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Emerging technologies for the Early location of Entrapped victims under Collapsed Structures & Advanced Wearables for risk assessment and First Responders Safety in SAR operations

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Executive Summary

The objective of the present document is that of presenting the design of the first version of the PHYSIO DSS component (PHYSIOlogical evolution of the victim Decision Support System), constituted by a series of functions (submodules), algorithms and classes of instances, supported by a taxonomy, for the description of the management of victims of a real crisis event.

The development and implementation of the PHYSIO DSS Component is object of the deliverable D4.6 ("Development of the PHYSIO DSS component") and is based on a client-server architecture provided as Web Services.

The PHYSIO DSS component, follows a fully Bayesian approach for the estimation of the evolution over time of the victim physiological status and enable the S&R DSS to exploit a runtime update of the physiological conditions of the victims, based on the health measurements recorded in the field as well as on the treatments administrated by the care givers. All computations are performed in terms of probability distributions and at each time and for each victim a PIE (an encoded long character string, for a given victim, at a given time, collecting all the information representing the victim's situation from a physiological point of view) summarizes where the victim is likely to be in the Physiological State Variables' (PSVs) space.

The present document describes, in terms of inputs and outputs, all the developed functions, which can be used both in a simulated and in a real crisis situation (Section 2.2 Description of the Methodology), as well as the content of all the defined classes (Section 3 The PHYSIO DSS CLASSES and external inputs). To notice that the class contents can be only provisional and that can be updated and improved in the subsequent version of the component.

After a general description of the architecture of the PHISIO DSS component and of its functioning (Section 2 Design of the PHYSIO DSS Component), with a description of the offered services, the document presents the physiological variables of interest (PSVs) that describe the patient's state (Section 3.1 The Physiological Dimensions Class) and whose evolution forecast provides the information necessary for the estimate of the Expected Time to Death (ETD) which provides information for the prioritization of victims.

Sections 3.2, 3.3, 3.4, 3.5 and 3.6 report the detailed description of the PHYSIO DSS classes. The defined classes are the Events class (different types of incidents), the Injuries class (including different types of lesions that can occur during an incident), the Treatments class (the set of therapies and medications that can be administered to a victim affected by some injuries), the Health resources class (the set of ambulances, operating rooms, first responders, that is the resources able to deliver a certain type of treatment) and the Health measurements class, measures that can be taken on the victims

related to their physiological status (e.g. heart rate, systolic and diastolic pressure, O2 oxygenation, etc.).

The PHYSIO DSS functions, which can be external (that is functions that offers a named service and can be called by the S&R DSS) or internal (that is hidden functions that support some of the functionalities of the external functions), and algorithms (which implement rules for triage assessment or scores' computation) are detailed in section 4.1**Error! Reference source not found.**. The g enerate_scenario function was introduced in the PHYSIO DSS architecture to let the user to work in a virtual situation. This was necessary to test and demonstrate the use of the PHYSIO DSS in this initial development phase of the project, as the current versions of the modules and S&R technologies have not yet been integrated. The virtual victims will sustain lesions randomly, with a probability depending on the frequency of occurrence of that specific lesion in that type of event. In this way it is possible to simulate different crisis scenarios and different rescue actions. All the other developed functions will remain the same even in a real crisis situation.

Section 4.1.7 Victim Prioritization **Error! Reference source not found.**, illustrates the function ETD, w hich computes the distribution of the expected times to death (here representing the physiologic time of death, that occurs when the victim's vital functions ceased) according to the distribution of the PSVs. It is not intended in substitution to the triage algorithms used in practice, but it can be considered as an additional information for victim prioritization. The ETD also provides a tool to help the physician to decide which health resources to assign to a victim (for example based on the expected time to death in correspondence of each possible treatment to deliver).

Along with the functionalities described above, the PHYSIO DSS component also offers the automatic computations of scores (from signs and symptoms, as the Glascow Coma Scale) for the victim's impairment assessment, as well as the implementations of triage algorithms used in the event of crisis situations (Section 4.1.7.2 Scores and algorithms of triage). Conversely to what mentioned above, the computation of these scores and the assignment of colour codes do not follow a stochastic approach.

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List of Abbreviations

Abbreviation /acronym	Description
ABCDE	Airway, Breathing, Circulation, Disability, Exposure
AMP	Advanced Medical Post
DSS	Decision Support System
EMDAT	Emergency Events Database
EMS	Emergency Medical serivice
EMT	Emergency Medical Team
ETD	Expected Time to Death
pdf	probability density function
PDS	Physiological Distributional State
PSV	Physiological State Variable
START	Simple Triage And Rapid Treatment
S&R	Search & Rescue

1 Introduction

1.1 Objectives and Scope

The PHYSIO DSS component design and its relative development are the initial results of the work to be carried out in tasks T4.4 and T4.5. As part of the S&R Decision Support System, and according to the DoA, the component will provide modules and services necessary to support an efficient real-time health resource allocation in the field. The PHYSIO DSS will be designed indeed to address part of the objectives defined at the tactical decisional making level, which is pertained to field deployment (ambulance, treatments, field teams, triage, victim prioritization). Along with the use of machine learning algorithms, network models and mathematical programmes to optimise the resource allocation (objective of the overall DSS), the model-based PHYSIO DSS component is specifically addressed to the forecasting of the evolution of the physiological status of the victims of the crisis by modelling both the impact of the injuries and treatments, with respect to evolving time.

The final objective of the PHYSIO component is therefore to provide, within the S&R project, "a simulation service" focused on the physiological state of the victim, with the aim of following the victim from the moment he/she is taken care of by the rescue personnel or first responders until the end of his/her observation period, when the victim is delivered to definitive care-givers and no other decision has to be taken, which may also happen due to death.

1.2 The PHYSIO DSS Component in the S&R project

The PHYSIO DSS component is part of the overall S&R DSS and its ultimate goal is, therefore, to provide a tool for efficient decision making in emergency health operations, supporting suggestions in relation to the management of the several victims at an accident scene, so as to provide the largest number of patients with the most effective treatment possible, even in case of resource shortage. It will be the DSS's task to provide suggestions; at the time of the crisis, the DSS will be served by the PHYSIO DSS component with the requested forecasts.

This first version of the design of the PHYSIO component includes most of the functions and algorithms that will constitute the final version, foreseen at month 22 with the deliverables 4.10 (Design of the PHYSIO DSS component, final version) and provides the description of the development, in a testing environment, provided in D4.6 (Development of the PHYSIO DSS component, first version, M14). The present document and the associated development will show the general functioning of the component, even if the project has not yet addressed all the technical aspects of communication and data transmission from the field to the decision support platform. This first version therefore will include functions that simulate a typical scenario (one of those foreseen in the S&R Use Cases), generating individuals with some injuries and simulating their management and their physiological status over a timespan of several hours. The simulated results are shown in the associated development deliverable D4.6. This will afford the opportunity both to make a first validation of the PHYSIO component functionalities and to lay the foundation for facing the technical aspects related to the integration of the PHYSIO component in the overall DSS structure. Testing and Validation of each S&R component will be also carried out in the framework of Task 4.6, where all the S&R tools will be evaluated and validated to ensure the quality and the consistency of the delivered solution which will be then validated during the planned Use Cases, when all the tools, and hence also the DSS PHYSIO component and the overall DSS, will be tested in a live demo environment.

1.3 Overall description

The PHYSIO component includes the function PHYSIOEVO and a set of other functions and classes of objects to implement the testing simulation environment able to either reproduce a set of different crisis scenarios or handle a real crisis situation. In this simulated crisis scenario, a certain number of victims will be generated, each one presenting with a set of anatomical lesions, typical of the hypothesized scenario, and with different levels of severity. First responders have to triage victims and treat them with the most appropriate care, in the field with first aid and until they are transported to hospital or to some other health facilities to be administered definitive care. While the aim of the present deliverable from Task 4.4 (Design of DSS component) is that of providing a first version of the design of the S&R PHYSIO DSS component, the design of the component has been expanded to incorporate a function (generate_scenario) necessary to overcome the drawback of not yet having data flowing directly from the field at this stage of the project. Moreover, the need of testing and validating the S&R tools (task 4.6, DSS Validation), has pushed the design of this component towards a configuration that allowed the validation of the component in a virtual setting also. The present version, therefore, includes modules that generate a virtual scenario of an emergency situation, with virtual wounded victims whose vital functions are compromised and who need specific treatments in order to restore or improve their conditions. Some functions also allow the user (personnel operating in the field) to exploit the PHYSIO component for training activities, by comparing their ability to triage patients with scores and codes generated automatically by the system from signs and symptoms that can be detected from the field. The present design of the PHYSIO component, therefore, represents a setting where each victim is generated, followed and treated, and provides also a first triage based on the expected time to death (ETD). In principle, the ETD can be very large, indicating that the victim is not in danger (in analogy with a green code).

