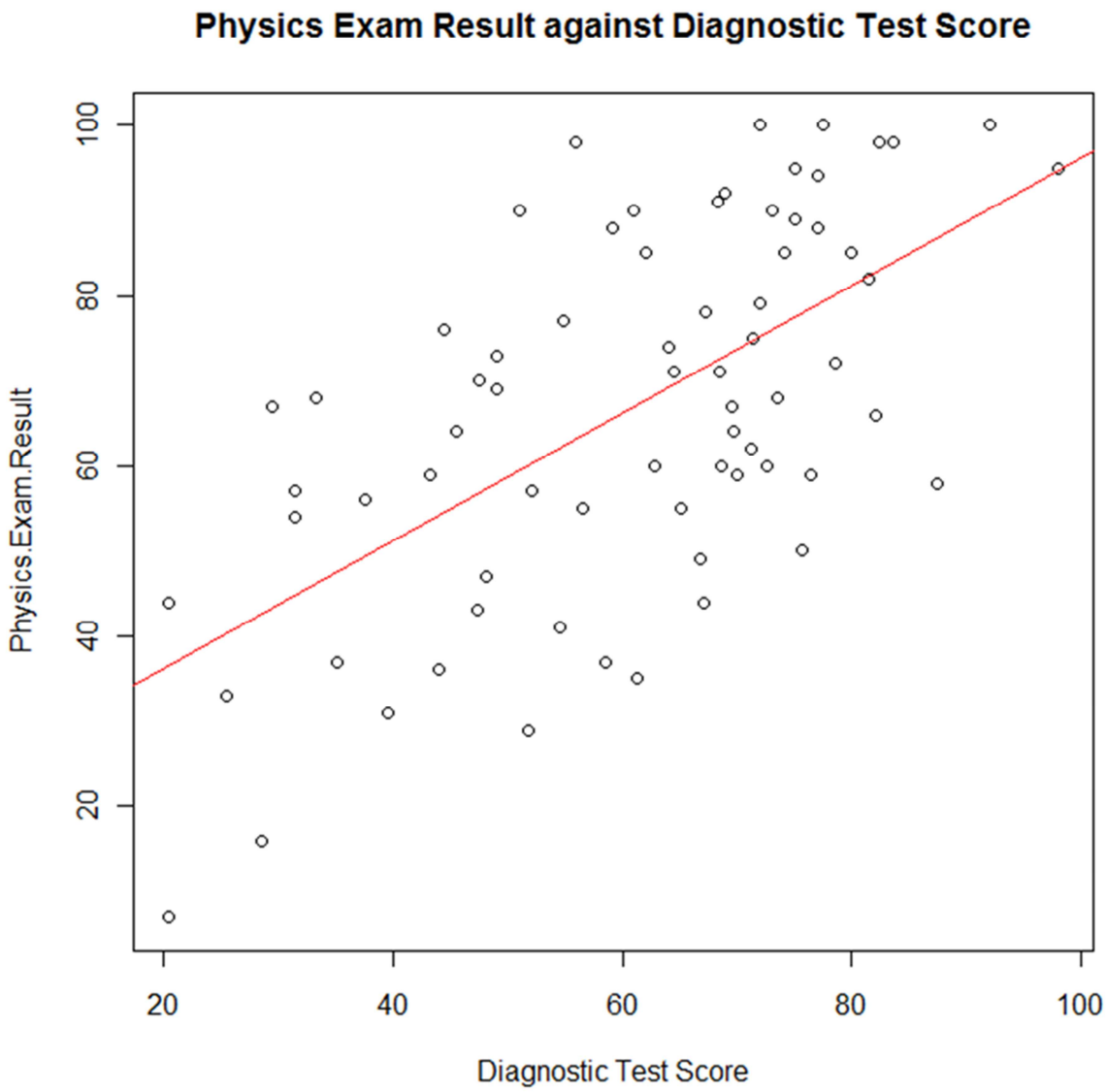
MSE1a Exam Result = 23.15988 + 0.60576*Diagnostic Test

RSE: 13.8


Pass Rate of MSE1a Course Exam
Estimated probability of passing course examination
0.0
0.2
0.4
0.6
0.8
1.0
40%
60%
0
20
40
60
80
100
Diagnostic test score


40/60/80% Prediction Interval for MSE1a Exam
Exam.Result
Diagnostic.Test
40%
60%
80%
0
20
40
60
80
100

