Livia Managadze
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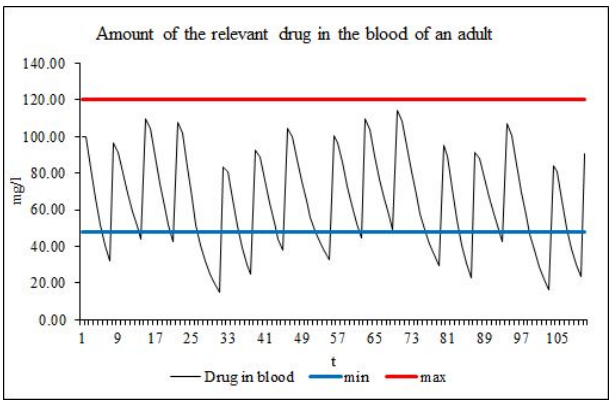
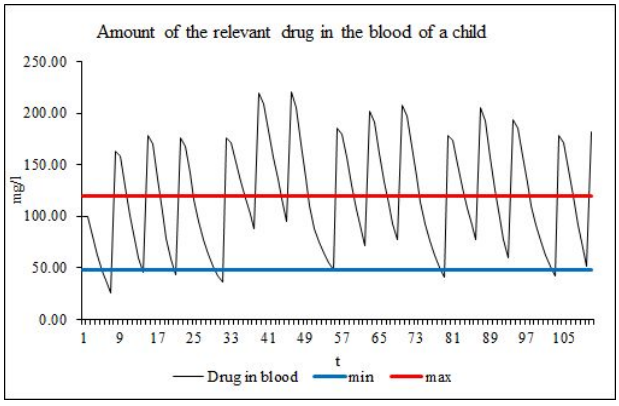
Group H7

Assignment 1: Formulating and validating statements and adapting models

Question #2a

- Adapt the blood volume to the volume of a young child, i.e. 3 liters. Describe what you observe concerning the medication level in the blood compared with that of the value of an adult





Analysis for the amount of relevant drug in the blood of an adult
The highest spike for the adult was when it hit 114.31 mg/l, at t = 69. This value was 5.69 mg/l below the max, thus close but not above it. The lowest value was given at t = 30, which was 15.04 mg/l. This value was 32.96 mg/l, below the min. Despite the values being below the min, all upward spikes were below the max for the adult.

Analysis for the amount of relevant drug in the blood of a child
220.47 mg/l, at t = 45 was the highest value reached for the child, which is 100.47 mg/l above the max. On the other hand, the lowest point was 25.97 mg/l, at t = 6. Thus, below the min by 22.03 mg/l. For this graph, all upward spikes were above max except for the starting point, at t = 0 to t = 1.

Comparison analysis for the amount of relevant drug in the blood of an adult and child
When comparing the two graphs, it displays that the child's peaks are taller than the peaks that are shown in the adults graph. Having calculated the difference between the two graphs' highest spikes, it gave a value gap of 106.16 mg/l. Despite the child having more spikes above the max, the amount of downward spikes below the min value that the adult has is larger than the children. Thirteen spikes are below the min for the adults, whereas the child has only six spikes. The adult has seven more spikes below the min and fourteen spikes below the max, in comparison to the child spikes.

