Problem 1

1(a)

In [1]:
```
def temp_tester(normal_temp):
    def health_temp(temp):
        if normal_temp - 1 <= temp <= normal_temp + 1:
            return True
        else:
            return False
    return health_temp
```

1(b)

The description doesn't specify whether the temperature is in Fahrenheit or Celsius. The normal body temperature differs depending on the scale, e.g., 98.6°F is normal for humans in Fahrenheit, while 37°C is normal in Celsius. Clarifying the unit of temperature would avoid confusion.

1(c)

In [2]:
```
human_tester = temp_tester(37)
chicken_tester = temp_tester(41.1)
```

In [3]:
```
print(chicken_tester(42))
print(human_tester(42))
print(chicken_tester(43))
print(human_tester(35))
print(human_tester(98.6))
```

```
True
False
False
False
False
```

Problem 2

2(a)

In [4]:
```
import pandas as pd
data = pd.read_csv("us-states.csv")
data

# data source from New York Times at https://github.com/nytimes/covid-19-data
```

Out[4]:

	date	state	fips	cases	deaths
0	2020-01-21	Washington	53	1	0
1	2020-01-22	Washington	53	1	0
2	2020-01-23	Washington	53	1	0
3	2020-01-24	Illinois	17	1	0
4	2020-01-24	Washington	53	1	0
...	...	...	...	...	...
61937	2023-03-23	Virginia	51	2298300	23782
61938	2023-03-23	Washington	53	1940704	15905
61939	2023-03-23	West Virginia	54	645710	8132
61940	2023-03-23	Wisconsin	55	2014524	16485
61941	2023-03-23	Wyoming	56	185800	2014

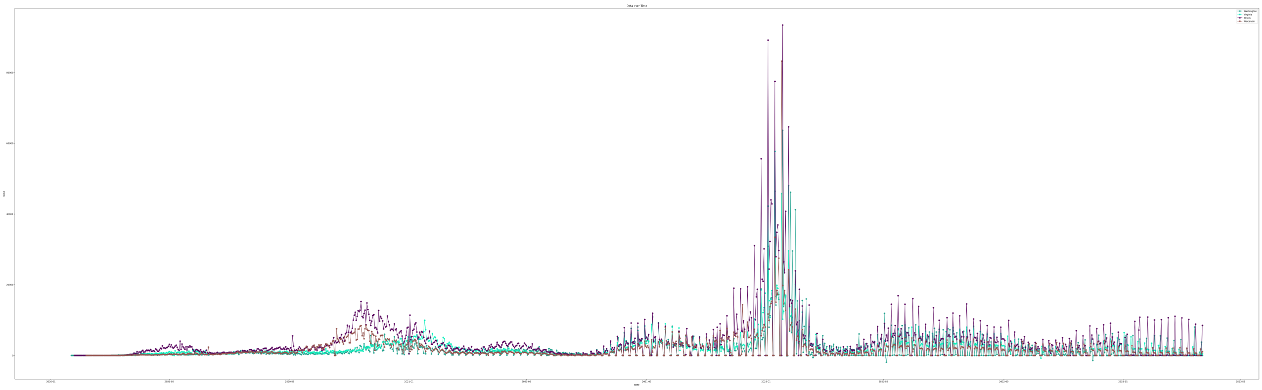
61942 rows × 5 columns

2(b)

In [5]:
```
import matplotlib.pyplot as plt
import matplotlib.dates as mdates
from datetime import datetime
import numpy as np
def statecases(state_name):
    plt.figure(figsize=(100, 30))
    for i in state_name:
        filtered_df = data[data['state'] == i]
        new = []
        for j in range(len(filtered_df)-1):
            new.append((filtered_df.iloc[j+1,0],filtered_df.iloc[j+1,3]-filtered_df.iloc[j,3]))
        dates = [datetime.strptime(item[0], "%Y-%m-%d") for item in new]
        values = [item[1] for item in new]
        random_color = np.random.rand(3,)
        plt.plot(dates, values, marker = 'o', linestyle = '-', color = random_color, label = 'i')
    plt.title('Data over Time')
    plt.xlabel('Date')
    plt.ylabel('Value')
```

```
    plt.legend(state_name)
    plt.show()

statecases(['Washington','Virginia','Illinois','Wisconsin'])
```



2(c)

In [6]:
```
def peak_case(state):
    filtered_df = data[data['state'] == state]
    new = []
    for j in range(len(filtered_df)-1):
        new.append((filtered_df.iloc[j+1,0],filtered_df.iloc[j+1,3]-filtered_df.iloc[j,3]))
    flag = 0
    date = 0
    for i in new:
        if i[1] > flag:
            flag = i[1]
            date = i[0]
    return date,flag
state = "Washington"
peak_date,peak_casenum = peak_case(state)
print('the peak date for state',state,'is',peak_date,'with',peak_casenum,'new cases.')
```

```
the peak date for state Washington is 2022-01-18 with 63640 new cases.
```