In the next section we are going to describe the flow of information among the different functions, modules and data that will be processed within the DSS PHYSIO component.

2 Design of the PHYSIO DSS Component

2.1 The architecture of the PHYSIO DSS Component

The present section provides an overview of the functioning of the PHYSIO component, which works in the same way during a real crisis or in a simulation environment. The architecture of the PHYSIO component includes **functions** implementing **algorithms**, which take in input values of variables and parameters and return either modified values of the same variables at different time points during the crisis event, or different outputs**. Classes** of homogeneous objects are defined and integrated with the functions.

The information flow starts with the identification of an event from the **EVENT** class. This class includes the list of events collected and analyzed in D4.1. The function **generate_scenario**, has been created to start a possible simulated scenario, including simulated victims with possible lesions and defects on the physiological dimensions. The following description is focused on an earthquake, which represents the first real setting (Use Case 1) where S&R will be demonstrated. Clearly, **generate_scenario** is alternative to the real-life identification of a given event and of the ensuing victims, which is accomplished by other modules within the S&R software system. However, once the event (say, an earthquake) is defined and victims are either virtually created or really identified, the subsequent information processing by PHYSIO DSS is identical in both simulated and real situations.

Each object of the class EVENT is characterized by the values of some parameters, such as the minimum and maximum number of potential victims (bystanders) or the relative frequencies of typical injuries observed in past crises and reported in historical databases, which is the object of analyses conducted in T4.1 and T4.2. The parameters for each instance of the class EVENT will be indeed set to values derived by the processes carried out in tasks T4.1 “Identify, analyse and connect to existing databases” and T4.2 “Data Aggregation”, when available, or set to reasonable, expert-suggested values when missing. Each event is therefore associated with a certain number of “victims”, that is individuals affected by the incident, each positioned somwhere in the vicinity of the location of the incident and thus characterized by its distance, in meters, from the event site. The total number of victims in a simulated event is function of the event severity parameter, which quantifies for instance the extent of the earthquake, or the power of the bombs, etc.. In a real event of course the number of victims is assessed from the field, and it is in fact not necessary to know it at the outset, new victims potentially being identified along the duration of the crisis.

Each event (i.e. each instance of the EVENT class) may produce on the affected individuals (victims) a series of anatomical lesions, categorized in the **Lesions** class, according to frequencies derived from the analysis carried out in T4.1 or from information reported in the literature. In a real situation, absent any further information from the field except the identification of the victim and its position with respect to the location of the event, each anatomical lesion is thus assumed to occur, *a-priori*, with a probability depending on the frequency of occurrience of that specific lesion in that type of event: this information is also retrieved from the results of tasks T4.1 and T4.2. In a simulation situation, virtual victims will sustain lesions randomly generated according to the same probabilities. The most significant functions/algorithms and classes of the PHYSIO DSS will be detailed in sections 3 and 4. All the functions and classes are represented in Figure 2-1.

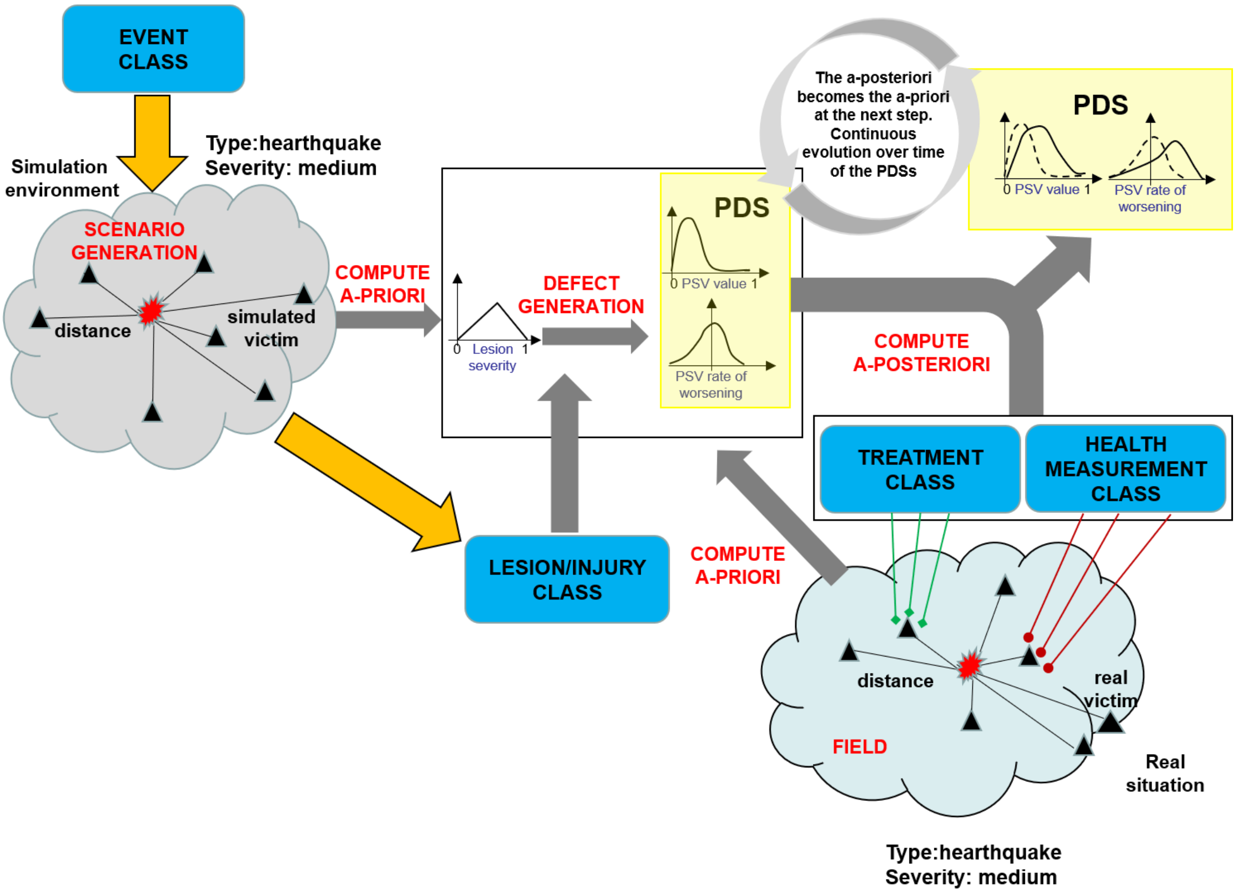

Figure 2-1: Overall overview of the PHYSIO DSS component

Subsections 2.2.1 and 2.2.2 will detail the flow of information and the interconnections among all the functions and classes which will be included into the first version of the DSS PHYSIO component.