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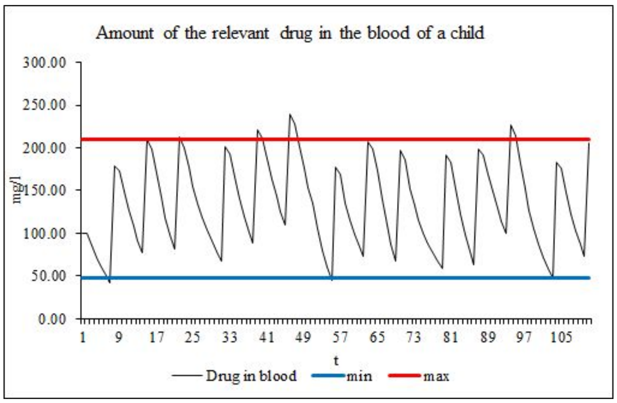
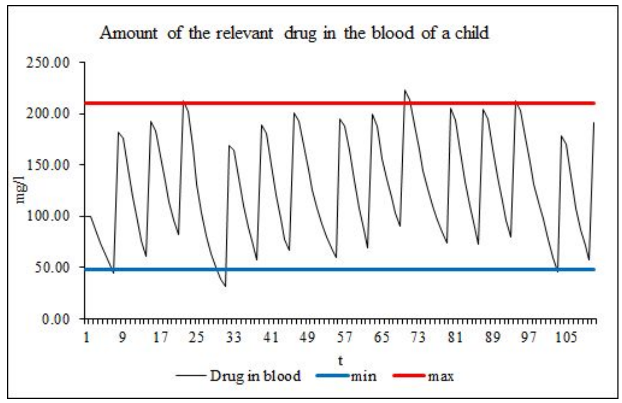
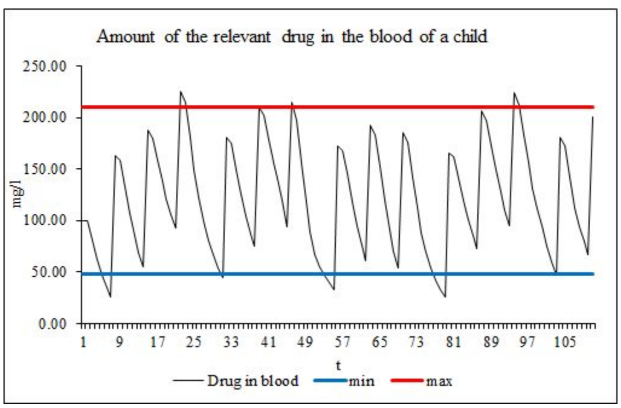
Question #2b

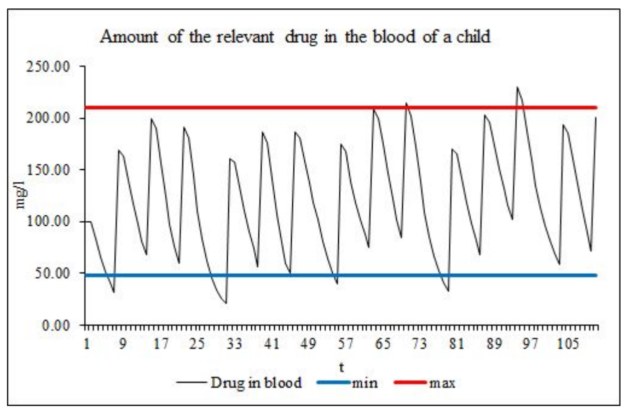
- Change the maximum value to 210 mg/l. Rerun the model 10 times. How often is the medication **on average** above the maximum during the simulation period of 110 hours?

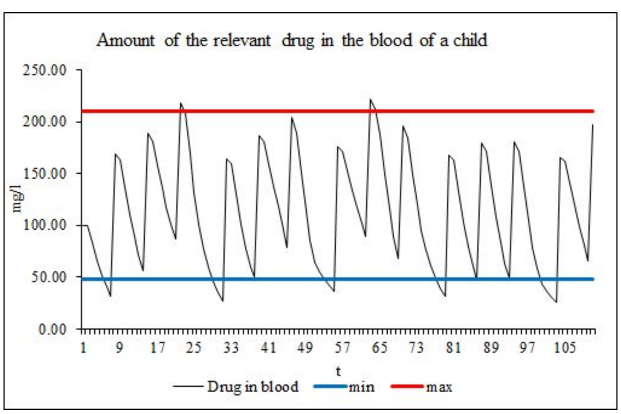
The average was calculated by counting all the spikes exceeding the max line by the use of the graphs displayed below.

