



Metasystem for Modeling Emergency Departments

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Research area: High-performance computing

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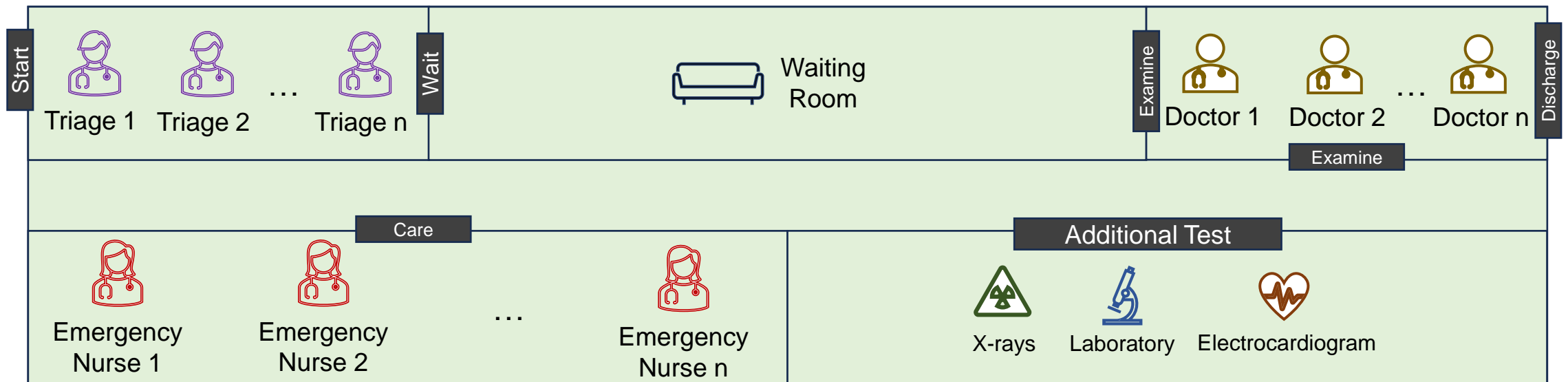
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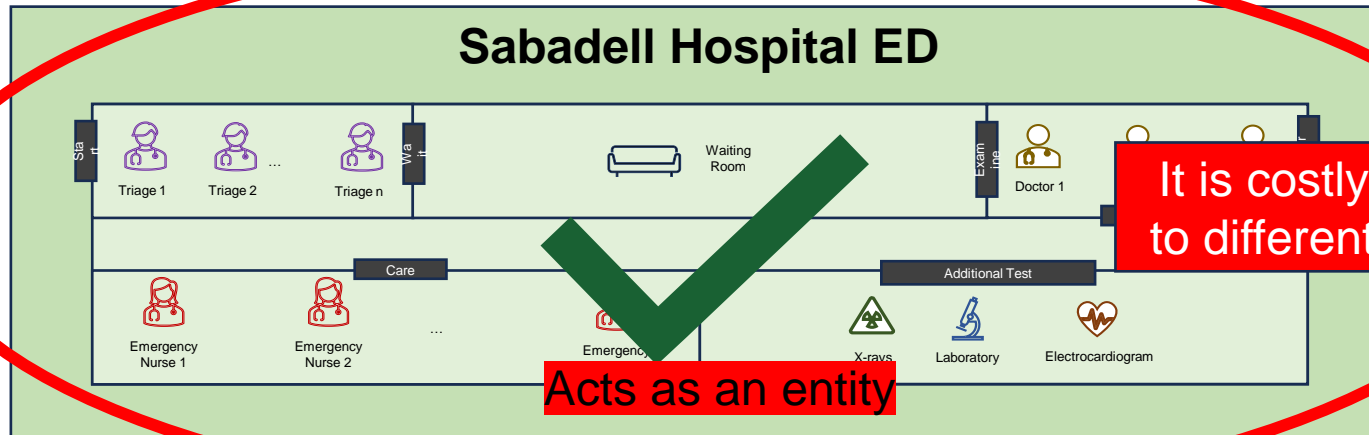
Motivation

- **Emergency Departments are complex systems;** the situation changes every day, requiring rapid adaptation.
- **Lives depend on the response.**