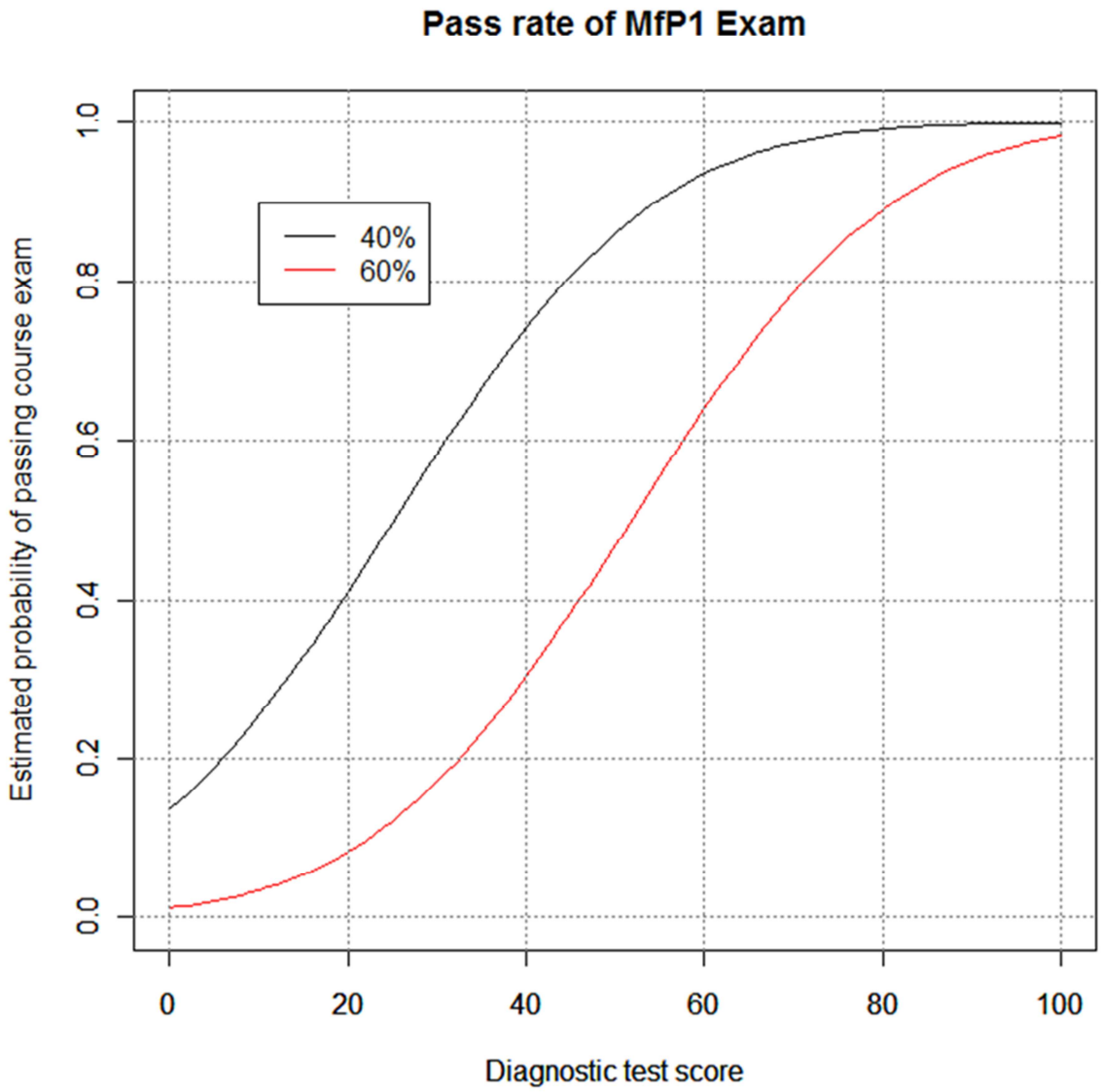
Maths for Physics 1

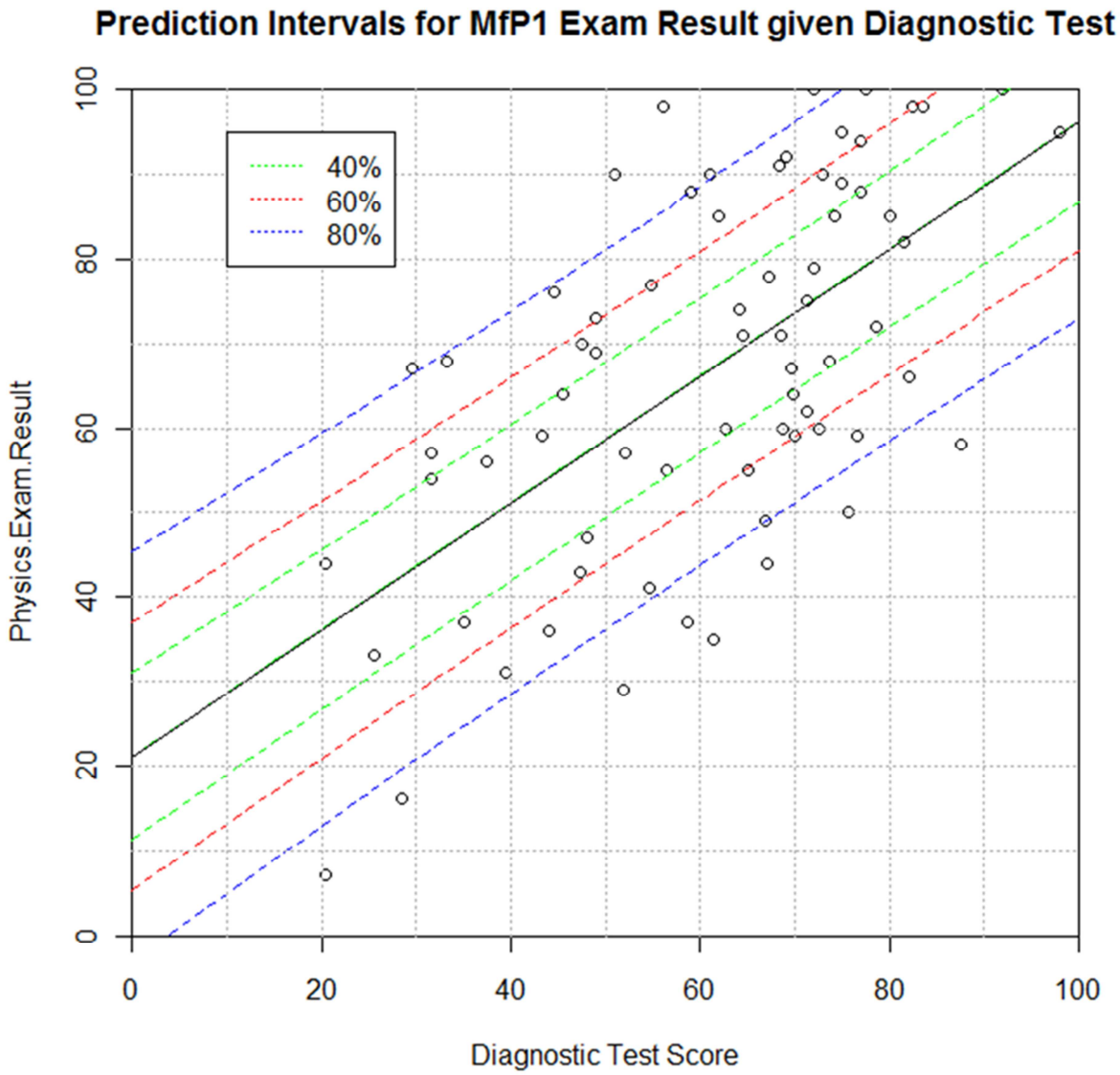


Model:

MfP1 Exam Result = 21.0996 + 0.7513*Diagnostic Test

Residual Standard Error: 17.23


Pass rate of MfP1 Exam
Estimated probability of passing course exam
0.0
0.2