2.2 Description of the Methodology

The implementation of the overall architecture follows a webservice approach: a webservice, located into a directory at the https://biomatlab.iasi.cnr.it/SearchAndRescue address, will provide the set of executable functions necessary for the functioning of the PHYSIO DSS component. The technical aspects will be covered in the deliverable D4.6. The following two subsections will describe the functioning of the PHYSIO DSS component both in a real and in a simulated crisis. The tool will address the following specific objectives:

- ***Simulation of different Crisis Scenarios***
- Description of the ***evolution of the victim distributional physiological status*** *based on health measurements from the field and assigned treatments.*
- ***Estimated Time to Death*** *for each victim*

Based on the forecasted evolution of the patient physiological status, the DSS will be able to deliver suggestions on:

- ***which resources to assign to a victim*** *(for example based on the expected time to death corresponding of each possible treatment to deliver)*
- ***patient prioritization*** *on the basis of the expected time to death or according to the values of computed scores and implemented triage algorithms*

To make the following discussion clearer, we introduce some relevant notation:

- The Physiological State Variables (PSVs) are ten dimensions along which patients change their physiological conditions following injuries (lesions) or therapy administration.
- A victim's Physiological Distributional State (PDS) expresses the probability density (the distribution) of the values of the PSVs at any given instant in time for a given victim. The PDS is represented by four matrices (necessary to numerically approximating the collection of density functions). Each PDS is described by interval extremes and associated frequencies for each one of the ten dimensions (Xs) and corresponding rates of change (Vs) and describes where the victim is likely to be in the PSVs' space. The intervals (which cover the entire support of the variables Xs and Vs) and their relative frequencies provide the information necessary to describe the distributions in terms of frequency histograms. Each victim PDS matrix has the dimension ($nbins \times nvar$), where nbins is the number of intervals into which the supports of X and V have been divided and nvar is the number of the physiological dimensions considered. The first pair of matrices (matrix of the extremes and matrix of frequencies) describes the

distribution of the values assumed by the ten physiological dimensions; the second pair of matrices describes the worsening rate distribution of the ten physiological dimensions.

- A PIE for a given victim, at a given time, is the collection of all the information representing the victim's situation from a physiological point of view. In particular, it contains the victim's PDS (four matrices) as well as a set of further additional information: synthesis measures of the PDS (such as means, medians, modes and standard deviations of the X and V variables, that is vectors of dimensions *nvar*), relevant demographic characteristics of the individual (gender, age, weight, height), as well as other additional information. A detailed description of the structure of the PIE is provided in the deliverable D4.6. THe PIE does NOT contain any patient identifying information, but it does contain a reference number, which is used by the calling client (other DSS functions using the PHYSIO component) to identify the set of information supplied to and the corresponding set of information retrieved from the PHYSIO DSS. The PIE has the form of an encoded long character string. While it is not directly readable outside of the PHYSIO component, ad-hoc functions are made available to the client services to extract the desired information from a PIE. PIEs are kept in memory outside the PHYSIO DSS component, care of the calling clients, in order to be used in subsequent calls. In other words: the client service is charged with maintaining the latest updated physiological information of each of the victims, supplying such information in the form of a PIE, together with additional appropriate information, in order to update the physiological state of a given victim, obtaining from the PHYSIO component an updated PIE. The PHYSIO DSS component never stores patient information itself.

The next two sections will present the overall functional description in a simulation environment (section 2.2.1) and in a real situation (section 2.2.2)

2.2.1 The simulated environment

A set of functions let the user to work in a simulated situation. The introduction of several modules was necessary to test and demonstrate the use of the PHYSIO DSS in this particular phase of the project, as the initial versions of the modules and S&R technologies have not yet been integrated.

Deliverable D4.6 shows the results and outputs obtained in the testing environment with the use of the Matlab [1] language. The development environment will make use of C++ [2]. Here we simulate the process of a user who starts the process by selecting an event ID (corresponding to a certain type of incident, e.g. an earthquake) from the **Event** class. As already mentioned above, the Event Class is a set of types of incidents including all the incidents considered in the S&R Use Cases (*Victims trapped under rubble; Plane crash; Earthquake / heavy storms; Forest fire; Chemical substance spill)* and part of the incidents individuated as to be the most frequent from the analysis carried out in task T4.1. It is to be noted that the present suggested content of the classes is provisional and that all the instances of the classes can be modified by adding new elements or deleting existing ones. The function **generate_scenario** simulates a new event (incident, ie. an earthquake), along with a certain number of victims**,** each one characterized by a series of **lesions/injuries,** extracted with a certain probability (parametrized on the basis of the selected event and on the information derived from the analysis of past events, deliverables D4.1 and D4.2) from the **Lesion** class. Some functional parameters determine the extent and the severity of the accident, in terms of the number of victims and the probability of injury occurrency. The anatomical lesions determine (via the **defect_generation** function) the occurrence of physiological impairments along some or all of the physiological dimensions (the **Physiological State Variables,** PSVs, included into the **PSV** class). Then, the **compute_a_priori** function returns the distributional form of the PSVs, each one starting with the its initial value (which represents the initial defect) and the rate of worsening depending on the type of lesion. The evolution over time of each PSV and its updating is determined by the delivered treatment (if any) by the considered **Health Resources**, or by additional information from the field (see Figure 2-2). A health resource is for example an ambulance carrying oxygen or blood bags. Each health resource can be employed in the field for patient care and can be subjected to competitive allocation (to some victims or to some other victims). Clearly, different health resources deliver different therapies/treatments/manoeuvres: while in an hospital setting oxygen, fluids, vascular repair can be provided for care, with an Ambulance it is possible to administer oxygen and fluids only. Each Health resource is therefore characterized by the set of therapies/treatments/manoeuvres it can deliver. We refer the reader to section "The PHYSIO DSS CLASSES and external inputs" for further details. Lesions and treatments have effect on certain Physiologic State Variables set (PSVs): while a traumatic brain and spinal cord injury can compromise Central Nervous System functions, a massive bleeding following a crush injury by a heavy weight decreases Central Venous Pressure and cardiac filling. A matrix associating injuries and PSVs and treatments to PSVs must be defined. On the basis of the effect that each treatment (delivered by a specific resource) produces on the health status of the victim, expressed by the distributional form of the PSVs, the DSS will provide support to the decision maker suggesting what treatments and in what quantities (expressed in the their own unit of measurements) must be employed to produce an improvement, or a complete restoration, of the compromised PSVs. The necessary treatments to be delivered to the victims of the incident ultimately provide the DSS with an estimate of the necessary Health Resources to be employed.

The updating of the PSVs distributions occurs also by the measurement from the field (by means of the **compute_a_posteriori_given_hm**). The function GCS_COMPUTATION, provides instead, from a series of symptoms and signs from the field, the automatic computation of the Glascow Coma Score.

2.2.2 Deterministic versus Stochastics approaches

At this stage of the project the PHYSIO DSS component will act as a completely autonomous system allowing the complete simulation of the fate of a victim as well as the evolution in terms of physiology of the first responders involved in the rescue operations. While the victim appears at the initial state of the simulation with some lesions caused by the event, the first responder exhibits a normal (healthy) status which could change over time if he/she is injured during the rescue operations. In a deterministic situation the objective would be that of predicting the state of a patient (victim) at a future time on the basis of his/her actual conditions and on the basis of the treatments he/she is receiving by the health services (by physicians on the crisis scene or in an ambulance during transportation towards the hospital or in an emergency or operating room in some health facilities). In a stochastic approach, the prediction of the health status of a victim will be given in terms of a probability distribution over the possible values of the physiological state variables in their domains. Inputs, measures from the field (as vital signs detected by first responders and health measurements from sensors and S&R instrumentations) will be employed to update the a-priori distribution in order to provide a posterior distribution that will be used as a-priori in the next evaluation.

At the beginning of the event (time zero), when very little information are available, the a-priori distribution on the "physiological status" of the victim is a probability distribution that reflects the most probable values of the state variables according to the very first information coming from the field. These initial observations can be limited for example to the distance of the victim from the incident site. While it is assumed that an accident victim will suffer some injuries, first responders should be healthy, at least at the start of the event. However, during the rescue operations, they could incur some accident and injure themselves. The a-priori distributions (initialization phase) of the physiological variables for a first responder are therefore centred on the maximum value that a physiological dimension can assume (the value 1, corresponding to a state of complete health).

The introduction of a distributional form for the physiological state of a victim addresses the formalization of that source of uncertainty occurring when facing a real situation This aspect finds its application in stochastic approaches.

Let us imagine what happens in a real situation: at the beginning, in the very first few minutes from the occurrence of the incident, the system and the ConCORDE database have not yet recorded anything on the victims; once on the scene, the first responders meet the first victims and start their rescue operations by communicating what they immediately observe: the position of the victim at a certain distance from the incident location, the gender, perhaps the age with a certain degree of uncertainty, and no other information.

