Software Architecture 2022
Lecture 1, part 3/3

Introduction to the application case

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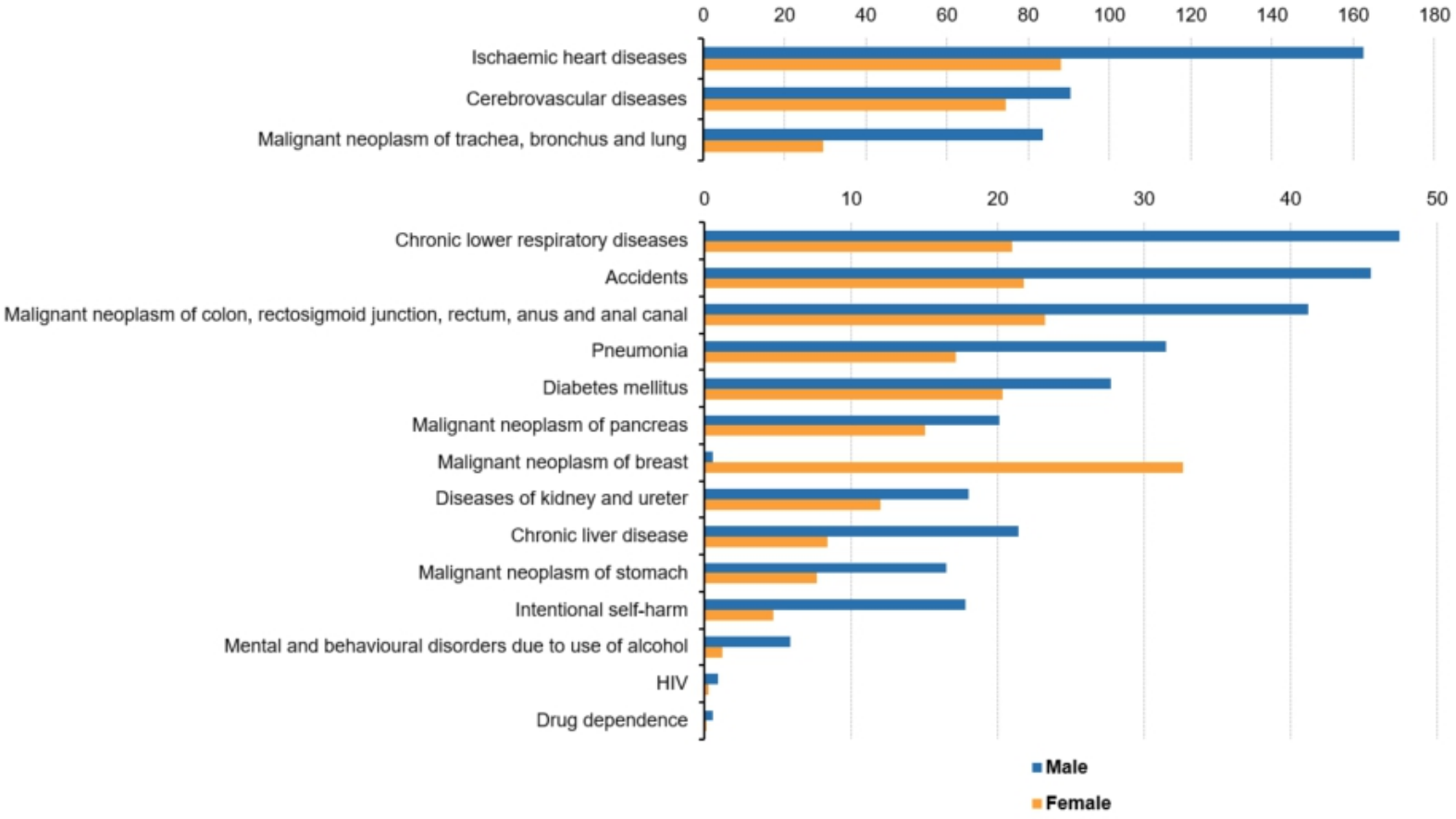
Causes of death — standardised death rate, EU, 2016
(per 100 000 inhabitants)



