1. (a) Elmo - $94 * 10^6$, Jan 2018, https://allennlp.org/elmo,

   GPT-2 - $1,5 * 10^9$, Feb 2019, https://openai.com/blog/gpt-2-1-5b-release/

   Megatron-LM, $8,3*10^9$, Mar 2019,https://www.deepspeed.ai/tutorials/megatron/

   Turing-NLG- $17*10^9$, Feb 2020, https://www.microsoft.com/en-us/research/blog/turing-nlg-a-17-billion-parameter-language-model-by-microsoft/

   GPT-3 $175 * 10^9$, Juni 2020, https://openai.com/blog/openai-api/

   Megatron-Turing-NLG - , $530*10^9$,October 2021, https://developer.nvidia.com/blog/using-deepspeed-and-megatron-to-train-megatron-turing-nlg-530b-the-worlds-largest-and-most-powerful-generative-language-model/

   All of these are taken from the website of the company that created them. And thus we can be sure the data is correct. See table 1.

   (b) See figure 1.

   (c) The amount of months after the start of 2018 as our x value and log parameters as our y value. See table 2.

   (d) See figure 2.

   (e) No we can not see any visual outliers.

2. (a) z^x exponential function $log(z)^x = x*log(z)$ linear function We require a linear function for the regression model which is why the y variable is logarithmic.

   (b) Running code seen in code example we get $\alpha = 0.084273354794008888$ and $\beta = 8.190329535314607$

   (c) See figure 2c.

   (d) See figure 2d.

   (e) Did not understand question.

   (f) One step would be a step of 10. So to solve this we would solve $1 * x = \beta$ which is the same as $x = 1/\beta$. Which is roughly 11.866.

3. (a) H0 : beta = 0. H1: beta != 0. If zero is included in our interval we know there is no linear relation. See our calculations. We get the interval to [0.049654, 0.11888]. As zero is not included in this interval we can discard H0 and say that we have a significant linear correlation.

   (b) Here we need 1/limits from question 3a. Which gives us: [8.41184, 20.139]

   (c) This question has been done on paper see figure 6.

   (d) No I do not think so. This regression curve is based on a small set of data and therefor will have a hard time predicting far into the future.

Code

```
#Code for 2b
import math

x = [1,14,15,26,30,46]
y = [math.log10(94 *10**6),
     math.log10(1.5*10**9),
     math.log10(8.3*10**9),
     math.log10(17 *10**9),
     math.log10(175*10**9),
     math.log10(530*10**9)]

def average(list):
    total = 0
    for i in range(len(list)):
        total += list[i]
    return (total / len(list))

x_average = average(x)
y_average = average(y)

def calc_s (list1,list2,average1,average2):
    total = 0
    for i in range(len(list1)):
        total += (list1[i]-average1)*(list2[i]-average2)
    return total

sxx = calc_s(x,x,x_average,x_average)
syy = calc_s(y,y,y_average,y_average)
sxy = calc_s(x,y,x_average,y_average)

BHat = sxy/sxx
alpha = y_average - x_average*BHat

print(BHat)
print(alpha)
```

Graphs and tables:

Table 1: Uppgift 1a

Release date	**Number of parameters**
Jan 2018	$94 * 10^6$
Feb 2019	$1.5 * 10^9$
Mar 2019	$8.3 * 10^9$
Feb 2020	$17 * 10^9$
June 2021	$175 * 10^9$
Oct 2021	$530 * 10^9$