0.4
0.6
0.8
1.0
40%
60%
0
20
40
60
80
100
Diagnostic test score


Prediction Intervals for MfP1 Exam Result given Diagnostic Test
40%
60%
80%
Physics.Exam.Result
Diagnostic Test Score
0
20
40
60
80
100

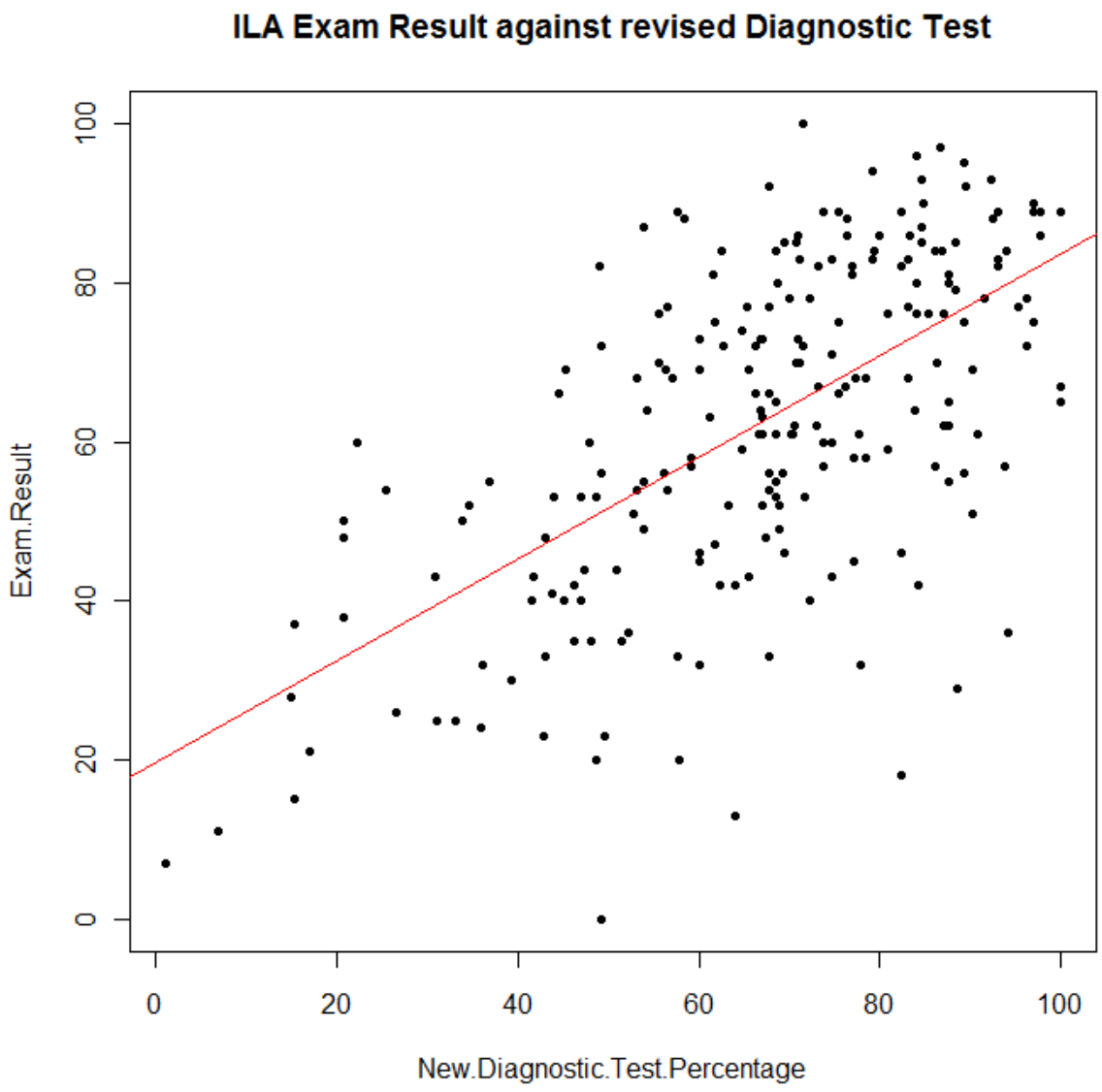
Reduced 20 Questions (IRT)

