



POLITECNICO
MILANO 1863



B³ LAB
Biosignals
Bioimaging
Bioinformatics

A monitoring system for Heart Failure patients

Project Specifications

Tutors:

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MEDICAL INFORMATICS 2019-2020
Politecnico di Milano - 04/03/2020

SCHEDULE OVERVIEW

- **DEADLINE** □ **12th March:**

Team proposals: **6** students per team.

Each team must send an email to ALL of the following addresses:

annamaria.bianchi@polimi.it (To)

pierluigi.reali@polimi.it, davide.coluzzi@polimi.it (Cc)

... providing members': name, surname, student ID (matricola), email address

- 18th - 26th March → UML (introduction; examples; work on project)
- **1st April → Use Case Diagram: presentation (3 teams) + discussion (all together);** work on project
- **2nd April → Activity Diagram: presentation + discussion;** work on project
- 8th - 9th April → UML (work on project)
- **15th April → Class Diagram: presentation + discussion;** work on project
- 16th April → ER Diagram (work on project)
- 22nd - 23rd April → SQL (introduction; examples; work on project)
- 29th April → Forms on MS Access (introduction; examples; work on project)
- **30th April → Project implementation: presentation + discussion;** work on project
- **DEADLINE** □ **30th April:** Delivery of the modeling report on BeeP
- **6th - 28th May → Project implementation (1 presentation per week; 2-3 teams each time)**
- **DEADLINE** □ **4th June:** Delivery of the project report on BeeP
- **10th - 11th June → Final presentations of the project, with practical demonstration**

SYSTEM DESCRIPTION

- The system allows the **at-home** and **in-hospital** monitoring of several biological parameters with the aim of tracking physiological changes to detect early deterioration of heart failure patients.
- **Heart failure (HF)** is a cardiovascular disease characterized by a weakened heart muscle, affecting at least 26 million people worldwide and is increasing in prevalence. HF health expenditures are considerable and will also increase with an ageing population. Therefore, continuous monitoring of patients with chronic heart failure could greatly improve life quality (e.g., preventing the insurgence of acute episodes), and reduce the health expenditure associated with the pathology.
- This goal requires the regular assessment of several clinical indices. Some of these parameters can be collected **either at-home or in-hospital**, while others must be collected **in hospitals**.
- The complexity of the pathology requires appropriate evaluation of **comorbidities** and **risk factors**.

- The system is used by **patients** and **specialized practitioners** with different user interfaces because of their different aims.
- Moreover, the system requires a **technical administrator** for the registration of new users (patients, specialized practitioners and other technical administrators).

SYSTEM USERS: Specialized practitioners

Specialized practitioners can:

- Log in
- Visualize their profile
- Visualize the list of patients along with the last visit
- Visualize the list of visits of the day
- Book a visit for a patient
- Book an exam for a patient
- Manage patients' prescriptions / therapy
- During a visit, the doctor can insert the measured parameters (hereafter named as “in hospital” parameters), add notes, and, if needed, book a follow-up visit
- Set thresholds for all the parameters to identify *abnormalities* (even the one inserted at-home)
- Visualize diagrams and statistics regarding the temporal trend of the inserted parameters, in a selected time window, for a specific subject and, for comparison and research purposes, across the entire list of patients
- Count how many times a certain parameter was labeled as *abnormal*

SYSTEM USERS: Patients

Patients can:

- Log in
- Manage their profile and booked visits
- *Insert* or *upload* parameters (hereafter named as “at-home” parameters) that were measured at home. Let’s assume these parameters are collected through wearables, medical devices or mobile apps. Some of them are *manually inserted* into the system, while others (data streams and temporal trends) are *uploaded* into it through formatted files
- Visualize a set of statistics and diagrams regarding the temporal trend of his/her inserted parameters in chosen time frames
- Fill in clinical questionnaires

SYSTEM USERS: Technical administrators

Technical administrators can:

- Log in
- Visualize their profile
- Add/Modify/Delete a user among the three categories. For simplicity, the password is decided by the technical administrator for all the users, but you might decide to release this constraint as well ...
- Visualize a set of statistics regarding the number of users and the number of logins per day. You might also include other system performance metrics, like access time, query execution time, user session duration and so on.
- Create and update risk evaluation models, based on the latest indications from the literature.

PARAMETERS

At-home measured parameters must include:

Parameter	Insertion mode	How often?
Blood pressure (from BP monitor)	From file	Daily
Heart rate (from BP monitor)	From file	Daily
Sleep quality index (from smartwatch)	From file	Daily
Height, weight (from smart scale), BMI	Manually	Weekly
Glycemia (from glucose meter)	Manually	Daily
Physical activity (from smartwatch)	From file or Manually	Daily
Therapy adherence (from Morisky Medication Adherence Scale) *	Manual insertion of the inputs	Weekly
Sleep efficiency *	Manual insertion of the inputs	Daily

* Computed as in the following slide

Example of a structured file (CSV)

HR_from_device_example.csv - Blocco note

File	Modifica	Formato	Visualizza	?
Dates	HR			
31/12/18	109			
01/01/19	115			
02/01/19	67			
03/01/19	115			
04/01/19	98			
05/01/19	65			
06/01/19	76			
07/01/19	93			
08/01/19	118			
09/01/19	118			
10/01/19	69			
11/01/19	119			
12/01/19	118			
13/01/19	89			
14/01/19	108			
15/01/19	68			
16/01/19	85			
17/01/19	115			
18/01/19	108			
19/01/19	118			
20/01/19	100			
21/01/19	62			

Sleep efficiency calculation

1. I went to bed at: *HH:MM:SS*

5. The total duration of these awakenings was:

2. I turned out the lights after:

6. After awakening for the last time I was in bed for:

3. I fell asleep in:

7. I got up at: *HH:MM:SS*

4. I woke up ____ times during the night.

A = time between bedtime (1) and rise time (7) in minutes

B= sum of 2, 3, 5 and 6

(all these parameters are measured in minutes)

Sleep efficiency = $[(A - B)/A] * 100$

Sleep quality scale assessment - PSQI index

Once at month

Material on beep

Sleep Quality Assessment (PSQI)

What is PSQI, and what is it measuring?

