Cognitive Modeling - lab 1

Group 15 **November 19, 2021**

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Question 1:

A. For the two experimental conditions (steering focus or "dualSteerFocus"; dialing focus or "dualDialFocus") report the mean (M) of the total dialing time, standard deviation (SD), and standard error of the mean (SE) of total dialing time.

	M	SD	SE
Steering focus	5.07s	1.32	0.38
Dialing focus	3.43s	0.90	0.26

B. Make a similar table for average absolute lateral deviation (in m), when you only look at the data points where a key or "." sign was pressed (that is, the start of dialing and the final "." that ends the dialing task; in Janssen & Brumby 2010 a "#" was dialed instead of a ".").

	M	SD	SE
Steering Focus	0.59m	0.22	0.06
Dialing Focus	0.38m	0.19	0.05

C. Make a plot of how lane deviation changes over time with each keypress, similar to the plot in Figure 1 of Janssen & Brumby (2010).

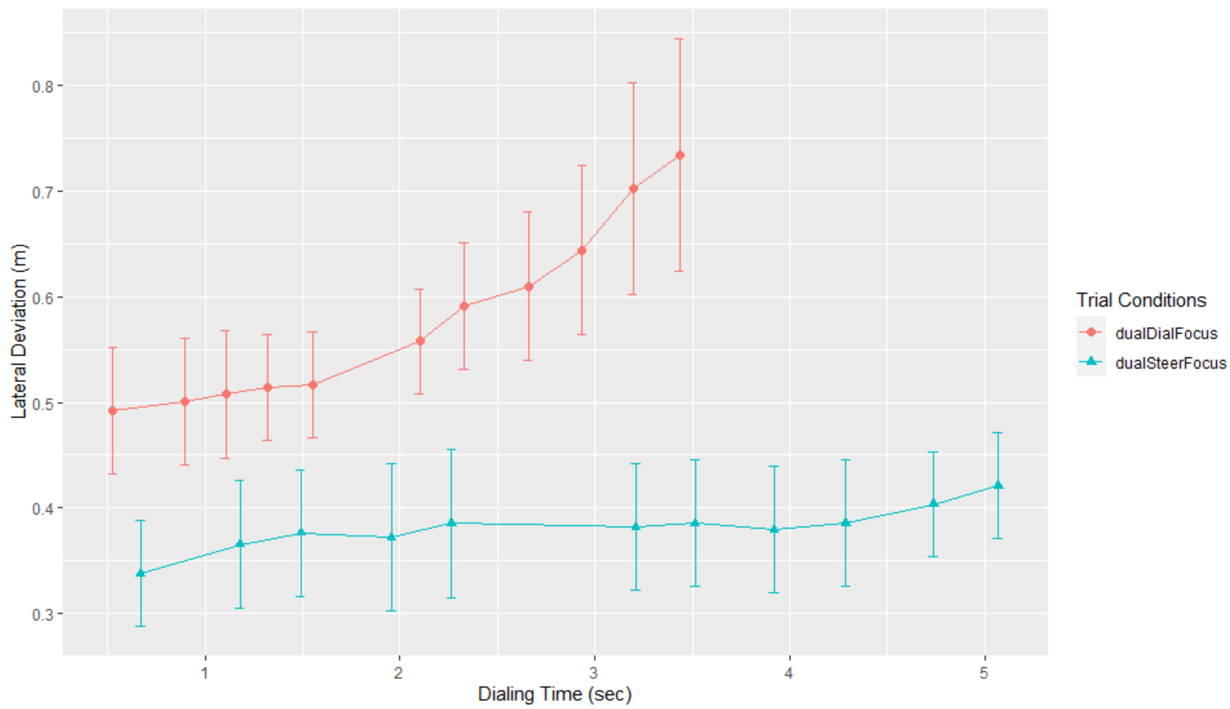

Figure 1: Data plot shows changes in vehicle lateral deviation between consecutive keypresses (#-07854-325698) under varying dual-task performance objective

D. *Based on the plot in question C, answer the following question: "For each condition argue whether you think the average participant waited until the natural breakpoint (between 5th and 6th digit) with interleaving dialing for driving." Motivate your opinion clearly based on the observed pattern.*

Luca's answer: For the *dialing condition*, the average participant does not seem to have waited for the natural breakpoint to shift attention from dialing to driving. The lateral deviation increases for this condition between the 5th and 6th digit, whereas we would expect it to remain the same if the participant chose driving over dialing. The increase in dialing time can be attributed to the training phase, where the participants practice dialing the number in 2 parts, with the first part being the first 5 digits. For the *steering condition*, the average participant does seem to wait till the natural breakpoint to interleave dialing for driving. The dialing time increases, and lateral deviation remains steady between 5th and 6th digit.

Xinhao's answer: As observed in the figure above, there is a gradual increase in the lateral deviation in both focus situations. For the dialing condition, there is an obvious increase between the 5th and 6th digit and the Dialing occurs earlier. It means that participants always focus on dialing instead of driving and steering. For the steering condition, the lateral deviation between the 5th and 6th digit is almost constant, and the time is slower than the dialing condition, it clearly means that participants want to get control of the car and focus more on the steering instead of dialing the phone number.

Yanming's answer:
For the dialling condition, the answer is yes and the steering condition is no.
For the dialling condition, participants received "the time taken to dial the number correctly" feedback, and for the steering condition, participants received "the vehicle's RMSE lateral deviation" feedback. Hence, intuitively, participants in the dialling task are more likely dialling the first chunk digits correctly as soon as possible, then steering and trying not to take the vehicle out of control (actually, for this "trying" here, it can lead to a different result, make the things worse or better, but we are not sure), and quickly swift into the next dialling task. In contrast, the participants in the steering task were more likely to steer the car just after finishing dialling one or two single digits (which means they did not wait until the natural breakpoint between 5th and 6th).
From the plot above, firstly, without considering the natural breakpoint, it's obvious that the curve of the dialling task, the gradient of the curve of the last 6 digits is much larger than the first 5 digits, which doesn't show much difference in the steering task. For this, we can infer that something happened in between the natural breakpoint and made car control worse in the dialling task. For the time between the natural breakpoint, we can see that the curve in the dialling task is starting to significantly increase, in the meanwhile, the lateral deviation is a slight drop in the steering task. Here, we can only drop the conclusion that in the steering task the participants steering the car into the right track. But we also notice that there is another drop between the time of dialling the 3rd and the 4th digits, which means participants had already interleaved at that time.
So we can get our conclusion: for the dialling condition, the average participant waited until the natural breakpoint with interleaving dialling for driving, and for the steering condition, the average participant interleaved before the natural breakpoint.

Note: for our answers, Luca and Xinhao looked only between digit 5 and 6 and argued that the lateral deviation goes up for the dialing condition, whereas Yanming considered the dialing time intervals between the other digits and argued that there are gaps between every other digit too, in the steering condition.

Question 2:
A.Create a plot in which you show how the lateral position (posX) of the car changes over time (trialTime) for the subset of data between 15000 and 18000 milliseconds (i.e., between 15 and 18 seconds).