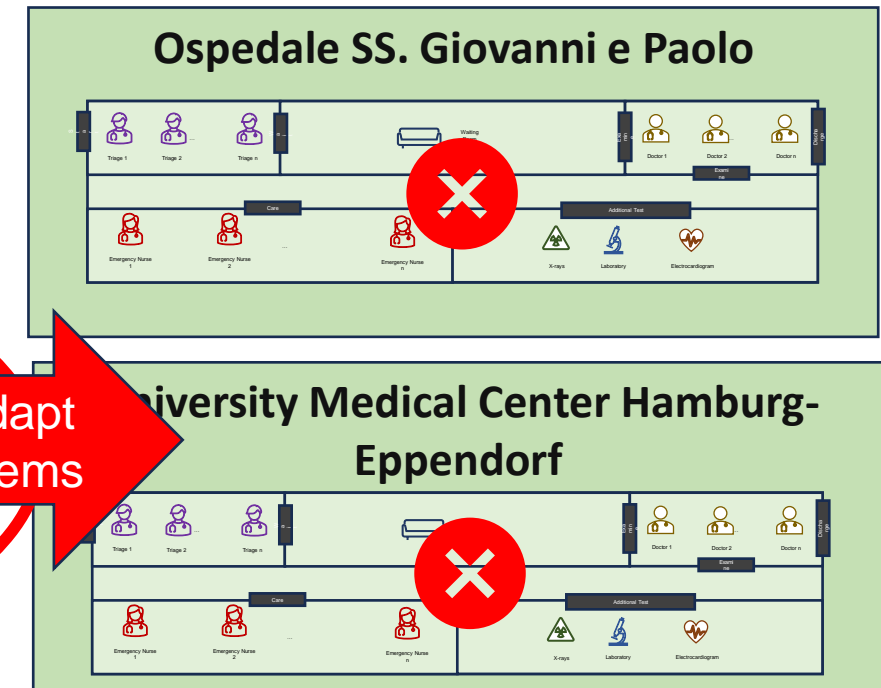


Motivation

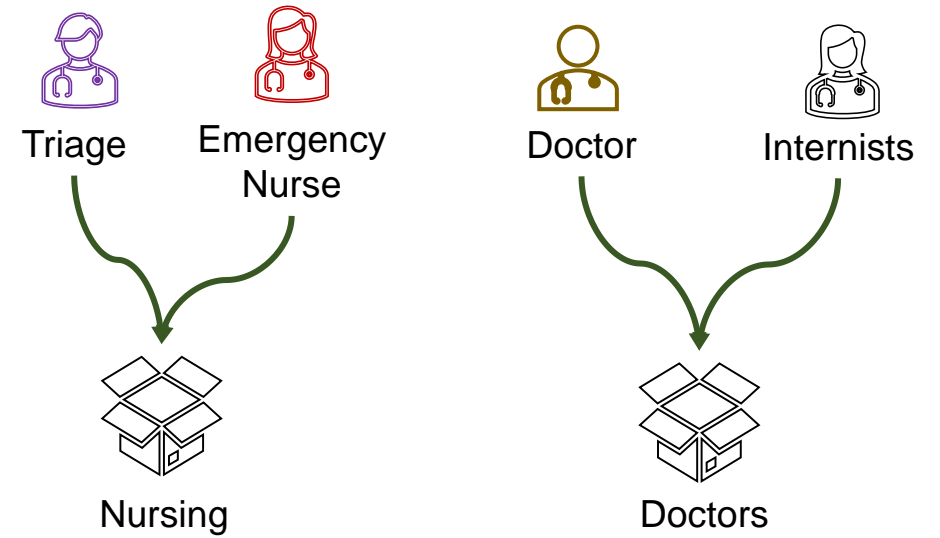
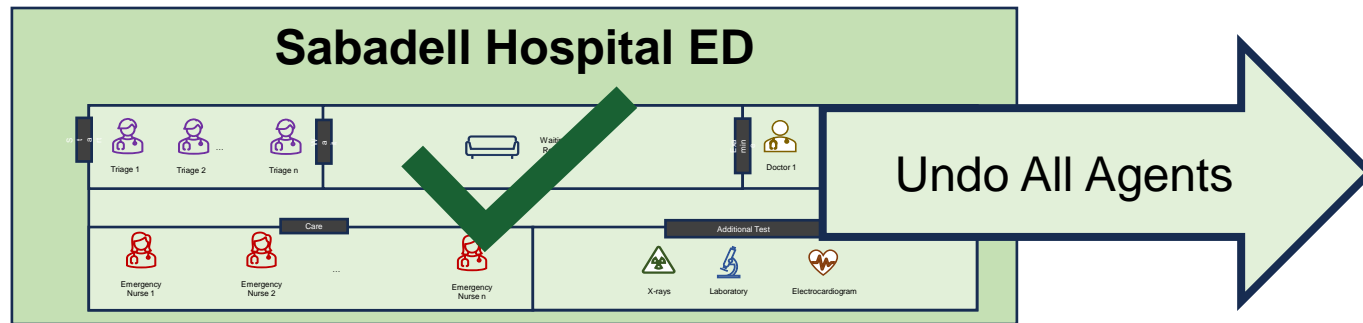
- **Emergency Departments are complex systems;** the situation changes every day, requiring rapid adaptation.
- **Lives depend on the response.**
- Management are essential!
- We have a validated simulator for this purpose.



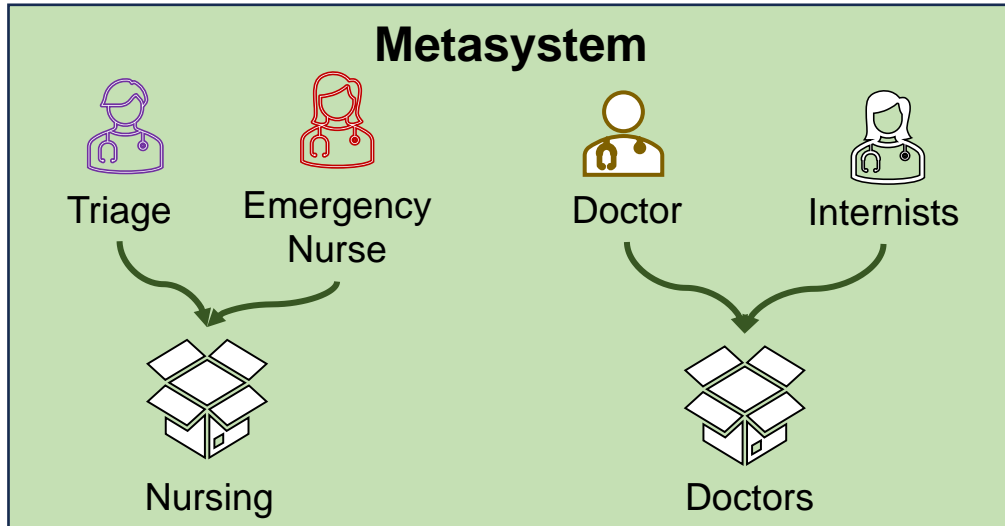
It is costly to adapt to different systems