The diagnostic test we have analysed included 32 items which we have cut down to 20 items in order to make the test shorter. We based our selection of which questions to keep in the test using Item Response Theory. When doing this we took the complete data set of students from all courses that had sat the diagnostic test and looked at their individual question marks. Using a model in R and also using a program called WinBUGS we managed to produce a-values which described the discriminating value of the question and also b-values which described the difficulty of each question. We aimed to keep questions with particularly high a-values and discard those which had low discriminating values. The 12 questions we eliminated were:

1, 2 ,4 ,5 ,6 ,9 ,10 ,12 ,16 ,21 ,22 ,31.

Using the revised diagnostic test score from the 20 questions kept, we reran our previous analyses:

Introduction to Linear Algebra



Model:

ILA Exam Result = 19.73274 +0.63804*Diagnostic Test

RSE: 16.43

Combined Model:

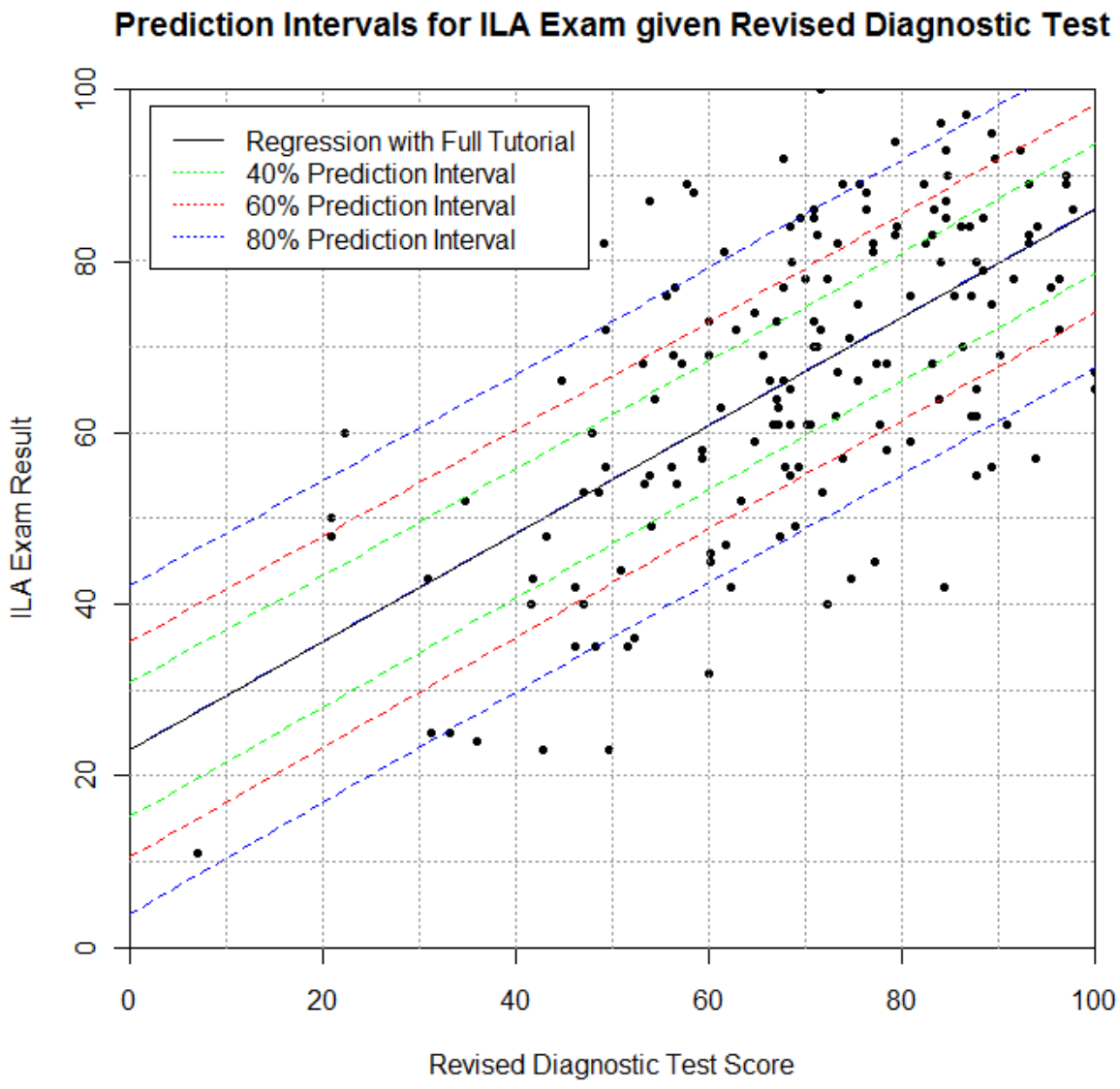
ILA Exam Result = -8.63071 + 0.60072*Revised Diagnostic Test + 3.47347*Tutorial Attendance