The *a-priori* probability distribution of the Physiologic State Variables for one victim is derived by these first few items of information: the **type of incident** which determines the most likely injuries and the **distance** of the victim with respect to the exact event location, which determines a probability distribution of the severity of the possible lesions.

1. The type of incident is one from the list presented in Table 3-2
2. The distance of the victim is expressed in meters from the site of the incident

The function responsible for the generation of the a-priori distribution is the **compute_a_priori** function, which produces a first set of probability density functions (pdf) on the PSVs which will be subsequently updated when new information becomes available. The core of the PHYSIO DSS component becomes its ability to implement a fully asynchronous Bayesian approach: with the time passing further observations on the victim, appearing at arbitrary times, will improve the knowledge about the victim and the *a-priori* information will be updated to obtain an *a-posteriori* estimate of the physiological status of the victim, once again in terms of probability distributions. The function carrying out the updating is the **compute_a_posteriori** function, "*given*" the health measurement or the treatment administered. We underscore the fact that all the physiological information about a victim at any given time during the incident is represented by the "**PIE"**. The detailed description of the PIE is provided later in the document and in particular in deliverable D4.6.

2.2.3 Information flow from-to the field

As described above, the set of health measurements, signs or symptoms from the field are used by the system to update the physiological victim's status. Figure 2-2 summaries this flow. The overall DSS exploits the PHYSIO component output by taking in input the set of PIEs, one for each victim, and computing the number of minimal necessary quantity of each health resource at the current moment providing the optimal (possible unattainable) distribution of health resources and the desirable quantity for each of them at a particular moment. The term "desirable" is used to stress the concept that the quantity that would be necessary to take care of each patient is independent of the current availability of that resource, which in a situation of major crisis could be insufficient to cover the needs. The displacement of the resources will take into account the possible severity of each victim and will be the result of a balance between the resources needed at a given time, actual availability and possible future needs. Moreover, by comparing the effects of different treatments on the evolution of the PSVs the DSS will be able to provide support in terms of the best treatment for a specific victim or will be able to address first responders in the care of one victim rather than another, on the basis of a prioritization based on the expected time to death or on other computed indices or triages.

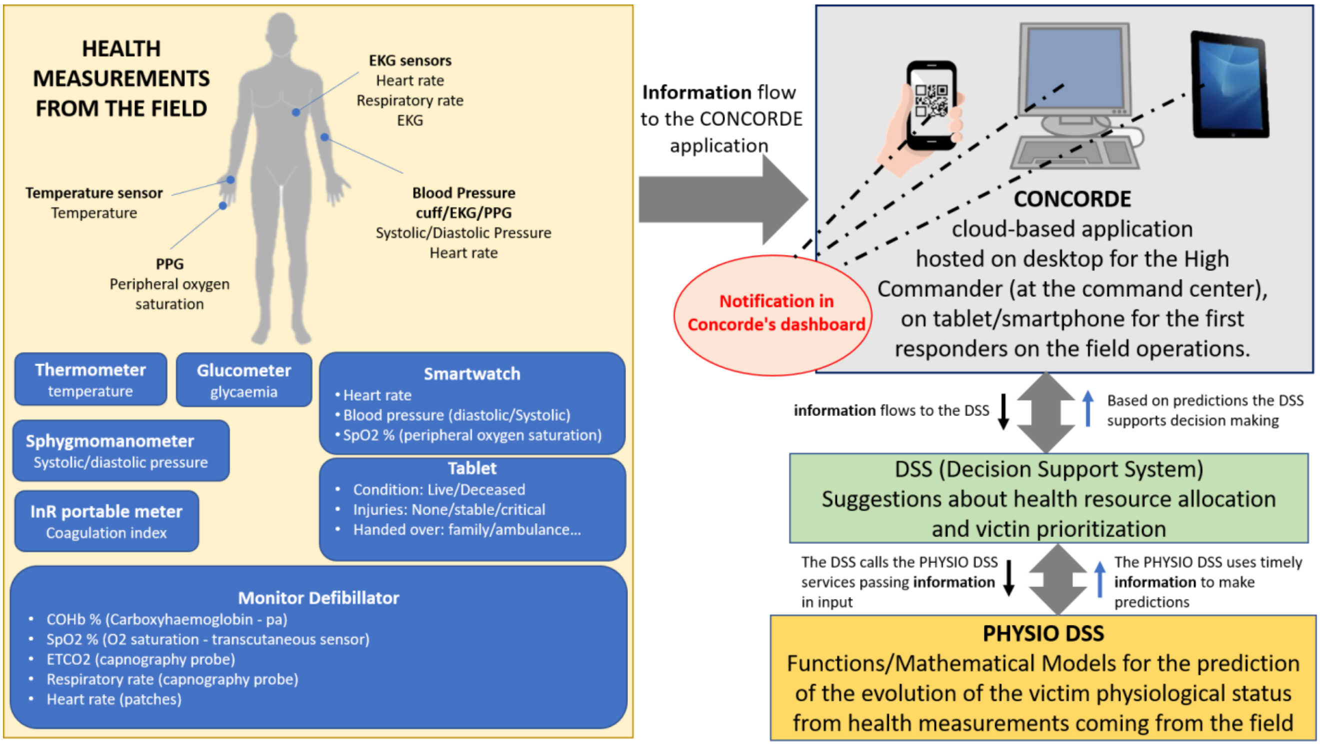

Figure 2-2: Information flow from the field to the DSS

3 The PHYSIO DSS CLASSES and external inputs

In the present section we give a description of all the classes necessary for the functioning of the PHYSIO component. It should be remembered that the content of each class can be modified and updated; a description of the classes in the present form is reported in order to provide the reader with a complete, albeit provisional, overview of the PHYSIO DSS.

3.1 The Physiological Dimensions Class

As already mentioned previously, the DSS PHYSIO component describes the evolution over time of ten physiological dimensions, each of them summarizing and describing some human vital function. **Error! Reference source not found.** reports the taxonomy related to the PSVs along with their description and an example of a damage causing a defect in the PSVs.

PSV code	PSV name	Description	Example of a case determining a defect in the PSV
PSV1	A1	Airway patency	Pharyngo-tracheal foreign body aspiration
PSV2	B1	Reduced respiratory rate and drive	Head trauma, CO_2 intoxication
PSV3	B2	Tidal volume and mechanics	Chest compression
PSV4	B3	Oxygen transport	CO intoxication (exposure to combustion smokes)
PSV5	C1	Heart pump function	Chest trauma producing cardiac or aortic injury
PSV6	C2	Decreased central venous pressure and cardiac filling, and increased systemic vascular resistance	Massive bleeding
PSV7	D1	Central nervous System Function	Traumatic brain and spinal cord injuries
PSV8	D2	Seizures	Head trauma
PSV9	D3	Blockers of acetylcholinesterase	Poisonous gas inhalation
PSV10	E1	Frostbite, hypothermia, burns	Exposure to low temperatures, Fire

Table 3-1: Description of the physiological State Variables

The above taxonomy is an extension of the ABCDE (Airway, Breathing, Circulation, Disability, Exposure) approach to assess and treat the patient [3]

3.2 The Event Class

The Event class is constituted by the events selected in the analysed sources presented in deliverable D4,1 and D4.8 and the taxonomy used here is derived by the transformations and mappings carried out in Task 4.1 (see Table 2-18: Field Transformation in EMDAT). It includes all the events object of the S&R Use Cases.

Event ID	Disaster Group	Disaster Subgroup	Category in SnR
1	Technological	Technological	FIRE
2	Natural	Geophysical	EARTHQUAKE
3	Natural	Geophysical	VOLCANO
4	Natural	Geophysical	LANDSLIDE
5	Natural	Meteorological	STORM
6	Natural	Hydrological	FLOOD
7	Technological	Technological	TRANSPORTATION
8	Technological	Technological	COLLAPSE
9	Natural	Biological	EPIDEMY
10	Natural	Hydrological	AVALANCHE
12	Technological	Technological	CHEMICAL
13	Natural	Geophysical	EARTHQUAKE

Table 3-2: Event Class

A severity is associated with each event: MINOR = 1, MEDIUM = 2, MAJOR = 3, CRITICAL = 4, according to the EMDAT classification. The event severity is an input parameter of the function EVENT_GENERATOR (see section 4), where the severity is normalized to vary between 0 and 1:

NO SEVERITY = 0;

MINOR = 0.25;

MEDIUM = 0.5;

MAJOR = 0.75;

CRITICAL = 1.