Motivation

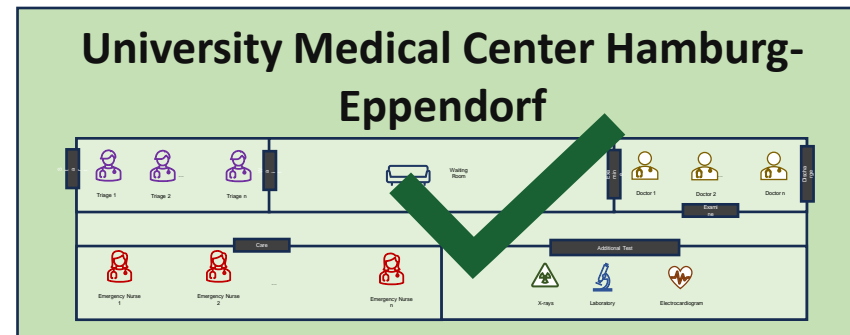
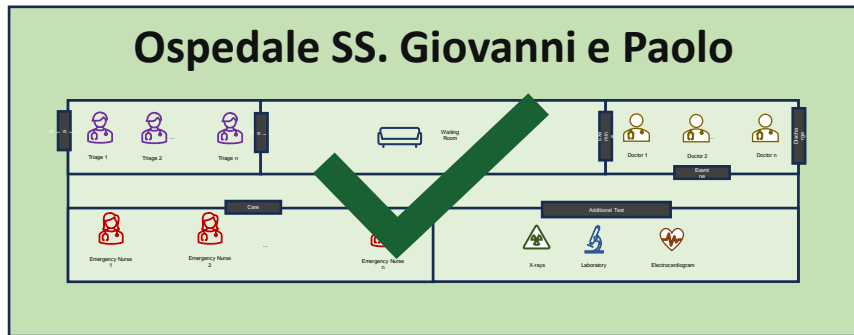


Motivation



Steps for modeling a new ED:

- **Identify** each agent and their interactions.
Not only the operation of the service.
- **Transform** the requirements into our metasystem modules
(Or create a new one)
- Create a **new model adapted**.



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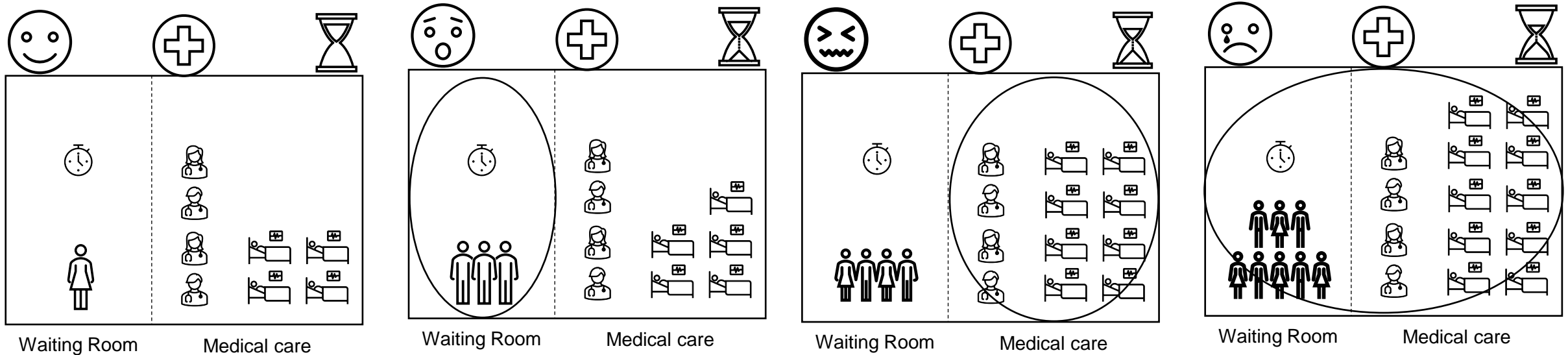
- Introduction
- Objective
- General characteristics for the Metasystem
 - Conceptual Model
 - Computational Model
 - Adaptation
- Conclusion
- Future work



Introduction

Complexity of the management in Emergency Departments (ED)

- Increase in the **demand** for an emergency care.
- **Saturation** and **complexity** are increasing.
- Fast answers needed for a **high-pressure environment**.