RSE: 15.22

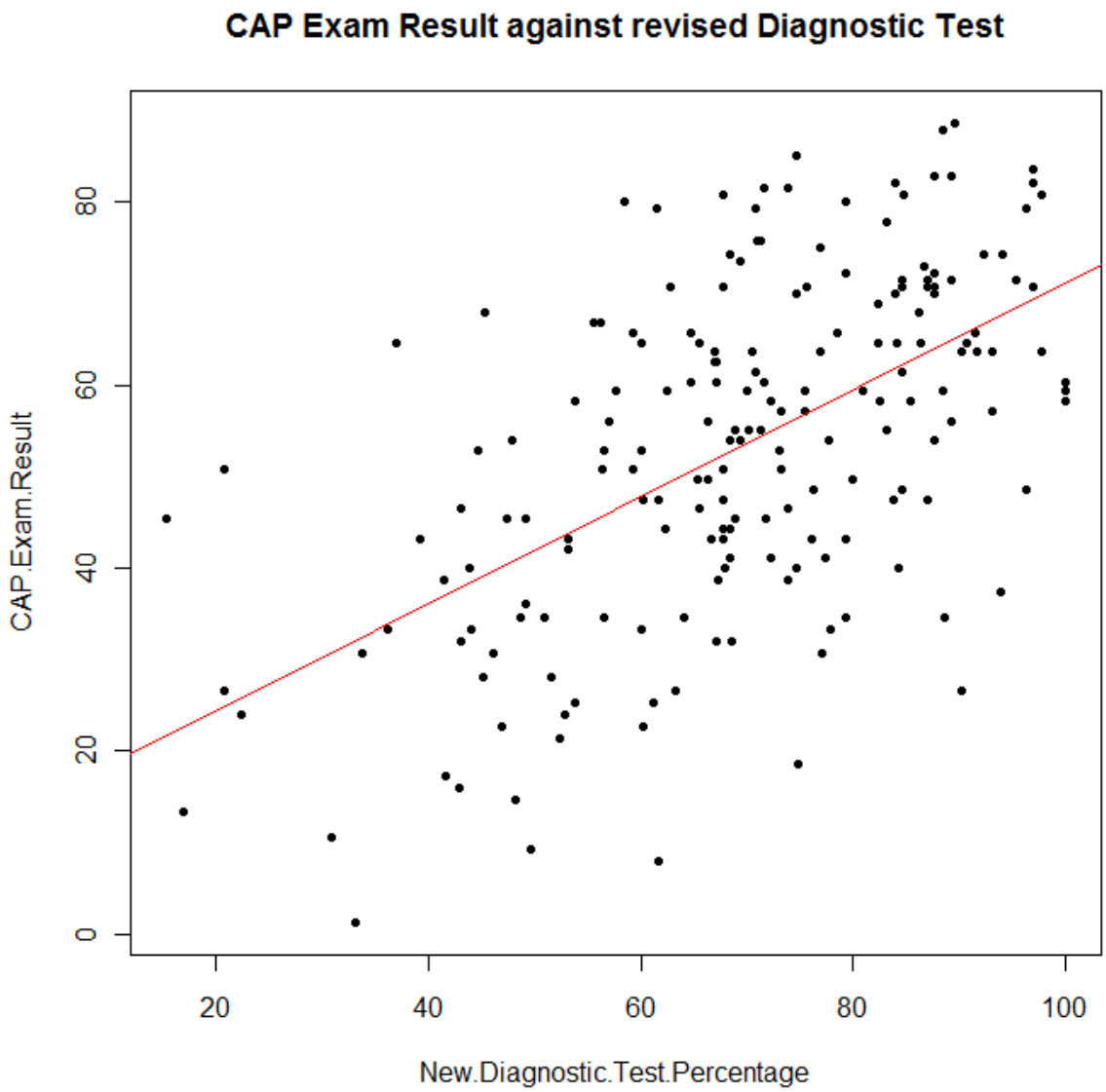
Full Tutorial Attendance Model:

ILA Exam Result = 23.05305 + 0.63032*Revised Diagnostic Test

RSE: 14.21 (All three models highly significant as in the original analysis)



Calculus (CAP)



Model:

CAP Exam Result = 12.78068 + 0.58377*Revised Diagnostic Test

RSE: 15.29

Combined Model:

CAP Exam Result = -4.91656 + 0.55641*Revised Diagnostic Test + 2.34015*Tutorial Attendance

