How being in a coma after brain injury impacts IQ and which factors affect the IQ in real life

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1. The main idea

The main ideas of our project are to identify how coma after brain injury influences IQ in different ages by comparing:

1) IQ of people who were in a coma and who were not;
2) IQ of people who were in a coma in different periods;

and identify which personality and demographic factors affect the IQ.

2. Data description

In our project we use three datasets:

- Wrong dataset from carData library in R: post-coma recovery of IQ - observations are longitudinal data on recovery of IQ after comas of varying duration for 200 subjects - consists of those columns
  `id` - patient ID number
  `Days` - number of days post coma at which IQs were measured
  `Duration` - duration of the coma in days.
  `Sex` - a factor with levels Female and Male.
  `Age` - in years at the time of injury.
  `Piq` - performance (i.e., mathematical) IQ.
  `Viq` - verbal IQ.

  Source: Wong, P. P., Monette, G., and Weiner, N. I. (2001) Mathematical models of cognitive recovery. *Brain Injury*, **15**, 519–530.

- VIQT_data.xls - answers to the Vocabulary IQ Test - it consists of 45 vocabulary questions, 30+ personality, and demographic items

  Source: https://openpsychometrics.org/_rawdata/

- cor_gpd.csv - file with countries abbreviator and its GDP in 2018 it is merged from files :
  - countries.txt - file with the countries abbreviations and their names

  Source: https://www.realifewebdesigns.com/web-marketing/abbreviations-countries.asp
  - gdp.cvs - World Bank national accounts data, and OECD National Accounts data files

  Source: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD
  - gdp.py - This program takes the GDP of 2018 year and merges it with the abbreviator of the respective country.

3. Steps

You can see steps in our code and its explanation is below.

SECTION 1 - How being in a coma after brain injury impacts on IQ

STEP 1

After downloading the data with people who were in a coma we are making age as integer and cutting the data to leave only those people, who were in a coma at least 1 day and whose IQ was measured in 100 days after getting out of a coma - we need it for the first research.

STEP 2

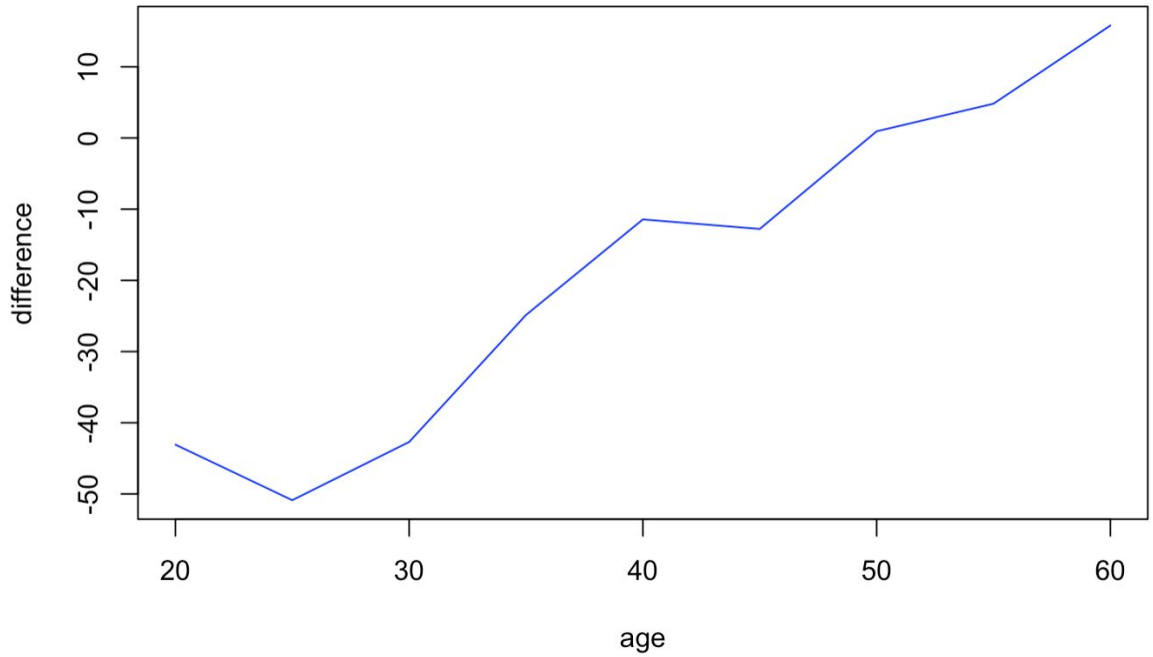
Downloading data with questions for verbal iq, personality, and demographic factors and then expressing IQ through the score_full - score, which is measured by the formula for this IQ test - find it in the 'codebook.txt' file.