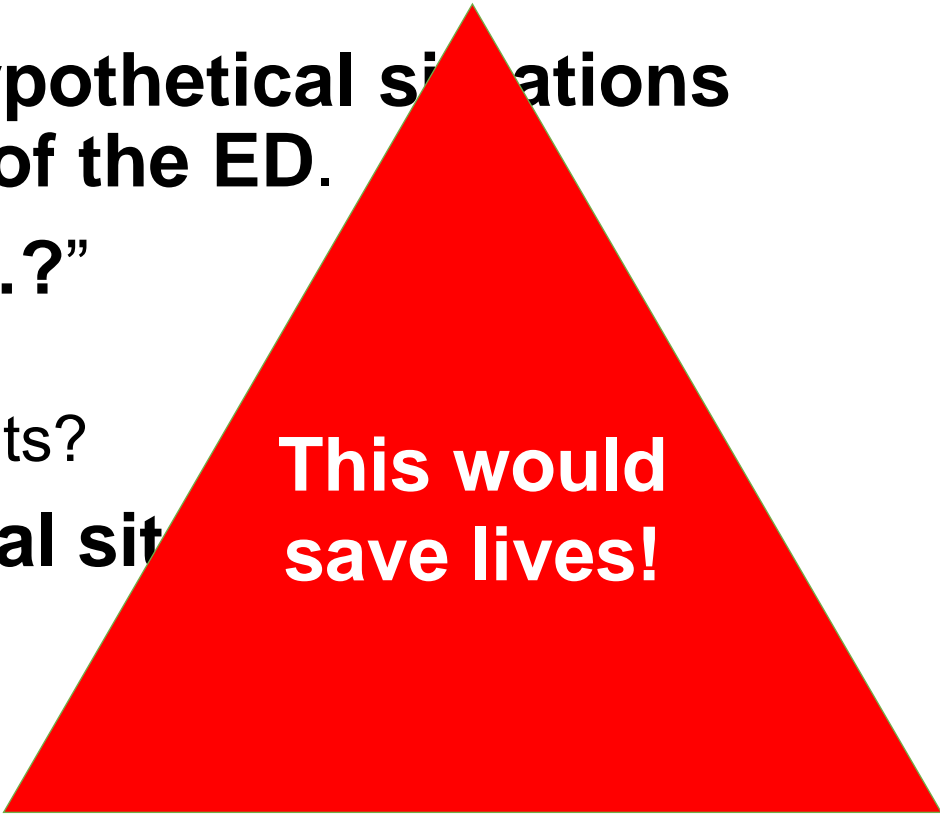


Simulation for improve the management of the ED

1. Simulation for the analysis of **hypothetical situations** allowing a better **management of the ED**.
2. Allows questions like: “**What if...?**”
 1. ¿... increase the beds?
 2. ¿... increase the number of patients?
3. Allows for the **analysis of critical situations** like:
 - Pandemic
 - Flu outbreaks

Simulation for improve the management of the ED

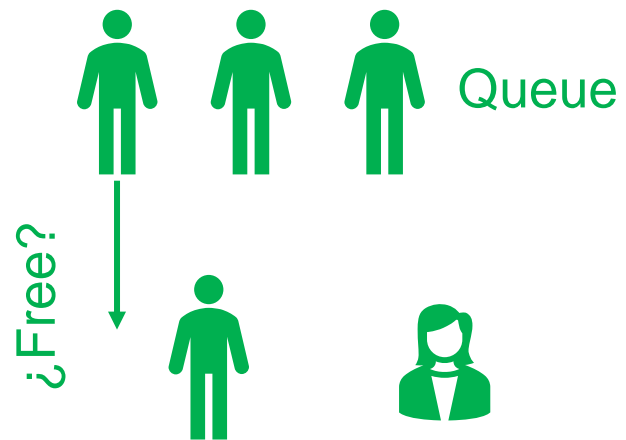
1. Simulation of hypothetical situations of management of the ED.
2. Allocation of resources "What if...?"
 1. ...
 2. ... patients?
3. Allocation of resources in critical situations
 - Pa...
 - Flu...



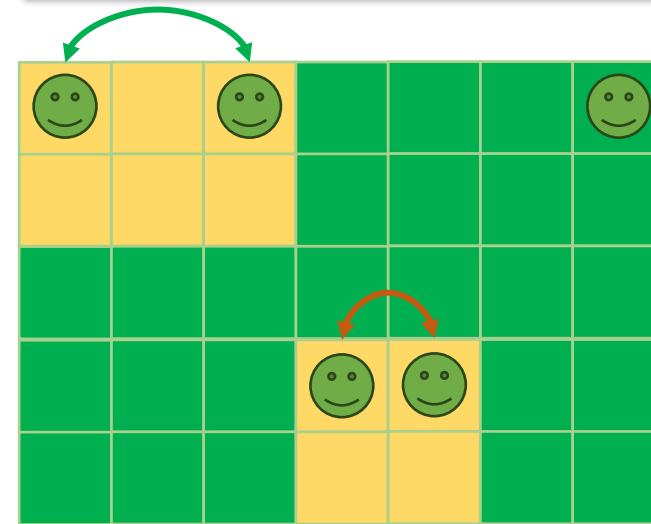
Sustainable Development Goals

Simulation strategies

Discrete-event simulation
(DES)



Agent-based modeling and
simulation
(ABMS)