2(d)

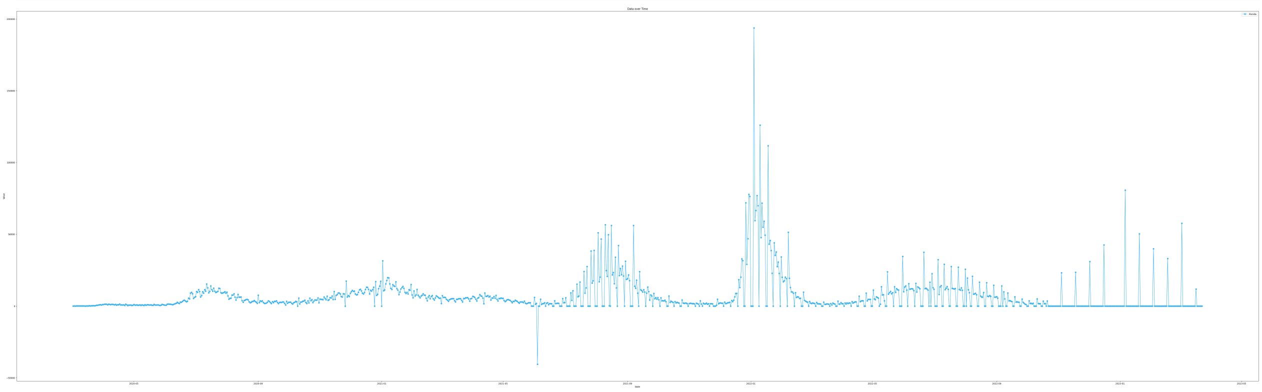
In [7]:
```
def compare_peak(state0,state1):
    peak_date0,peak_casenum0 = peak_case(state0)
    peak_date1,peak_casenum1 = peak_case(state1)
    peak_date0,peak_date1 = pd.to_datetime(peak_date0),pd.to_datetime(peak_date1)
    if str(peak_date1 - peak_date0)[0] == '-':
        print(state1,'had its peak first, the number of days between the peaks of two states are',str(peak_date0 - peak_date1)[:-10])
    else:
        print(state0,'had its peak first, the number of days between the peaks of two states are',str(peak_date1 - peak_date0)[:-10])

compare_peak("Washington",'Virginia')
```

```
Virginia had its peak first, the number of days between the peaks of two states are 8 day
```

2(e)

In [8]:
```
statecases(["Florida"])
```



There is a negative days for the new cases, which means the total cases drops at that time. The possible reasons might be at that time an accident occured at a hospital and some patient dead.

Problem3

3(a)

In [9]:
```
import sqlite3

with sqlite3.connect("hw0-population.db") as db:
```

```
    data = pd.read_sql_query("SELECT * FROM population", db)
data
```

Out[9]:

	name	age	weight	eyecolor
0	Edna Phelps	88.895690	67.122450	brown
1	Cara Yasso	9.274597	29.251244	brown
2	Gail Rave	18.345613	55.347903	brown
3	Richard Adams	16.367545	70.352184	brown
4	Krista Slater	49.971604	70.563859	brown
...	...	...	...	...
152356	John Fowler	23.930833	71.532569	blue
152357	Diana Shuffler	21.884819	67.936753	brown
152358	Kevin Cuningham	87.705907	60.074646	brown
152359	James Libengood	21.727666	81.774985	brown
152360	Cathleen Ballance	10.062236	34.327767	brown

152361 rows × 4 columns

There are 4 colmuns: name, age, weight, eye color. Contains total 152361 rows.

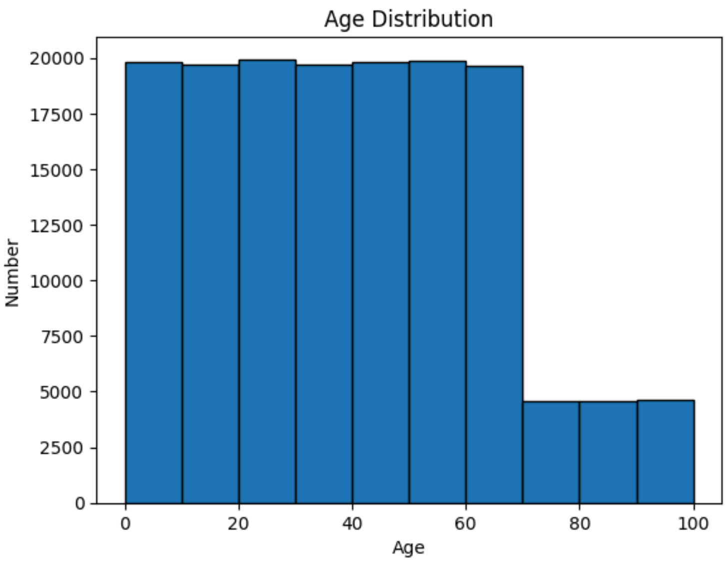
3(b)