Note: the figure is ranked on the average of male and female. Note the difference in the scales employed in the two parts of the figure.
Source: Eurostat (online data code: hlth_cd_asdr2)

eurostat
INET

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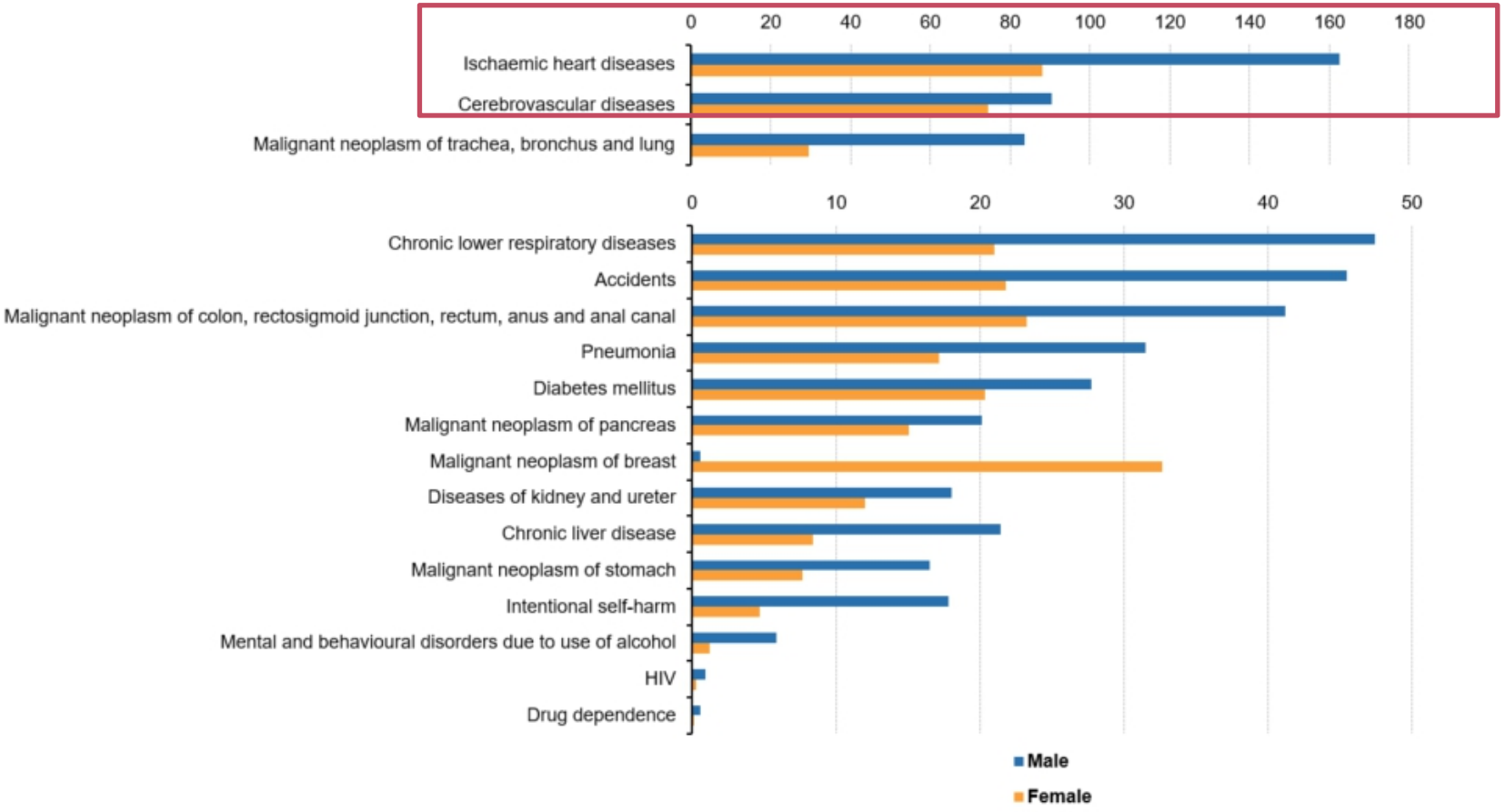

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Application case

PMS: a Patient Monitoring Service for cardiovascular disease (CVD)