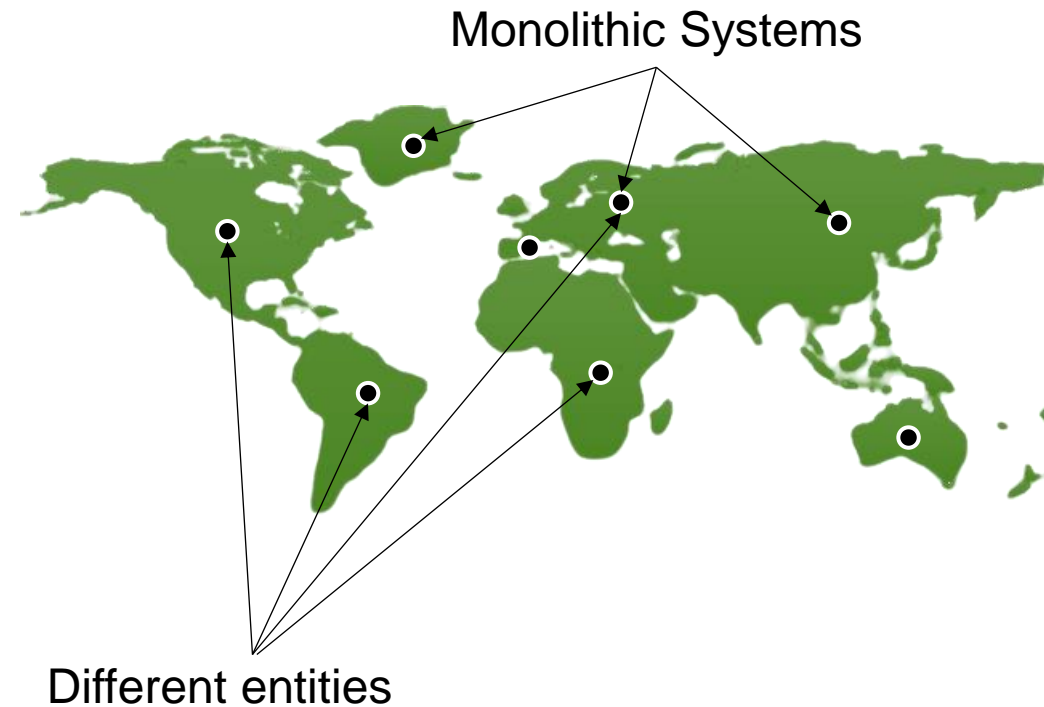


Objectives

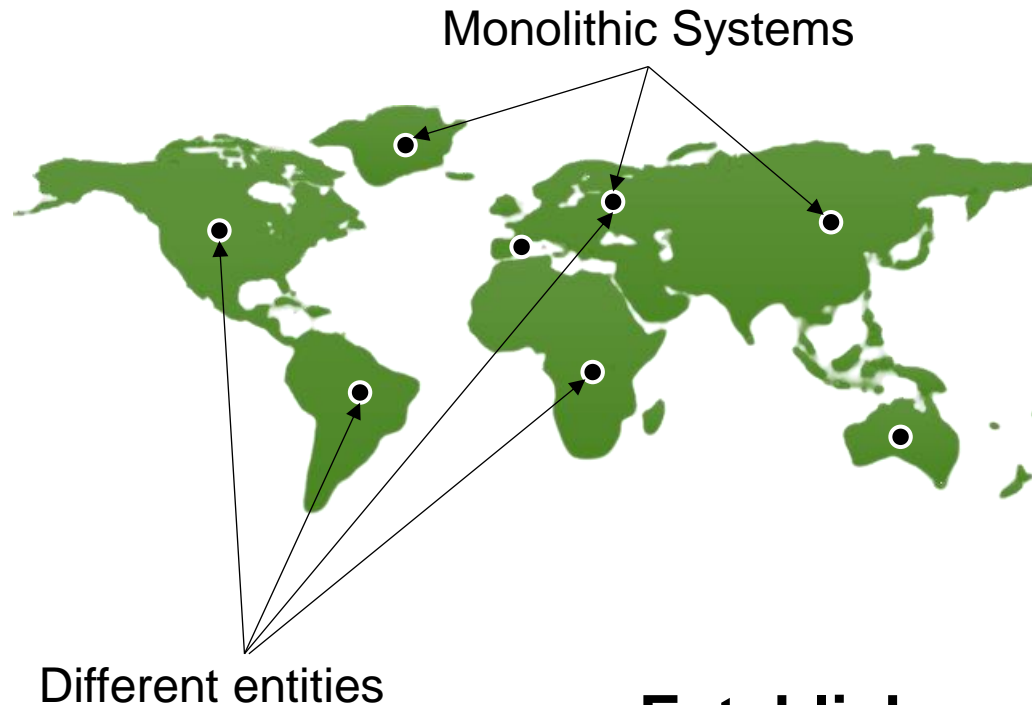
Monolithic Simulation Systems: Adaptability and cases of interest

Monolithic Systems

- Each system (ED) acts as an entity.
- Can **adapt** to different parameters in **the ED for which the model was designed**, but not to another entity with different behavior.