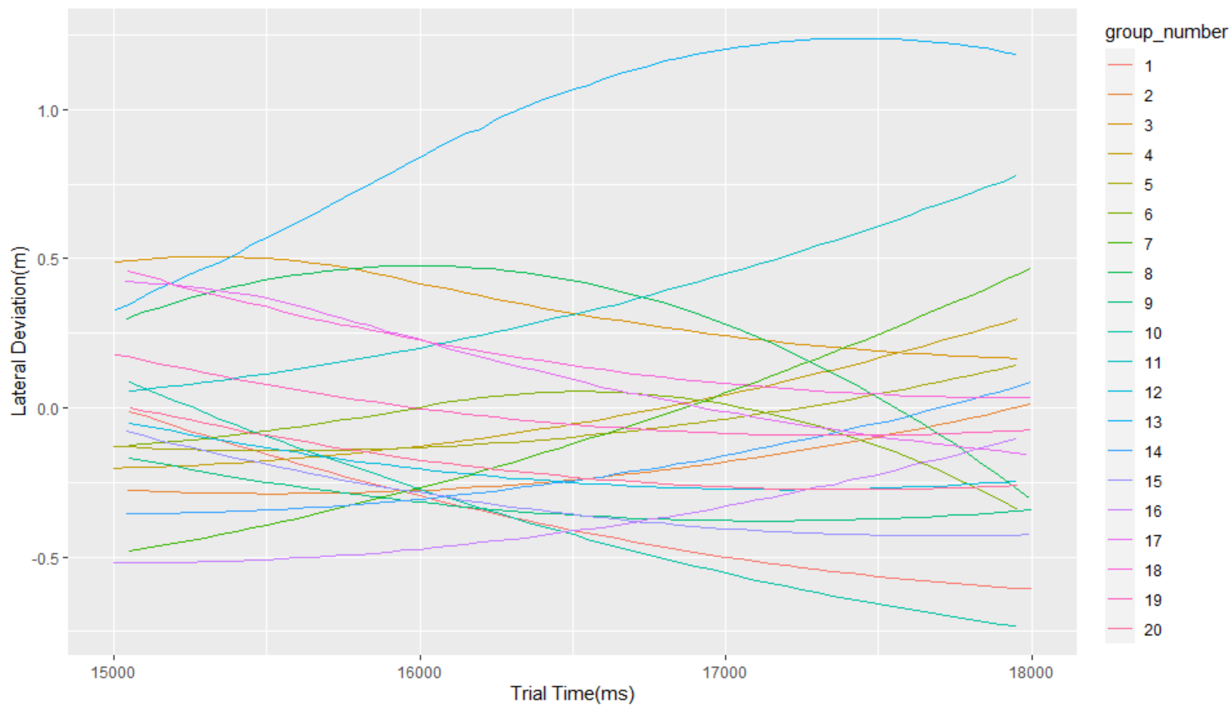

Figure 2: Value of PosX over time of actual human data

B. Generate simulated lateral position data for (at least) 20 simulated trials in which you assume that the car starts drifting from a point 0, and samples values from the modeling distribution (M = 0, SD = 0.13) every 50 milliseconds for a period of 3000 milliseconds. Use different colors for different simulated trials.

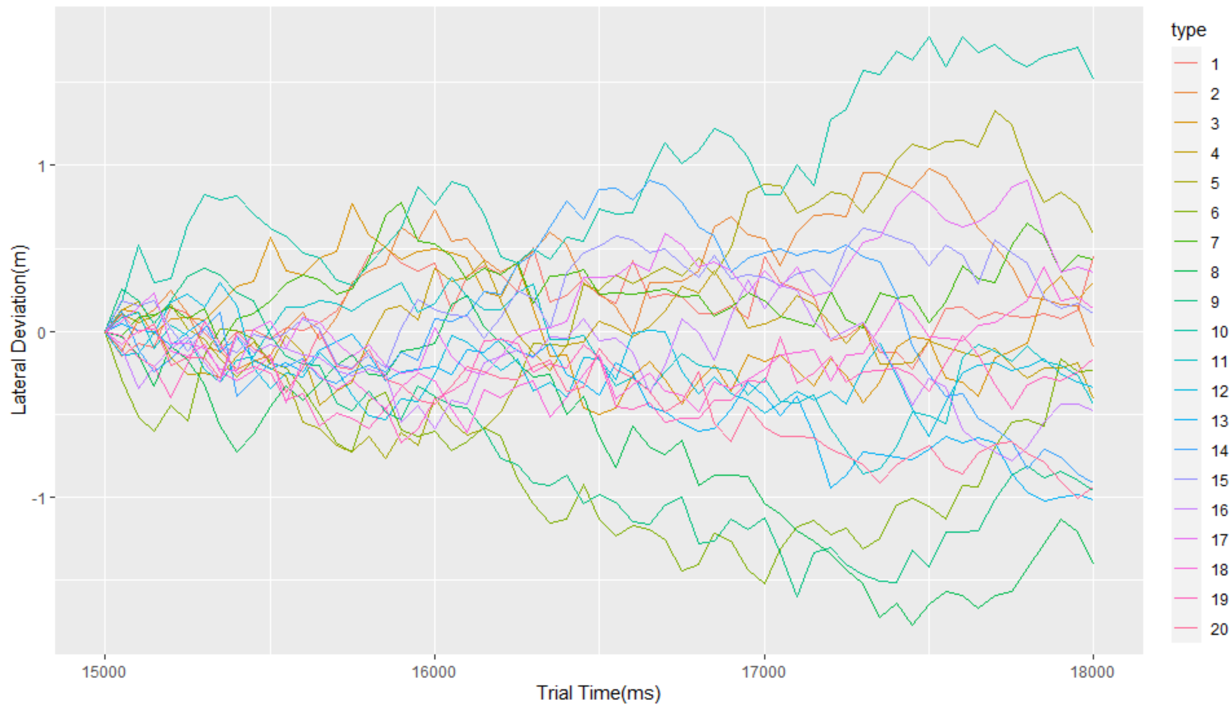

Figure 3: Lateral Deviation over time of simulated human data

C. Create two histograms for our report:

(i). one histogram that shows the distribution of car positions as measured in the human trial (i.e., a histogram of the data from Question 2A).

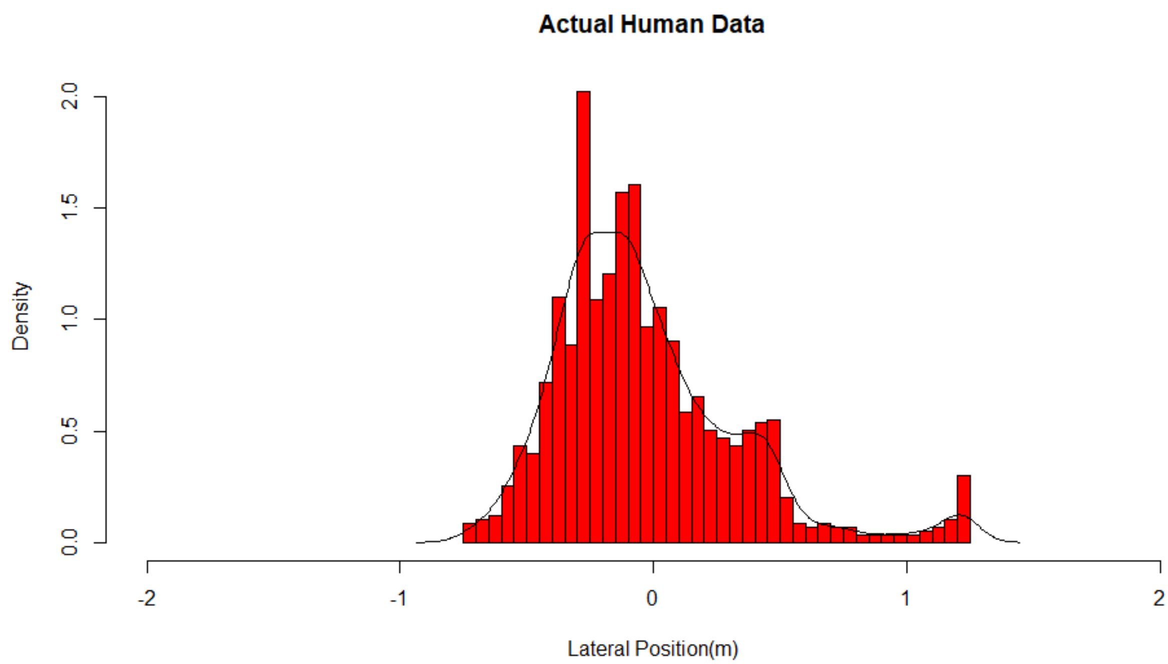

Figure 4: Histogram of lateral position among actual human data

(ii). one histogram that plots the simulated data (i.e., the data from question 2B).