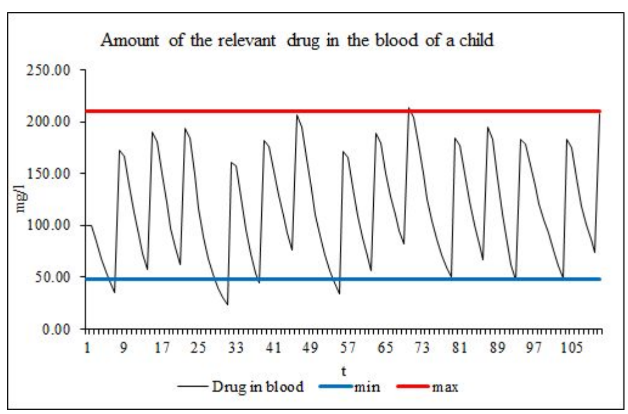


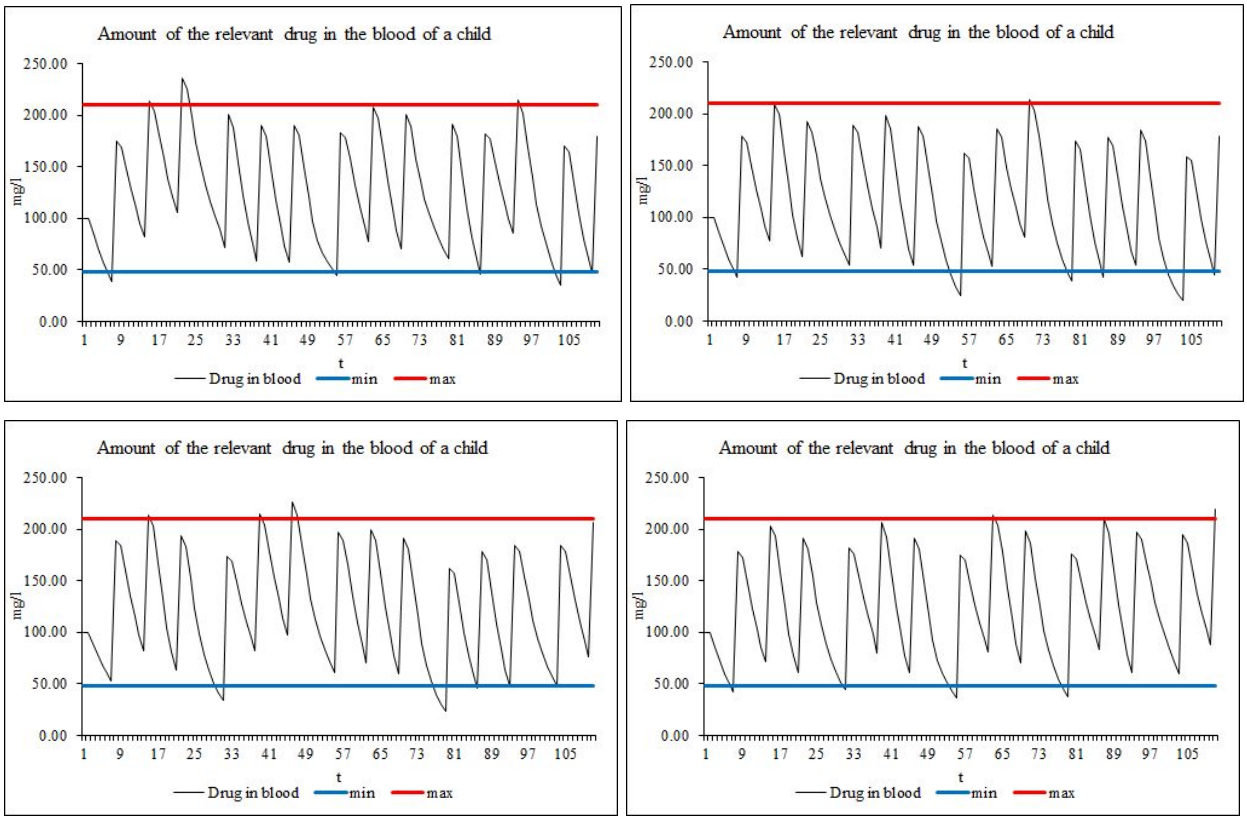












The formula to calculate the average, in this case, is the following.