Monolithic Simulation Systems: Adaptability and cases of interest



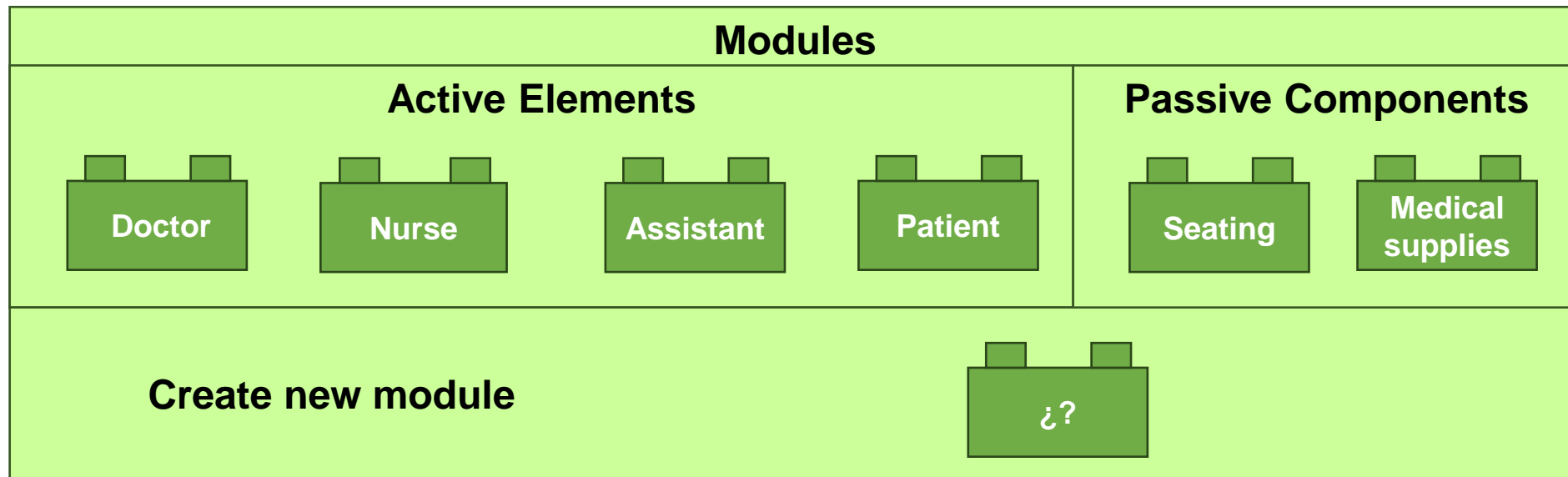
How to adapt one hospital system to another?

- To adapt the existing model to a new one
- Create a new model from scratch.

Establish a common metasystem

Proposal

- **Define modules** that have key characteristics identified by experts from ED.



Key Challenges

- **Adapt the monolithic system** to the new ED.
 - *Create a Metasystem to make it possible.*
- Enhance the capabilities of the management personnel to **make better decisions in any emergency department.**
- **Establish guidelines for data collection** to obtain **significant operational data for each agent** within hospitals.

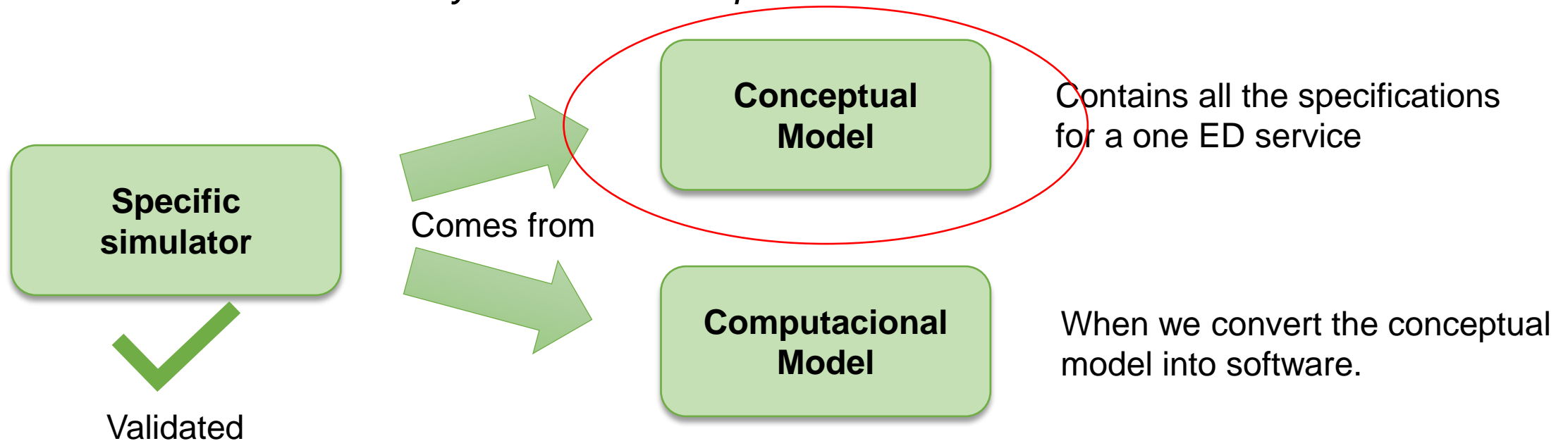
General Characteristics of the Metasystem

Extracting Modules from a Monolithic System

How can we decompose monolithic systems?