3.3 The Lesion/Injuries Class

Multiple injuries are associated with each event. Some injuries are more likely to occur in certain events and have low probabilities to occur in other types of events. Table below reports the widely used ICD-9-CM ECOI classification [4]. It is an extensive list which may be reduced on the basis of the retrieved information from the existing database. An analysis of the content of the databases related to past events will help to select the subset of injuries reported in the different incidents.

InjuryID	Region	Injury Description ICD-9
1	Head	(800) Fracture of skull

2		(830) Dislocation of jaw
3		(850) Concussion
4		(851) Cerebral laceration and contusion
5		(852) Subarachnoid, subdural, and extradural hemorrhage, following injury
6		(853) Other and unspecified intracranial hemorrhage following injury
7		(854) Intracranial injury of other and unspecified nature
8		(870) Open wound of ocular adnexa
9		(871) Open wound of eyeball
10		(872) Open wound of ear
11		(873) Other open wound of head
12		(900.1) Injury to blood vessels of head
13		(910) Superficial injury of face and scalp except eye
14		(918) Superficial injury of eye and adnexa
15		(920.1) Contusion of face, scalp, except eye(s)
16		(921) Contusion of eye and adnexa
17		(925.1) Crushing injury of face, scalp
18		(930) Foreign body on external eye
19		(931) Foreign body, ear
20		(932) Foreign body, nose
21	Neck	(805) Fracture of vertebral column without mention of spinal cord injury
22		(806) Fracture of vertebral column with spinal cord injury
23		(807.5) Closed fracture of larynx and trachea
24		(807.6) Open fracture of larynx and trachea
25		(874) Open wound of neck
26		(900.2) Injury to blood vessels of neck
27		(910.2) Superficial injury of neck,
28		(920.2) Contusion neck
29		(925.2) Crushing injury of neck
30		(933) Foreign body in pharynx and larynx
31	Thorax	(807.0) Closed fracture of rib(s)

32		(807.1) Open fracture of rib(s)
33		(807.2) Closed fracture of sternum
34		(807.3) Open fracture of sternum
35		(807.4) Flail chest
36		(860) Traumatic pneumothorax and hemothorax
37		(861) Injury to heart and lung
38		(862) Injury to other and unspecified intrathoracic organs
39		(875) Open wound of chest (wall)
40		(879) Open wound of other and unspecified sites, except limbs
41		(901) Injury to blood vessels of thorax
42		(934) Foreign body in trachea, bronchus, and lung
43	Abdomen	(863) Injury to gastrointestinal tract
44		(864) Injury to liver
45		(865) Injury to spleen
46		(866) Injury to kidney
47		(867) Injury to pelvic organs
48		(868) Injury to other intra abdominal organs
49		(868.0) Injury to other intra abdominal organs without mention of open wound into cavity
50		(868.1) Injury to other intra abdominal organs with open wound into cavity
51		(869) Internal injury to unspecified or ill defined organs
52		(878) Open wound of genital organs (external), including traumatic amputation
53		(879) Open wound of other and unspecified sites, except limbs
54		(902.1) Injury to blood vessels of abdomen
55		(902.2) Injury to blood vessels of pelvis
56		(935) Foreign body in mouth, esophagus, and stomach
57		(936) Foreign body, intestine/colon
58		(937) Foreign body, anus/rectum
59		(938) Foreign body in digestive system, unspecified

60		(939) Foreign body in genitourinary tract
61	Extremity	(808) Fracture of pelvis
62		(810-9) Fracture of upper limb
63		(820-6) Fracture of lower limb
64		(827) Other, multiple, and ill defined fractures of lower limb
65		(830-9) Dislocation
66		(840-8) Sprains and strains of joints and adjacent muscles
67		(876) Open wound of back
68		(877) Open wound of buttock
69		(880-7) Open wound of upper limb
70		(890-7) Open wound of lower limb
71		(903) Injury to blood vessels of upper extremity
72		(904) Injury to blood vessels of lower extremity and unspecified sites
73		(911-7) Superficial injury of extremities
74		(922) Contusion of trunk
75		(923) Contusion of upper limb
76		(924) Contusion of lower limb and of other and unspecified sites
77		(926) Crushing injury of trunk
78		(927) Crushing injury of upper limb
79		(928) Crushing injury of lower limb
80		(929) Crushing injury of multiple and unspecified sites
81	External	(910) Superficial injury
82		(940) Burns
83		(990) Effect of radiation, unspecified
84		(991) Effect of reduced temperature
85		(992) Effect of heat and light
86		(993) Effect of air pressure
87		(994) Effect of other external causes

Table 3-3: The Lesion Class

3.4 The Therapy/Treatment/Manoeuvres Class

Treatments are delivered from health resources dislocated on the field and in the surrounding, as Hospitals and other points of care, to resolve or mitigate the harmful effect of the injuries on the physiological variables. Different Health Resources deliver different treatments. The following table reports a provisional list of treatments and medications that can be delivered both in the field, by Emergency Medical Teams (EMTs), and in an ambulance or in a hospital setting.

Treatment/Manoeuvres/Medication ID	Treatment/Manoeuvres/Medication description
T01	Ventilation
T02	Wound cleaning and debridement
T03	Wound closer (strips, sutures, or staples)
T04	Wound dressing
T05	Tourniquet or advanced haemostatic dressings for bleeding control
T06	Oxygen
T07	Intubation
T08	Bag Valve Mask (BVM)
T09	Saline infusion*
T10	Haemodynamic support*
T11	General surgery
T12	Neuro surgery
T13	Cardio surgery
T14	Orthopedic surgery
M1	Medications for prevention and treatment of communicable diseases
M2	Medications for Gastrointestinal Tract Problems
M3	Medications for injuries (for physical trauma or for prevention and management of wound infections)
M4	Medications for major and minor surgery (anaesthetics, antialergics and medicine used in anaphylaxis such as cortisone and adrenaline)
M5	Medications for mental health (to treat epilepsy and convulsion)
M6	Medications for skin infections
M7	Medications for severe acute asthma

*require the availability of IV Infusion Pump

Table 3-4: The Treatment/Manouvres/Medication Class

Classification for medications have been derived by [5]. For each delivered treatment, whose administration is expressed in quantities, a minimum and a maximum are provided; all the other treatments can assume either value 0 (no treatment) or 1 (treatment administered).

3.5 The Health Resources Class

The Health Resources listed in the table below are those that are dislocated in the field as well those provided in a Hospital setting after evacuations and transportation of the victims

Health Resources code	Health Resources description
HR01	Emergency Medical Teams (EMTs)
HR02	Fire Service
HR03	Police
HR04	Military Defence Force
HR05	Advanced Medical Post (AMP)
HR06	Ambulance Service EMS
HR07	Decontamination zone
HR08	Emergency Room
HR09	XRay
HR10	Laboratory
HR11	General Operating Teathre a Hospital Setting
HR12	Neuro Operating Teathre a Hospital Setting
HR13	Cardio Operating Teathre a Hospital Setting
HR14	Intensive Care Unit

Table 3-5: The Health Resources Class

Advanced Medical Post (AMP): station or field hospital near the site of a disaster, equipped with appropriate medical supplies and equipment. Here victims receive first aids and stabilization.
EMTs: groups of health professionals (doctors, nurses, paramedics etc.) who treat patients affected by an emergency or disaster.
Fire Service, Police, Military Defence Force if trained they may provide first aid and advanced medical care
The selected health resources are derived from [6] *with some modifications.*

3.6 The Health Measurements Class

Table below reports the set of measurements deriving from sensors and instrumentation used in the field. This represent the information coming from the place of the incident and flowing directly to the CONCORD platform and then to the DSS in order to compute an updated state of the victim in terms of his/her physiological variable distributions. The normal range and the domain of each measurement is also reported along with the instrumentation used as source and the partner responsible for providing the instrument.

