Portfolio part 3

Multivariate linear models

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Github: https://github.com/nanmat/Assignment-3-4.-semester/blob/master/Portfolio%203.Rmd

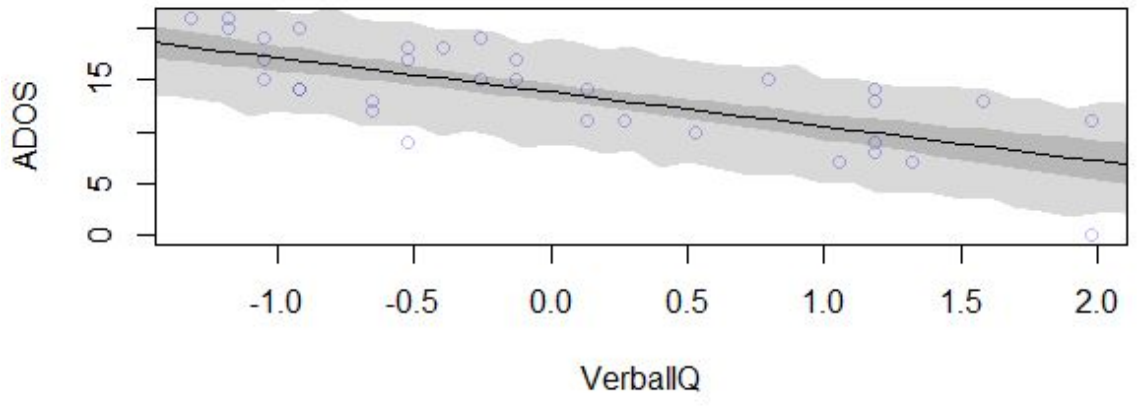
1. Assess the relation between symptom severity and IQ (focus on visit 1 and children with ASD) and report the model, a plot of the model, a couple of lines describing the quality of the model and interpreting the results

We wanted to assess the relation between symptom severity and IQ. The IQ measurements are: social, verbal, and nonverbal IQ. To compare and use all three measurements, we scaled the values of social IQ, verbal IQ, and nonverbal IQ. By doing so, we worked with standardized values.

We chose the same prior for all three models. The prior for the intercept was set to (mu = 13, sigma = 10) because the mean of ADOS was 13 and as we do not know about the relation of Social IQ and ADOS, we chose a wide prior. For the beta of Social IQ and for sigma, we chose the prior (mu = 0, sigma = 5), because we had scaled the variables, meaning that the mean is zero in standard deviation. The sigma was set to 5, in order to be versatile, thus being able to fit the entire data. This was a quite broad sigma, chosen deliberately, in order to have a prior, which does not influence the direction of our analyses, as we have little prior knowledge of how ADOS affects IQ, or vice versa.

