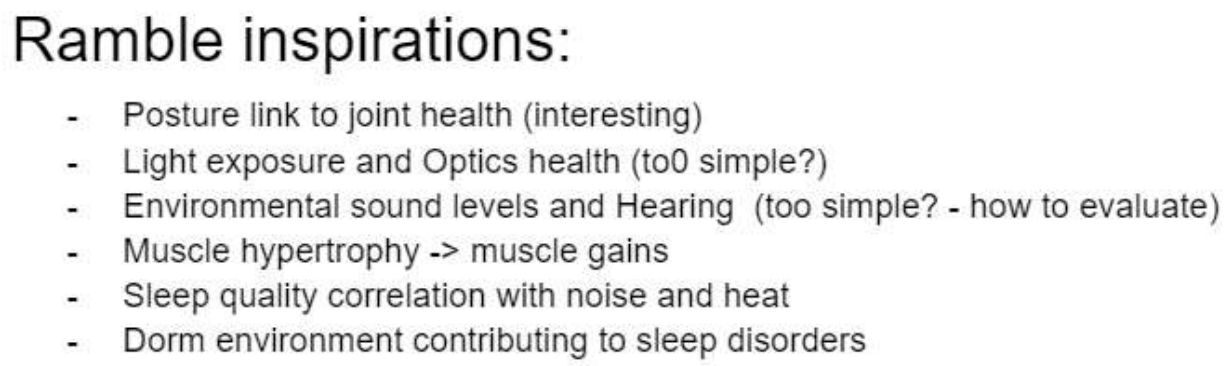
NIEjr04: Exploring Local Micro-Climates With Open-Source Sensors

This log will detail the timeline of my research journey with the hurdles and lessons along the phases of the project.

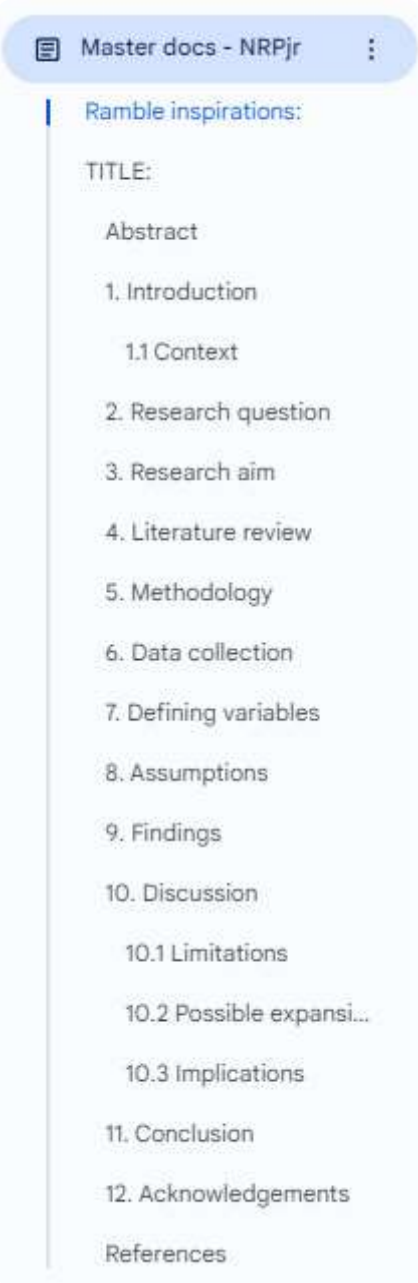
Planning phase

April - Outlining of project and choosing focus

- Beginning half: the commencement of NRPjr -> Phong and I get together to brainstorm rough ideas that we can expand on from the broad title code.



- 19th: Me and my partner meet up with our superviser Mr. Kenneth in person to discuss how we should procceed. We also brought up brainstormed ideas and got consulted them. He also shared about the procedures of the competition with deadlines and targets.
    - Actions points of the meeting:
        - Beginning writing out report stucture



        - Contacting the teacher in charge of equipment from Mr. Ken's team - Mr. Ahmed.
        - Phong will be researching past publications regarding similar topics. to aid in data analysing,

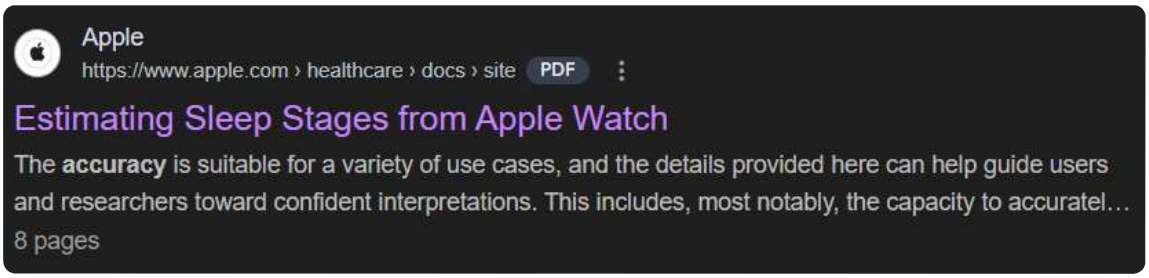
        - I will be researching implementation of the sensors, learning them and requesting their purchase from Mr. Ahmed
        - We narrowed the research aim to analysing sleep stages and quality
    - Our goals is learn as much as possible about metrics of sleep quality and possible ways we can measure them using open-source sensors.
    - We need to come up with a final thesis statement and plan our research

- End of month: I started learning arduino on my own with prior knowledge of c++, and some parts I borrowed from a friend.

