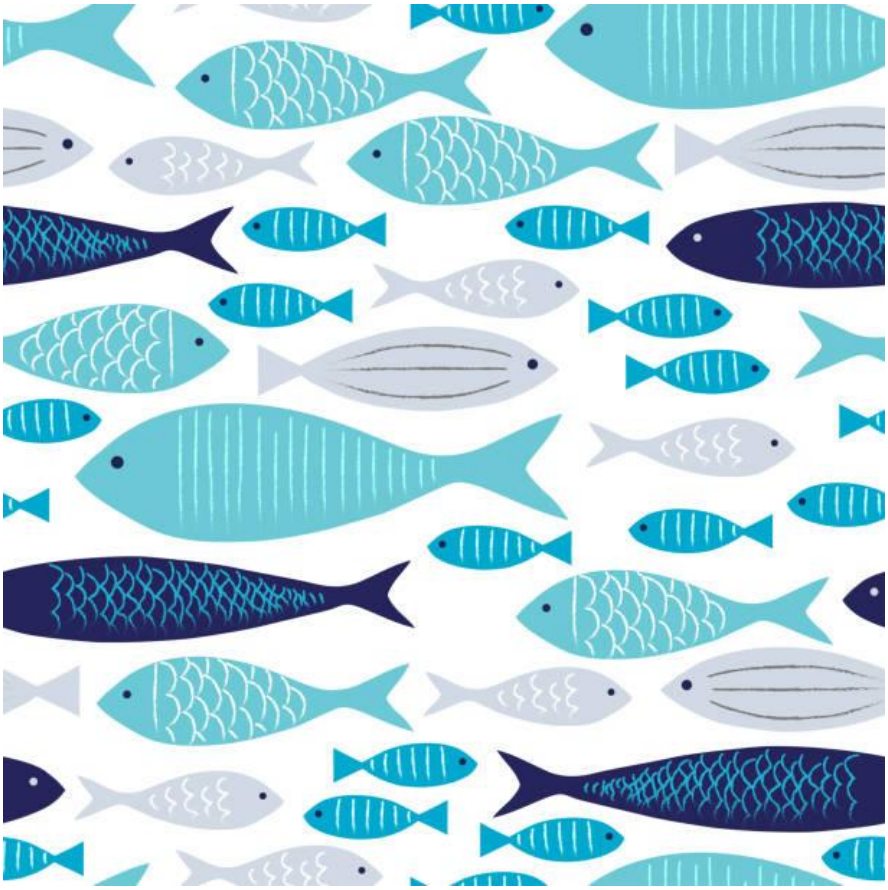

Project 2: Is it safe to eat fish?

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Introduction

The prime reason for mercury accumulation in the human body is due to eating a lot of fish. Bigger fish consume smaller fish which leads to higher MeHg(a mercury compound) percentage the bigger the fish is.

Goals

1. Construct fictional characters to analyze various fish diets for different people.
2. See, if it's really possible to get mercury poisoning from eating too much fish
3. Find out whether humans should avoid eating sharks and swordfish altogether

The characters

I. Miguel

Miguel is a 17 year old student who does not really look after his diet and is not aware of mercury in fish. He's 75 kilos. One day he bet his friends that he could eat absurd amounts of exotic fish until the end of the year, which happened to be 7 months from the day of the bet. Every week he would eat shark, swordfish, halibut and squid.

II. Mario

For the holidays, Mario decided to go to Guangzhou to celebrate the Chinese Spring Festival. It is known for its shiny decorations and abundance of fish dishes. Each day of his stay there he went out for fish soups, fried fish and other sorts of exotic looking plates. As a 100 kilo dude, his appetite was pretty good to eat all of this. His average weekly meals had tuna, whiting, cod.

III. Mateo

Mateo is a 125 kg 190 cm man who lives on the sea coast and for that reason enjoys an occasional fish meal. His favorite fish to eat are fresh tuna, sardines, halibut and cod.

Calculations

The primary formulas used for the project are:

$A_{n+1} = \alpha A_n + \beta$ Linear difference equation

$A_n = \frac{\beta}{1-\alpha} + (A_0 - \frac{\beta}{1-\alpha})\alpha^n$ General term formula

Where

n – time(weeks)

H – half life of MeHg(in weeks)

α – $exp(\frac{-ln(2)}{H})$ decay of MeHg in the body

β – amount of MeHg in the fish consumed weekly(mg)

A_0 – initial amount of MeHg in the body(mg)

Miguel's Diet

Miguel's weight is 75kg, his mercury half-life is average, 10 weeks. From the table we can see that he eats 41.5 kg of fish per week from which his mercury income is 31.003 mg. We took the starting mercury amount in the body as $3.5 * 10^{-7}$ mg, which is so insignificant that it can be rounded to 0.