The Pittsburgh Sleep Quality Index (PSQI) is an effective instrument used to measure the quality and patterns of sleep in adults. It differentiates "poor" from "good" sleep quality by measuring seven areas (components): subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction over the last month.

INSTRUCTIONS:

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

During the past month,

1. When have you usually gone to bed?
2. How long (in minutes) has it taken you to fall asleep each night?
3. What time have you usually gotten up in the morning?
4. A. How many hours of actual sleep did you get at night?
B. How many hours were you in bed?

5. During the past month, how often have you had trouble sleeping because you	Not during the past month (0)	Less than once a week (1)	Once or twice a week (2)	Three or more times a week (3)
A. Cannot get to sleep within 30 minutes				
B. Wake up in the middle of the night or early morning				
C. Have to get up to use the bathroom				
D. Cannot breathe comfortably				
E. Cough or snore loudly				

Scoring

- Component 1** #9 Score
Component 2 #2 Score (<15min (0), 16-30min (1), 31-60 min (2), >60min (3))
+ #5a Score (if sum is equal 0=0; 1-2=1; 3-4=2; 5-6=3)
Component 3 #4 Score (>7(0), 6-7 (1), 5-6 (2), <5 (3))
Component 4 (total # of hours asleep) / (total # of hours in bed) x 100
>85%=0, 75%-84%=1, 65%-74%=2, <65%=3
Component 5 # sum of scores 5b to 5j (0=0; 1-9=1; 10-18=2; 19-27=3)
Component 6 #6 Score
Component 7 #7 Score + #8 score (0=0; 1-2=1; 3-4=2; 5-6=3)

C1 _____
C2 _____
C3 _____
C4 _____
C5 _____
C6 _____
C7 _____

Add the seven component scores together _____

Global PSQI _____

Therapy adherence (Morisky Medication Adherence Scale)

Q1 – I will ask you few questions about your medication that you were using after Heart Failure

SNO	MMAS-8 Adherence Questions	Patients Response
Q1_1	Do you sometimes forget to take your prescribed medicines?	<input type="checkbox"/> Yes[0] <input type="checkbox"/> No[1]
Q1_2	Over the past 2 weeks, were there any days when you did not take your prescribed medicines?	<input type="checkbox"/> Yes[0] <input type="checkbox"/> No[1]
Q1_3	Have you stopped taking medications because you feel worse when you took it?	<input type="checkbox"/> Yes[0] <input type="checkbox"/> No[1]
Q1_4	When you travel or leave home, do you sometimes forget to bring along your meds?	<input type="checkbox"/> Yes[0] <input type="checkbox"/> No[1]
Q1_5	Did you take your prescribed medicine yesterday?	<input type="checkbox"/> Yes[0] <input type="checkbox"/> No[1]
Q1_6	When you feel like your health is under control, do you sometime stop taking your meds?	<input type="checkbox"/> Yes[0] <input type="checkbox"/> No[1]
Q1_7	Do you feel hassled about sticking to your prescribed treatment plan?	<input type="checkbox"/> Yes[0] <input type="checkbox"/> No[1]
Q1_8	How often do you have difficulty remembering to take all your prescribed medicine?	<input type="checkbox"/> Never/rarely[1] <input type="checkbox"/> Once in a while[0] <input type="checkbox"/> Sometimes[0] <input type="checkbox"/> Usually[0] <input type="checkbox"/> All the time[0]
Total Score		_____

- The total MMAS-8 score is calculated by adding all of the eight individual question scores. Patients with a score of eight are classified as adherent, otherwise non-adherent.

Rehman et al. 2019

PARAMETERS

In hospital measured parameters must include:

Parameter	Insertion mode	How often?
Heart rate (from clinical device)	From file	During visit
Blood pressure supine and standing (sphygmomanometer)	Manually	During visit
JVP (Jugular Venous Pressure)	Manually	During visit
Cardiac Auscultation (textual report)	Manually	During visit
Blood exam results (values and comment)	Manually	During visit (not always)
Medical report (textual report)	Manually	During visit

IMPORTANT: Visits are planned at least every 6 months, but could be planned more frequently if needed.

PERIODICAL REPORTS and FINAL PRESENTATION STRUCTURE

AIM OF THE WORK

SYSTEM DESIGN

Context analysis

Modeling and describing the system in UML (Use case, activity, class diagrams)

Modeling and describing the database (via E-R Diagram)

Modeling Report

SYSTEM IMPLEMENTATION

Technical description of the tables

Description of the queries (with some examples)

Description of the Graphical User Interface (GUI)

CONCLUSIONS

Including limitations and future work

REFERENCES

Project Report

HOW TO START

1. Make teams: we will (try to) create a “separate room” for each team...
2. Send us an email with the required information of your team (see the first slide)
3. Start by analyzing the context: look for Heart Failure related topics on the internet/literature, together with your current team members

Today and tomorrow's exercises will be dedicated to **making teams**, **context** and **requirements analysis** (don't hesitate to ask questions!)