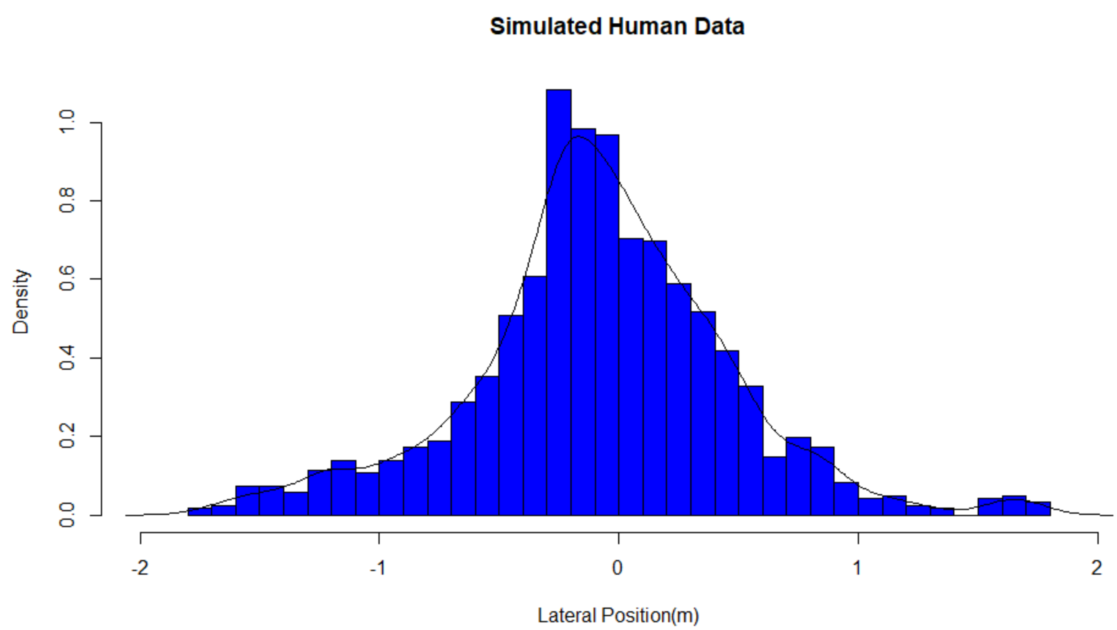

Figure 5: Histogram of lateral position among simulated human data

D. For the two histograms we plotted in question C we can also calculate the standard deviation of each of the two datasets.

Standard deviation (SD) for actual human data (2A) is 0.36

Standard deviation (SD) for simulated human data (2B) is 0.57

E. Try different values in this model (instead of SD = 0.13), and decide which value results in a distribution that is most close to the human data.

(i) The final SD to which you want to set the model (what is the value needed to generate this distribution?)

The final SD value we set should be 0.065.

(ii) A plot of how lane position changes over time for the individual simulated trials

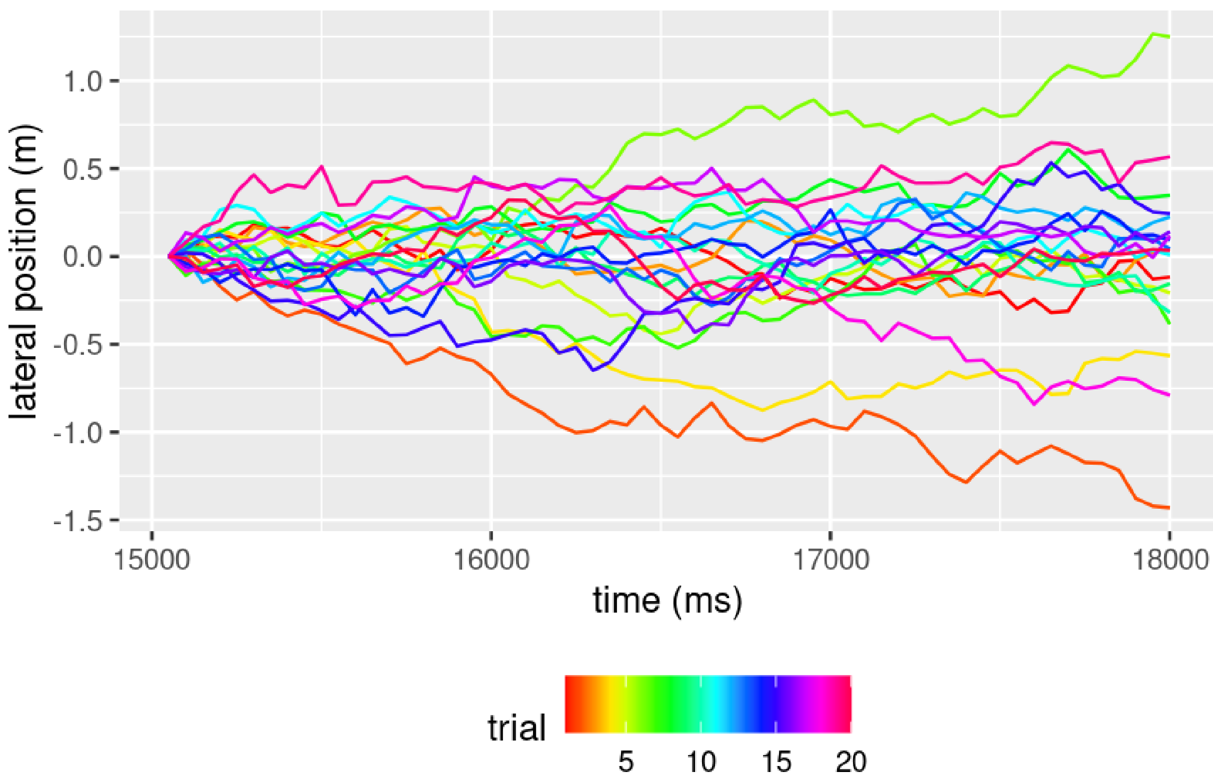

Figure 6: Lateral Deviation over time of new simulated human data

(iii) A plot of the resulting distribution

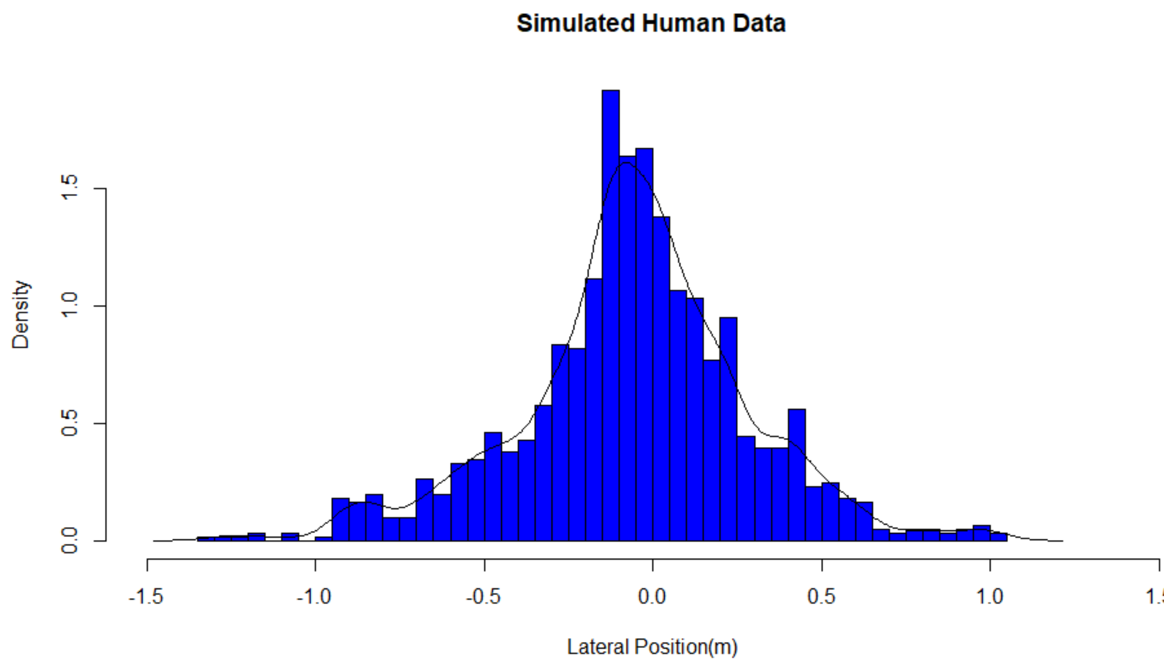

Figure 7: Histogram of lateral position among new simulated human data

(iv) the SD of this resulting distribution

Standard deviation (SD) for new simulated human data is 0.34 and it is similar to the human data whose SD is equal to 0.36

Question 3:

A. What was the average value of the interkeypress intervals?

The value we calculate is 257.51ms. We simply omit the time when the Event is equal to "Start" and calculate the average value if a new digit shows.

B. What value did you pick for your model and why?

We think we should choose 258ms as the value of the parameter for our model as it is a round value of the average value across all participants.

Question 4:

A.Plot the graphs of the various simulations in your report, for at least 4 different numbers of simulations. For each type of simulation, plot two versions of the graph which are based on the output from different students. So, if you ran simulations for 1, 5, 10, and 50 simulations, you should have 8 graphs total. Clearly label each graph to show how many simulations you used, and which computer this was.