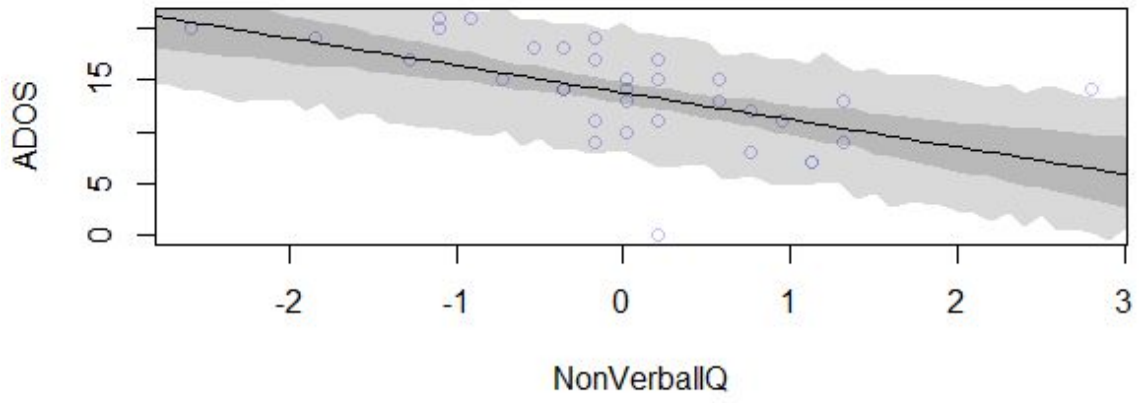
1.1. Verbal IQ and ADOS

The plot below displays the relation between symptom severity, measured in ADOS, and IQ. The IQ in this case, is Verbal IQ. The model displays a mean of ADOS 13.81 (sd=.54, 5.5%=12.95, 94.5%=14.68). The beta of the model appears to be negative. For every ADOS decrease, the score of verbal IQ descends with -3.32 standard deviations (sd=0.55, 5.5%=4.19, 94.5%=2.44). This is visualized in the negatively tilted line in the plot below. The model had a mean error value of 3.16 standard deviations, (sd=.38, 5.5%=2.55, 94.5%=3.78). The plot shows that most of the data points are fitted snugly to the line, within the shaded area of the model error.



1.2. Non Verbal IQ and ADOS

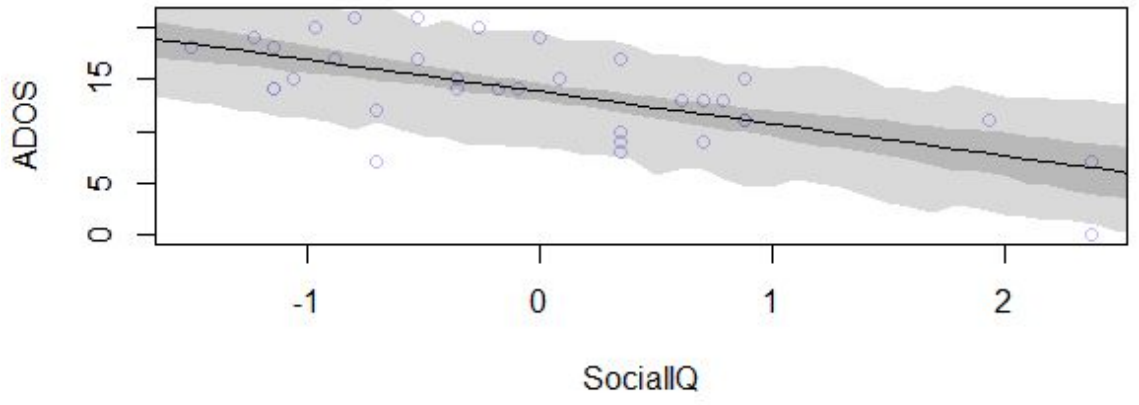
The plot below displays a negative relation between ADOS score and score of non verbal IQ. For every value of ADOS, the model has a negative beta value for non verbal IQ, descending 2.64 standard deviations (b=-2.64, sd=0.64, 89% intervals; 5.5%=3.67, 94.5%=1.61). This model had a mean error value of 3.73 standard deviations (b=3.73, sd=0.45, 89% intervals; 5.5%=3.01, 94.5%=4.46). Looking at the plot, the model can be perceived as sufficiently fitting the data, with only one more extreme outlier.



1.3. Social IQ and ADOS

The model displays that the posterior mean for Social IQ is -3.07 (SD = 0.59, 89 % interval; 5.5% = -4.01, 94.5% = -2.13). For each increase in Social IQ, the score of ADOS decreases with -3.07 SD. The model had a mean error value: 3.40 SD (SD=0.41, 5.5%=2.74, 94.5%=4.06). The higher the Social IQ, the lower the symptom severity is. Therefore, lower Social IQ can be suggested to be related to autism.

The plot shows the relation between Social IQ and symptom severity called ADOS. The data points follow the slope of the regression line and are within the area of the mean error value, only two obvious outliers. With this in mind, the model is sufficient to describe the relation.



2. Do the different aspects of IQ account for different portions of the variance in ADOS?

2.1. Does it make sense to have all IQ measures in the same model? First write a few lines answering the question and motivating your answer, including a discussion as to what happens when you put all of them in the same model. Then build a model following your

answer. If your answer is "no", you are not free, you still have to answer: are there alternative ways of answering the question?

