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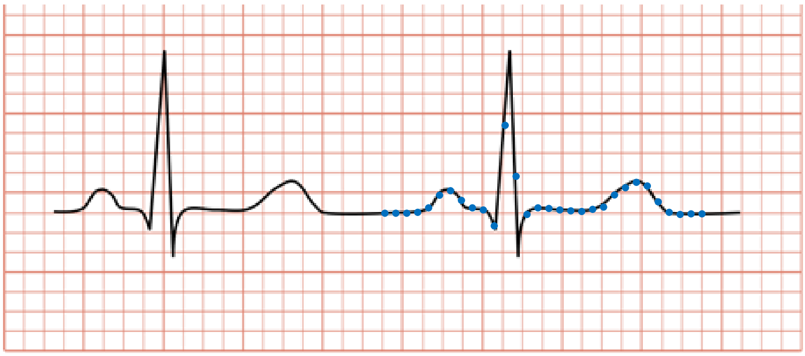
Exercise: Interfaces – Electrocardiography (ECG)

In this exercise you will work with the collection and processing of *electrocardiography* (ECG) samples. In short, ECG is the process of recording the electrical activity of the heart over a period of time.

The focus of this exercise is interfaces, which we will use to decouple our software and make it more flexible and "ready for change".

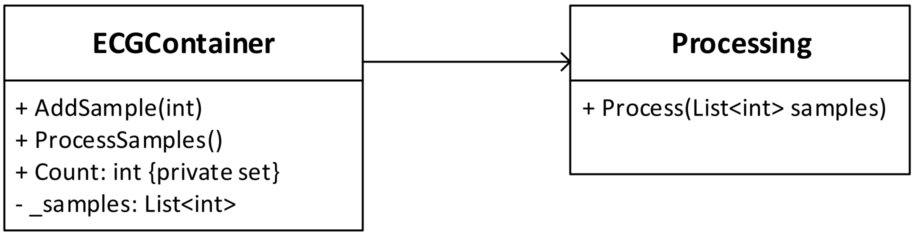
You must finish at least exercises 1-4 incl. of this exercise as they are used in a later exercise.

An *ECG signal* is a continuous signal with – in a healthy person – looks similar to the below. We will create a small system that can receive samples periodically of such a signal and process it.



Our aim in this exercise is to design and implement a system that will allow us to easily change how information about the signal is processed.

A simple design (implemented in the handout) is shown below. The `Process()` method of the `Processing` class simply prints the list of samples to the console.



ECGContainer

+ AddSample(int)
+ ProcessSamples()
+ Count: int {private set}
- _samples: List<int>

Processing

+ Process(List<int> samples)

Exercise 1:
Consider the design above. As you can see, the two classes are tightly coupled. How can you use an *interface* to lower the coupling between the two classes?

Exercise 2:
Create a design (a UML class diagram) of the system, which uses an interface of the `Processing` class. Your class diagram should contain all methods for all classes and interfaces.

Exercise 3:
Implement your design. Use the provided `Main()` program that tests your program by adding some samples and prints them afterwards. Notice: Did you have to do any changes to the `Main()` program to use your new design? No? That's great! This means that we have implemented the design changes without affecting the of the classes, namely `Main()`.

Exercise 4:
Now imagine that we must include a new way to process the ECG samples, namely an *extremes processing*: Given a list of samples, we should only print the *minimum* sample value and the *maximum* sample value.

What changes and additions are required to your existing classes and interface to accommodate the new kind of processing? Compare this to the old design - which design is more “flexible”, i.e. ready for change? Why?

Add `ExtremesProcessing` to your class diagram from Exercise 2. Add the class to your implementation and test it using the same `Main()` program as before. Again note how the `Main()` program does not need to change to use the new feature.

Exercise 5 (optional):
Change your implementation so that the user can decide which type of processing to use when the program starts (printing the samples or finding the extremes). Hint: This requires changes to `ECGContainer`’s constructor and therefore to the declaration of it in the beginning of `Main()`.

Exercise 6 (optional):
Add a new way to process ECG samples to your design, `BPMProcessing`. This processing will report the *average pulse* of the ECG signal, defined as the average number of heartbeats per minute (BPM). To do this, you will need some additional info:

- The sample rate is exactly 1000 Hz.
- Any sample with a value of 20 or below (the blue line on the figure below) can be considered as not being “on the peak” of the heartbeat.

After you have added `BPMProcessing` to your design, implement it and extend your `Main()` to include the selection of this processing.