STEP 3

This code is the first research - comparing the IQ of the people who were in a coma and who were not. For doing it in the right way we grouped all people by the age - before 20 - from 20 to 25 - from 25 to 30 - and up to 60 like this - so we have 9 groups (for the age after 60 we have not the appropriate number of patients to do the correct research and conclusions)

We counted the mean of IQ in each group for people who were in a coma and for people who were not. As we wanted to see the initial effect of the coma on IQ we should include only people whose IQ was measured at the 'nearest' time after getting out of the coma - that is why we cut the data at the first step to have the people whose IQ was measured in 100 days after being treated and worked only with it.

On this plot, You can see the differences of mean IQ of people who were in a coma and who were not as Y and the age as X



Before seeing this plot we thought that older people's IQ will suffer more, but we can see and make a conclusion that with age increasing, the impact of the coma on IQ is decreasing and tends to be near zero. Also, there is a minimum dot at the age of 25 - this is the age when the brain stops 'developing' - in this age people are the most vulnerable.

After seeing this plot we had an idea that older people don't suffer from being in a coma after brain injury, however, they are recovering slower than younger people. We tested it in the next step.

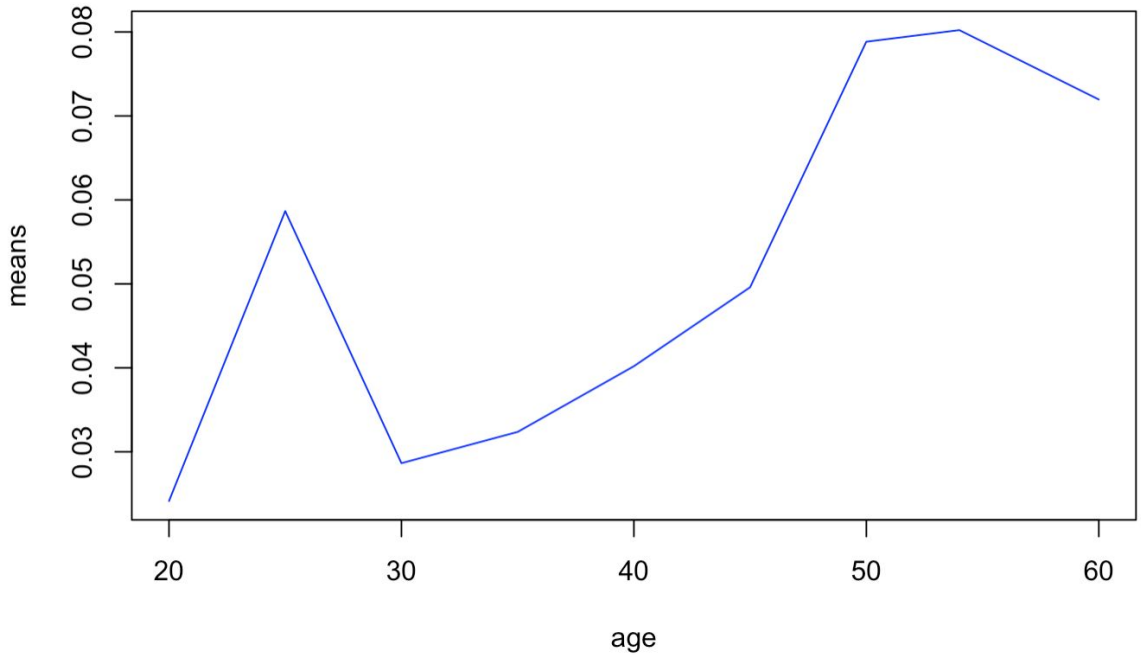
STEP 4

So, to see how people recover from coma in different ages we cut the data and leave only those patients, whose IQ was measured more than 1 time in different periods after getting out of the coma.