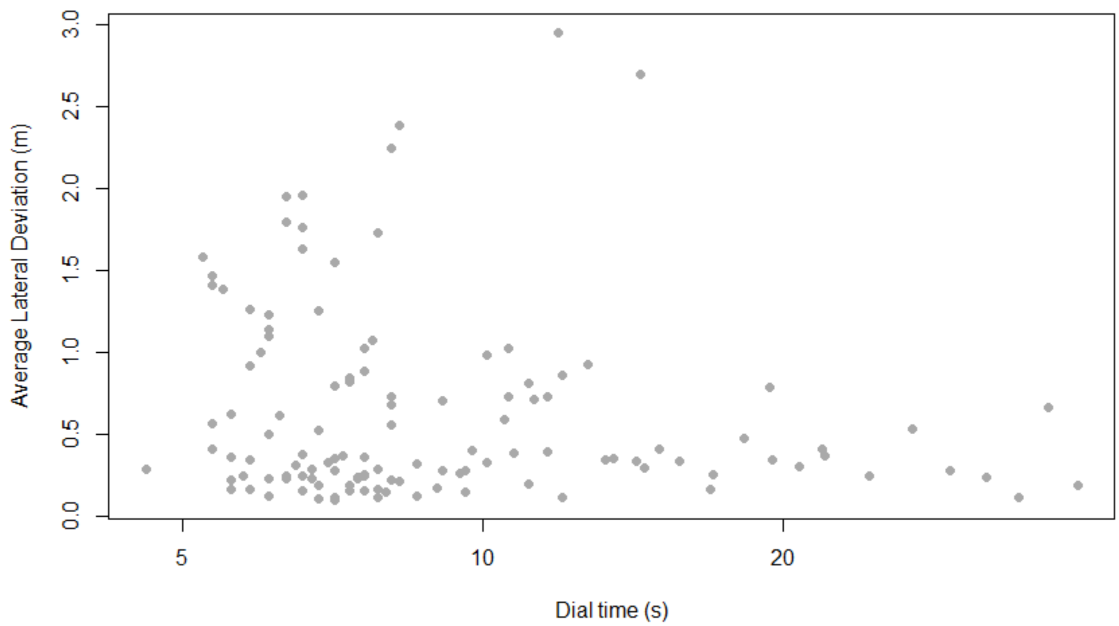

Figure 8: First computer(Dell G15 Intel(R) Core(TM) i7-11800H @ 2.30GHz, 16GB RAM) and 1 simulation for the data

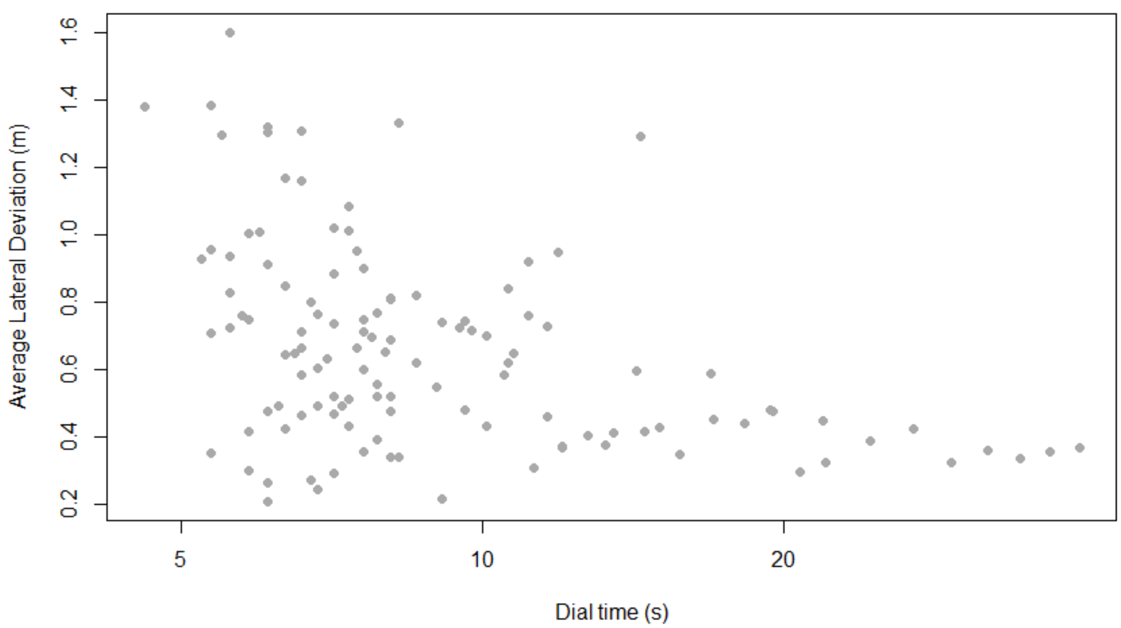

Figure 9: First computer(Dell G15 Intel(R) Core(TM) i7-11800H @ 2.30GHz, 16GB RAM) and 5 simulations for the data

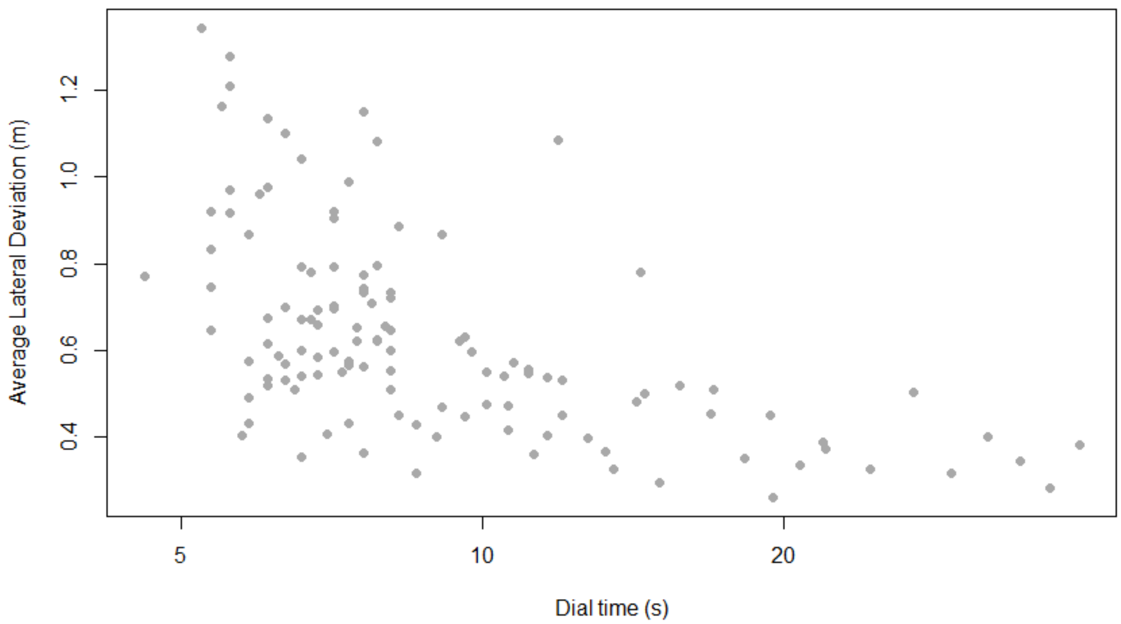

Figure 10: First computer(Dell G15 Intel(R) Core(TM) i7-11800H @ 2.30GHz, 16GB RAM) and 10 simulations for the data