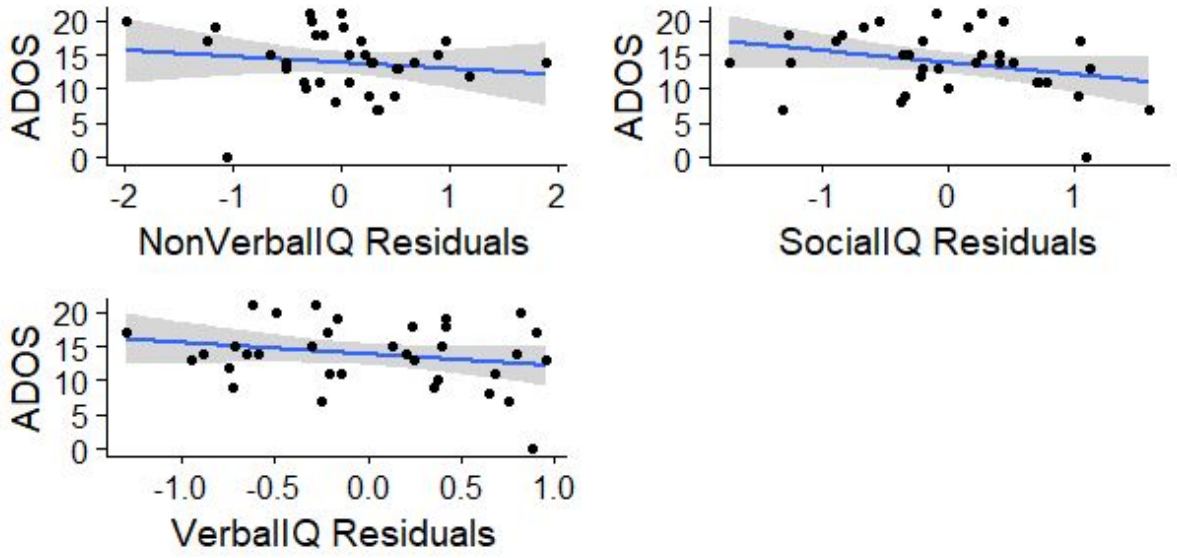
To assess whether it makes sense to include all the IQ measure in the model, a correlation test was performed on the data using cor.test(). The results are displayed below:

Correlation	Verbal IQ	Nonverbal IQ	Social IQ
Verbal IQ	1	0.67	0.61
Nonverbal IQ	0.67	1	0.37
Social IQ	0.61	0.37	1

Looking at the results, we see that the correlation between verbal IQ and nonverbal IQ, as well as the correlation between social IQ and verbal IQ are relatively high, indicating that they explain some of the same variance. However, we suspect that they still contribute individually in predicting ADOS, as the correlation is still pretty far from perfect correlation.

Social IQ and nonverbal IQ on the other hand are only slightly correlated, indicating that they explain different partitions of the variance associated with ADOS.

To further investigate the individual contributions of each IQ measure, we plot the ADOS score as a function of the residuals from each measure. This is done to visualize the unique contribution of each variable in explaining ADOS.



From the plots, we see that each IQ measure contributes uniquely in explaining ADOS. However the unique contribution seem to be quite low for especially nonverbal and verbal IQ, while the unique contribution of social IQ seem to be a bit higher.

On this basis, it seems sensible to include all three measures of IQ in the final model.