Type of data	Data Description	Unit of measurement	Range	Normal range	Source/device	Partner Provider
Heart rate	Heart rate	heartbeat per minute	0-200	60-90	EKG or Photoplethysmograph (PPG)	CERTH
Systolic Pressure	Systolic Pressure	mmHg	0-300	110-129	Blood Pressure Cuff or (EKG and PPG)	CERTH
Diastolic Pressure	Diastolic Pressure	mmHg	0-300	75-89	Blood Pressure Cuff or (EKG and PPG)	CERTH
Temperature	Temperature	°C	-10 - 50	35.2-36.9	Temperature sensor	CERTH
Respiration rate	Respiratory rate	Breaths per minute	0-50	12-16	EKG and PPG	CERTH
Blood oxygen saturation	O2 % haemoglobin saturation level in the blood	percentage %	0-100	95-100	PPG	CERTH
condition of the victim	Live/Deceased	mark a box				PUI
injuries	None/stable/critical	mark a box				PUI
victim handed over to	Family/ambulance…	mark a box				PUI
Systolic pressure	Systolic Pressure	mmHg	0-300	110-129	smartwatch	KT
Diastolic pressure	Diastolic Pressure	mmHg	0-300	75-89	smartwatch	KT
Heart rate	Heart rate	heartbeat per minute	0-200	60-90	smartwatch	KT
O2 oxygen saturation	Blood oxygen saturation	percentage %	50-100	95-100	smartwatch	KT

Table 3-6: The Health Measurements Class

4 Interconnection between CLASSES, FUNCTIONS TREATMENTS and MEASUREMENTS from the field

4.1 The set of the PHYSIO DSS Functions

The table below lists all the functions that will be implemented in the first version of the PHYSIO component. All the functions reported below have been implemented in Matlab, the language used for the testing environment (see deliverable D4.6 for more details). The column headed "Level" indicates whether a function is external, that is it offers a named service and can be called by the DSS, or if it is merely called internally, that is it is a hidden function that supports some of the functionalities of the external functions.

Function name	Description	Level
generate_scenario	Function generating an event characterized by a random number of victims affected by a number of lesions causing damages on the physiological dimensions	external
compute_a_priori	Function generating the a-priori distribution of the physiological variables from the very few initial information on the victim	external
defect_generation	Function generating damages on the physiological dimensions of the victims on the basis of the reported lesions and their severities	internal
compose_PIE	Function for the PIE composition: it generates a long encrypted vector containing all the information on the victim	internal
decompose_PIE	Function for the PIE decomposition: it returns all the relevant information from the PIE	internal
compute_empirical_distribution	Function that returns the frequency histogram (empirical distribution) in terms of interval extremes and the associates relative frequencies	internal
ETD_PIE	Function that computes the empirical distribution of the expected time to death for each victim of the incident, taking in input the PIE	external
sample_from_empirical_distribution	Function that draws samples from the a general empirical distribution	internal
compute_a_posteriori_given_hm	Function generating the a-posteriori empirical distribution by updating the a-priori distribution with values of health measurements from the field at a given time	external
compute_a_posteriori_given_treatment	Function generating the a-posteriori empirical distribution by updating the a-priori distribution with values of the	external

	delivered treatment at a given time	
conditional_probability_hm_given_psv	Function generating the conditional empirical distribution of the health measurements given the values of the physiological variables	internal
compute_synthesis_measure	Function computing a characteristic synthesis measures of an empirical distribution (mean, median, mode, standard deviation)	internal
Triangular_Distribution_Cumulative	Function generating the cumulative distribution of a triangular probability density function to allow direct sampling from a triangular distribution	internal
PHYSIOEVO	Function for the evolution over time of the PDS	external
Glascow_Coma_Scale_computation	Function returning a score between 3 and 15 from signs detected from the field	external

Table 4-1: List of the relevant functions in the DSS PHYSIO component

In the following we detail all external functions and some relevant internal functions in terms of INPUT and OUTPUT; a description of the underlying assumptions is also provided.

4.1.1 Generation of a scenario

The generate_scenario function was developed in order to allow the PHYSIO component to be tested independently of the current availability of data from the field. It generates a set of simulated victims from one of the events included in EVENT class. While in the testing phase of the entire S&R solution in a real environment the capabilities of the generate_scenario function will no longer be exploited, the function could still be embedded into a future simulation environment for training first responders in victim triage and health resources allocation.

Input	Description
event_type	Event ID, it is a number between one and the maximum number of events in the the Event Library
event_severity	In [0,1]: NO SEVERITY = 0; MINOR = 0.25; MEDIUM = 0.5; MAJOR = 0.75; CRITICAL = 1
event_dimension	A number that represents the extension of the event (in meters from the point of occurrence)
event_delay	Duration between the time of the occurrence of the event and the time of arrival on the scene of the first rescue teams.
Output	**Description**
num_victims	Generated number of victims. It is a number less or equal to the number of bystanders. The number of bystander is read internally by loading the Event class

longitudinal_deviations	A matrix including for each victim the distance in meters from the point of occurrence along the East (positive) and West (negative) directions (num_victims × 2)
latitudinal_deviations	A matrix including for each victim the distance in meters from the point of occurrence along the North (positive) and South (negative) directions (num_victims × 2)
PIE_VICTIMS	A matrix where the columns contains for each generated victim the corresponding PIE
[extremes_lesion, frequencies_lesion, central_measures_lesion, std_distr_lesion]	Empirical distribution (extremes_lesion, frequencies_lesion) of the lesion severities for each generated victim, along with synthesis measures (central_measures_lesion, std_distr_lesion)
victims_delays	Vector containing for each victim the time when the victim enters the system. For example, a victim is recuperated under the rubble some time after the occurrence of the event (i.e. one hour later)

Table 4-2: The generate scenario external function

The number of victims is generated from a binomial distribution with parameters (n,p), where n is the maximum number of bystanders and p is the event_severity. The bystanders are people close to the incident location, who do not necessarily require emergency medical help, but who may be victims of the incidents, that is they are at risk to be affected by the incident. From the analysis of past events (T4.1 and T4.2) for each event in the Event class, the minimum, maximum and average number of bystanders will be derived. The function calls internally the compute_a_priori function, described below, and the output is a description of the generated victims in terms of their position with respect to the incident site and in terms of distributions of their physiological variables and lesions.

4.1.2 Computation of the a priori distribution of the victim physiological status

The function **compute_a_priori** returns the values of the PSVs from the initial, very limited information on the victim, essentially just from the type of event and from the position of the victim with respect to the event location (distance in meters from the event in terms of latitude and longitude deviations).

The output represents the a-priori estimate of the physiological status and of the rate of worsening of the patient, embodied in a PIE.

It may be helpful to explain the logic of this function: when an emergency professional (say, an emergency surgeon in a hospital) first learns that some accident has happened and that a possible victim is about to be transferred to the hospital, this professional has a vague idea of what might be wrong with this person: in case of chemical fumes a ventilator might be needed, in case of a road accident blood or an orthopaedic surgeon will likely help. In other words, "compute_a_priori" generates the first probability density on the physiological status based upon initial, extremely limited information.

This will then be progressively sharpened and strengthened as more and more information arrives about the victim from the field.

The function uses two matrices:

M1: The matrix that associates to each event the **maximal probability of occurrence** of each lesion.

M2: The matrix that associates to each event the **modal severity of** each lesion, with the Severity a number between 0 and 1.

From matrices M1 and M2 the maximal probability of a lesion and the modal severity of a lesion for each victim is computed as a decreasing function of the distance of the victim from the event. Once it is stated (randomly, according to the computed victim-specific maximal probability of occurrence of a given lesion) that a subject is affected by a lesion, then the severity of the lesion is drawn from a triangular distribution with mode the computed victim-specific modal severity for that victim.