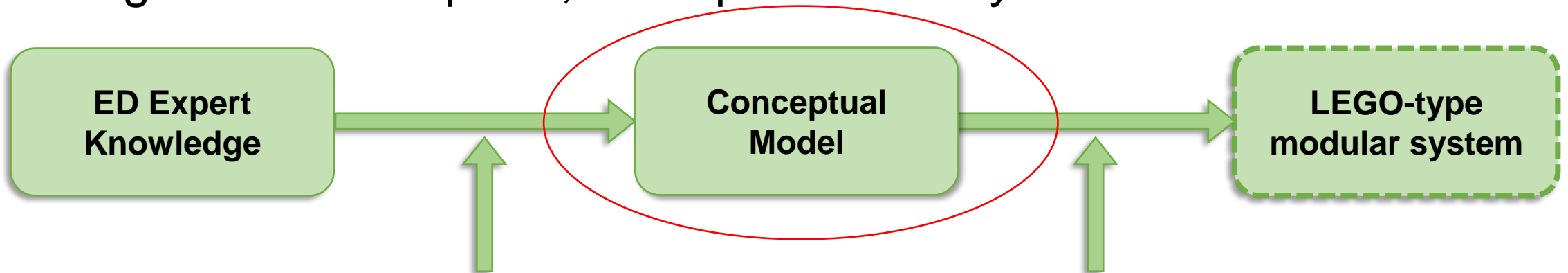
- Key Challenge

- **Adapt the monolithic system** to the new ED.
 - *Create a Metasystem to make it possible.*



Conceptual Model

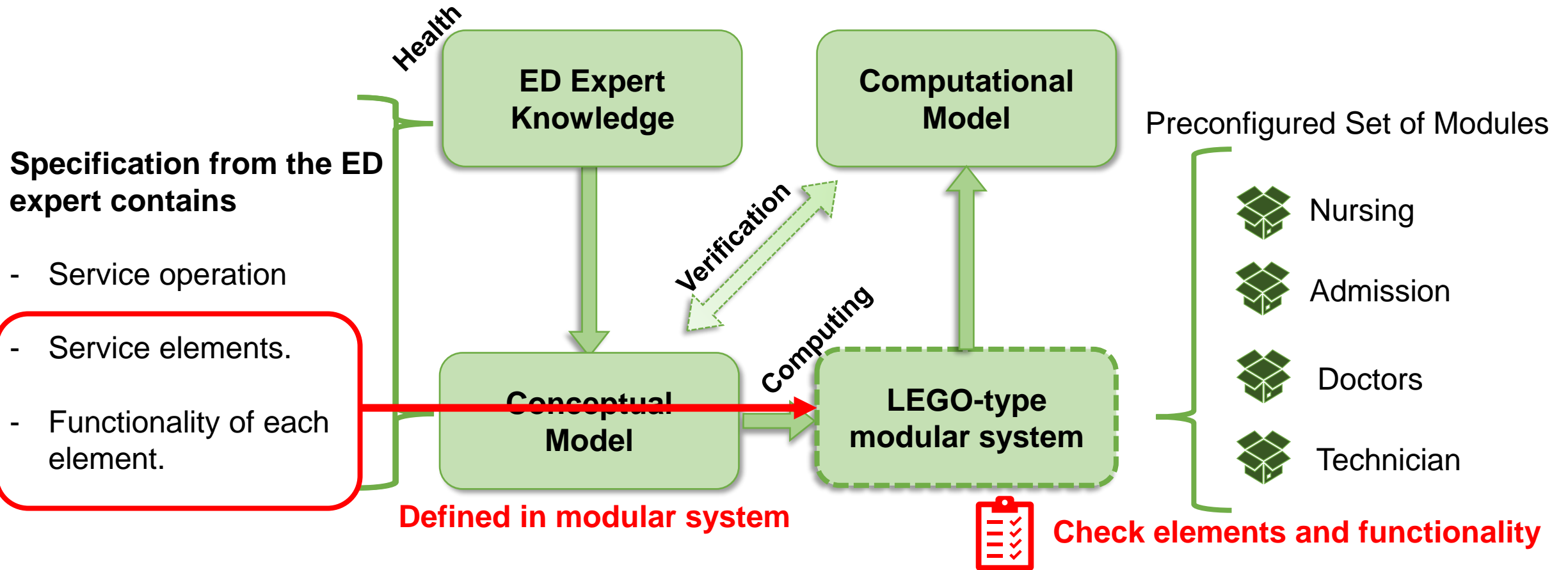
- It is based on previous research by the department, in which, together with experts, each part of the system is identified.



*What are the active elements?
What are the basic components?
How do they interact with each other?*

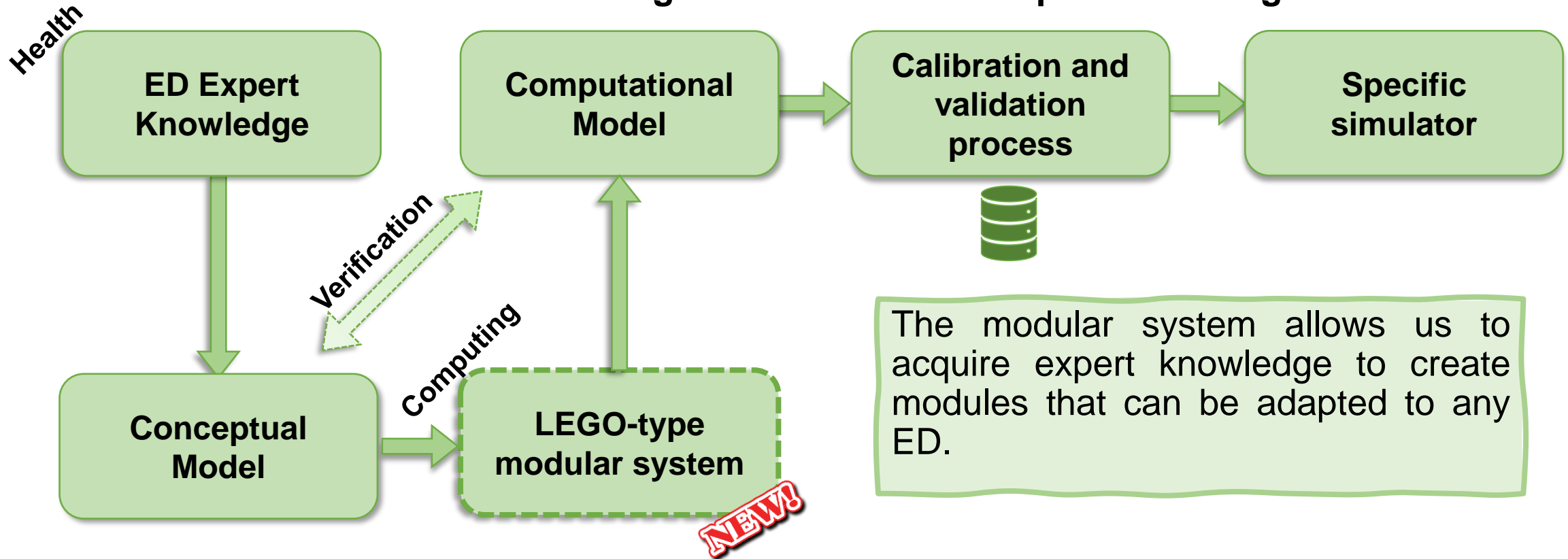
*How can we generalize these elements?
How can we allow new elements?*

