Lab 6 - Heart rate sensor data

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

In [3]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
hrO2 = pd.read_csv("results.csv")

hrO2
```
✓

Out[3]:

| | HRvalue | ts | HRvalid | SpO2vaild | SpO2value |
|---|---|---|---|---|---|
| **0** | 115 | 1712373557000 | True | True | 69.81524999999999 |
| **1** | 75 | 1712372746445 | True | True | 86.398056 |
| **2** | 65 | 1712373346868 | True | False | '-999 |
| **3** | 65 | 1712373617034 | True | True | 99.519096 |
| **4** | 166 | 1712373376885 | True | False | '-999 |
| **5** | 55 | 1712373286829 | True | True | 99.462504 |
| **6** | 150 | 1712373466958 | True | False | '-999 |
| **7** | 93 | 1712372956571 | True | True | 47.63735399999999 |
| **8** | 136 | 1712373316844 | True | False | '-999 |
| **9** | 71 | 1712372566340 | True | False | '-999 |
| **10** | 71 | 1712372596358 | True | True | 2.9477999999999724 |
| **11** | 71 | 1712372656388 | True | True | 99.016626 |
| **12** | 71 | 1712372686416 | True | True | 99.0534 |
| **13** | 71 | 1712372716425 | True | True | 62.00625 |
| **14** | 71 | 1712372776462 | True | True | 77.36426399999999 |
| **15** | 71 | 1712372806488 | True | True | 66.02340000000001 |
| **16** | 71 | 1712372836498 | True | True | 90.46571399999999 |
| **17** | 71 | 1712373226788 | True | True | 97.74405 |
| **18** | 71 | 1712373526979 | True | True | 73.3818 |
| **19** | 214 | 1712373076651 | True | False | '-999 |
| **20** | 88 | 1712373046631 | True | False | '-999 |
| **21** | 88 | 1712373406907 | True | True | 62.827704 |
| **22** | 78 | 1712372926549 | True | True | 92.771946 |
| **23** | 78 | 1712373106671 | True | True | 52.37546399999999 |
| **24** | 78 | 1712373166725 | True | False | '-999 |
| **25** | 107 | 1712373256806 | True | True | 99.275976 |
| **26** | 68 | 1712372626373 | True | False | '-999 |
| **27** | 68 | 1712372986592 | True | True | 96.6558 |
| **28** | 68 | 1712373016609 | True | True | 74.74533599999998 |
| **29** | 68 | 1712373496963 | True | True | 88.747986 |
| **30** | 83 | 1712372866536 | True | True | 72.68651399999999 |
| **31** | 83 | 1712372896533 | True | True | 75.413586 |
| **32** | 83 | 1712373196727 | True | False | '-999 |
| **33** | 83 | 1712373436934 | True | True | 68.32554599999999 |
| **34** | 83 | 1712373587014 | True | True | 99.43662599999999 |
| **35** | 60 | 1712373136689 | True | True | 98.169384 |

In [4]:
```
hrO2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 36 entries, 0 to 35
Data columns (total 5 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   HRvalue    36 non-null     int64
 1   ts         36 non-null     int64
 2   HRvalid    36 non-null     bool
 3   SpO2vaild  36 non-null     bool
 4   SpO2value  36 non-null     object
dtypes: bool(2), int64(2), object(1)
memory usage: 1.0+ KB
```

In [5]:
```
# Converting the ts value to date-time format
hrO2.ts=pd.to_datetime(hrO2.ts, unit='ms')
```