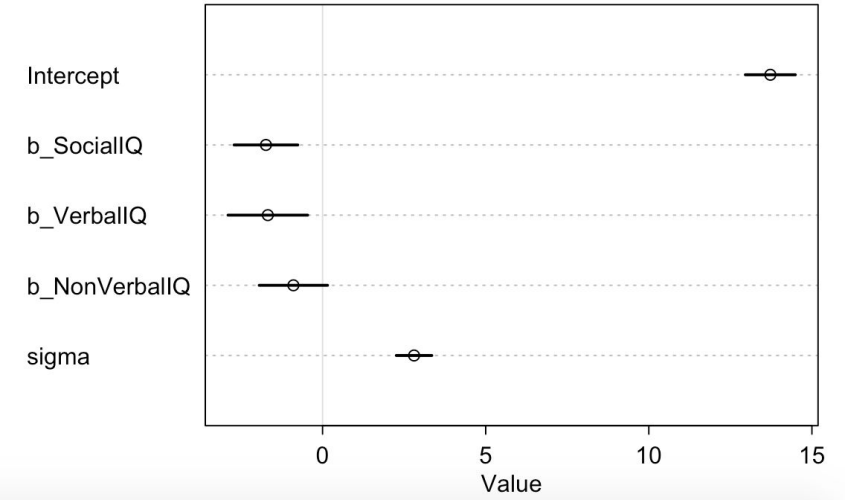
2.2. Build the model, assess its quality, write a few lines interpreting the results.

We build the following model including all three IQ measures:

$$ADOS_i \sim Normal(\mu_i, \sigma)$$
$$\mu_i = \alpha + \beta_{SocIQ} * SocIQ_i + \beta_{VerbIQ} * VerbIQ_i + \beta_{NonVerbIQ} * NonVerbIQ_i$$
$$\alpha \sim Normal(0, 5)$$
$$\beta_{SocIQ} \sim Normal(0, 5)$$
$$\beta_{VerbIQ} \sim Normal(0, 5)$$
$$\beta_{NonVerbIQ} \sim Normal(0, 5)$$
$$\sigma \sim Uniform(0, 10)$$

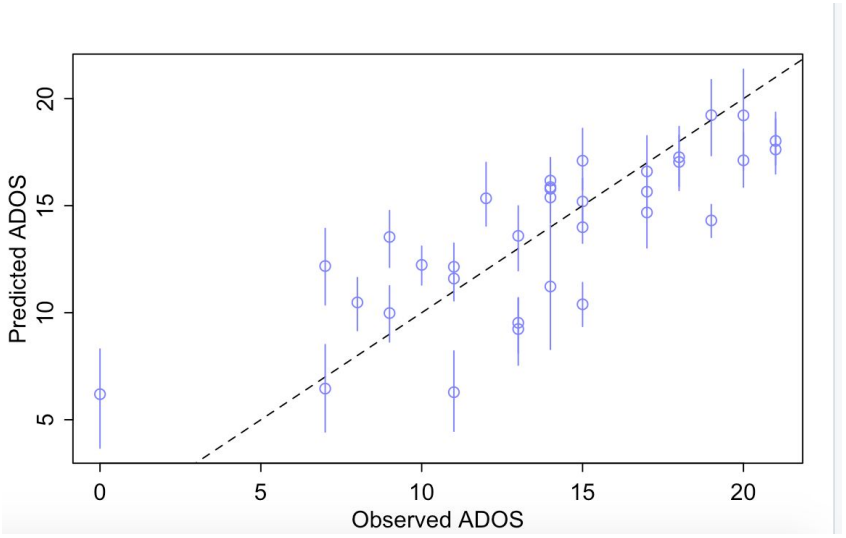
The results can be found below:

	Mean	StdDev	5.5%	94.5%
Intercept	13.73	0.48	12.96	14.49
b_SocialIQ	-1.74	0.61	-2.71	-0.76
b_VerbalIQ	-1.68	0.76	-2.90	-0.46
b_NonVerbalIQ	-0.89	0.66	-1.94	0.15
sigma	2.80	0.34	2.26	3.35



From the model results, we see that all 3 parameters are negatively correlated with ADOS. However looking at 89 percentile interval from the precis() output we see that nonverbal IQ overlap with zero, indicating that this effect is somewhat uncertain.