Type of Fish	Amount (kg)	Amount of MeHg (mg)
Shark	13	12.727
Swordfish	17	16.915
Halibut	5	1.205
Squid	6.5	0.156

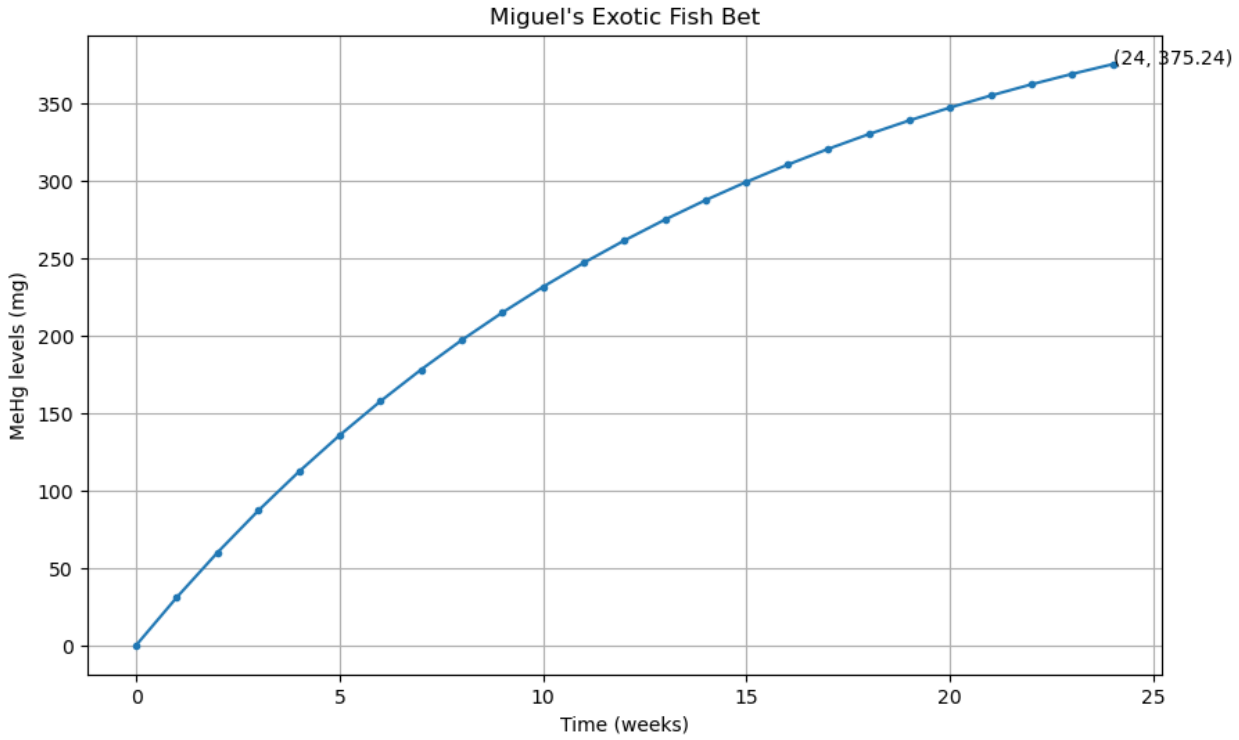
$$375 = \frac{31.003}{1-exp(\frac{-ln(2)}{10})} + (0 - \frac{31.003}{1-exp(\frac{-ln(2)}{10})})exp(\frac{-ln(2)}{H})^n$$

$$-87.959 = (-\frac{31.003}{1-exp(\frac{-ln(2)}{10})})exp(\frac{-ln(2)}{H})^n$$

$$0.18999 = exp(\frac{-ln(2)}{H})^n$$

$$n = 23.96$$

$$n \sim 24$$



From the calculations and the graph we notice that his mercury levels surpass 0.5 mg/kg of body weight at around week 3 and 5 mg/kg of body weight at week 24, making him reach the deadly point of mercury amount in the blood. Eating so much shark and swordfish for half a year has caused the desperate better to lose his life.

Mario's Diet

Mario is 100kg, his half-life is 100 days, making him a little more vulnerable to mercury sickness. His starting mercury amount is 0 as well.

