Fetching Data from different smart watches:

1) Apple Watch
   Phone: Iphone
   App: Health
   Steps: Iphone -> Health App -> Click on Profile image on top left -> Export All Health Data -> Export -> Share via various options
   The data collected is a zip file and within it .xml files are present
2) MI Watch
   App: MI Fit
   Steps: Phone -> MI Fit App -> Profiles -> settings -> about -> exercising user rights -> export
   The user needs to select the parameters and date, from which he/she wants the data to be exported.
   The data collected in a zip file and a password is required to open the zip file.
3) Redmi Smart Band Pro
   App: MI Fit
   Steps:
   The user needs to select the parameters and date, from which he/she wants the data to be exported.
   The data collected in a zip file and a password is required to open the zip file.

Akshat

Converting xml to csv file format:
(using MS Excel)
https://support.microsoft.com/en-us/office/import-xml-data-6eca3906-d6c9-4f0d-b911-c736da817fa4
To convert xml to xlsx format

1) Create a new Excel file
2) Go to Developer -> Import
3) Select the xml file from Desktop
   (If a schema is not present, excel will create its own schema)

To convert xlsx to csv:

4) Go to File -> Export -> Change File Type -> Save as csv

Sensors in Smartwatches:
Not a complete list, other type of sensors may be used. Many manufacturers protect the information about the sensors they use, along with the algorithms they program

1) Accelerometer:
    - Inertial measurement of velocity and position
    - Track movement of your body: **number of steps**
    - Movement during **sleep**
2) Gyroscope:
    - Measure the orientation and angular rates of the body
    - Paired with 3 axis accelerometer: 6 degree of freedom motion tracking
    - Detect **motion and gestures**: Running or jogging?
3) Magnetometer:
    - Compass: works with GPS to determine exact location and direction
4) Barometric Pressure Sensor:
    - Detect your altitude
5) Altimeter:
    - Detect any change in height/ elevation change
    - Improves calorie burn rate
6) Temperature Sensor:
    - Ambient Temperature Sensor
        i) Measure the temperature of the surrounding environment.
    - Body Temperature Sensor
        i) Measures **skin temperature**
7) Bioimpedence Sensor:
    - Resistance of skin to small electric current
    - Measure **sleep**, **heart rate**, **respiration data**
8) Optical Heart Rate Sensor:
    - Measure **pulse rate**
9) Oximetru Sensor:
    - Pulse Oximeter
    - **SpO2**, oxygen concentration in your blood
10) ECG Sensor:
    - Heart's rhythm and electrical activity
    - Possible heart problems
11) GPS

Secondary Components:
1. Pedometer: Uses accelerometer data to count no of steps
2. Calorie Counter: Uses accelerometer, altimeter, gyroscope data to count calories burnt
3. Electrodermal Activity Sensor: helps measure stress using ECG, Skin Temperature and heart rate

Motion Sensors: Accelerometer, GPS, Gyroscope, Magnetometer

Difficulties in Data Creation:

1. Many brands do not support data extraction due to security concerns.(e.g. Redmi, RealMe, etc). Also can't access sensor data directly.
2. After collecting a few datasets, we realized that the dataset varies hugely from watch to watch and brand to brand, so it is not feasible for us to analyze datasets of different types.
3. Limited number of smartwatch users on campus.

Possible Solution:

- To do sample analysis on Datasets, publicly available on internet
- To have a smart watch, and do complete analysis using its data

Resources:

- https://archive.ics.uci.edu/ml/machine-learning-databases/00507/
- https://www.kaggle.com/datasets/arashnic/fitbit/versions/1?resource=download
- https://datasets.simula.no/pmdata/

Research Papers:

- https://www.hindawi.com/journals/js/2019/6514520/

https://edps.europa.eu/press-publications/publications/techsonar/biometric-continuous-authentication_en#:~:text=Biometric%20continuous%20authentication%20is%20a,tapping%2C%20walking%20patterns%20or%20voice.