To test the quality of the model we make a plot to compare the predictions of the model with the actual values of ADOS. The plot can be found below:

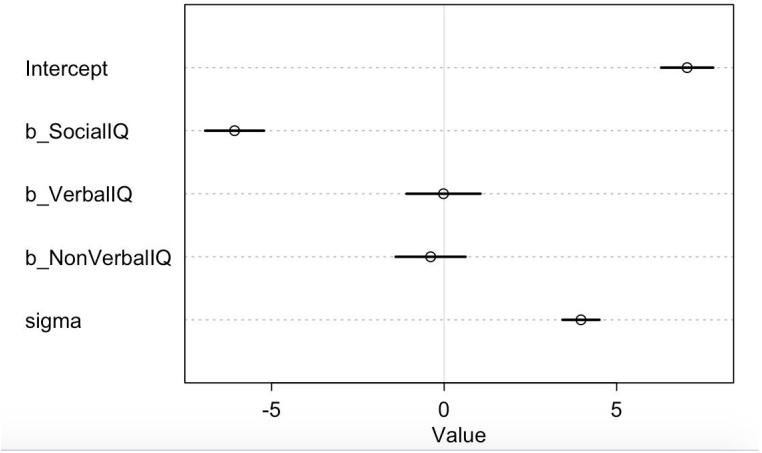


Looking at the predictions of the model compared to the actual values, we see that the model does an okay job at predicting the ADOS values. However, we still see some noise, which appears to be unsystematic. This could be attributed to general uncertainty in the ADOS measurement.

3. Let's now include also the TD children. Does it make sense to ask whether IQ and ADOS are related? Motivate your answer. In any case, if you wanted to build a model to answer that question, which model would you build? Run the model, assess its quality, write a few lines interpreting the results.

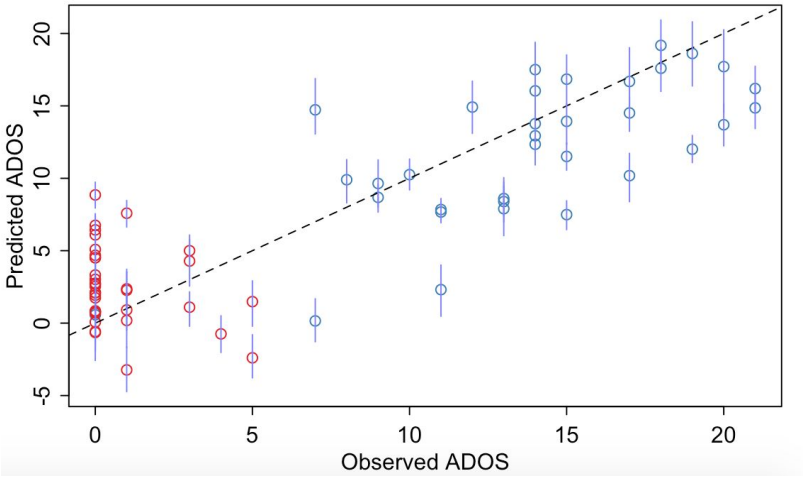
It makes sense to ask whether IQ and ADOS are related, when including TD children, as our previous model, only containing ASD children, showed a relation between ADOS and IQ. We want to investigate, if the relation can prove to also predict the symptom severity for TD children.
We decided to use the same model as in in task 2.2, including the data from the TD children.

	Mean	StdDev	5.5%	94.5%
Intercept	7.04	0.47	6.29	7.80
b_SocialIQ	-6.07	0.53	-6.93	-5.22
b_VerbalIQ	-0.02	0.67	-1.09	1.05
b_NonVerbalIQ	-0.39	0.63	-1.40	0.62
sigma	3.97	0.34	3.43	4.50



When including the TD children, the predictive power of verbal IQ and non-verbal IQ decreases, from when only including ASD children. Social IQ shows to have greater predictive power of ADOS. This makes sense, if you include knowledge about ASD. ASD children tend to have more difficulties in reading social cues.

To make a quality assessment of the model, we made a plot with predicted ADOS as well as the observed ADOS.