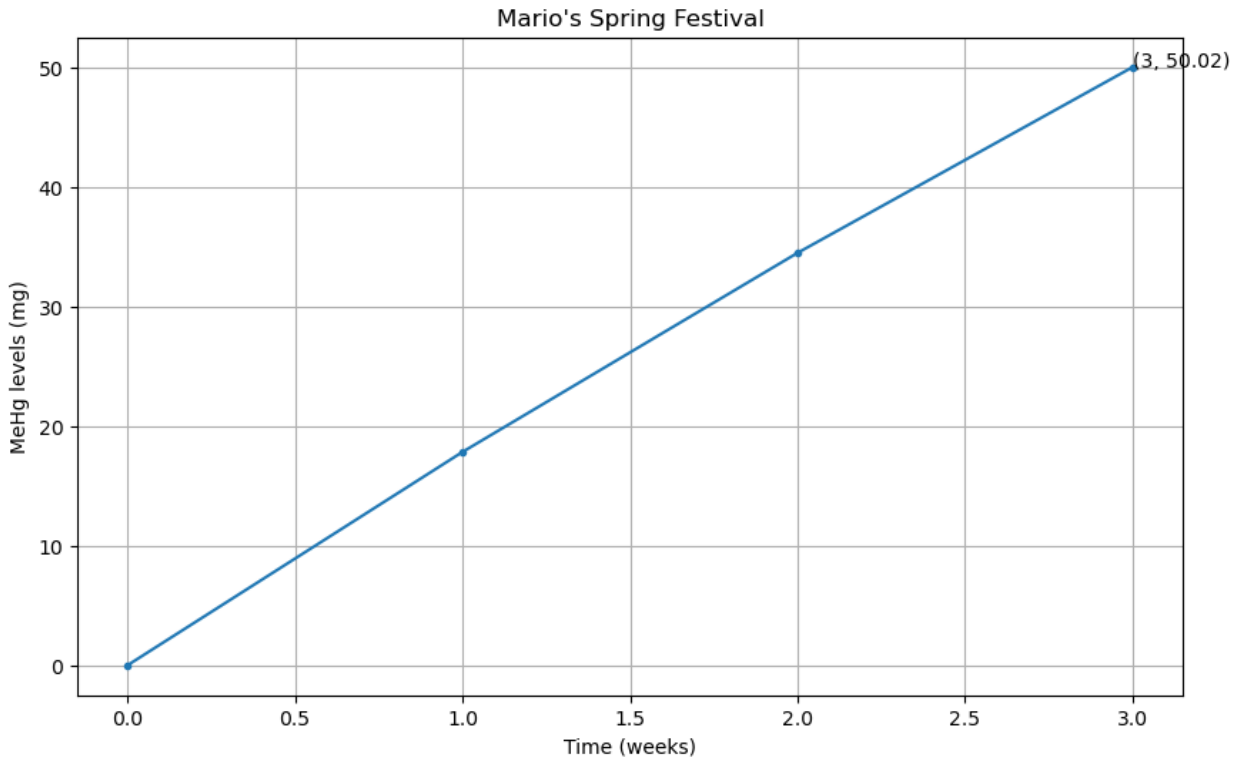
Type of Fish	Amount (kg)	Amount of MeHg (mg)
Tuna(Fresh)	35	14
Cod	22	2.42
Whiting	29	1.45

$$50 = \frac{17.87}{1-exp(\frac{-ln(2)}{10})} + (0 - \frac{17.87}{1-exp(\frac{-ln(2)}{10})})exp(\frac{-ln(2)}{H})^n$$

$$-216.85 = (-\frac{17.87}{1-exp(\frac{-ln(2)}{10})})exp(\frac{-ln(2)}{H})^n$$

$$0.81 = exp(\frac{-ln(2)}{H})^n$$

$$n \sim 3$$



In just 3 weeks of eating a big number of small and medium sized fish Mario earned himself adverse effects and after visiting the doctor, decided to never eat this much fish again.

Mateo's Diet

Mateo's weight is 125 kilos, his half-life is average, being 70 days and he eats 5.7 kg of fish per week. A0 is $\frac{\beta}{1-\alpha}$ since he eats the same amount of fish every week, so it's 23.3.

$$62.5 = \frac{1.5601}{1-exp(\frac{-ln(2)}{10})} + (23.3 - \frac{1.5601}{1-exp(\frac{-ln(2)}{10})})exp(\frac{-ln(2)}{H})^n$$