Input	**Description**
idpat	Identification number of a victim
demogragraphic	Victim related characteristics including gender, age, height and weight
longitudinal_deviations	A matrix including for each victim the distance in meters from the point of occurrence along the East (positive) and West (negative) directions (num_victims × 2)
latitudinal_deviations	A matrix including for each victim the distance in meters from the point of occurrence along the North (positive) and South (negative) directions (num_victims × 2)
event_type	Event ID, it is a number between one and the maximum number of events in the the Event Library
event_dimension	A number that represents the extension of the event (in meters from the point of occurrence)
date	Date in posix format
Output	**Description**
PIE	A column encrypted vector

Table 4-3: The compute_a_priori external function

The severity of the lesions is used to compute the instantaneous defects on the physiological state variables as well as their rate of worsening. This is done by the function **DEFECT_GENERATION** which is called internally by different functions of the PHYSIO component

4.1.3 From Lesions to Health Status Impairment

The **defect_generation** function makes use of two pre-compiled matrices, one associating with each lesion an instantaneous defect along one or more physiological dimensions and one associating with each lesion the rate of worsening of each physiological variable. It takes in input the type of event and the distribution of the generated severities of each lesion for the considered victim and returns the distributions of the physiological variables and of the rate of worsening. It is an internal function used both in a simulation environment and in a real situation.

Input	Description
event_type	Event ID, it is a number between one and the maximum number of events in the the Event Library
lesion_matrix	It contains the realizations of lesion severity for each lesion associated to the victim
Output	**Description**
XD	Distribution of the values of the Physiological Variables
VD	Distribution of the rate of worsening for each Physiological Variables

Table 4-4: The defect_generation internal function

4.1.4 Health Status Update from Field Measurements

The main objective of the PHYSIO component is that of providing an updated knowledge on the victim status with elapsing of time from the availability of new information coming from the field. This objective can be achieved by the computation of the a-posteriori distribution of the physiological status given either the measurements taken on the individuals from the sensors and the instrumentation used in the field or the type of treatment delivered by the care givers during the rescue operations: in both cases the current a-priori distribution (representing all the knowledge available at a specific time) is updated by combining it with incoming new experimental information.

The **compute_a_posteriori_given_health_meas** function make use of a matrix that associates to each measurement one or more physiological variables. The dependence between each measurement and the physiological variable exists when the measurement affects a particular physiological aspect of the individual (for example the pressure affects the Heart pump function and vice versa).

The implementation of the function is based on the Bayes' Theorem [7] according to which:

$$p(X|Y) = \frac{p(Y|X)p(X)}{\int p(Y|X)p(X)dX} \quad (1)$$

where in the specific case, X is one of the Physiological Variables (e.g. the Heart pump function), Y is a measurement from the field (e.g. the diastolic/systolic pressure), p(X|Y) is the a-posteriori distribution of the PSV given the observed value of the Variable Y, p(X) is the a-priori distribution of X. While the a-priori distribution p(X) is derived by the "compute_a_priori" function, or represents the a-posteriori of the previous step (that is the last output of the "compute_a_posteriori" function called at a previous time), p(Y|X) is derived from an internal function performing the computation of the conditional distribution of the "health measurement" given the values of the physiological State variable X. The same stands for the rates of worsening.

Each health measurement, is transformed to a value ranging between 0 and 1. Values close to 0 indicate the health measurements in the range of normality; values close to 1 indicate the value of the health measurement far away from the normality range (independently of the direction).

The probability distribution p(Y|X) is therefore supposed to follow a triangular distribution with domain [0-1] and parametrized by X: high values of X (close to 1, that mean no defect on the physiological variable) produce a distribution for (Y|X) centred on the zero (values of the health measurement within the normality range); conversely low values of the physiological variable (presence of defect), produce for (Y|X) a distribution centred on one. Figure below shows the underlying reasoning. The support of the distribution probability of Y|X, that is the domain of Y, shifts towards the value 0 (making very small values more likely) or towards the value 1 (making larger values, near 1, more likely) depending on the fact that the value of the physiological variable, parametrizing the distribution, is above or below pre-specified thresholds, respectively (20% and 80%).

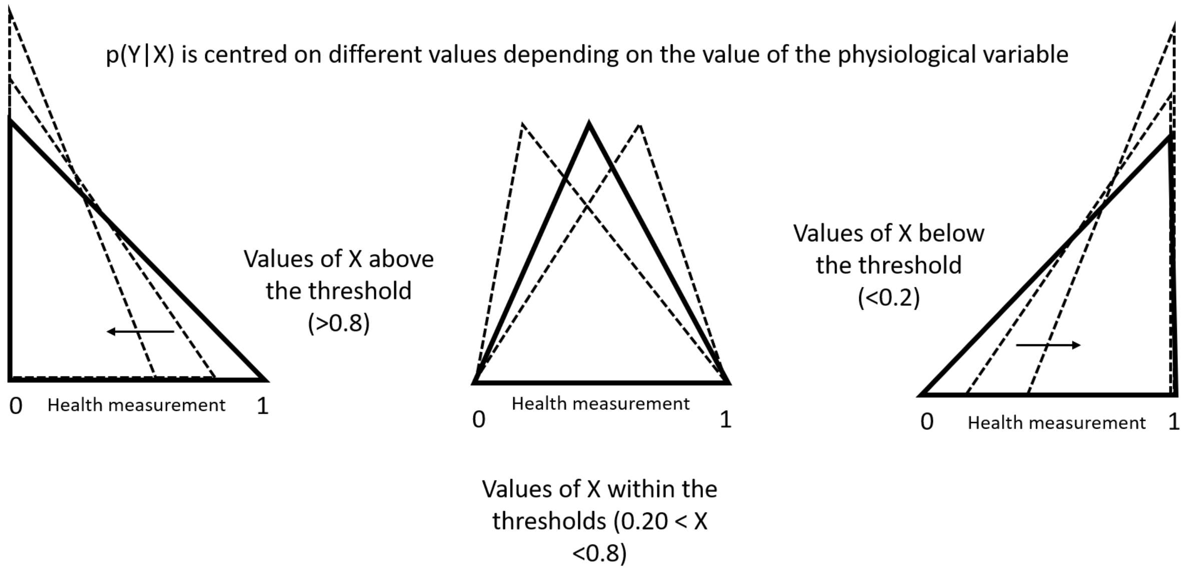

Figure 4-1: The conditional probability distribution p(Y|X)

The values of the health measurements are transformed in the way that values in the range produce a normalized value close to 0 and values that move away from the limits of the normal range are transformed into values gradually closer to 1 (see for example Figure 4-2 for the measurement "systolic blood pressure")

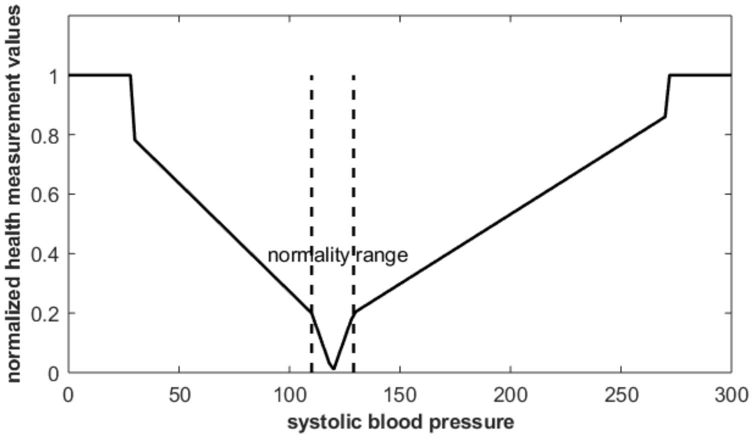

Figure 4-2: Normalization of the "health measurements"

Input	Description
PIE	a-priori PIE (last available PIE)
Health_measurement_ID	Identification number of the health measurement
Health_measurement_Value	Original value of the health measuremet
Output	**Description**
PIE	a-posteriori PIE

Table 4-5: The compute_a_posteriori_given_health_meas external function

4.1.5 Health Status Update from Treatment Administration

The update of the current PIE takes place through new information on the victims both in terms of health measurements and of treatments/Manouvres/Medications administered to mitigate or resolve the damages resulting from the injuries suffered during the incident. in the same way as described above, the crucial point lies in the calculation of the distributions of the physiological variables given the treatment administered. It becomes necessary to calculate p(X|T) and p(V|T) (for the values and rate of worsening of the PSVs, respectively) where T in this case is the treatment value. The transformed value of the Treatment/Manouvre/Medication will be a number between 0 and 1 which represents the proportion of the maximum quantity that can be delivered for a given treatment in the event when the treatment is intended for administration in variable quantities (i.e. oxygen). In the case of a treatment for which it is delivered or is not delivered (i.e Wound cleaning and debridement), its value will be 1 or 0 respectively. The update of a PIE corresponding to a delivered treatment is always in a positive direction, in the sense that while a lesion causes a damage on the considered physiological dimensions, a treatment or a manoeuvre causes restoration of the values of the physiological values towards pre-incident values, even if they may not be completely effective. The computation of p(X|T) and of p(V|T) is a stochastic process where the randomness on the X or V variables is combined in a cause/effect relationship with a randomness on the effect of the treatment.