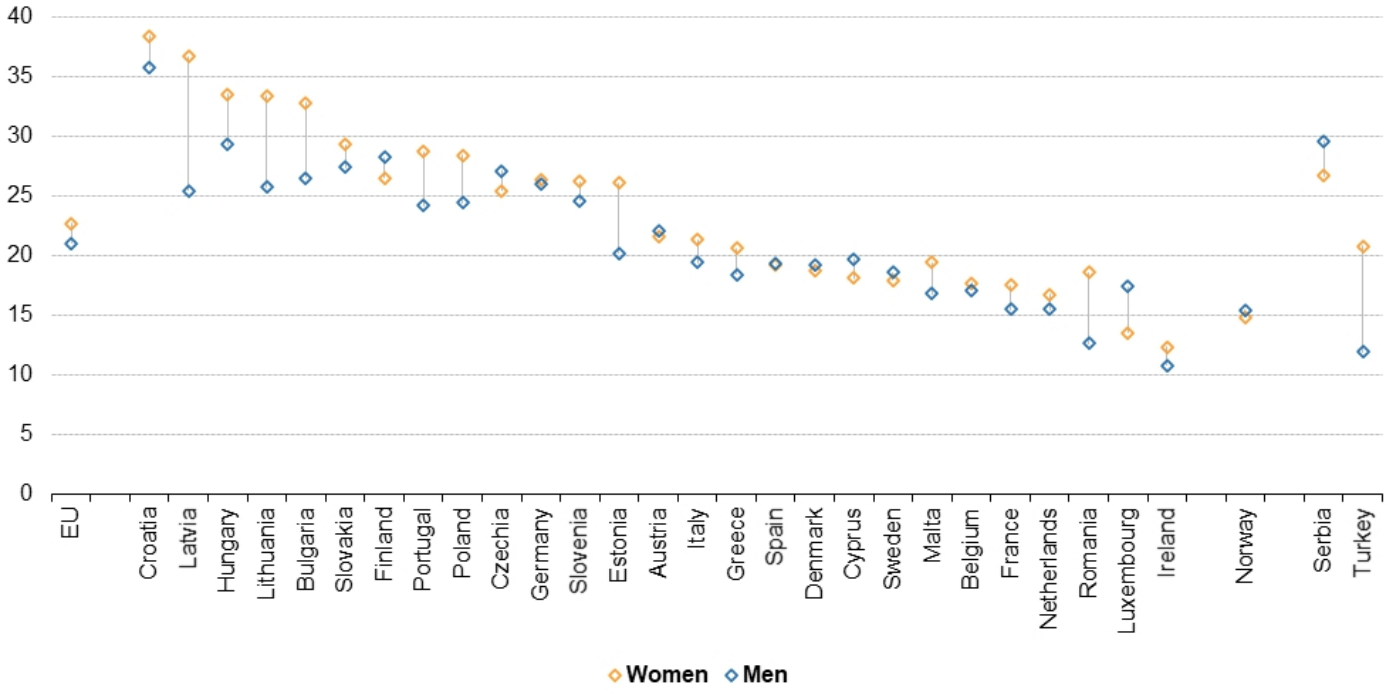
Cardiovascular diseases (CVD)

- a broad group of medical problems that affect the circulatory system (the heart and blood vessels),
  - often resulting from atherosclerosis, the abnormal build-up of plaque in the patient's arteries
- Leads to ischaemic heart disease (heart attacks) and cerebrovascular diseases (strokes)

Context

- Persistent effect of **high blood pressure** in arteries may lead to **chronic failure of vital organs**
- **Chronic disease**, slowly evolving
- Lifestyle, genetics, ..

Share of the population aged 15 years and over reporting that they had high blood pressure, by sex, 2019
(%)



Note: the figure is ranked on the share of the total population reporting that they had high blood pressure.