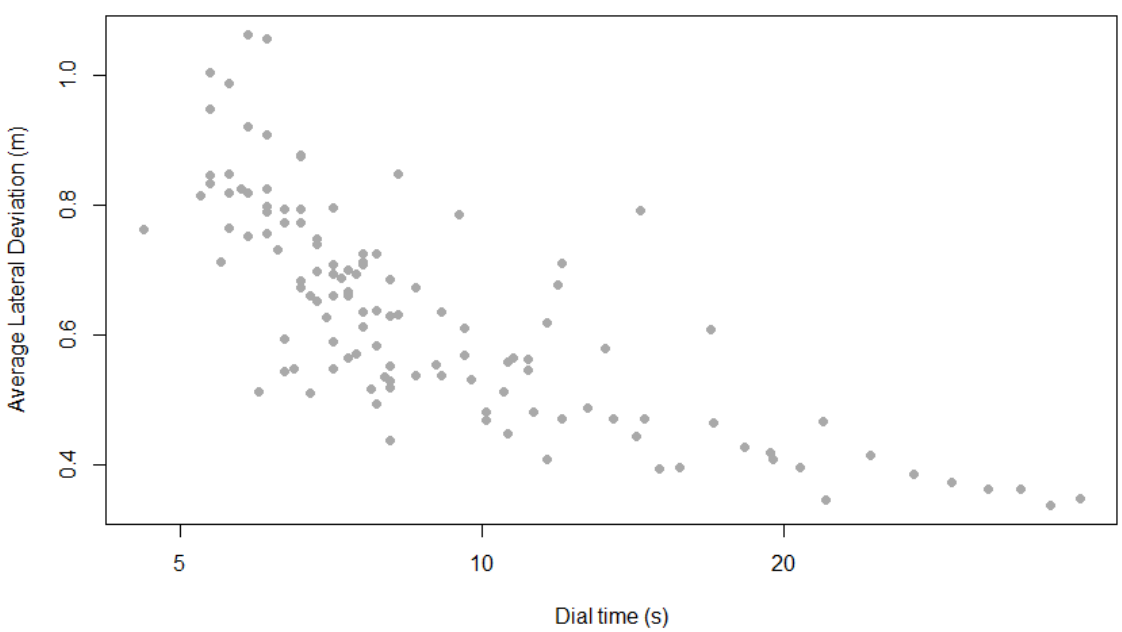

Figure 11: First computer(Dell G15 Intel(R) Core(TM) i7-11800H @ 2.30GHz, 16GB RAM) and 50 simulations for the data

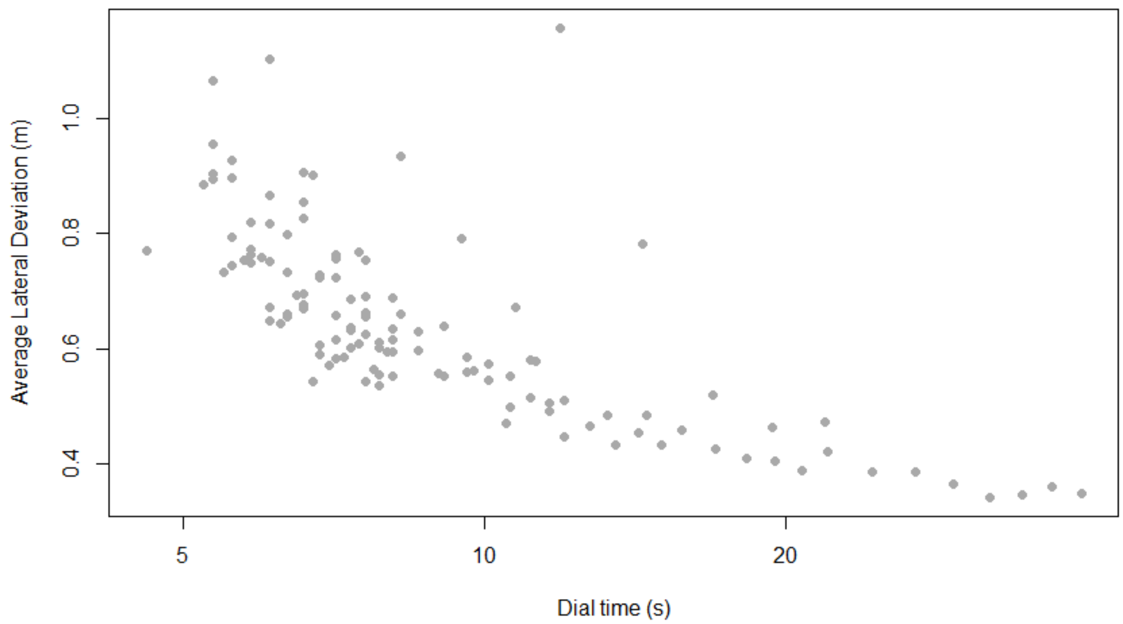

Figure 12: First computer(Dell G15 Intel(R) Core(TM) i7-11800H @ 2.30GHz, 16GB RAM) and 100 simulations for the data

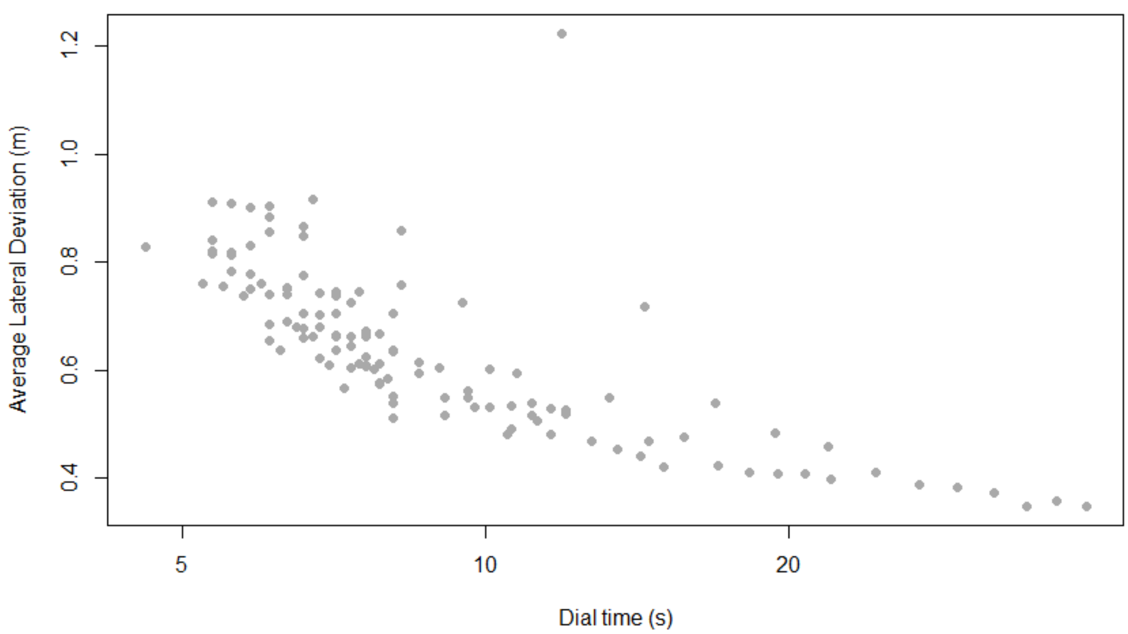

Figure 13: First computer(Dell G15 Intel(R) Core(TM) i7-11800H @ 2.30GHz, 16GB RAM) and 200 simulations for the data

Luca's plots

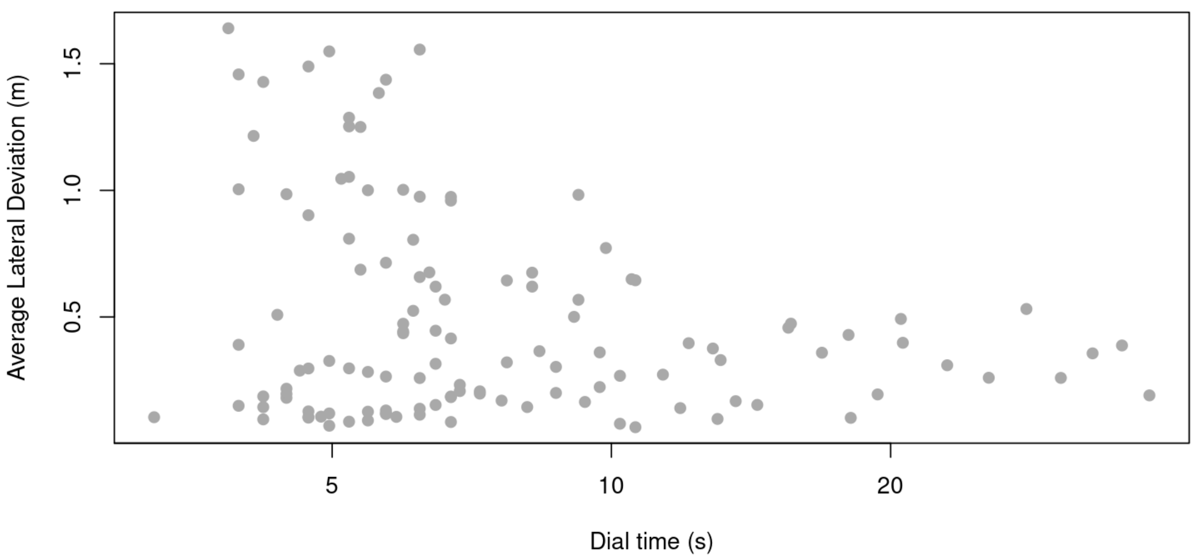

Figure 14: single simulation, HP pavilion, Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz