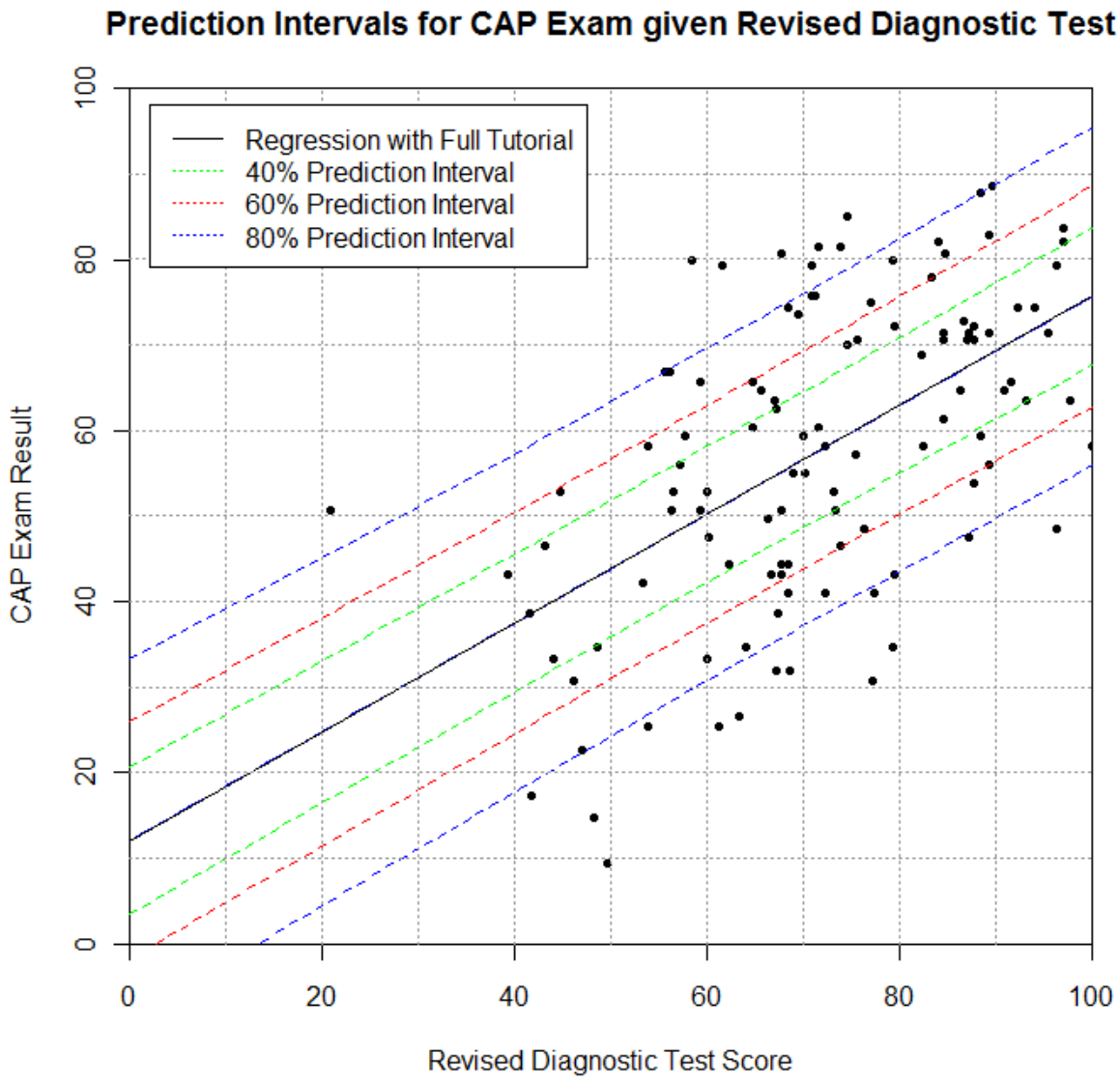
RSE: 14.71

Full Tutorial Attendance Model:

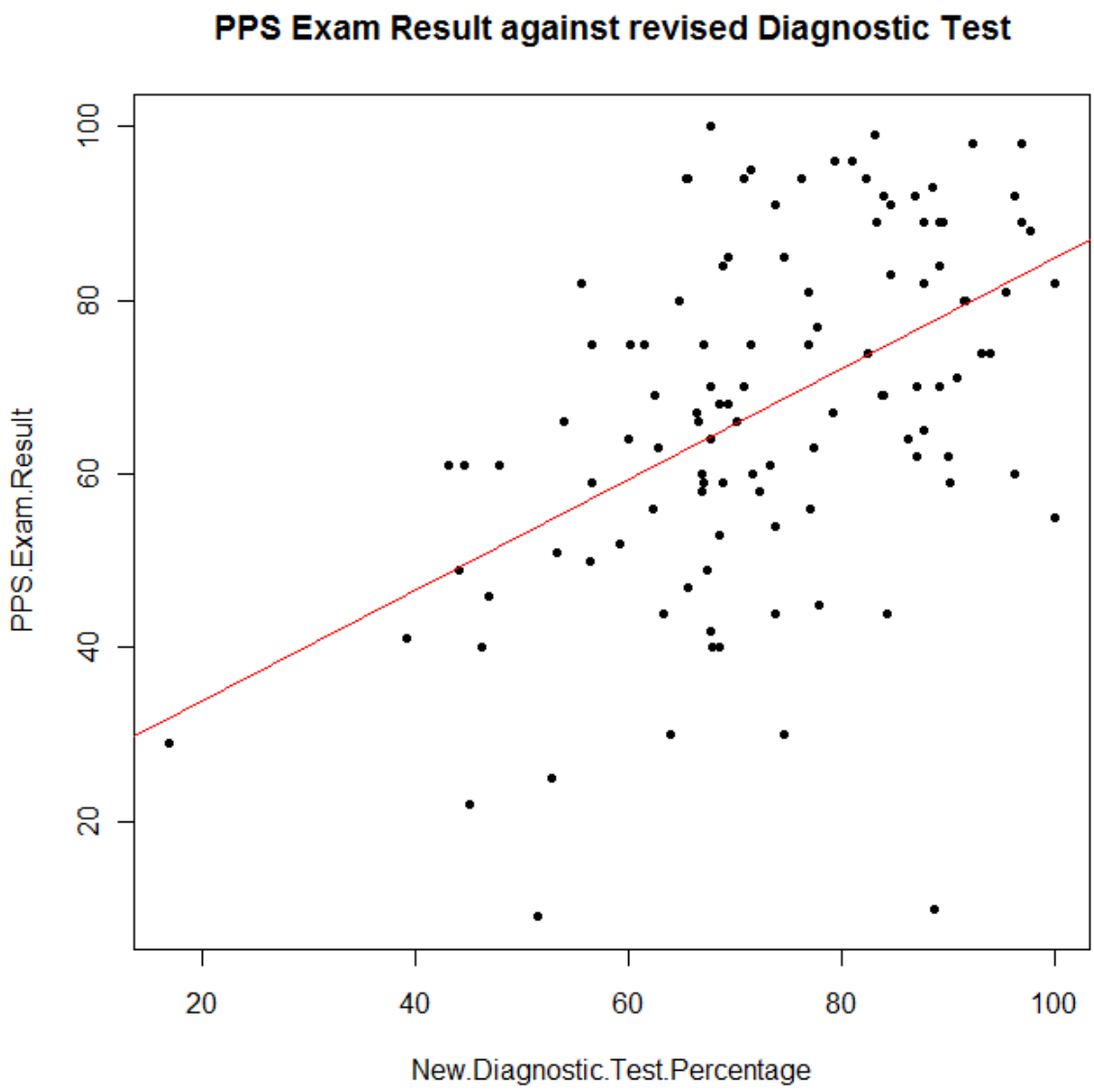
CAP Exam Result = 12.05176 + 0.63603*Revised Diagnostic Test

RSE: 14.99

(All three models highly significant as in the original analysis)



Proofs and Problem Solving



Model:

PPS Exam Result = 21.2168 + 0.6356*Revised Diagnostic Test

RSE: 17.56

Combined Model:

PPS Exam Result = 0.5203 + 0.5661*Revised Diagnostic Test + 3.2064*Tutorial Attendance