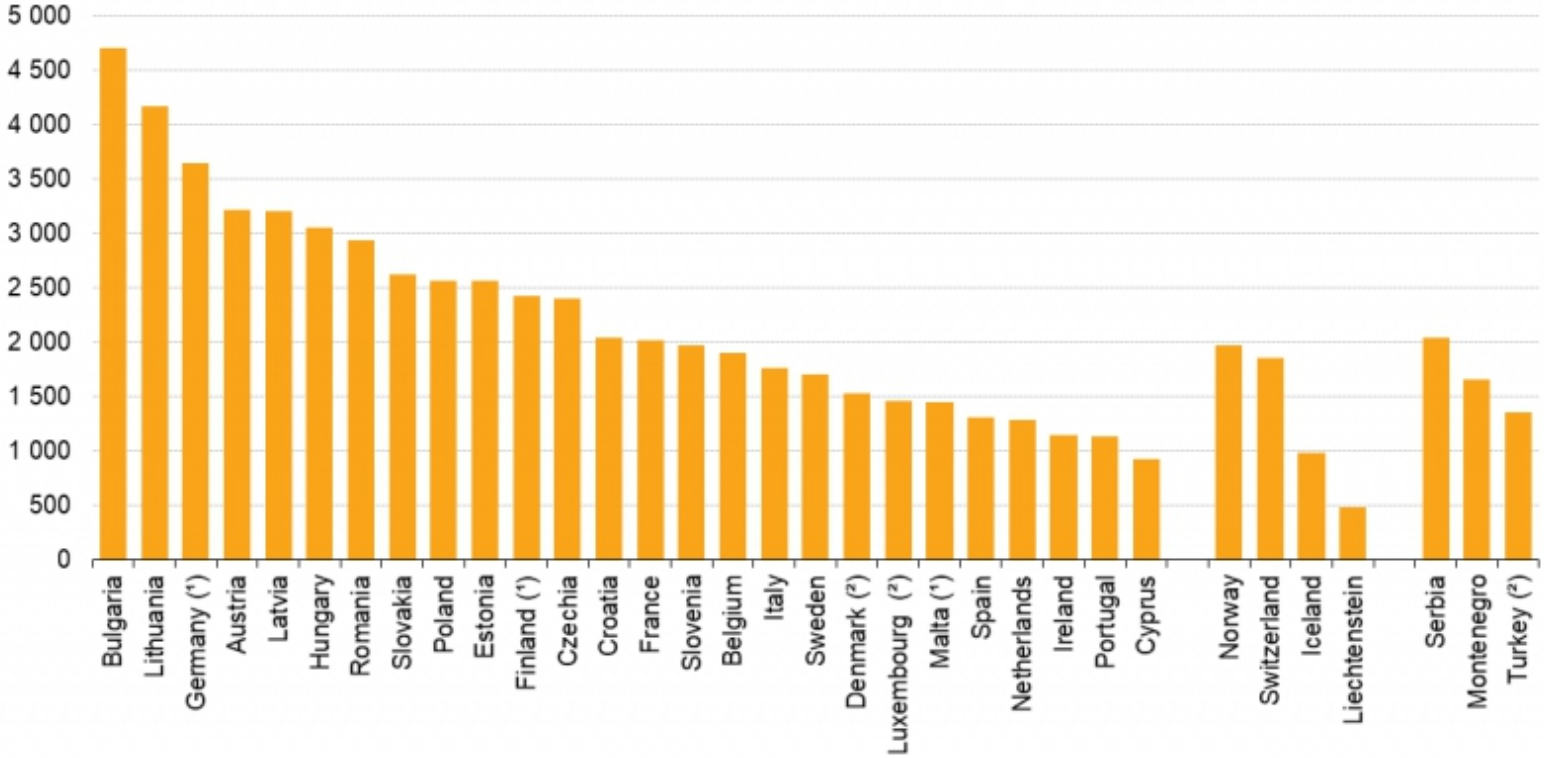
Source: Eurostat (online data code: hlth_ehis_cd1e)

eurostat

Context

CVD is a cause of **pressure** on hospitals and healthcare systems

Hospital discharge rates for in-patients with diseases of the circulatory system, 2019
(per 100 000 inhabitants)