Researching phase

May until mid-July - Main inspirations from lit-review

- In May, both Phong and I was only working up our knowledge of the specialty and of coding.
- Resources I investigated and learned from(for coding and for sleep medicine):
    - Sleep quality assessment using a standardised questionaire - Pittsburgh Sleep Quality Index (PSQI). Use of statistical models to correlate with sociodemographic, and anthropometric data, obstetric information, lifestyle habits, and sleep hygiene practices
        - Gomes, M.R.d., Rodrigues, J.C.M., Barbosa, L.M.A. et al. Factors associated with sleep quality in adolescent pregnant women. Sleep Breath 29, 54 (2025). https://doi-org.remotexs.ntu.edu.sg/10.1007/s11325-024-03205-y (https://doi-org.remotexs.ntu.edu.sg/10.1007/s11325-024-03205-y)
    - Suggested to us to read due to similar equipments of open-source sensors for environmental factors
        - Lee, J., Yu, B., Lim, K. (2023). Exploring The Implementation of AI in a Cost-effective Device for Predicting Sleep Quality. In: Lucas Paletta, Hasan Ayaz and Umer Asgher (eds) Cognitive Computing and Internet of Things. AHFE (2023) International Conference. AHFE Open Access, vol 73. AHFE International, USA. http://doi.org/10.54941/ahfe1003981 (http://doi.org/10.54941/ahfe1003981)

- Apple's in-house sleep tracking accuracy evaluation:
  - 

- Public evaluation of wearables' sleep tracking abilities against **Polysomnography(PSG)**:
  - Lee T, Cho Y, Cha KS, Jung J, Cho J, Kim H, Kim D, Hong J, Lee D, Keum M, Kushida CA, Yoon IY, Kim JW. Accuracy of 11 Wearable, Nearable, and Airable Consumer Sleep Trackers: Prospective Multicenter Validation Study. JMIR Mhealth Uhealth. 2023 Nov 2;11:e50983. doi: 10.2196/50983. PMID: 37917155; PMCID: PMC10654909.
  - Miller DJ, Sargent C, Roach GD. A Validation of Six Wearable Devices for Estimating Sleep, Heart Rate and Heart Rate Variability in Healthy Adults. Sensors (Basel). 2022 Aug 22;22(16):6317. doi: 10.3390/s22166317. PMID: 36016077; PMCID: PMC9412437.
- PSG sleep stages used to match up with sleep posture:
  - Hatice Kutbay Özçelik, Mehmet Bayram, Emine Doğanay, Levent Kart. Effects of body position on sleep architecture and quality in subsyndromal adults without apparent obstructive sleep apnea Yakar https://doiorg.remotexs.ntu.edu.sg/10.1111/sbr.12116 (https://doiorg.remotexs.ntu.edu.sg/10.1111/sbr.12116)

Late July to August - Initial setup of data collection

- We contated Mr Ahmed to discuss the project.
- 5th of August we met up face to face to go over the equipments we'd need for the project. We also fill in the project details and progress so far for him.
- A week later we picked up the equipments Mr Ahmed sent over to our dorm and set up as the following instruction: https://docs.google.com/document/d/1iJ5y1pXXhdGfy8_7mez45kYNSWXKWL6B_d-jw0NOnyY/edit?usp=sharing

(https://docs.google.com/document/d/1iJ5y1pXXhdGfy8_7mez45kYNSWXKWL6B_d-jw0NOnyY/edit?usp=sharing)

September to December - Hiccups in setting up

- We intended to use only the seeduino wio terminal unit to collect data and log data out into a micro SD cards. But later testing found that the equipments do not quite function as intended and we formulated a new arrangement and new equipments had to be bought - final arrangements shown in report.
- Discussion logs with Mr. Ahmed regarding setup hiccups: https://docs.google.com/document/d/1kizx409GpZcOY5VnxNFBB6-i69fI5ZomP6G5IUiIYC4/edit?usp=sharing (https://docs.google.com/document/d/1kizx409GpZcOY5VnxNFBB6-i69fI5ZomP6G5IUiIYC4/edit?usp=sharing)
- At the end we used Coolterm to log the data out through the serial output into a text dump.
- We change from using the i2c extension to using only the 2 default Wio ports and buying an additional Arduino uno unit with a Base shield v2

Execution phase

December - results of research

- Our data collection kicked off in 12-12-2024 and our quota is 14 sleep sessions, totaling 2 weeks with the last night being Christmas night - 25 Dec.
- We use convert the environmental data into .csv formatting and the Apple health sleep data is extracted using a free app: Simple Health Export CSV on appstore.
- We plan to clean up, process and analyse the data using basic python programming and the IBM SPSS 27 software.

Finalising phase

January - Submission

- Writing the report and touching up the rough edges.