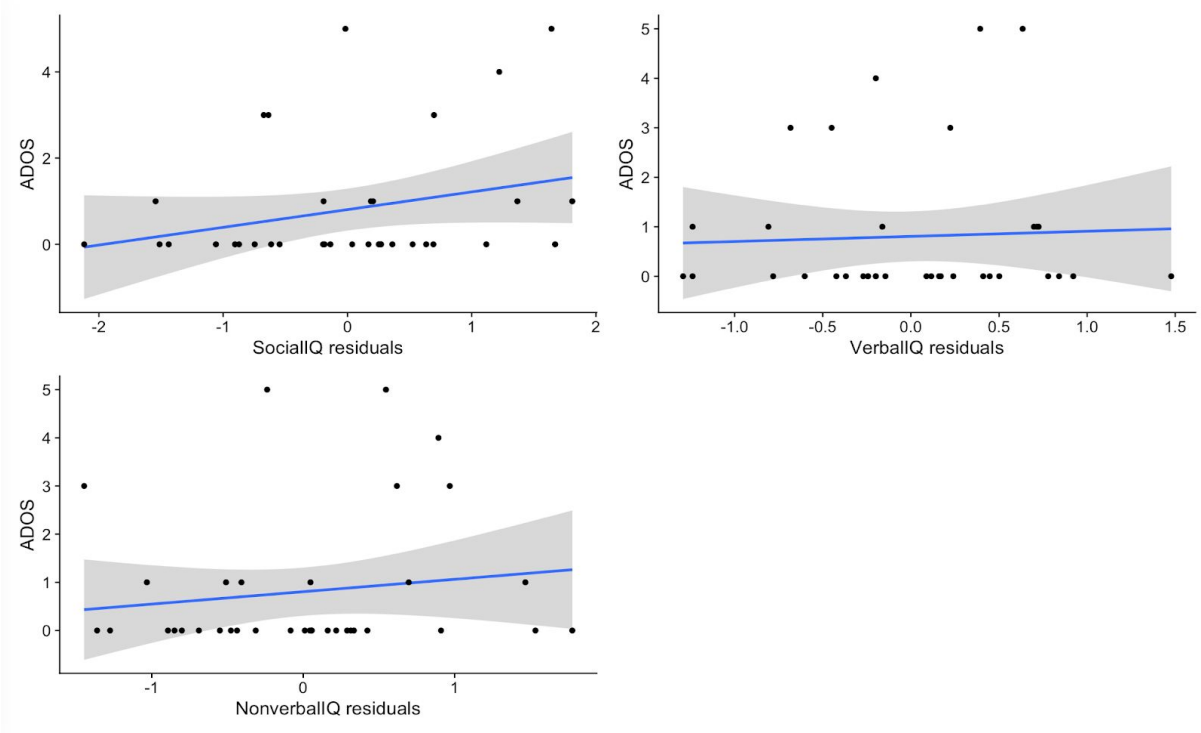


This plot shows, that ASD children follow the predicted ADOS to some extent. The TD children have much uncertainty in the prediction. In some cases, the predicted ADOS is around 8-9, whereas the observed ADOS value is 0.
There still seem to be some unsystematic noise in the data.

4. Let's discuss contents:

4.1. You have three scores for IQ, do they show shared variance? Is that the same in TD and ASD? What does that tell us about IQ?

- Yes they share variance but also seem to contribute uniquely in explaining ADOS in ASDs...



It seems like there is little relationship between ADOS and IQ in TD children. There are many outliers and it is especially noteworthy that there is a positive relationship between social IQ and ADOS meaning that the higher social IQ the child has, the higher the symptom severity of autism is. This does not fit with the knowledge of autism. Autistic children typically have problems reading social cues.
We can therefore conclude that it does not make sense to use IQ as a predictor for ADOS on TD children.

4.2. You have explored the relation between IQ and ADOS. How do you explain that relation from a cognitive perspective? N.B. You can present alternative hypotheses.

This is what we *want* to do, but haven't done yet: We want to run some of the same analyses on TD children, as we have on ASD children. This includes predictive posterior plots, residual plots, etc. and compare these plots to the plots we have found for the autistic children. On the basis of the outcome of these analyses, we will make a prose answer for question 4.