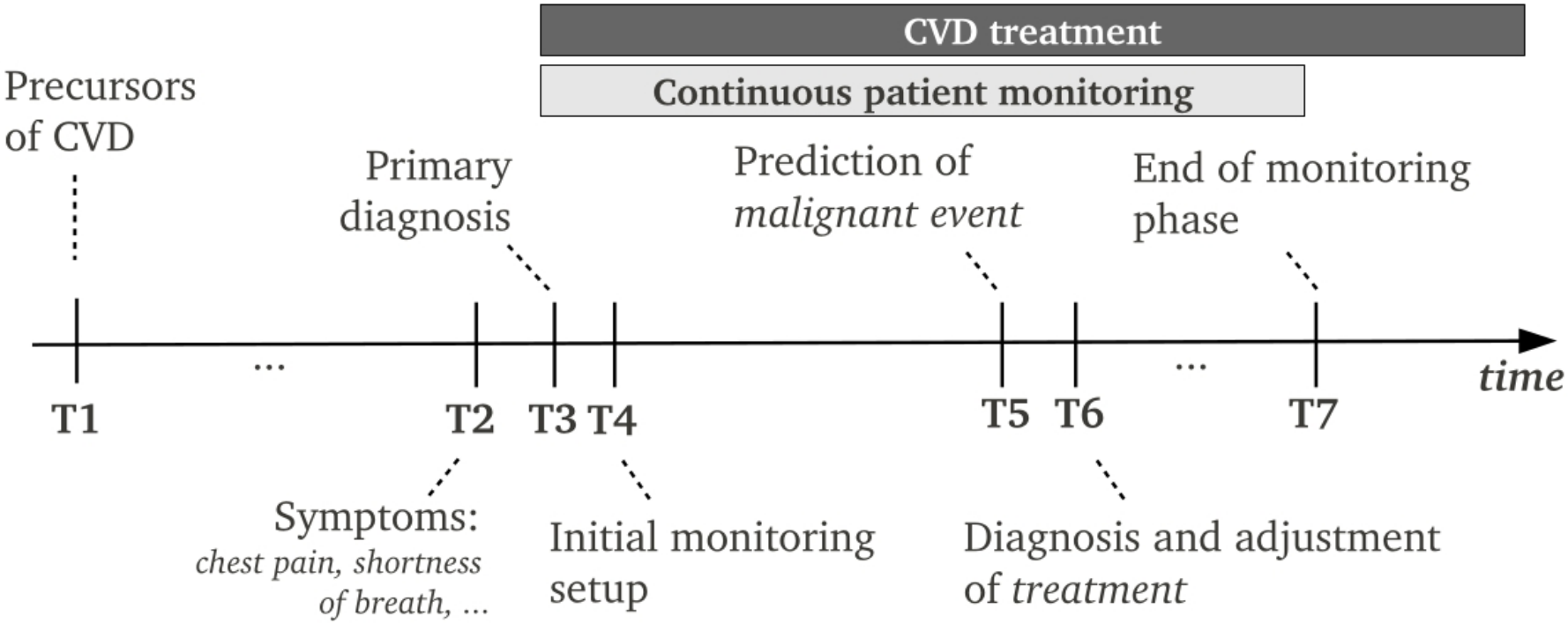


Note: Greece, data not available.
(1) 2018.
(2) 2016.
Source: Eurostat (online data code: hlth_co_disch2)