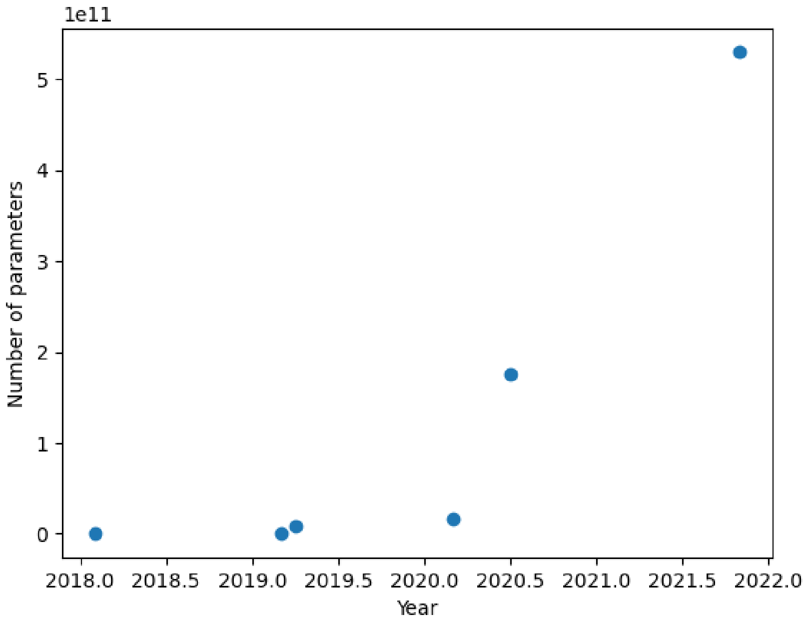


Figure 1: Uppgift: 1b

Table 2: Uppgift 1c

Uppgift 1c	**Number of parameters**
1	$log(94 * 10^6)$
14	$log(1.5 * 10^9)$
15	$log(8.3 * 10^9)$
26	$log(17 * 10^9)$
30	$log(175 * 10^9)$
46	$log(530 * 10^9)$