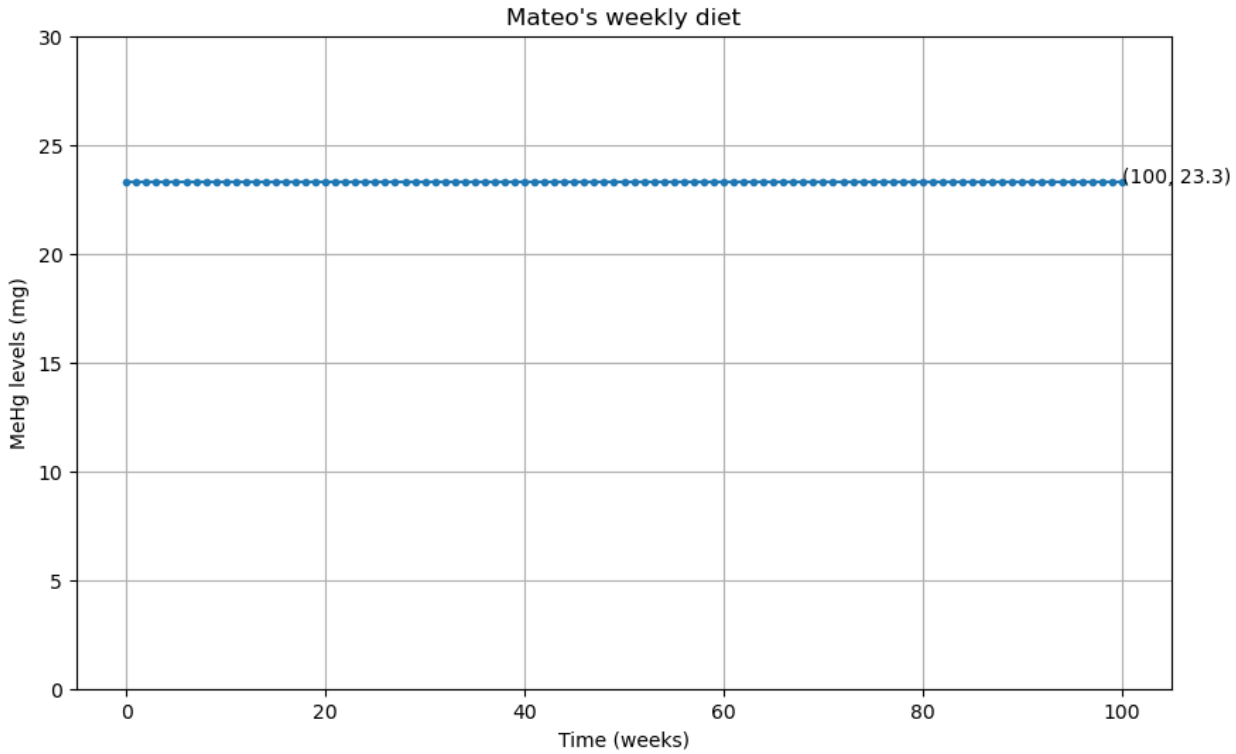
$$39.2035 = (23.3 - \frac{1.5601}{1-exp(\frac{-ln(2)}{10})})exp(\frac{-ln(2)}{H})^n$$

$$39.2035 = 0 * exp(\frac{-ln(2)}{H})^n$$

n cannot be calculated

Therefore Mateo will never get sick

Type of Fish	Amount (kg)	Amount of MeHg (mg)
Tuna (fresh)	3	1.2
Sardines	0.7	0.0091
Halibut	1	0.241
Cod	1	0.11



Although Meteo eats more fish in the long run, in the short run the mercury in his body has the possibility to decay and not accumulate, unlike the previous characters.

Conclusions

1. Is it really possible to get mercury poisoning from eating too much fish ?

While it is rare, mercury poisoning can be a consequence of eating too much fish. This can be seen in Mario's case where after eating ridiculous amounts of fish that contain low/medium amounts of mercury, eventually Mario will have enough mercury in his body to be poisoned. In Mario's case it may seem impossible however, if someone were to eat fish that contained higher amounts of mercury (shark, swordfish) it would become much easier to get poisoned.

2. Based on this analysis, do you think we should avoid shark and swordfish altogether?

No. While shark and swordfish contain the highest amounts of mercury compared to other fish, they can still be eaten in moderation without any adverse effects. This being said, young children below the age of 8 should avoid substantial amounts as it could lead to mercury poisoning.

References

Python code used to create graphs

```
import numpy as np
import matplotlib.pyplot as plt
import math

a0 = 23.296546102361518
hl = 70  # half-life in days
n = round(hl / 7)  # half-life in weeks
alpha = 1/(2**0.1)
mass = 125
beta = 1.5601
num_periods = 100 # time period

data = np.zeros((num_periods + 1, 2))
data[0, 0] = 0  # Initial time period
data[0, 1] = a0  # Initial MeHg level
for i in range(num_periods):
    data[i + 1, 0] = i + 1
    data[i + 1, 1] = alpha * data[i, 1] + beta

plt.figure(figsize=(10, 6))
plt.plot(data[:, 0], data[:, 1], 'o-', markersize=3)
plt.xlabel('Time (weeks)')
plt.ylabel('MeHg levels (mg)')
plt.title("Mateo's weekly diet")
plt.text(data[-1,0], data[-1,1], '({}, {})'.format(round(data[-1,0]), round(data[-1,1],2)))
plt.grid(True)
plt.ylim([0, 30])
plt.show()
```