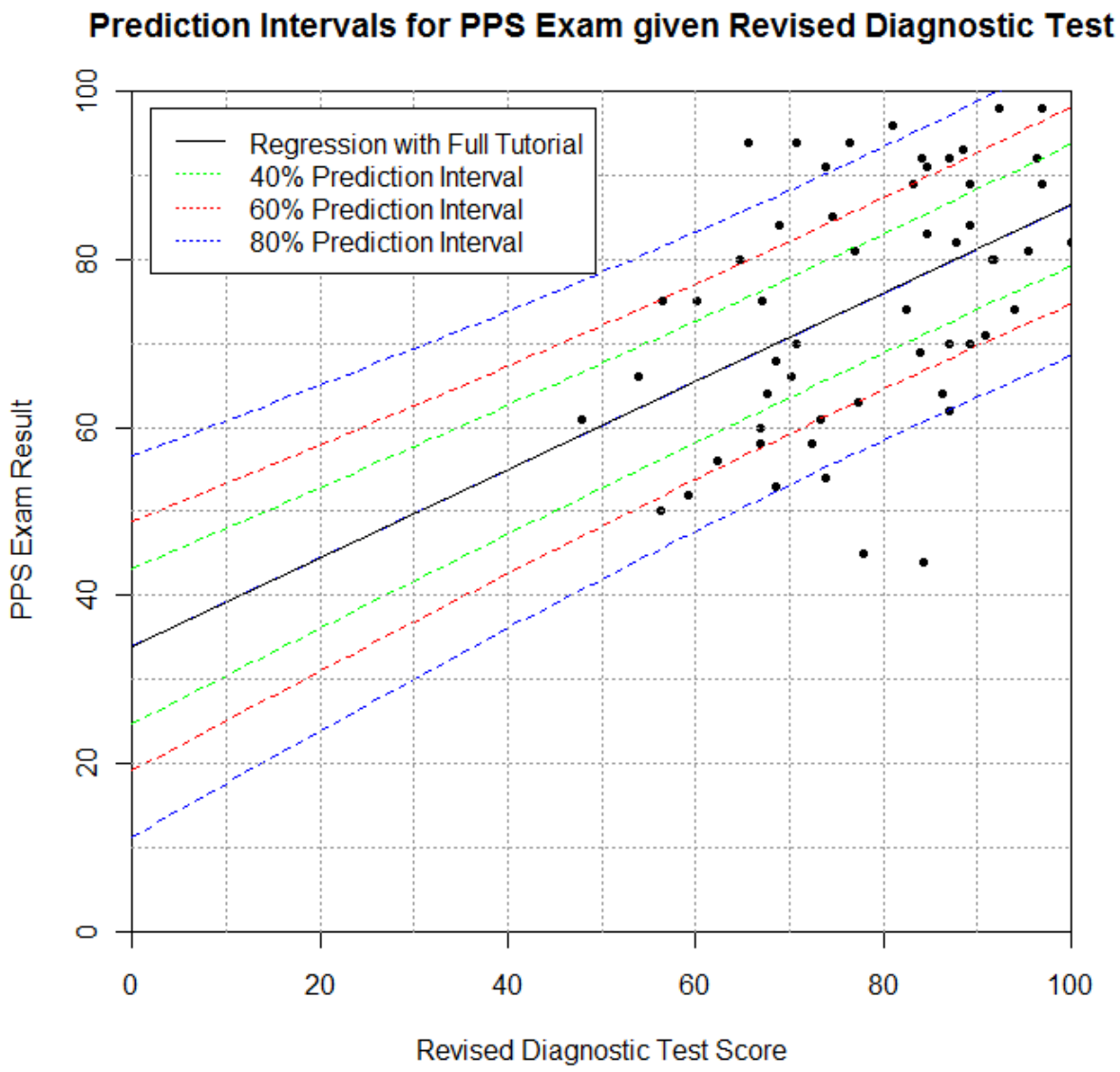
RSE: 16.4

Full Tutorial Attendance Model:

PPS Exam Result = 33.9488 + 0.5251*Revised Diagnostic Test

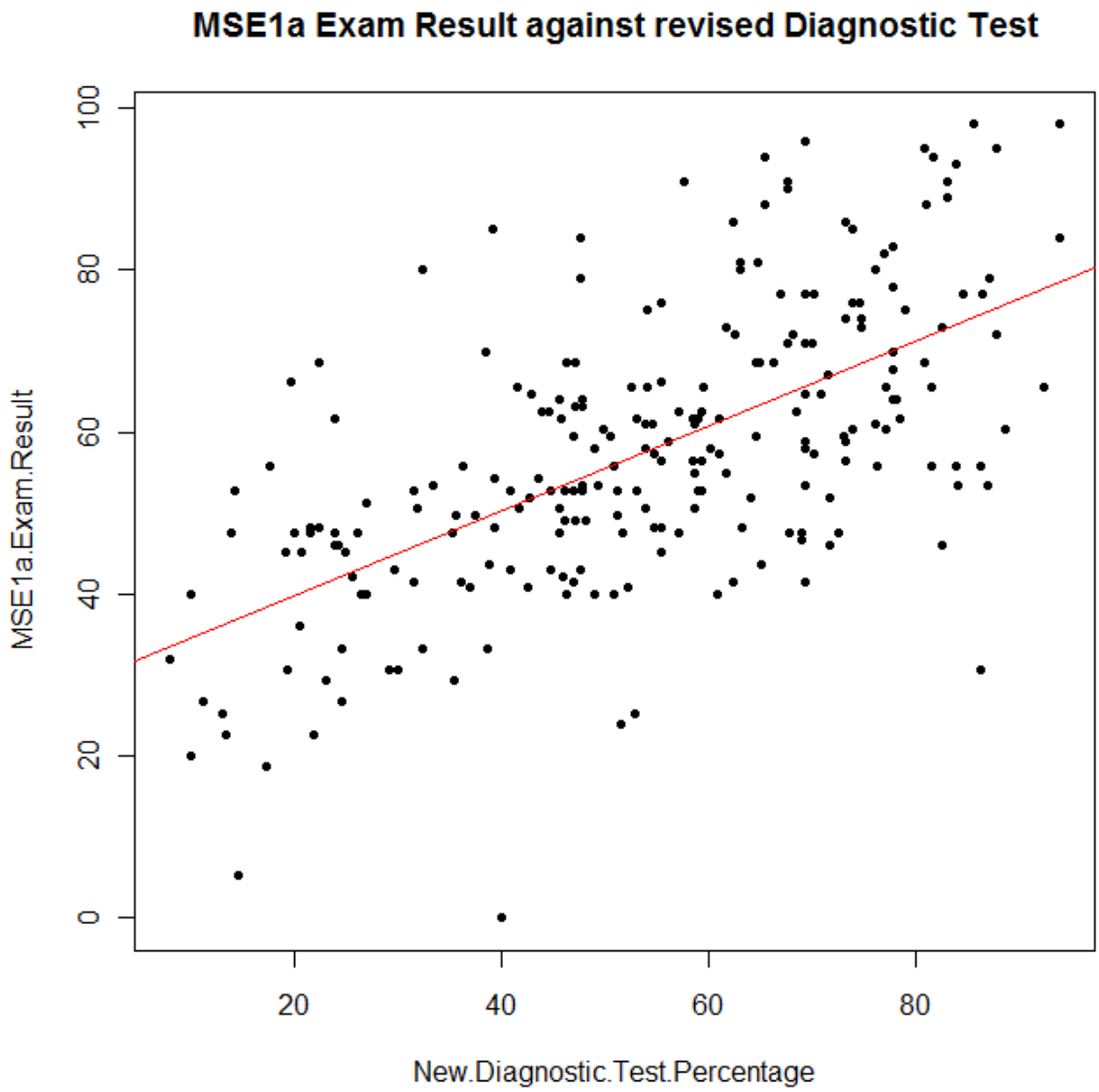
RSE: 13.35

(All three models highly significant as in the original analysis)



(Note: much fewer students in this data set)

Maths for Science and Engineering 1a



Model:

MSE1a Exam Result = 29.33438 + 0.52439*Revised Diagnostic Test

RSE: 13.73

(Again the model is highly significant as in the original analysis)