$$\frac{\textit{Sum of all the number of peaks above the maximum from all simulations ran}}{\textit{Total number of simulations ran}} = \text{The average number of peaks exceeding the maximum}$$

Thus, the values collected from the graph was used to calculate the average;

$$\frac{4 + 3 \times 4 + 2 \times 3 + 1 \times 2}{10} = 2.4$$

Therefore, the medication exceeds the maximum on average at 2.4 times during the simulation period of 110 hours, according to the model being run ten times.

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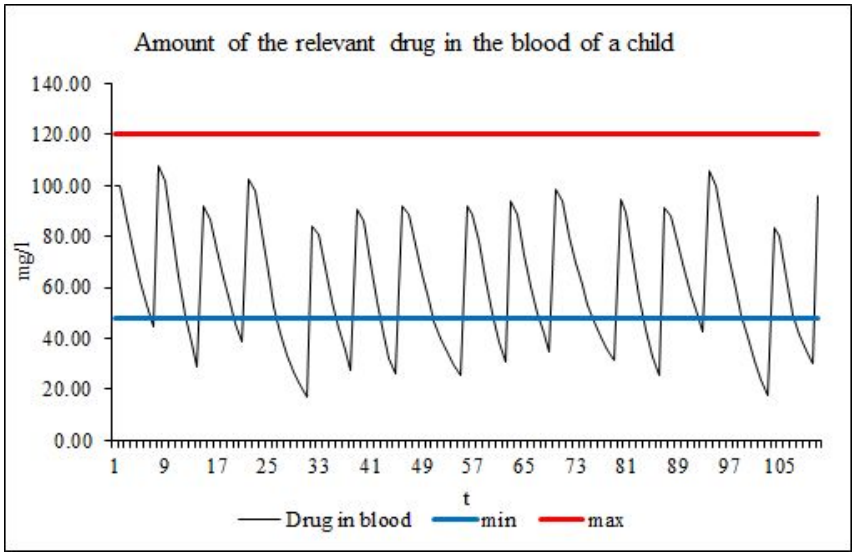
Question #2c

Change the maximum value back to 120 mg/l.

- ❖ Describe **three ways** in which you can reduce the number of times that the blood level is above the maximum for this child.
- ❖ Implement one of these ways and describe which values you have chosen so that they are rarely above the maximum.

1. Adjusting the pill size can lower the number of times the blood level is above the max.
2. Increasing the basic decay factor reduces the frequency of the blood level exceeding the max.
3. By distributing a smaller version of the pill throughout increased frequency of pill servings reduce the amount of peaks to exceed the max.



By adjusting the pill size to 210 mg (through trial and error) lowered the number of relevant drugs in the blood of an adult as shown in the graph above. After having run more than 10 simulations, it was clear that the values above were possibly exposed to having the probability of exceeding the max. Thus, to make sure that the values are all below the max, it was decided to adjust the pill size to 210 mg which is 231 mg smaller than the original(432 mg).

Question #3

- Formulate **three hypotheses or research questions** about the effect of some medication regime on a specific person.

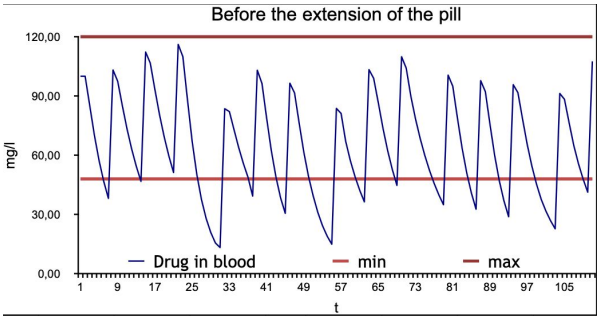
1. Is a larger pill size ($\times 1.5$, 648 mg) going to influence the overstepping below the minimum limit, which is equal to 48 mg/l?
2. By splitting the dose of the pill into two (216 mg and 216 mg), and updating the frequency of taking them twice, could we get rid of excess on the minimum limit (48 mg/l)?
3. How does the modification of the decay factor influence the exceed off the minimum limit (48 mg/l)?