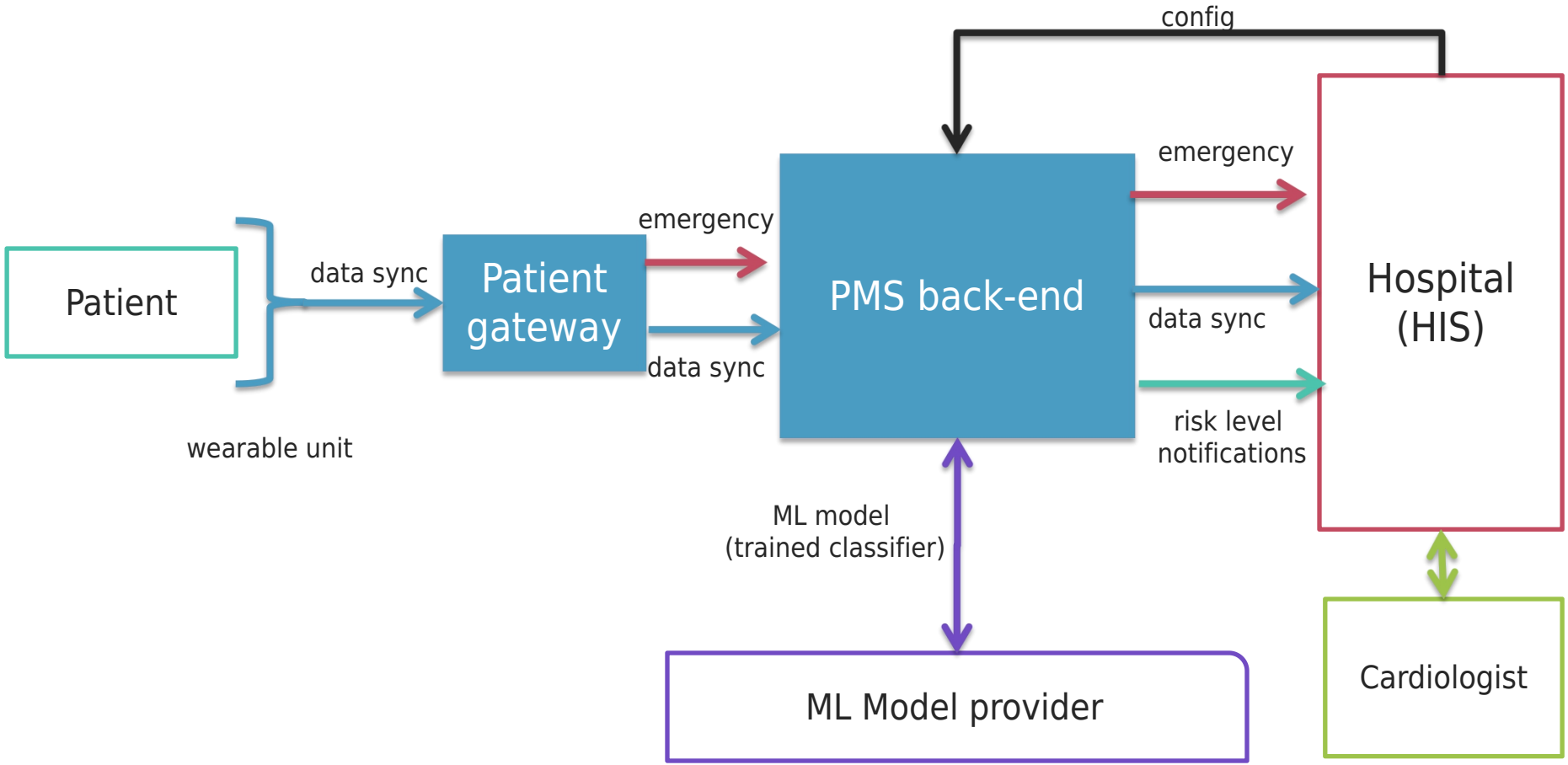
eurostat

Positioning

- Potential in longer-term management and follow-up of the evolution of CVD, outside of hospital context (“extra-muros”)
- Telemedicine, data centric, and IoT-based service:
  - Remote and continuous monitoring / data collection
  - Prediction of malignant events at the basis of collected data
  - Timely decision making
  - Limited impact on patient’s day to day life
- We are a small startup company, with strong ties to one specific hospital, building a pilot system


CVD treatment
Continuous patient monitoring
Precursors of CVD
Primary diagnosis
Prediction of *malignant event*
End of monitoring phase
time
T1
T2
T3
T4
T5
T6
T7
Symptoms: *chest pain, shortness of breath, ...*
Initial monitoring setup
Diagnosis and adjustment of *treatment*