```
hrO2
```

Out[5]:

| | HRvalue | ts | HRvalid | SpO2vaild | SpO2value |
|---|---|---|---|---|---|
| **0** | 115 | 2024-04-06 03:19:17.000 | True | True | 69.81524999999999 |
| **1** | 75 | 2024-04-06 03:05:46.445 | True | True | 86.398056 |
| **2** | 65 | 2024-04-06 03:15:46.868 | True | False | '-999 |
| **3** | 65 | 2024-04-06 03:20:17.034 | True | True | 99.519096 |
| **4** | 166 | 2024-04-06 03:16:16.885 | True | False | '-999 |
| **5** | 55 | 2024-04-06 03:14:46.829 | True | True | 99.462504 |
| **6** | 150 | 2024-04-06 03:17:46.958 | True | False | '-999 |
| **7** | 93 | 2024-04-06 03:09:16.571 | True | True | 47.63735399999999 |
| **8** | 136 | 2024-04-06 03:15:16.844 | True | False | '-999 |
| **9** | 71 | 2024-04-06 03:02:46.340 | True | False | '-999 |
| **10** | 71 | 2024-04-06 03:03:16.358 | True | True | 2.9477999999999724 |
| **11** | 71 | 2024-04-06 03:04:16.388 | True | True | 99.016626 |
| **12** | 71 | 2024-04-06 03:04:46.416 | True | True | 99.0534 |
| **13** | 71 | 2024-04-06 03:05:16.425 | True | True | 62.00625 |
| **14** | 71 | 2024-04-06 03:06:16.462 | True | True | 77.36426399999999 |
| **15** | 71 | 2024-04-06 03:06:46.488 | True | True | 66.02340000000001 |
| **16** | 71 | 2024-04-06 03:07:16.498 | True | True | 90.46571399999999 |
| **17** | 71 | 2024-04-06 03:13:46.788 | True | True | 97.74405 |
| **18** | 71 | 2024-04-06 03:18:46.979 | True | True | 73.3818 |
| **19** | 214 | 2024-04-06 03:11:16.651 | True | False | '-999 |
| **20** | 88 | 2024-04-06 03:10:46.631 | True | False | '-999 |
| **21** | 88 | 2024-04-06 03:16:46.907 | True | True | 62.827704 |
| **22** | 78 | 2024-04-06 03:08:46.549 | True | True | 92.771946 |
| **23** | 78 | 2024-04-06 03:11:46.671 | True | True | 52.37546399999999 |
| **24** | 78 | 2024-04-06 03:12:46.725 | True | False | '-999 |
| **25** | 107 | 2024-04-06 03:14:16.806 | True | True | 99.275976 |
| **26** | 68 | 2024-04-06 03:03:46.373 | True | False | '-999 |
| **27** | 68 | 2024-04-06 03:09:46.592 | True | True | 96.6558 |
| **28** | 68 | 2024-04-06 03:10:16.609 | True | True | 74.74533599999998 |
| **29** | 68 | 2024-04-06 03:18:16.963 | True | True | 88.747986 |
| **30** | 83 | 2024-04-06 03:07:46.536 | True | True | 72.68651399999999 |
| **31** | 83 | 2024-04-06 03:08:16.533 | True | True | 75.413586 |
| **32** | 83 | 2024-04-06 03:13:16.727 | True | False | '-999 |
| **33** | 83 | 2024-04-06 03:17:16.934 | True | True | 68.32554599999999 |
| **34** | 83 | 2024-04-06 03:19:47.014 | True | True | 99.43662599999999 |
| **35** | 60 | 2024-04-06 03:12:16.689 | True | True | 98.169384 |

In [6]:

```
#Make the date time sequential
hrO2.sort_values('ts', inplace=True)
```

In [7]:

```
hrO2
```

Out[7]:

| | HRvalue | ts | HRvalid | SpO2vaild | SpO2value |
|---|---|---|---|---|---|
| **9** | 71 | 2024-04-06 03:02:46.340 | True | False | '-999 |
| **10** | 71 | 2024-04-06 03:03:16.358 | True | True | 2.9477999999999724 |
| **26** | 68 | 2024-04-06 03:03:46.373 | True | False | '-999 |
| **11** | 71 | 2024-04-06 03:04:16.388 | True | True | 99.016626 |
| **12** | 71 | 2024-04-06 03:04:46.416 | True | True | 99.0534 |
| **13** | 71 | 2024-04-06 03:05:16.425 | True | True | 62.00625 |
| **1** | 75 | 2024-04-06 03:05:46.445 | True | True | 86.398056 |
| **14** | 71 | 2024-04-06 03:06:16.462 | True | True | 77.36426399999999 |
| **15** | 71 | 2024-04-06 03:06:46.488 | True | True | 66.02340000000001 |
| **16** | 71 | 2024-04-06 03:07:16.498 | True | True | 90.46571399999999 |
| **30** | 83 | 2024-04-06 03:07:46.536 | True | True | 72.68651399999999 |
| **31** | 83 | 2024-04-06 03:08:16.533 | True | True | 75.413586 |
| **22** | 78 | 2024-04-06 03:08:46.549 | True | True | 92.771946 |
| **7** | 93 | 2024-04-06 03:09:16.571 | True | True | 47.63735399999999 |
| **27** | 68 | 2024-04-06 03:09:46.592 | True | True | 96.6558 |
| **28** | 68 | 2024-04-06 03:10:16.609 | True | True | 74.74533599999998 |
| **20** | 88 | 2024-04-06 03:10:46.631 | True | False | '-999 |
| **19** | 214 | 2024-04-06 03:11:16.651 | True | False | '-999 |
| **23** | 78 | 2024-04-06 03:11:46.671 | True | True | 52.37546399999999 |
| **35** | 60 | 2024-04-06 03:12:16.689 | True | True | 98.169384 |
| **24** | 78 | 2024-04-06 03:12:46.725 | True | False | '-999 |
| **32** | 83 | 2024-04-06 03:13:16.727 | True | False | '-999 |
| **17** | 71 | 2024-04-06 03:13:46.788 | True | True | 97.74405 |
| **25** | 107 | 2024-04-06 03:14:16.806 | True | True | 99.275976 |
| **5** | 55 | 2024-04-06 03:14:46.829 | True | True | 99.462504 |
| **8** | 136 | 2024-04-06 03:15:16.844 | True | False | '-999 |
| **2** | 65 | 2024-04-06 03:15:46.868 | True | False | '-999 |
| **4** | 166 | 2024-04-06 03:16:16.885 | True | False | '-999 |
| **21** | 88 | 2024-04-06 03:16:46.907 | True | True | 62.827704 |
| **33** | 83 | 2024-04-06 03:17:16.934 | True | True | 68.32554599999999 |
| **6** | 150 | 2024-04-06 03:17:46.958 | True | False | '-999 |
| **29** | 68 | 2024-04-06 03:18:16.963 | True | True | 88.747986 |
| **18** | 71 | 2024-04-06 03:18:46.979 | True | True | 73.3818 |
| **0** | 115 | 2024-04-06 03:19:17.000 | True | True | 69.81524999999999 |
| **34** | 83 | 2024-04-06 03:19:47.014 | True | True | 99.43662599999999 |
| **3** | 65 | 2024-04-06 03:20:17.034 | True | True | 99.519096 |

In [8]:

```
### Use the pd.to_numeric( ) method with an option errors='coerce' to cast the column to float64 and set the non-numerical values to NaN
hr_1 = pd.to_numeric(hrO2['HRvalue'], errors='coerce')
hr_1
```

Out[8]:
```
9      71
10     71
26     68
11     71
12     71
13     71
1      75
14     71
15     71
16     71
30     83
31     83
22     78
7      93
27     68
28     68
20     88
19    214
23     78
35     60
24     78
32     83
17     71
25    107
5      55
8     136
2      65
4     166
21     88
33     83
6     150
29     68
18     71
0     115
34     83
3      65
Name: HRvalue, dtype: int64
```

In [9]:
```
### The row index with NaN is removed
hr_1.dropna(inplace=True)      # inplace=True will change hr_1
hr_1
```

Out[9]:
```
9      71
10     71
26     68
11     71
12     71
13     71
1      75
14     71
15     71
16     71
30     83
31     83
22     78
7      93
27     68
28     68
20     88
19    214
23     78
35     60
24     78
32     83
17     71
25    107
5      55
8     136
2      65
4     166
21     88
33     83
6     150
29     68
18     71
0     115
34     83
3      65
Name: HRvalue, dtype: int64
```

In [10]:
```
hr_1.index
```

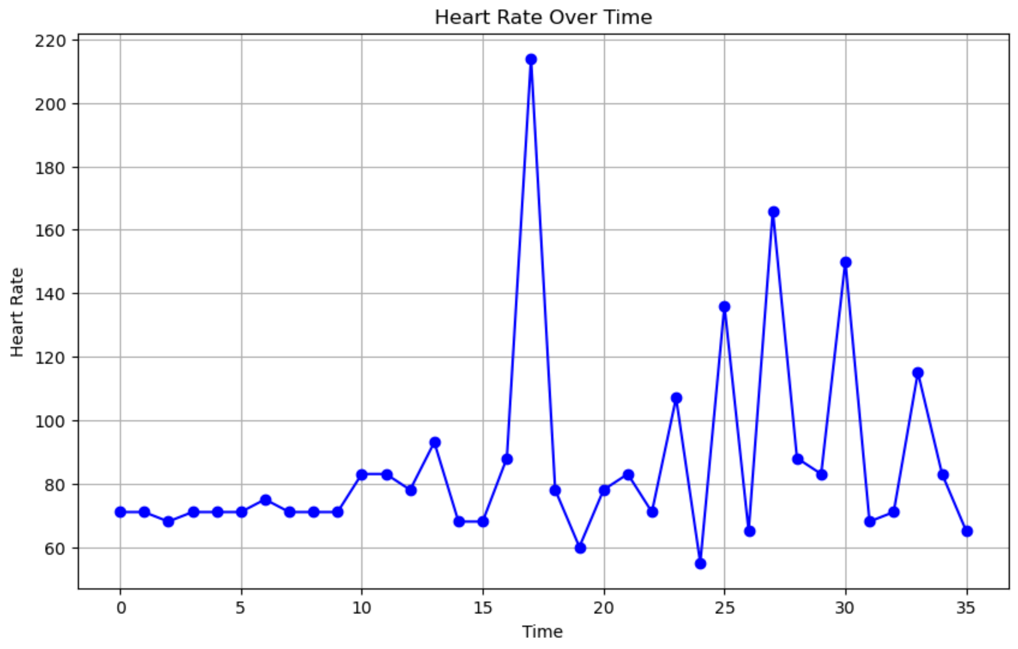
Out[10]:
```
Index([ 9, 10, 26, 11, 12, 13,  1, 14, 15, 16, 30, 31, 22,  7, 27, 28, 20, 19,
       23, 35, 24, 32, 17, 25,  5,  8,  2,  4, 21, 33,  6, 29, 18,  0, 34,  3],
      dtype='int64')
```

## To plot the HR chart, we need to reset the index of hr_1

In [11]:
```
hr_1.reset_index(drop=True, inplace=True)    # drop=True will remove the old index

hr_1
```

```
Out[11]: 0       71
         1       71
         2       68
         3       71
         4       71
         5       71
         6       75
         7       71
         8       71
         9       71
         10      83
         11      83
         12      78
         13      93
         14      68
         15      68
         16      88
         17     214
         18      78
         19      60
         20      78
         21      83
         22      71
         23     107
         24      55
         25     136
         26      65
         27     166
         28      88
         29      83
         30     150
         31      68
         32      71
         33     115
         34      83
         35      65
         Name: HRvalue, dtype: int64
```

```
In [12]: #Plot the line chart for Heart Rate
         plt.figure(figsize=(10,6))

         plt.plot(hr_1.index, hr_1, color='blue', marker='o')

         plt.ylabel("Heart Rate")
         plt.xlabel("Time")
         plt.title("Heart Rate Over Time")
         plt.grid(True)
         plt.show()
```