STEP 5

This code is the second research to identify how people recover from coma at different ages. So, as in the first research, to have the correct answers we divided people by their age to have 9 groups. We use the data that we had from step 4 - for every patient we have her/his IQ measured in different time after getting out of the coma - so we build a linear model for every patient to see how his/her IQ was increasing with days go by

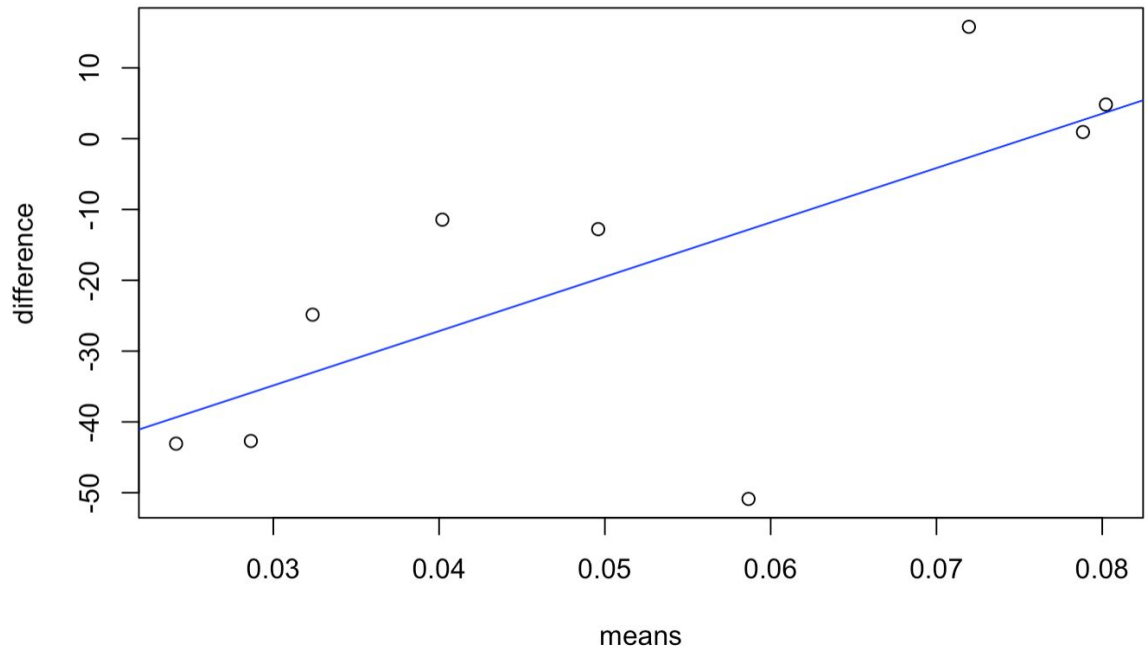
after getting out of the coma. Then we took those coefficients - the impact of days after coma on an increase of IQ - and calculated the mean of coefficients for each of 9 groups. The result You can see on the plot below: X - age, Y - coefficient of the impact.



From this plot we can see that with age increases the number of days which are needed for recovering increases too.
Also, there is a local maximum dot - 25 years - as in previous research this is the most vulnerable age in which people need more days to recover.

STEP 6

The last step in this research is to identify if the 'IQ injury' is correlated with its recovering after brain injury coma. You can see the correlation plotted below - Y is a coma effect in IQ and X is how quick people's IQ recovers from coma after brain injury.



CONCLUSION

Conclusion from these researches - younger people`s IQ suffer more from coma after brain injury, but it recovers quickly, unlike older people - their IQ suffers a little, but it's recovering takes a long time.