Overview and positioning



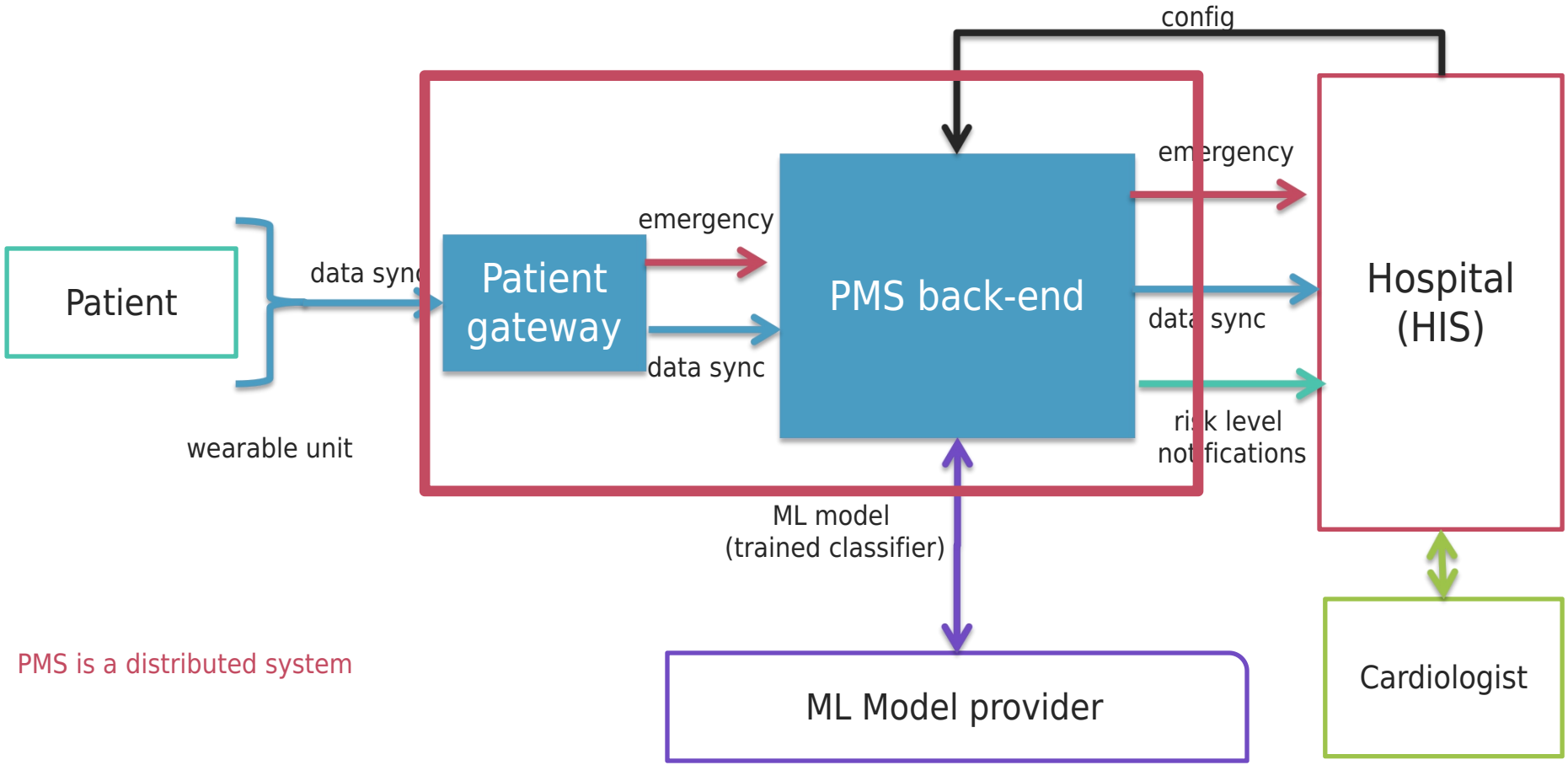
Wearable unit

- a **medical device**, fitted with a collection of sensors capable of acquiring relevant parameters
  - Heart rate
  - Electrocardiograph (ECG)
  - Respiratory rate
  - Blood oxygen level
  - Blood pressure
  - Activity level (accelerometer)
  - Body temperature
- Battery-operated, bluetooth connectivity

Patient gateway

- = a smartphone with a dedicated app
- Relays data to the back-end at fixed intervals
  - Interval depends on patient status/configuration
  - On-demand consultation, upon request
- Performs emergency assessment
- UI for patient

Overview and positioning



PMS is a distributed system

Automated risk estimation at the heart

Clinical risk models

- **Inputs**: new data, historical data, patient pathologies, current risk level, (persisted artifacts such as config, trained classifier)
- Output: suggest a **risk level (low, medium, high)**
  - Notifications can be sent in consequence to treating physician (or emergency services)

No single model suits all pathologies/patients

  - Configured on a per-patient basis (combination, thresholds, etc)
  - A single risk estimation=weighted combination of the outcome of individual models

Automated risk estimation at the heart

Different levels of complexity

Risk level	Normal	Worrisome	Dangerous
Low	105–120	90–105, 120–150	80–90, 150–190
Medium	95–135	90–95, 135–160	80–90, 160–190
High	90–150	85–90, 150–170	80–85, 170–190

Table 2: Default thresholds for systolic blood pressure (mmHg).
Notice the wider ranges for patients with higher risk-levels. Because of their cardiovascular conditions, their normal values will be, for example, more elevated, than the normal values of low-risk patients.

Automated risk estimation at the heart

Different levels of complexity

- Machine learning approach that involves pre-trained classifiers
  - External party = **CVD research institute** that optimizes different ML models for different pathologies
  - We will download these and use them
  - All **risk estimation** at the basis of **actual patient data** is performed by us
- Lightweight risk estimation for quick and reliable detection of emergencies on the patient gateway

Stakeholders

- Patients
- Physicians (GP, cardiologist)
- Nurse (trained nurse for registration)
- Emergency call center/services
- Telemedicine operators
- Hospital
- Electronic Health Record (EHR) services
- Legal/financial department
- Telecom operator
- ML model provider