```
In [13]: #Clean up the Sp02 values
         O2_1 = pd.to_numeric(hrO2['SpO2value'], errors='coerce')
         O2_1
```

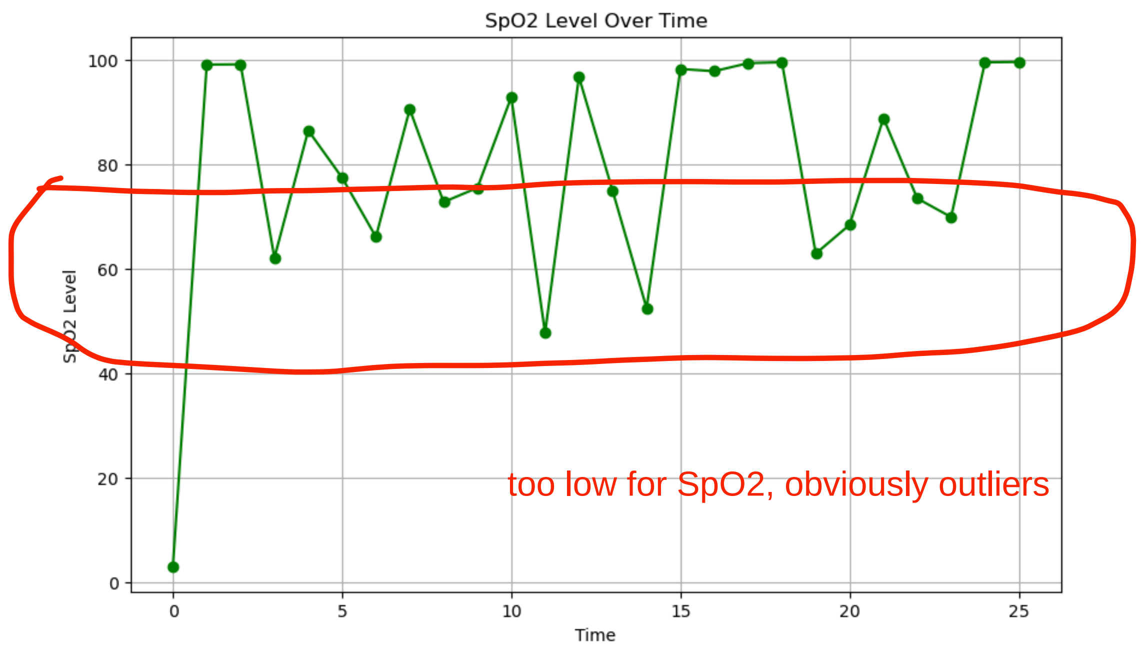
Out[13]:
```
9           NaN
10     2.947800
26          NaN
11    99.016626
12    99.053400
13    62.006250
1     86.398056
14    77.364264
15    66.023400
16    90.465714
30    72.686514
31    75.413586
22    92.771946
7     47.637354
27    96.655800
28    74.745336
20          NaN
19          NaN
23    52.375464
35    98.169384
24          NaN
32          NaN
17    97.744050
25    99.275976
5     99.462504
8           NaN
2           NaN
4           NaN
21    62.827704
33    68.325546
6           NaN
29    88.747986
18    73.381800
0     69.815250
34    99.436626
3     99.519096
Name: SpO2value, dtype: float64
```

There are a few outliers in these plots still, using a box and whisker plot can help with identifying their range and with filtering them out

In [14]:
```
# Remove the NaN and reset the index

O2_1.dropna(inplace=True)
O2_1.reset_index(drop=True, inplace=True)
O2_1
```

Out[14]:
```
0      2.947800
1     99.016626
2     99.053400
3     62.006250
4     86.398056
5     77.364264
6     66.023400
7     90.465714
8     72.686514
9     75.413586
10    92.771946
11    47.637354
12    96.655800
13    74.745336
14    52.375464
15    98.169384
16    97.744050
17    99.275976
18    99.462504
19    62.827704
20    68.325546
21    88.747986
22    73.381800
23    69.815250
24    99.436626
25    99.519096
Name: SpO2value, dtype: float64
```

In [15]:
```
#Plot the line chart for the Sp02 values
plt.figure(figsize=(10,6))

plt.plot(O2_1.index, O2_1, color='green', marker='o')

plt.ylabel("SpO2 Level")
plt.xlabel("Time")
plt.title("SpO2 Level Over Time")
plt.grid(True)
plt.show()
```


SpO2 Level Over Time
SpO2 Level
Time
100
80
60
40
20
0
0
5
10
15
20
25
too low for SpO2, obviously outliers

```
In [ ]:
```