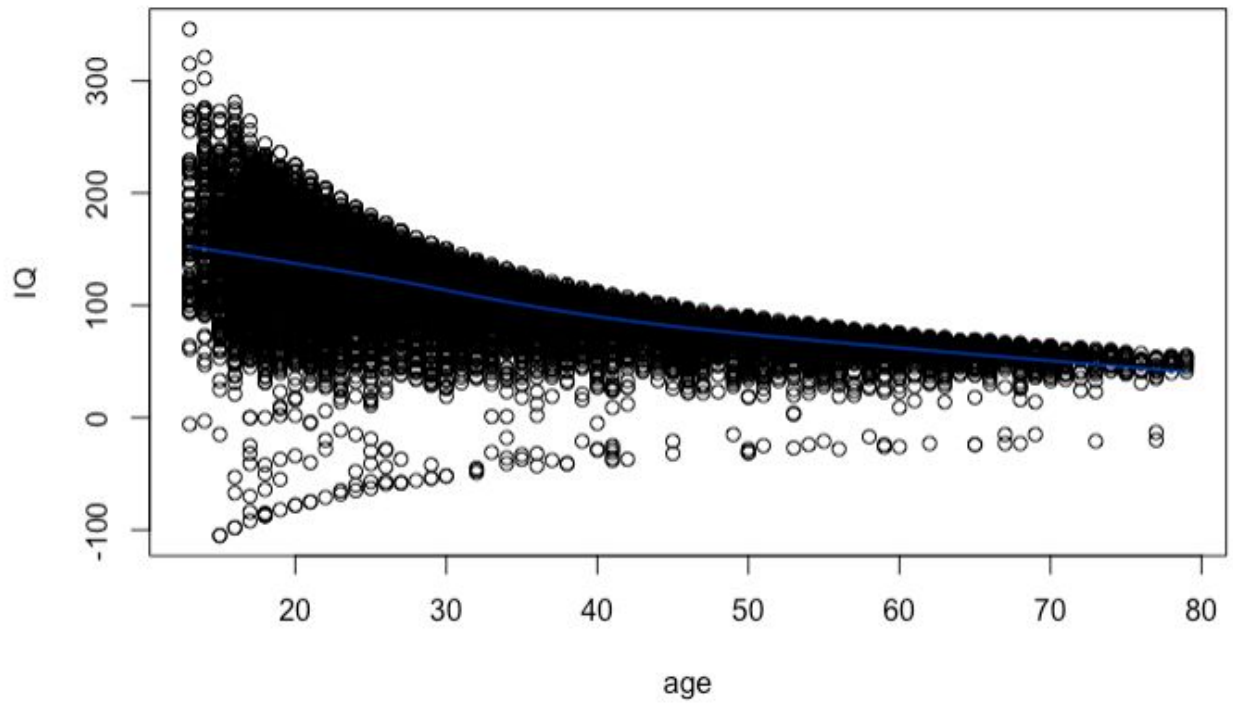
SECTION 2 - which factors affect the IQ in real life

STEP 1

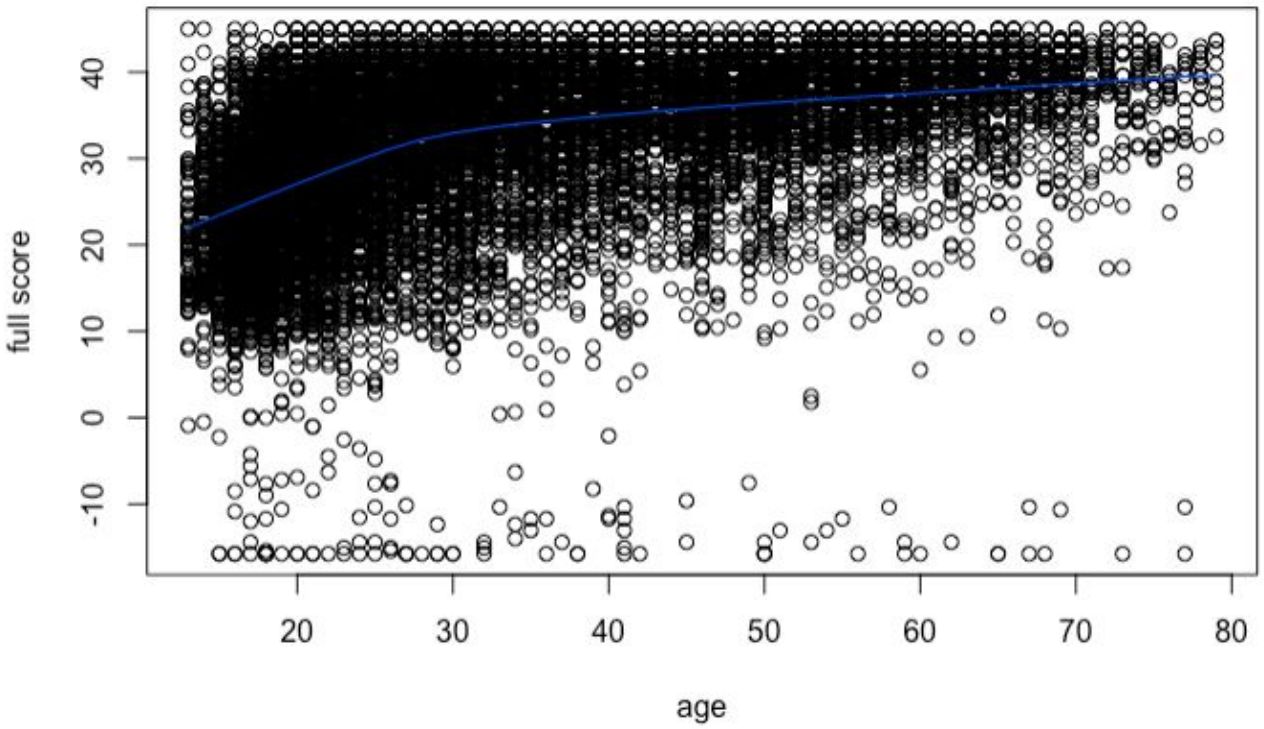
For this research we update our data 'VIQT_data.xls' and cut it to make our research more accurate. We have column countries and we leave only those countries, from which we have more than 30 numbers of IQ tests. Also we leave those people, whose age is from 5 to 80.