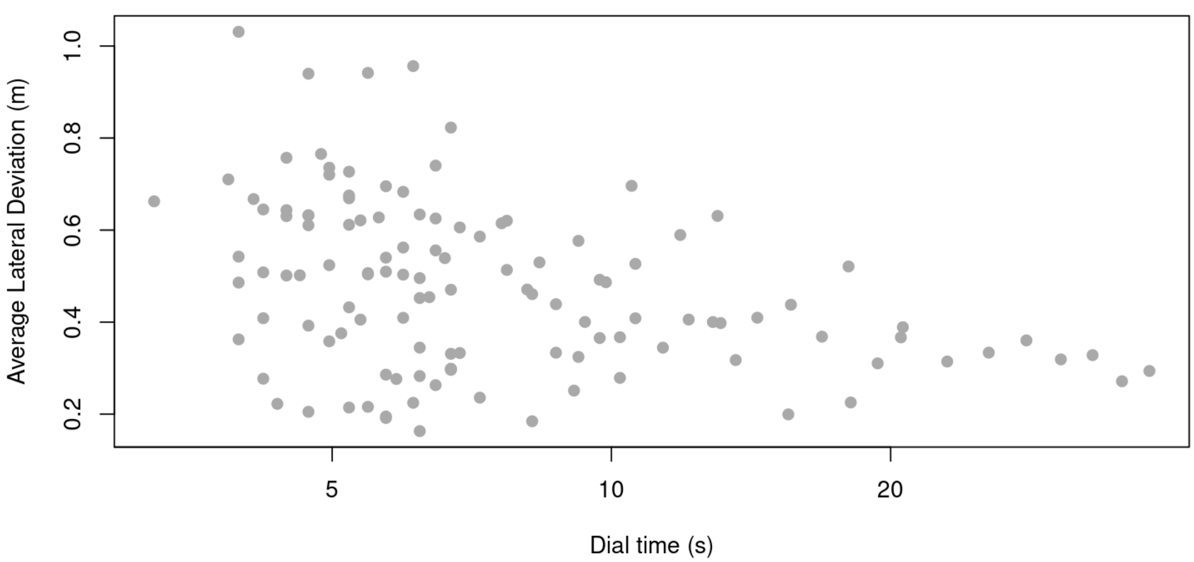

Figure 15: 5 simulations, HP pavilion, Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz

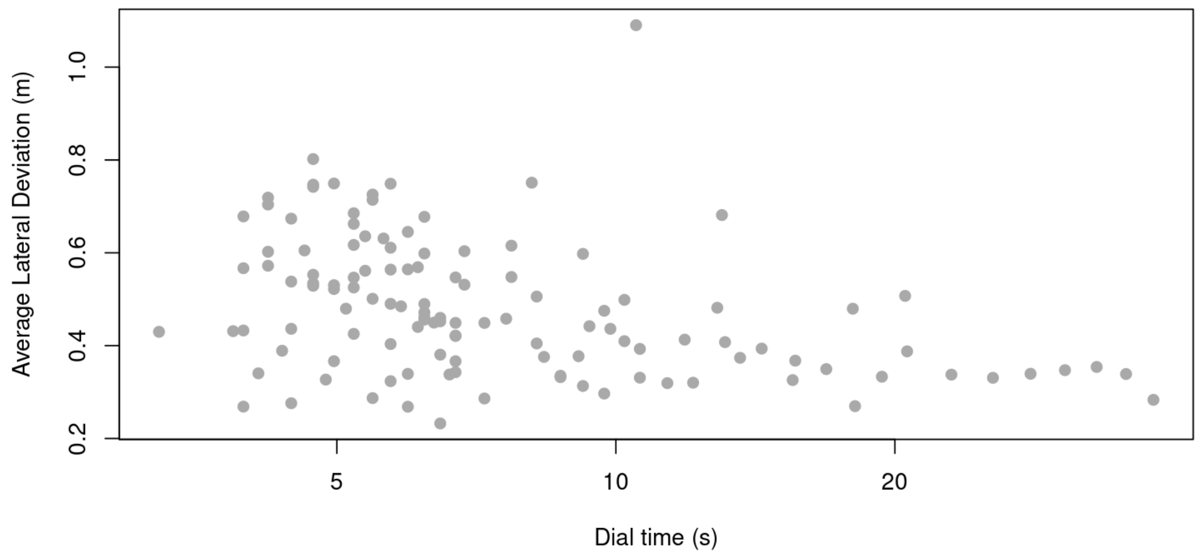

Figure 16: 10 simulations, HP pavilion, Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz

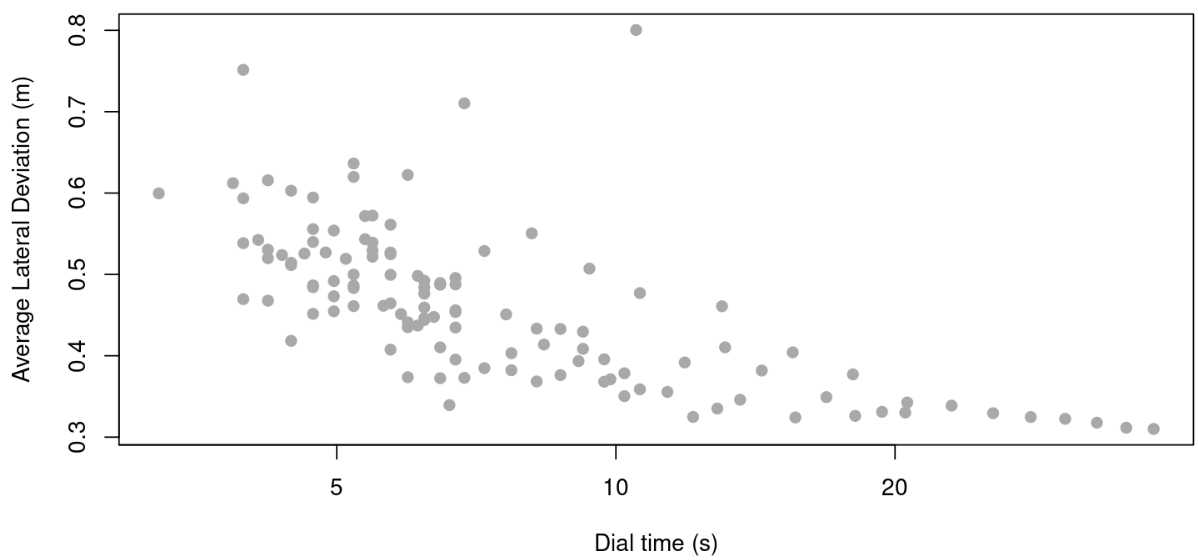

Figure 17: 50 simulations, HP pavilion, Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz

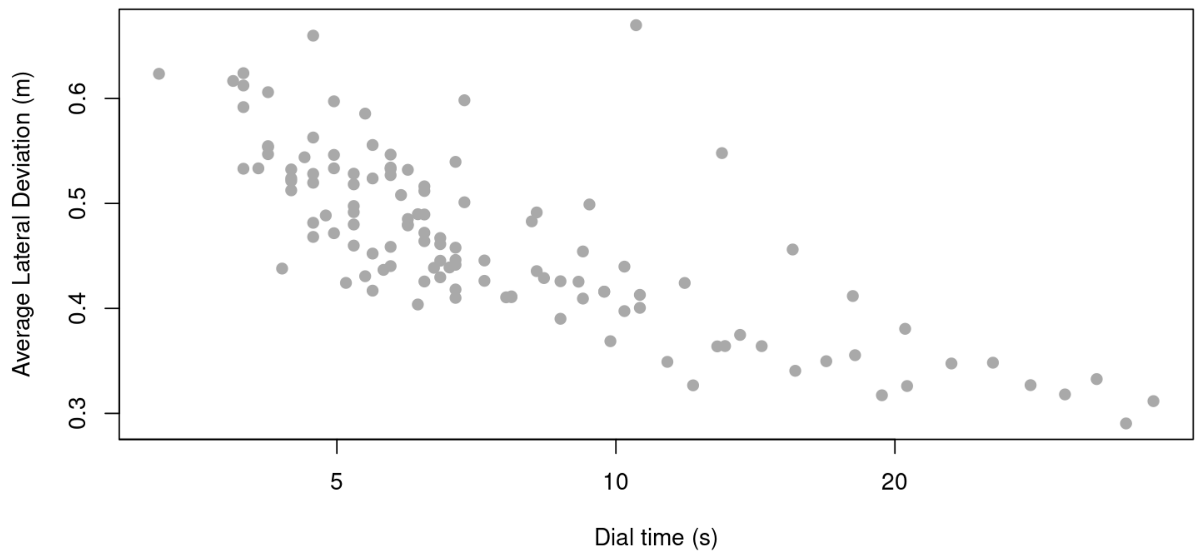

Figure 18: 100 simulations, HP pavilion, Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz