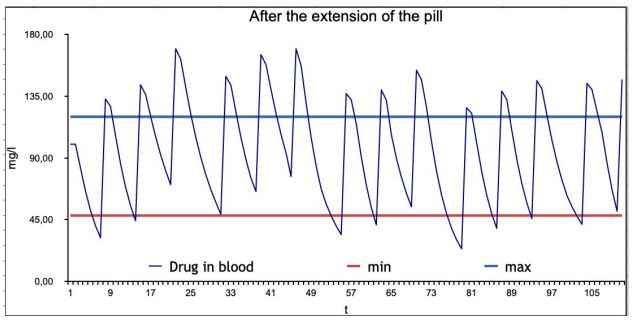
Question #4

- Use models to validate **two** of your hypotheses or research questions.

1. Extension of the pill size

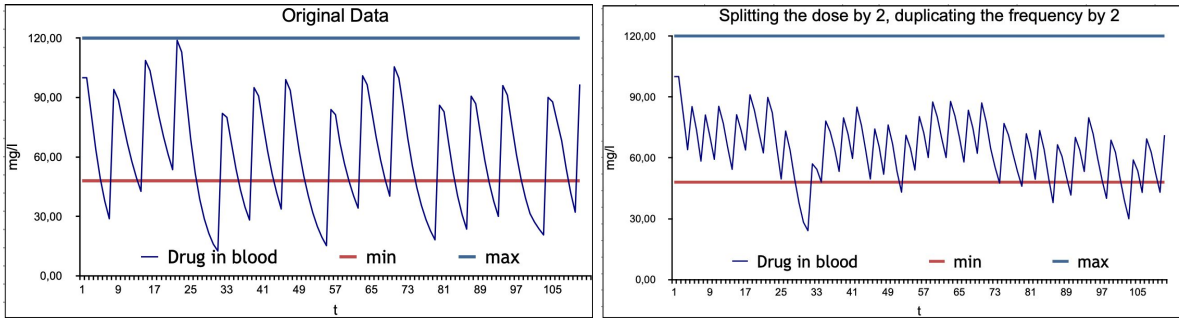
The original pill size is equal to 432 mg, it is hypothesized that it could be one of the reasons why the data was reaching some points below the minimum limit (48 mg/l). The first graph is a representation of the original influence of the drug, the minimum peak was achieved 13 times out of 14 (93%), but after the modification, increasement of the pill size 1.5 times, got us the result 7 out of 14 (50%). *The hypothesis has been proved*.





2. **Splitting the dose by 2, duplicating the frequency by 2**

Again, we confront the reachement below the minimum (48 mg/l). The original frequency and pill size was giving us the result of 93%, 13 out of 14 peaks were below the minimum. None of them were above the maximum limit (120 mg/l). We hypothesize that changing them by reducing the pill size twice and increasing the frequency of taking the medication twice could change that significantly. The first graph represents the original data, the second one presents the modification. 14 out of 29 of the peaks, 48%, were below the minimum, and, without any influence on the maximum. So, we reduced the excess by 45%, *the hypothesis is proved*.



3. **Decay Factor Modification**

The original decay factor is equal to 0.15 and almost all the peaks (13 of 14) were below the minimum limit (48 mg/l). We hypothesize that by changing the decay factor, it is possible to reduce the peaks below the maximum. We changed it from 0.15 to 0.11 and the second graph represents the result. Only one of the peaks (out of 14) is below the minimum, it is equal to 44,36. *The hypothesis is proved.*