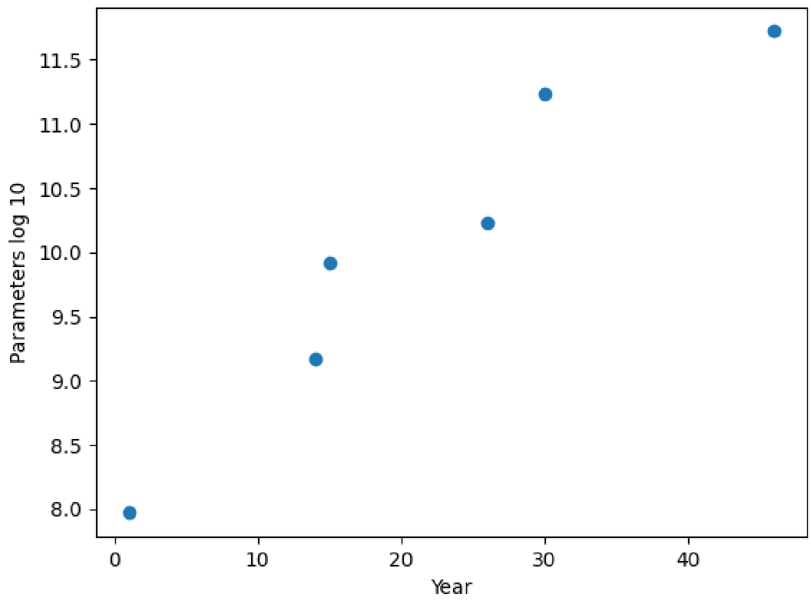


Figure 2: Uppgift: 1d

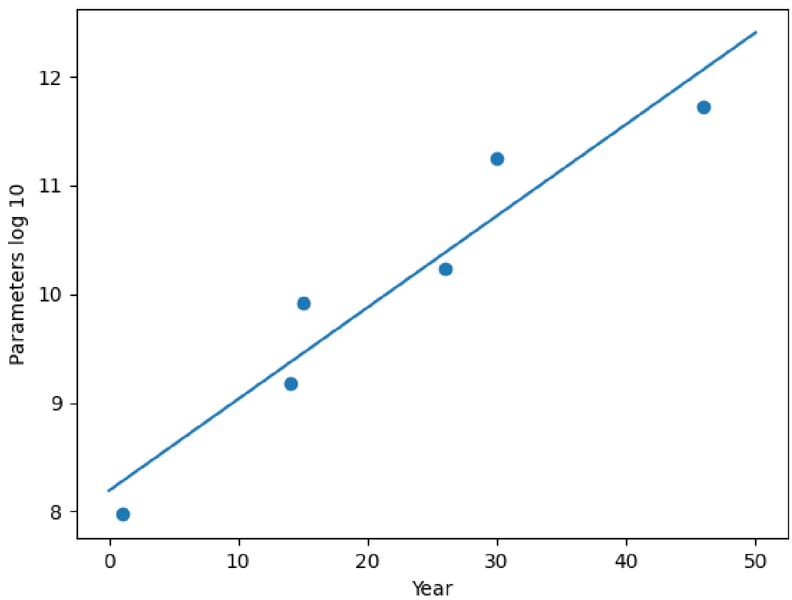


Figure 3: Uppgift: 2c

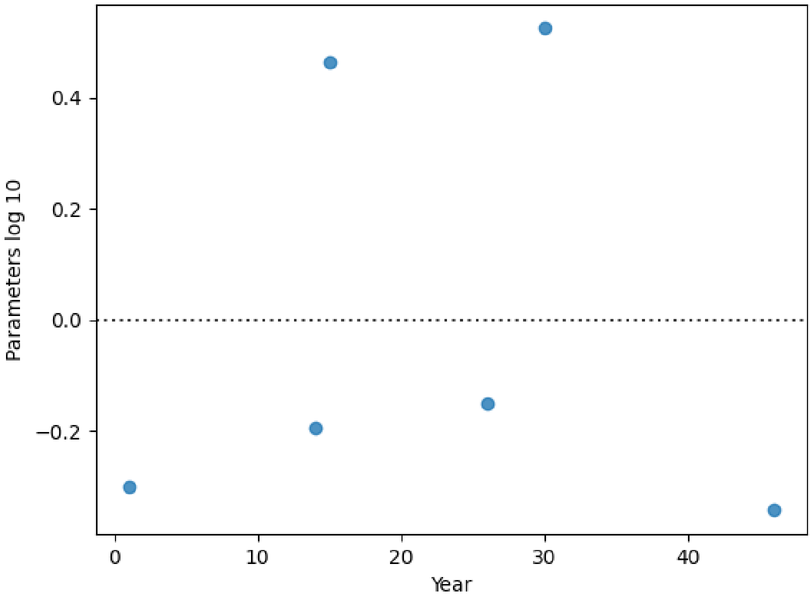
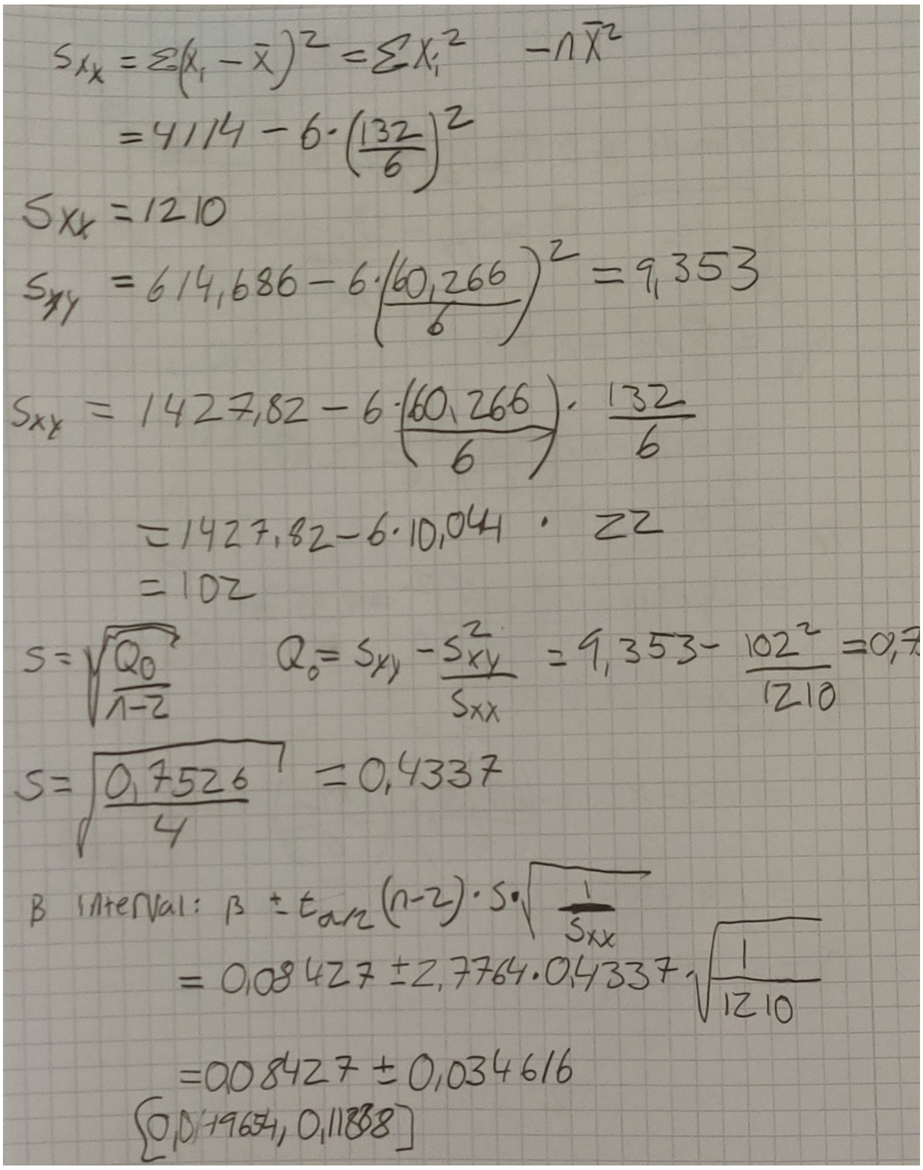