STEP 2

Interpreting graphic we can see, that this formula (only one for IQ) -
score for test *100/age - is not good enough because it doesn't allow older people to have bigger IQ (with age increasing the standard deviation is decreasing, mean IQ too) - You can see it on the plot below - but this is the only formula which exists

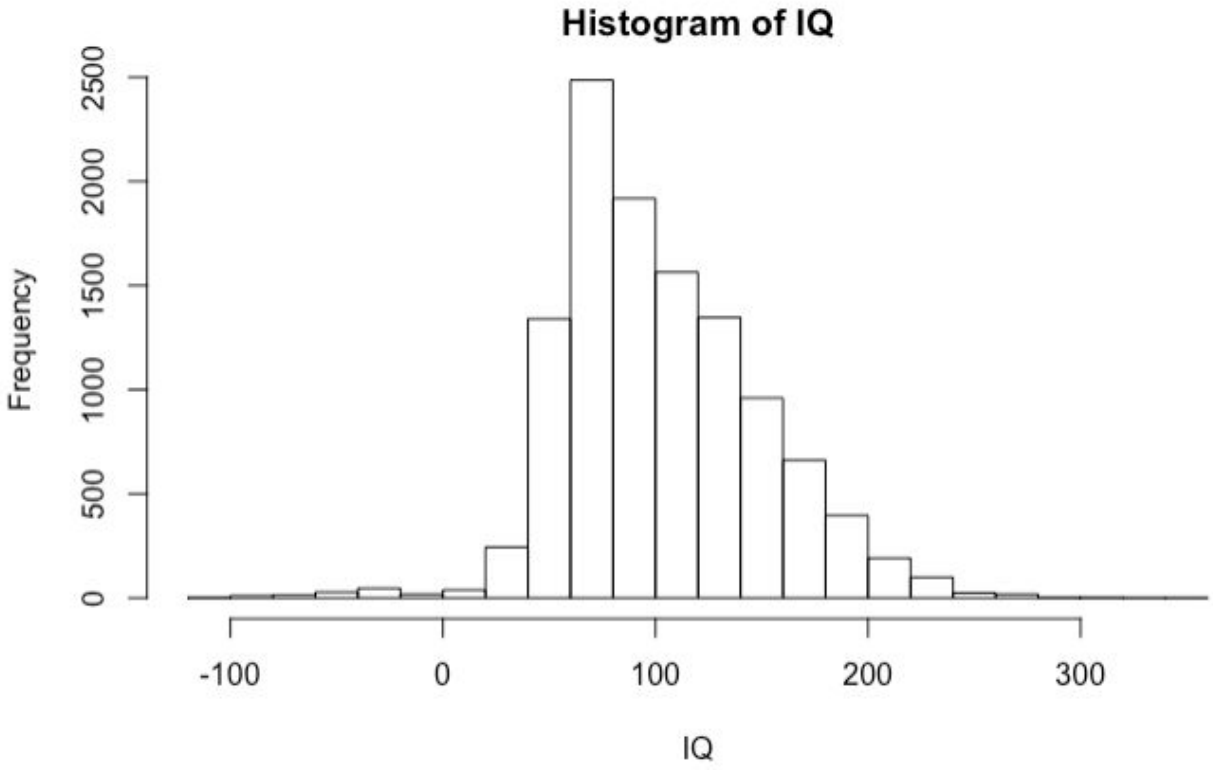


From the plot below You can see a strong increase of right answers from people whose age is from 5 to 35, after this the score increases slowly.



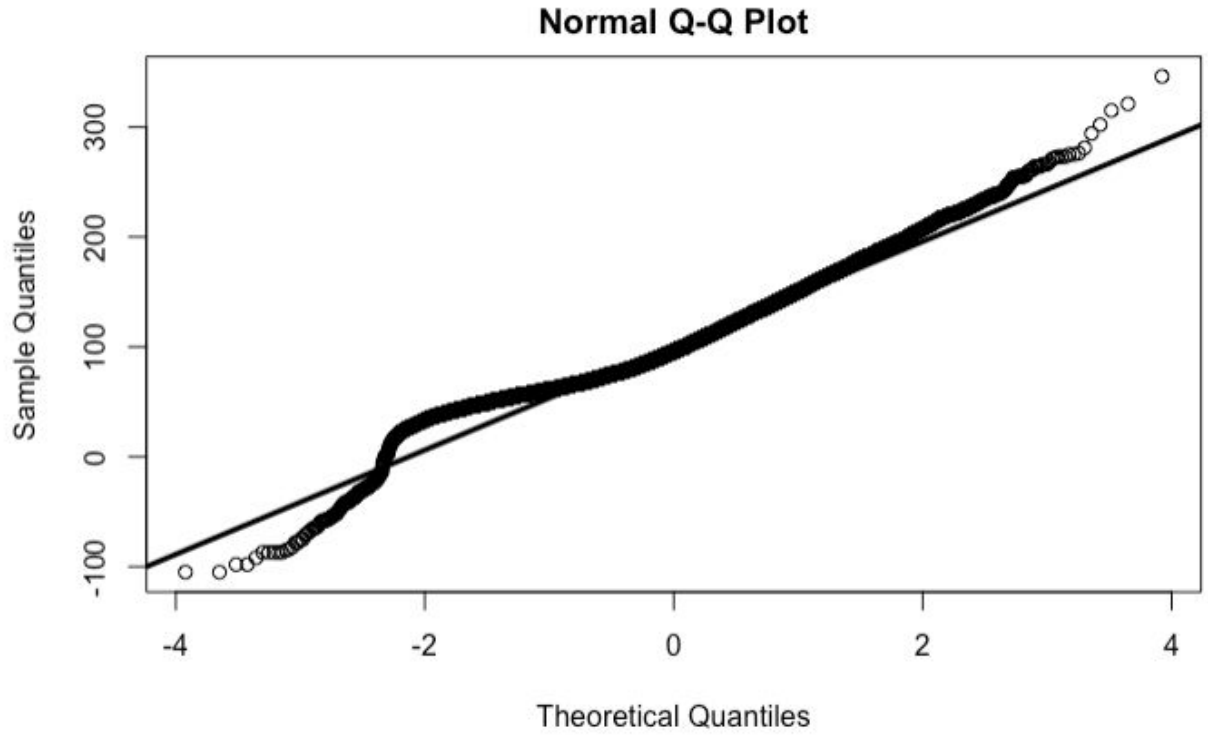
STEP 3

In real life IQ is distributed normally, so we check it to be normal



We compare it with a normal qq plot and we can see that our plot is symmetric and has deviations from the Gaussian distribution in the left and right tails. It means that our data has fat tails - more data distributed on the extreme values and less data distributed near the mean.
It means that the standard formula is not appropriate for our data, because it means that a 5 years old child who answered wrong for all questions can have IQ -100 and an old person(80 years) who answered right on all questions can't have IQ more than 50.