INPUT	Description
PIE	a-priori PIE (last available PIE)
Treatment_ID	Identification number of the administered treatment

Treatment _Value	1 in case of dichotomous values (a manoeuvre is performed=1) a value indicating the quantity of administered treatment (between a min and a max)
Output	**Description**
PIE	updated PIE

Table 4-6: The The compute_a_posteriori_given_treatment external function

Figure below shows the main relationships among the PHYSIO classes:

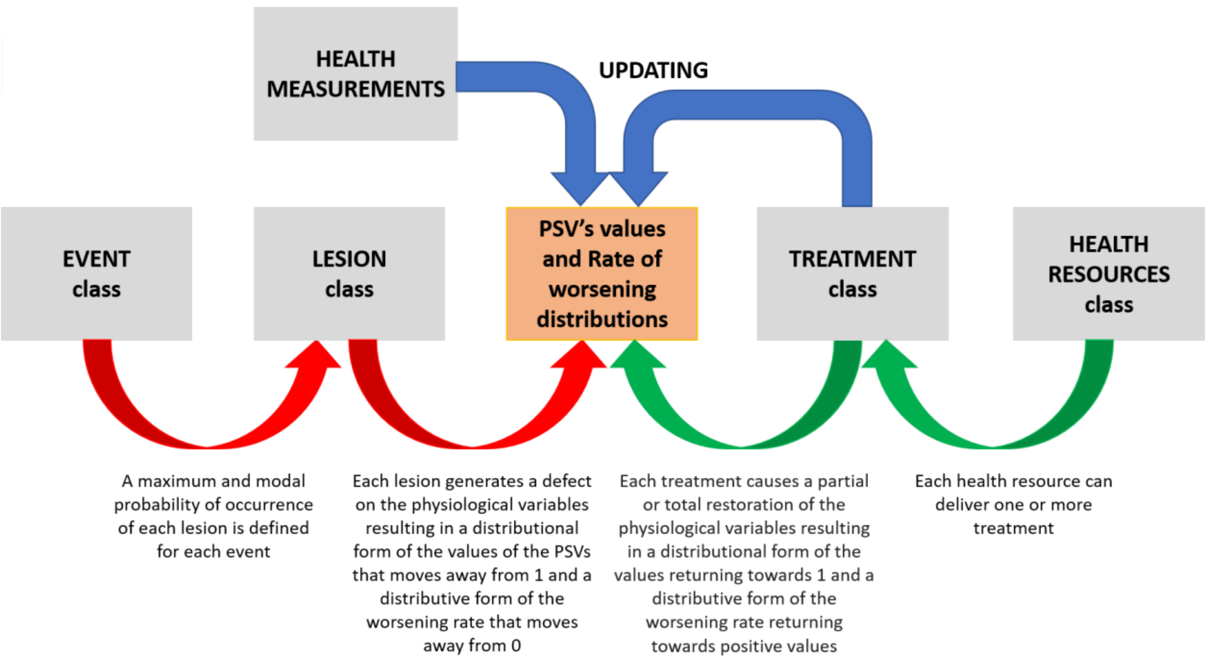

Figure 4-3: Interconnection among the PHYSIO classes

4.1.6 Physiological evolution of the PDSs

The evolution of the physiological distributional state is carried out by the PHYSIOEVO external function. It takes in input a PIE at time t and returns the modified PIE at a time $t+\Delta t$ based on an unconditioned (free) evolution and on the mathematical modelling adopted for describing improvements or worsening of the physiological variables. In this first version of the PHYSIO DSS, the evolution of the ten PSVs is hypothesized to be linear. The second version of the PHYSIO DSS will include a more sophisticated physiological modelling.

INPUT	Description
PIE	last available PIE at time t
Delta_t	Minutes from the actual time after which the updated PIE is computed
Output	**Description**
PIE	PIE containing the PDSs at time t+Delta_t

Table 4-7: The PHYSIOEVO external function

4.1.7 Victim Prioritization

4.1.7.1 Expected time to death

The ETD function computes the distribution of the expected times to death (here representing the physiologic time of death, that occurs when the victim's vital functions ceased) according to the values and rates of worsening of the physiological variables. The function takes in input a PIE and returns a distribution in terms of interval extremes with relative frequencies, as well as measures of synthesis of the distribution (mean, median, mode and standard deviation). The ETD provides a tool to support patient prioritization, helping the physician decide which health resources to assign to which victims (for example based on the expected time to death in correspondence of each possible treatment to deliver).

INPUT	Description
PIE	The last available PIE
Output	**Description**
[extremes_ETD, frequencies_ETD, central_measures_ETD, std_distr_ETD]	Empirical distribution (extremes_ETD, frequencies_ETD) of the Expected Time To Death for each victim, along with synthesis measures (central_measures_ ETD, std_distr_ ETD)

Table 4-8: The Expected Time To Death external function

4.1.7.2 Scores and algorithms of triage

With the second version of the deliverable (foreseen at M22), the component will be enriched to offer the automatic computation of relevant indices and scores for the assessment of the victim's impairment and triage. One of the computed indices is the Glasgow Coma Scale for the assessment of the impairment of the conscience level of acute medical and trauma patients in response to defined stimuli.

It was developed by Graham Teasdale and Bryan Jennett in 1974 [8]. The scale assesses patients according to three aspects of responsiveness: eye-opening, motor, and verbal responses. The total Coma Score assumes values between three and 15, three being the worst and 15 being the highest score.

EYE response	Verbal response	Motor response
No eye opening: 1	No verbal response:1	No motor response: 1
Eye opening to pain: 2	Incomprehensible sounds: 2	Abnormal extension to pain: 2
Eye opening to sound: 3	Inappropriate words: 3	Abnormal flexion to pain: 3
Eyes open spontaneously: 4	Confused: 4	Withdrawal from pain: 4
	Orientated: 5	Localizing pain:5
		Obeys commands: 6

Table 4-9: The Glascow Coma Scale

The PHYSIO DSS will provide also the implementation of algorithms for patient triage, such as the START([9] , [10]) and SORT algorithms ([11], [12]). The START algorithm (Simple Triage And Rapid Treatment) allows first responders to perform victim triage in 30 seconds or less, based on signs related to Respiration, Perfusion, and Mental Status (RPM). The SORT algorithm foresees four stages and patients are triaged according to a score. If the score is 10 or less, the victim is assigned to the red class; if the number is equal to 11, he will be placed in the yellow class; a score of 12 will assign the patient to the green class. Other triage algorithms will be evaluated after a thorough literature search and a confrontation with experts in the fields.

5 Conclusions

This deliverable details the first version of the design of the PHYSIO DSS component that will be embedded in the overall DSS. PHYSIO will support decision making in the management of victims on the basis not only of their present status, but also by looking to their possible physiological evolution over time. The description of each victim is provided in terms of ten physiological variables for which, at any time of the crisis event, the PHYSIO component provides a probability distribution which collocates the victim in the most likely points of the domain of the PSVs. While task T4.4 is responsible for the design, task T4.5 (with deliverable D4.6) provides the relative implementation of the functions and algorithms described in the present deliverable.

Annex I: References

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