Figure 4: Uppgift: 2d



$$S_{xx} = \Sigma(x_i - \bar{x})^2 = \Sigma x_i^2 \quad - n\bar{x}^2$$

$$= 4114 - 6\cdot\left(\frac{132}{6}\right)^2$$

$$S_{xx} = 1210$$

$$S_{yy} = 614{,}686 - 6\cdot\left(\frac{60{,}266}{6}\right)^2 = 9{,}353$$

$$S_{xy} = 1427{,}82 - 6\cdot\left(\frac{60{,}266}{6}\right)\cdot\frac{132}{6}$$

$$= 1427{,}82 - 6\cdot 10{,}044 \cdot 22$$

$$= 102$$

$$s = \sqrt{\frac{Q_0}{n-2}} \qquad Q_0 = S_{yy} - \frac{S_{xy}^2}{S_{xx}} = 9{,}353 - \frac{102^2}{1210} = 0{,}7$$

$$s = \sqrt{\frac{0{,}7526}{4}} = 0{,}4337$$

$$\beta \text{ interval: } \beta \pm t_{\alpha/2}(n-2)\cdot s\cdot\sqrt{\frac{1}{S_{xx}}}$$

$$= 0{,}08427 \pm 2{,}7764\cdot 0{,}4337\cdot\sqrt{\frac{1}{1210}}$$

$$= 0{,}08427 \pm 0{,}034616$$

$$[0{,}049654,\ 0{,}11888]$$

Figure 5: Uppgift: 3a

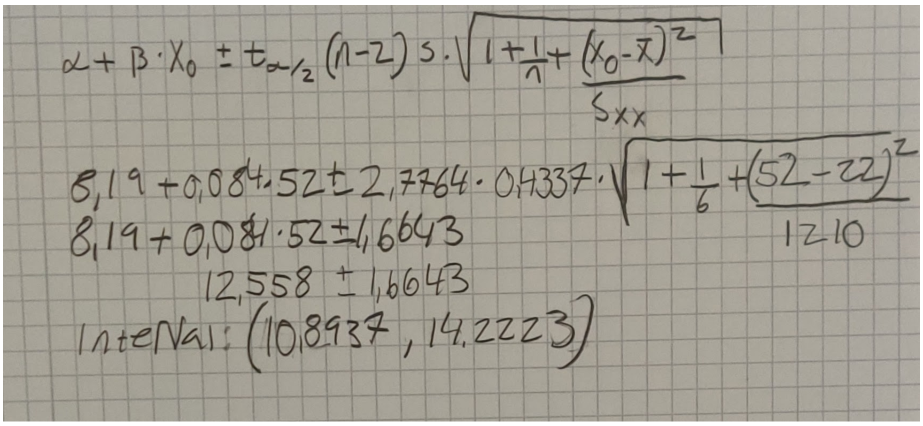


Figure 6: Uppgift: 3b