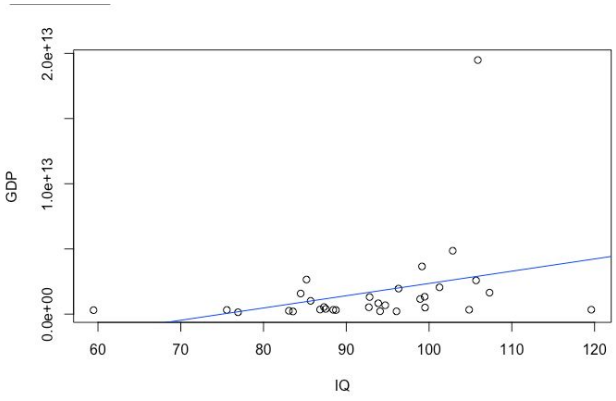
Check it one more time
Sharpio-Wilk test and Kolmogorov-Smirnov give p-value less than 2,2e-16,
so our distribution is normal with mean 103 and standard deviation 46.6.

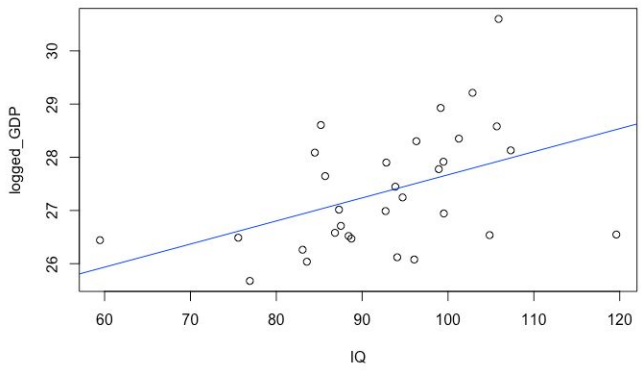


STEP 4

Now we will research if there is an impact of GDP of the country on its residents' IQ. We should prepare the data. We counted the mean of IQ for every country and then merged this data to the data, in which we have GDP for these countries for 2018 year - You can find gdp.py and see how we did it.
(Data for IQ was collected in 2017-2018 years)

STEP 5





We plotted the mean IQ and GDP of countries. But because the GDP is large, we should take the log(GDP) to see the correlation clearly. Above there are two plots - first with mean IQ and GDP and the second with mean IQ and log(GDP)
Correlation coefficients are equal to 0.3087967 and 0.4402467 (for mean IQ and log(GDP))

Using the linear model, we can see that GDP is statistically significant for IQ

And we can make a rough conclusion that each additional point of country mean IQ raises it's GDP per 94140000000 dollars

STEP 6

Now we will analyse the impact of personality factors on IQ - gender, education, urban, engnat(Is English a native language of the person).

Firstly, we should check if these factors are independent.

We test our factors for dependence, as we can see, variables are not dependent
There is a slight correlation(`0.15472`) between urban and not native English, it means that most of the foreigners were taken from cities

We can see, that engnat, education and gender impacts IQ

- **gender** : boy's IQ is higher
- people, whose native language was **English** passed the test much better

and we can determine that higher education level leads to lower IQ

- urbanization is not significant for t IQ

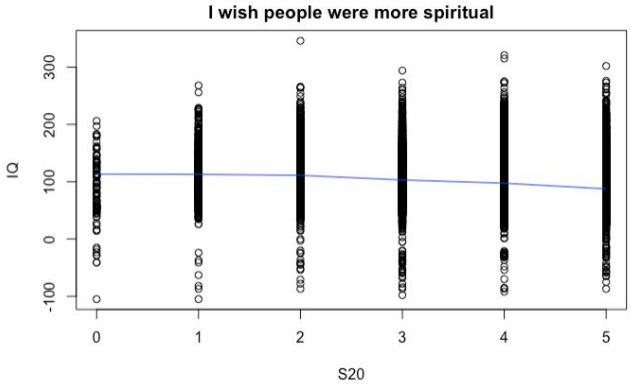
In our dataset we found a third gender, but we cut it and didn`t analyse it, because its quantity is not appropriate.