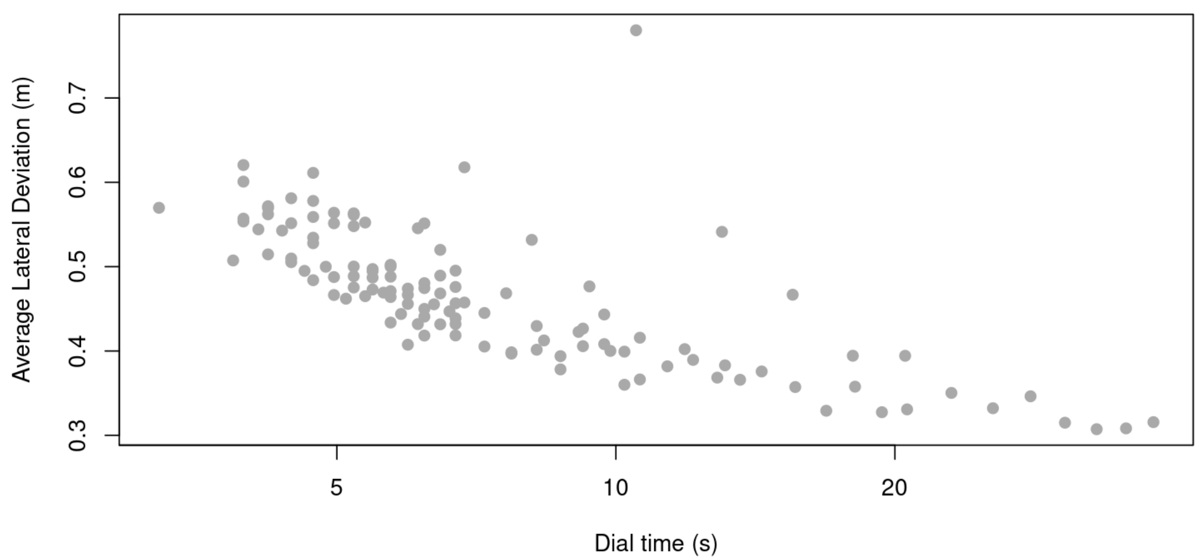

Figure 19: 200 simulations, HP pavilion, Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz

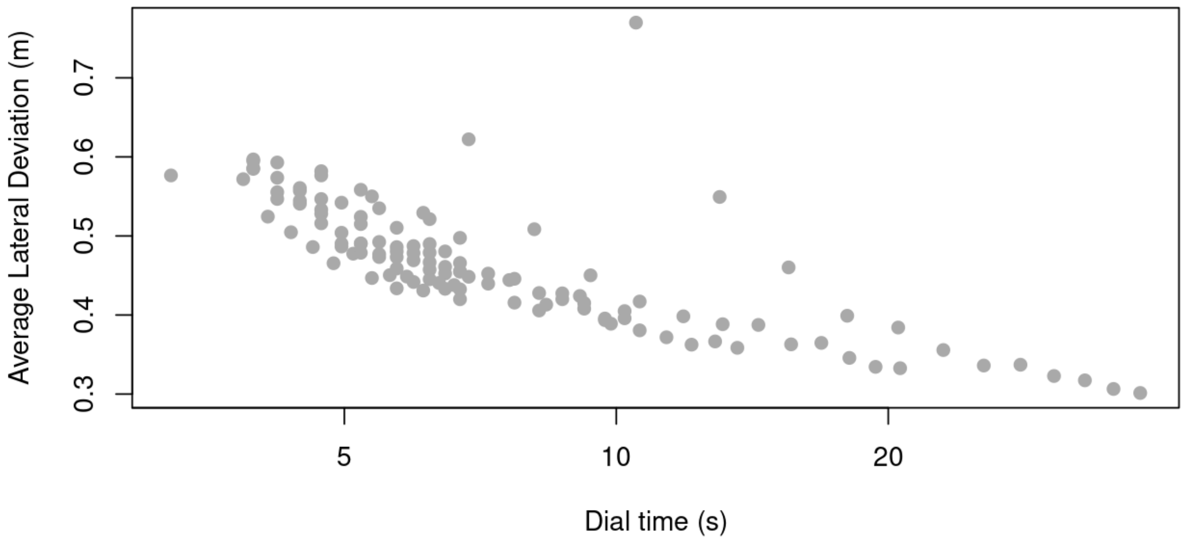

Figure 20: 1000 simulations, HP pavilion, Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz

B. Explain the following: what would be a good number of simulations for your model and why?

Increasing the number of simulations will decrease the standard deviation of average lateral deviations and bring the expected values closer to the real values. Thus, increasing the number of simulations will also provide better representations of the model. However, if we have limited time, then the number of simulations should simply be enough to show a trend. In the end, we want to compare the simulated data with human data. For our model, 200 simulations seem to provide good enough results when we consider the trade-off between time and complexity. 200 simulations can be run within a few seconds, whereas 1000 simulations require too much resources and take about half an hour on a HP pavilion, Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz with no multi-threading.

Cognitive Modeling - lab 1 Bonus

Group 15 **December 3, 2021**
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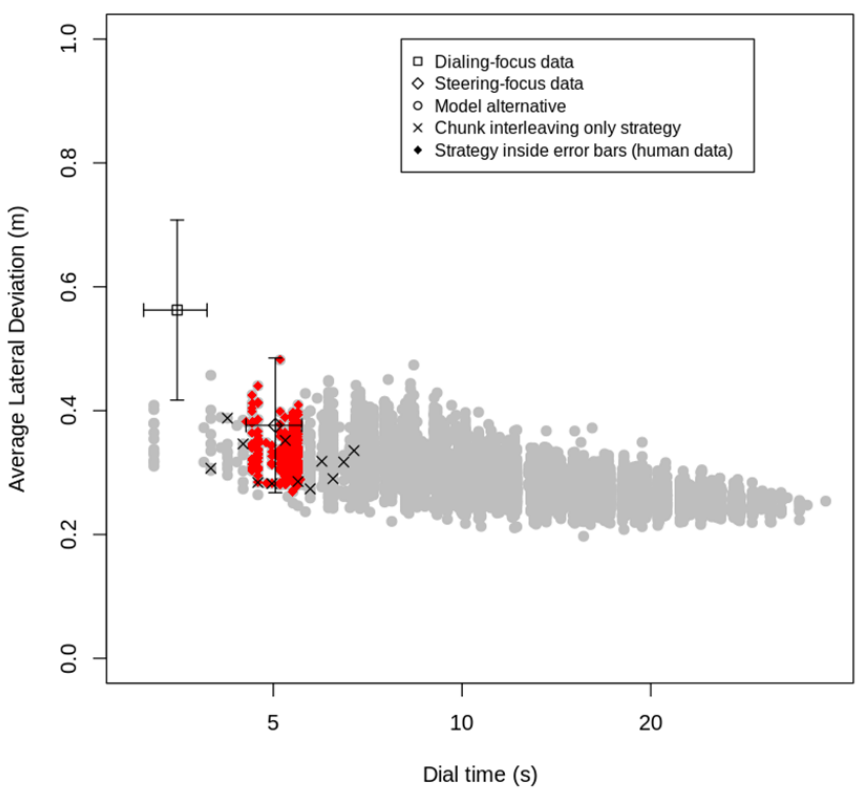
Bonus 0