In [10]:

```
print("the mean, standard deviation, minimum, maximum for the age column are:", data['age'].mean(),(data['age'].var())**0.5,data['age'].m
plt.figure()
plt.hist(data['age'], bins=10, edgecolor='black')
plt.title('Age Distribution')
plt.xlabel('Age')
plt.ylabel('Number')
```

```
the mean, standard deviation, minimum, maximum for the age column are: 39.51052792739697 24.152760068601573 0.0007476719217636152 99.99154
733076972
```

Out[10]: Text(0, 0.5, 'Number')



The number of bins in a histogram affects the interpretation of the data. Too much or too less bins will change the patterns of the original distribution. A higher number of bins creates more divisions and a lower number of bins provides a more generalized view.

The number of population drops significantly in age larger than 70. For population before age 70 and after age 70, the number in different bin is nearly the same.

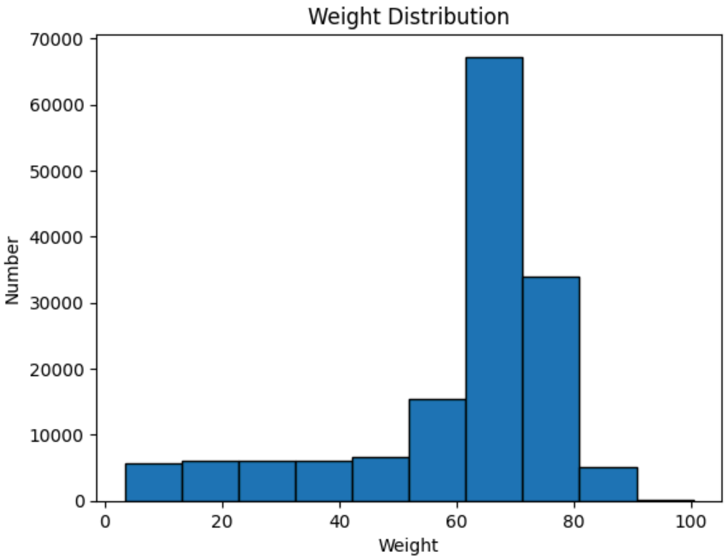
3(c)

In [11]:

```
print("the mean, standard deviation, minimum, maximum for the age column are:", data['weight'].mean(),(data['weight'].var())**0.5,data['w
plt.figure()
plt.hist(data['weight'], bins=10, edgecolor='black')
plt.title('Weight Distribution')
plt.xlabel('Weight')
plt.ylabel('Number')
```

```
the mean, standard deviation, minimum, maximum for the age column are: 60.884134159929715 18.41182426565962 3.3820836824389326 100.4357930
0336947
```

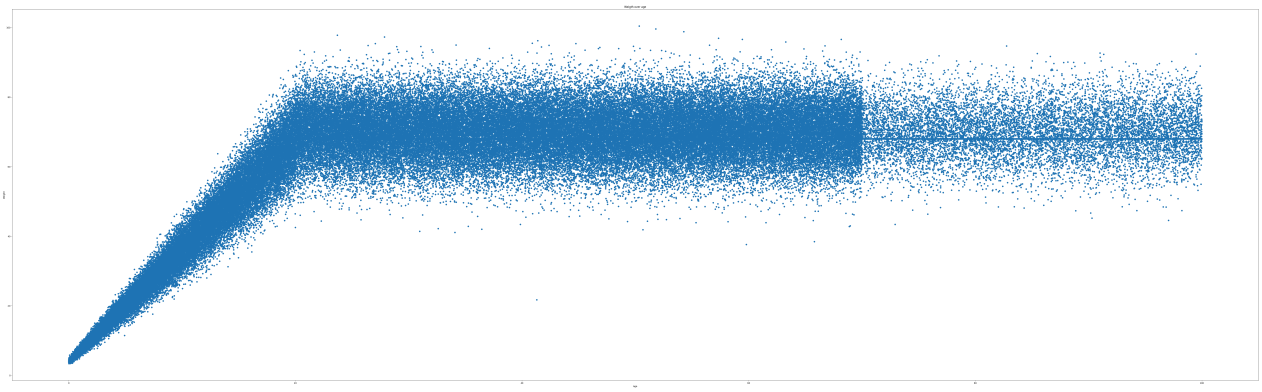
Out[11]: Text(0, 0.5, 'Number')



Most people's weight is around 70 kilograms. The whole distribution is closed to a normal distribution centered in 70.