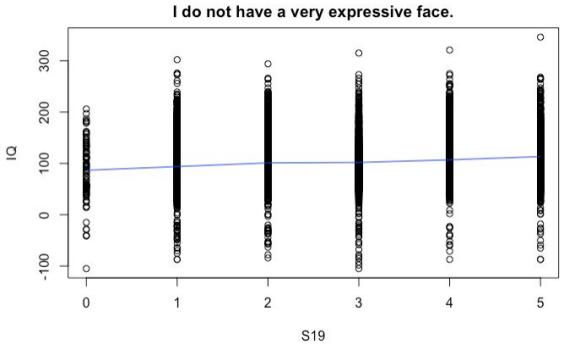
STEP 7

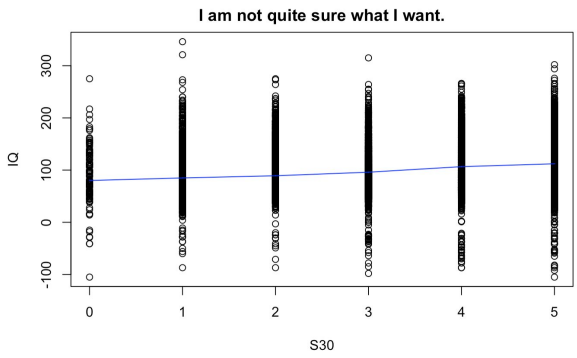
We test the questions for independence and we can see that several questions are not independent - there are some questions with correlation bigger than 0,3
(20~26 = 0,41), (12~6 = 0,44), (2~4 = 0,5), (12~16 = 0,35) (14~13 = 0,33), (18~20 = 0,42)
If we look at them, we can determine that they are similar, we will exclude them later
To get top significant question from our 30 questions, we use variable selection
Final Model (only relevant questions):

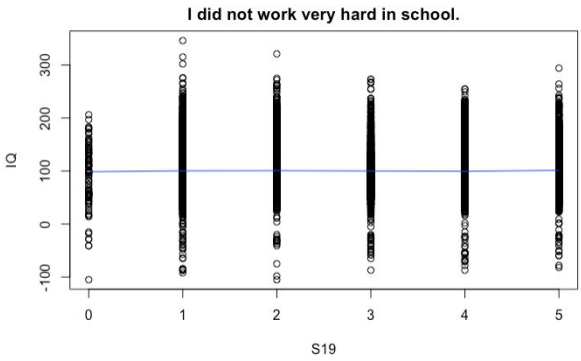
As we can see appropriate questions are S3, S9 , S10 , S12 , S13 , S18 , S19 , S20 , S21 , S22 , S25 , S27 , S28 , S29 , S30
We exclude highly correlated (S26, S18, S6, S16,S 14) and get S3, S9 , S10 , S12 , S19 , S20 , S21 , S22 , S25 ,S27 , S28 , S29 , S30 as a result.
Top - questions, where answer "Yes" for the questions **positive** impact on IQ
I had an imaginary friend as a child.
I've been interested in a historical wars
I am very unusual.
I do not have a very expressive face.
I sit on my legs.
I am a perfectionist.
I like to play devil's advocate.
I am not bothered by messy people.
I am not quite sure what I want.

Top - question answer "Yes" for the questions **negative** impact on IQ
I did not work very hard in school
I don’t apos;t like to analyze literature.
I do more than what & apos expected of me.
I wish people were more spiritual.
I am more artistic than scientific.









First of all, we can conclude, that working hard at any part of life increases IQ
Also, good imagination, curiosity in combination with the correct use also increase IQ

Conclusions

What impacts in IQ
People are rational beings and while it ‘develops’ its IQ increases. Positive effect on IQ has an environment in which a person grew up, GDP of the country in which he/she lives - higher GDP - higher IQ, also habitants of urban cities have higher IQ than habitants of small villages. Self-development, a lively interest in science, literature will undoubtedly increase your vocabulary IQ. Surprising is the fact that women have less IQ than men(in some countries women do not have access to education).
However, the test is far from always being able to correctly assess the true intelligence of a person and his true potential.
We were convinced of this, since we see that the formula is not very accurate.