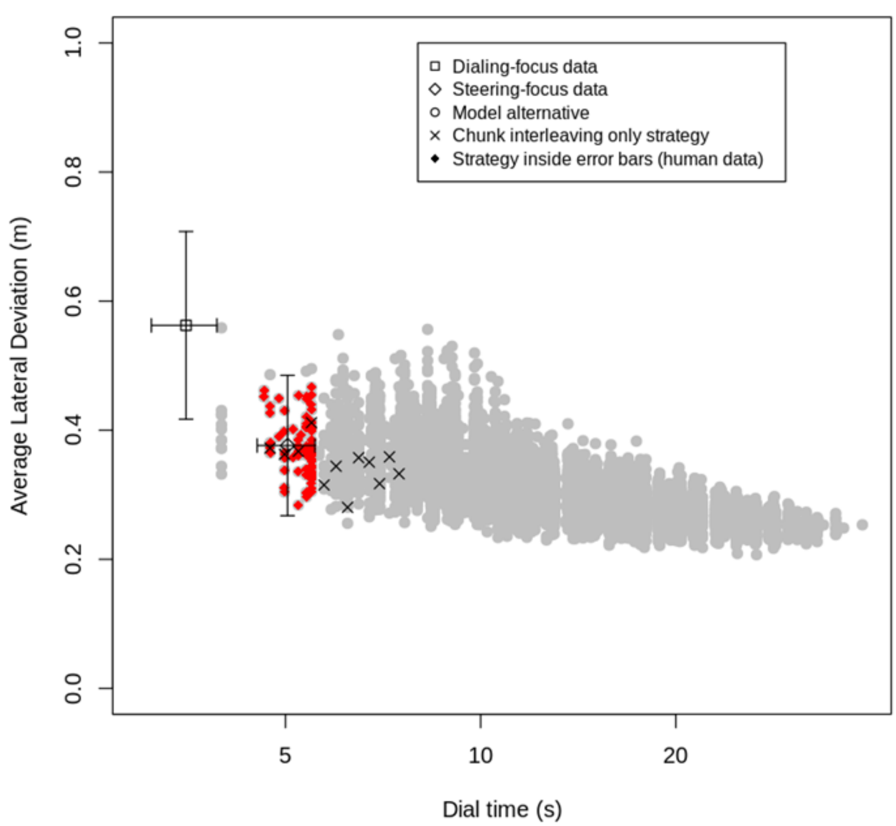
Plot a Figure like Figure 4 in Janssen & Brumby (2010). Make sure to include the axis labels, make sure to highlight the strategies that ONLY interleave between the fifth and sixth digit (i.e., only at the natural breakpoint, similar to the paper). Make sure to also include the human means with standardized errors of the mean around the points (use your data from question 1).



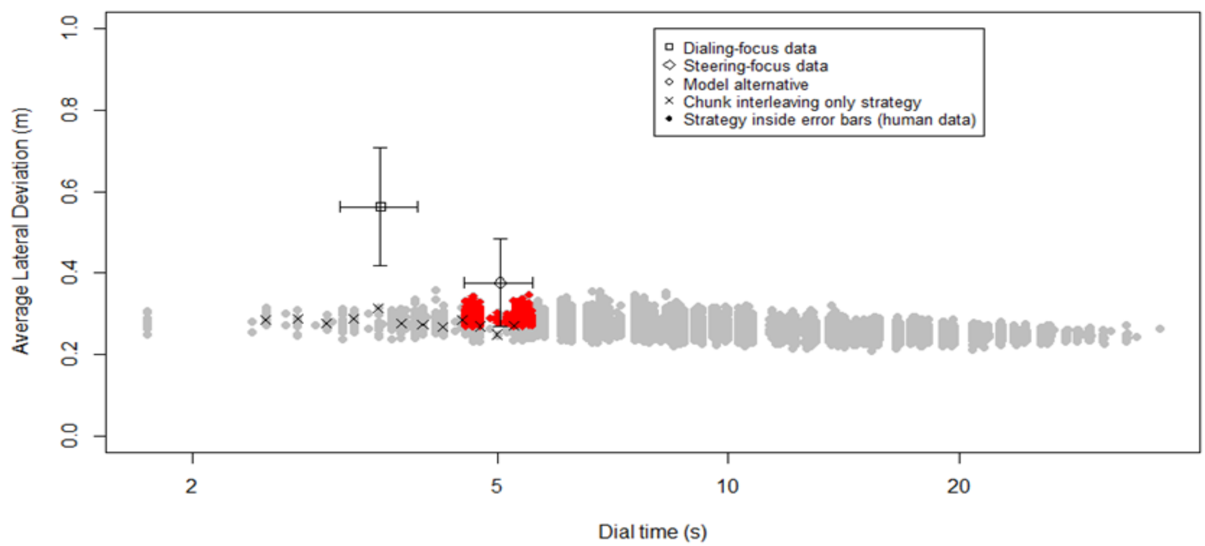
Bonus 1

In the model above we only looked at average interkeypress intervals for the average participant. However, some participants might have typed faster than others. Make a model that has a different average typing speed for different individuals. Specifically: calculate for each participant what their individual average typing speed is. Then run a model simulation for that participant using their average typing speed (you can use a constant value for each digit).
In your report, you should include a plot that shows the trade-off space for three individuals (e.g., in a similar fashion to Figure 4 in Janssen & Brumby, 2010):
- the slowest typing individual
- the fastest typing individual
- an individual with an average typing time
Make sure to describe which individual this is, what their typing speed was and what value you set the model to.
Then argue whether calibrating the model for individual differences is valuable, given the balance between having an extra free parameter and potential increase in fit.
(NB: It might be valuable to also plot the performance of these individuals on the general model space of the "average" participant. Perhaps the individual's data points fall outside the performance space of the average model, but inside the performance space of the individually calibrated models).

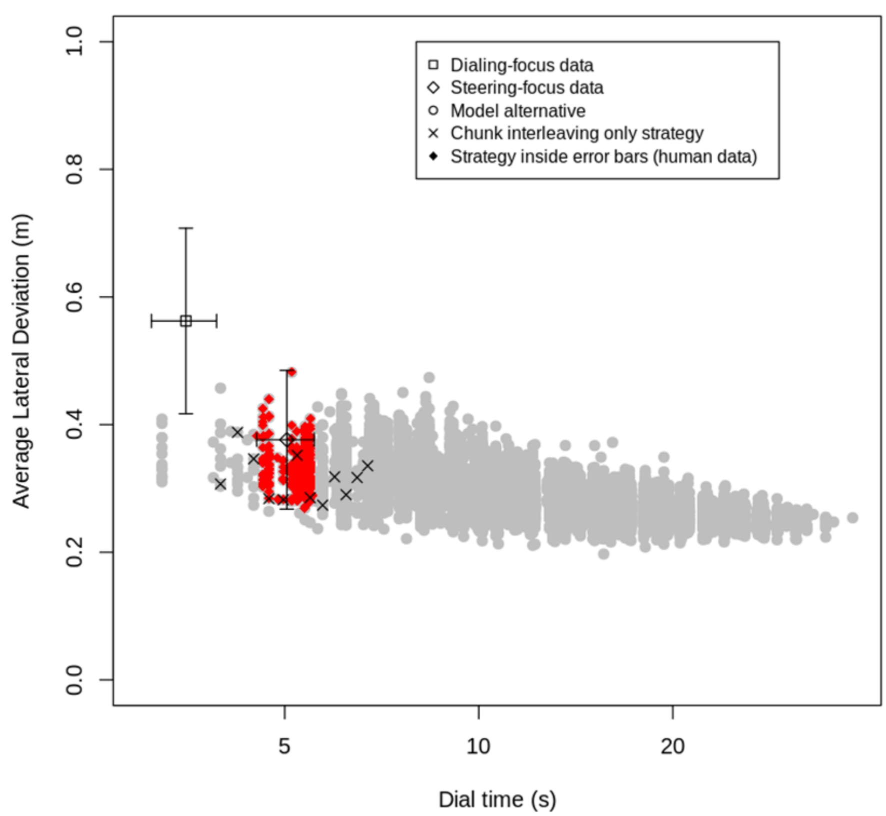
The fastest typing individual (344ms):



The lowest typing individual (140ms):



The average typing time individual (258ms):



We think calibrating the model for individual differences is valuable. For the individual with lowest typing speed, human performance points fall outside the performance space. There are a lot of differences between plots with individuals with average typing speed and other plots. Indeed, calibrating the data can make the model to be overfit. However, There is not much sense to research plots before calibrating the typing speed since the trade-off curve and performance space is totally different.