Biometric continuous authentication is a type of continuous authentication that verifies a user identity by using biometric traits or behaviors. Examples include facial images, typing, screen tapping, walking patterns or voice.

Applications of biometric continuous authentication can be seen in **banking services**, **identification of stolen mobile devices** or **authentication on smart home devices**.

https://dl.acm.org/doi/10.1145/3432206

We construct an IoT testbed in which we gather data pertaining to a **person's movement in space, interaction with certain physical objects, PC terminal**

usage, and keyboard typing, and construct machine learning models capturing the person's behavior traits.

https://ieeexplore.ieee.org/abstract/document/8424658

Wearable-Assisted Continuous Authentication framework called WACA, where a wearable device (e.g., smartwatch) is used to authenticate a computer user continuously utilizing the motion sensors of the smartwatch.

The acquired data is periodically and transparently **compared with the registered profile** of the initially logged-in user with **one-way classifiers**. With this, WACA continuously ensures that the current user is the user who logged in initially.
Error rate is as low as 1% with 30 seconds of processing time and 2 - 3% for 20 seconds

https://williamcheung94.github.io/
https://dl.acm.org/doi/10.1145/3264950
https://ieeexplore.ieee.org/document/9224356
https://www.sciencedirect.com/science/article/pii/S004579062200115X
https://github.com/beamb/ContinuousAuthentication
https://github.com/dynobo/ContinAuth
https://github.com/SoufianeDataFan/ECG-authentificate
https://github.com/tasoskakour/continuous-authentication-website

https://ieeexplore.ieee.org/document/5444466?arnumber=5444466
https://ieeexplore.ieee.org/document/8411233
https://ieeexplore.ieee.org/document/7791193

https://ieeexplore.ieee.org/document/9155526
https://www.winlab.rutgers.edu/~yychen/wellbeing_monitoring/TrueHeart%20Continuous%20Authentication%20on%20Wrist-worn%20Wearables%20Using%20PPG-based%20Biometrics.pdf
https://dl.acm.org/doi/10.1145/3300061.3343375
https://www.researchgate.net/publication/289980386_Exploratory_Use_of_PPG_Signal_in_Continuous_Authentication

https://towardsdatascience.com/time-series-classification-with-deep-learning-d238f0147d6f
https://ruor.uottawa.ca/bitstream/10393/40751/1/Zhang_Haolong_2020_thesis.pdf
https://www.sciencedirect.com/science/article/pii/S2352711020300017
https://www.researchgate.net/publication/326079197_Continuous_User_Authentication_Using_Smartwatch_Motion_Sensor_Data
https://arxiv.org/pdf/1802.10417.pdf

PPG(Photoplethysmography)

PPG is an uncomplicated and inexpensive optical measurement method that is often used for heart rate monitoring purposes. PPG is a non-invasive technology that uses a light source and a photodetector at the surface of skin to measure the volumetric variations of blood circulation.

https://python-heart-rate-analysis-toolkit.readthedocs.io/en/latest/
QuickStart Guide:
https://python-heart-rate-analysis-toolkit.readthedocs.io/en/latest/quickstart.html#quickstart
HeartPy Python Package:
https://github.com/paulvangentcom/heartrate_analysis_python
Code for Smartwatch PPG Analysis:

https://github.com/paulvangentcom/heartrate_analysis_python/tree/master/examples/3_smartwatch_data

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5981424/
https://paperswithcode.com/paper/evaluation-of-ppg-biometrics-for

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6426305/#:~:text=Photoplethysmography%20(PPG)%20is%20an%20uncomplicated,volumetric%20variations%20of%20blood%20circulation.

https://arxiv.org/abs/2203.14907
Code: https://github.com/EmbeddedML-EDAGroup/q-ppg

SARIMA Model:
https://www.section.io/engineering-education/univariate-time-series-analysis-with-arima-in-python/#time-series-dataset