3(d)

In [12]:
```
plt.figure(figsize=(100, 30))
plt.scatter(data['age'],data['weight'])
plt.title('Weigth over age')
plt.xlabel('Age')
plt.ylabel('Weight')
plt.show()
```



The pattern of weight over age is the weight increase before age 20, after age 20, the weight does not grow anymore and is around 70.

From the graph we can see there is an outlier which has a siginificant low weight compares to others. To narrow this outlier, we find that only this outlier's weight is lower than 30 while older than 20. By applying this constraints we can get this outlier.

In [13]:
```
for i in range(len(data)):
    if data.iloc[i,1] > 20 and data.iloc[i,2] < 30:
        print(data.iloc[i,0])
```

```
Anthony Freeman
```

Problem 4

4(a)

In [14]:
```
import random
def generate_population(n, d):
    a = []
    for i in range(d):
        a.append(True)
    for j in range(n-d):
        a.append(False)
    return a
```

4(b)

In [15]:
```
def sample_pop(a,s):
    b = random.sample(a,s)
    t = 0
    f = 0
    for i in b:
        c = random.randint(0,1)
        if c == 0:
            c = random.randint(0,1)
```

```
            if c == 0:
                t += 1
            else:
                f += 1
        else:
            if i == True:
                t += 1
            else:
                f += 1
    return t
```

4(c)

In [16]:
```
def est_func(n,d,s):
    a = generate_population(n, d)
    t = sample_pop(a,s)
    t = t/s*n
    return max(t,0) # to avoid negativity
```

4(d)

In [17]:
```
print(est_func(1000,100,50))
```

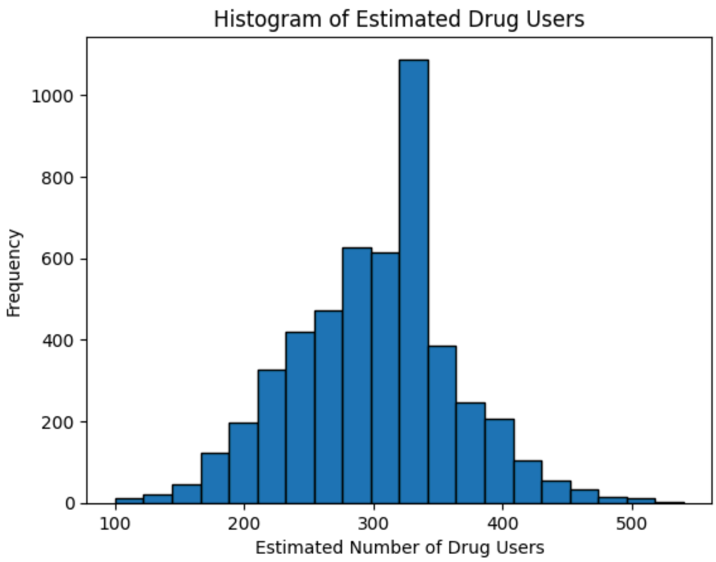
```
280.0
```

4(e)

to generate enough data to make sure the outcome is stable we choose a large number 5000 to simulate.

In [18]:
```
estimate = []
for i in range(5000):
    estimate.append(est_func(1000,100,50))

plt.hist(estimate, bins=20, edgecolor='black')
plt.title('Histogram of Estimated Drug Users')
plt.xlabel('Estimated Number of Drug Users')
plt.ylabel('Frequency')
plt.show()
```



4(f)

In [19]:
```
def explore_sample_size_effect(n, usernumber, samplesize, repetitions=100):
    means = {users: [] for users in usernumber}
    std_devs = {users: [] for users in usernumber}

    for s in samplesize:
        for users in usernumber:
            estimates = [est_func(n, users, s) for _ in range(repetitions)]
            means[users].append(np.mean(estimates))
            std_devs[users].append(np.std(estimates))
    plt.figure()

    for users, color in zip(usernumber, ['blue', 'green']):
        plt.plot(samplesize, means[users], label=f'{users} users', color=color)
        plt.fill_between(samplesize,
                         np.array(means[users]) - np.array(std_devs[users]),
                         np.array(means[users]) + np.array(std_devs[users]),
                         color=color, alpha=0.2)

    plt.title('Mean Estimate and Standard Deviation')
    plt.xlabel('Sample Size')
    plt.ylabel('Estimated Number of Drug Users')
    plt.legend()
    plt.show()
```

```
# Exploring with 100 and 500 drug users
explore_sample_size_effect(1000, [100, 500], range(10, 1001, 10))
```