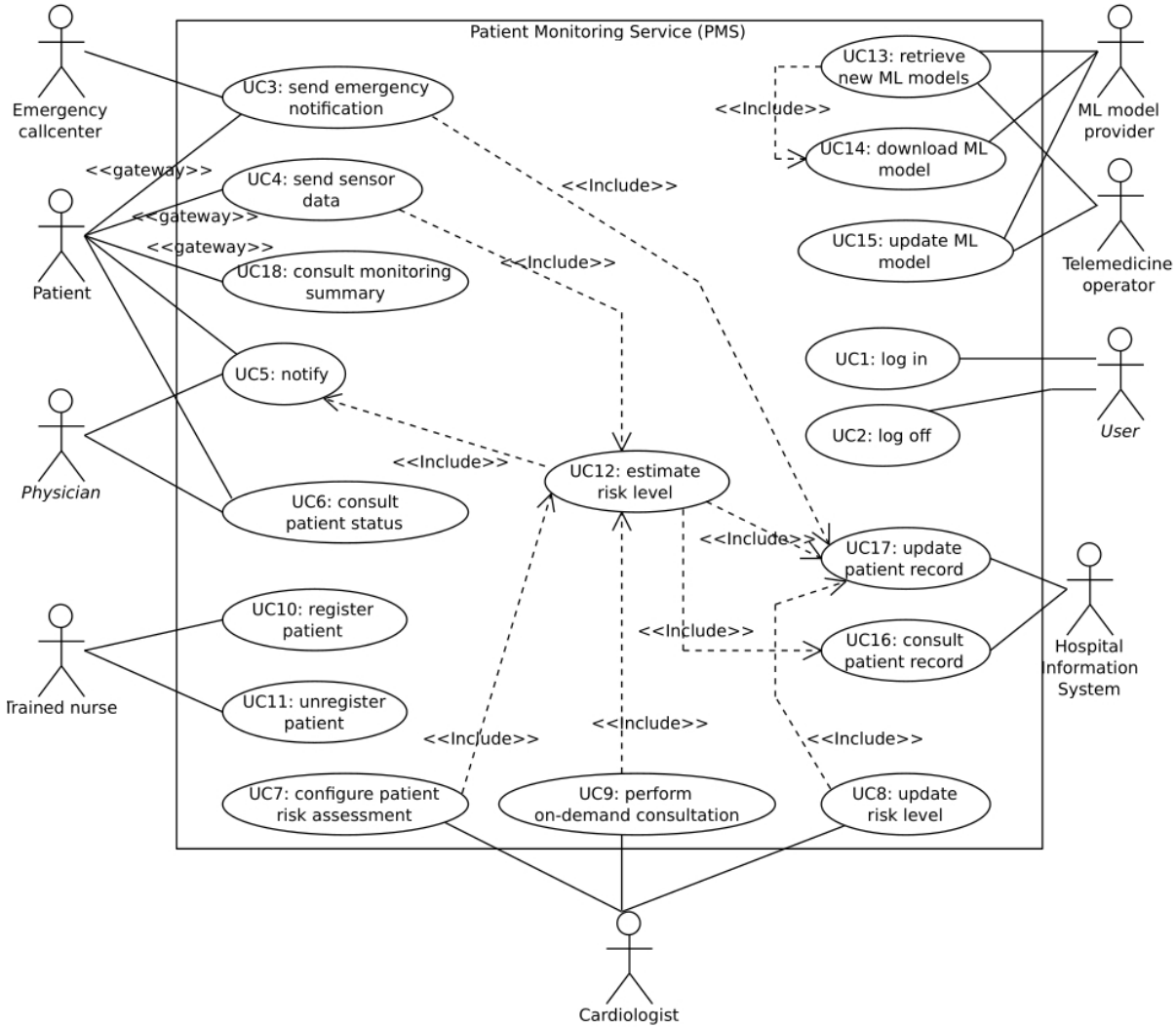
Constraints and considerations

- Hospital information system, and applicable HL7 FHIR (Fast Healthcare Interoperability Resources) standard
  - Physician workstation: request on-demand consultation, follow-up on evolution, change monitoring configuration
  - Patient enrollment, by a trained nurse
    - associating a Wearable unit to a patient, linking to the patient record, initializing the risk estimation, correct association to the treating physician
- Security/privacy/legal
- Financial

PMS Functional requirements

... in Appendix A

It’s all about the NFRs



Next week

- **Lab session**:
  - familiarize yourself with application case
  - do the self-test on Toledo
  - register team/meet team members
  - start a brainstorm about NFRs

- **Lecture**: The formal part 1 assignment
  - **Quality attributes** – different types, defining them
    - Low detail, long list: ASRs
    - Detailed: **quality attribute scenarios**