From the Conceptual to the Computational Model



From computational model to simulation

Scheme for creating a simulation from expert knowledge



Delving into the metasytem

Nurse: Specialty Triage

- Time.
- Location.
- **Communication capabilities**
 - Communicates with the patient to determine their classification.
 - Communicates urgency to other medical staff.
- **Functionality**
 - Quickly checks patients to decide their priority level.

LEGO-type modular system



Nursing



Triage

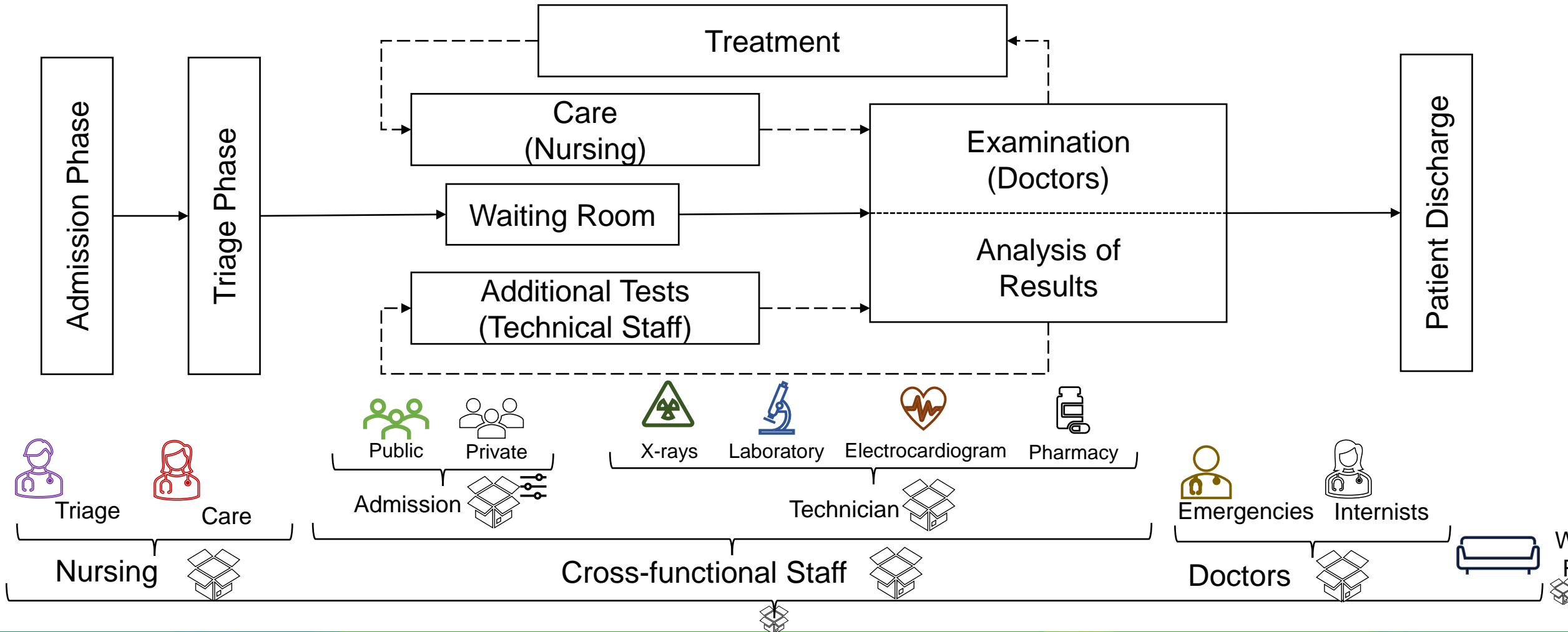


Care

Nurse: Specialty Care

- Time.
- Location.
- **Communication capabilities**
 - Coordinates with doctors.
 - Coordinates with other nurses.
 - Communicates the patient's family about care plans.
- **Functionality**
 - Administers treatment.
 - Monitors patient progress.
 - Adjusts care plans as needed.

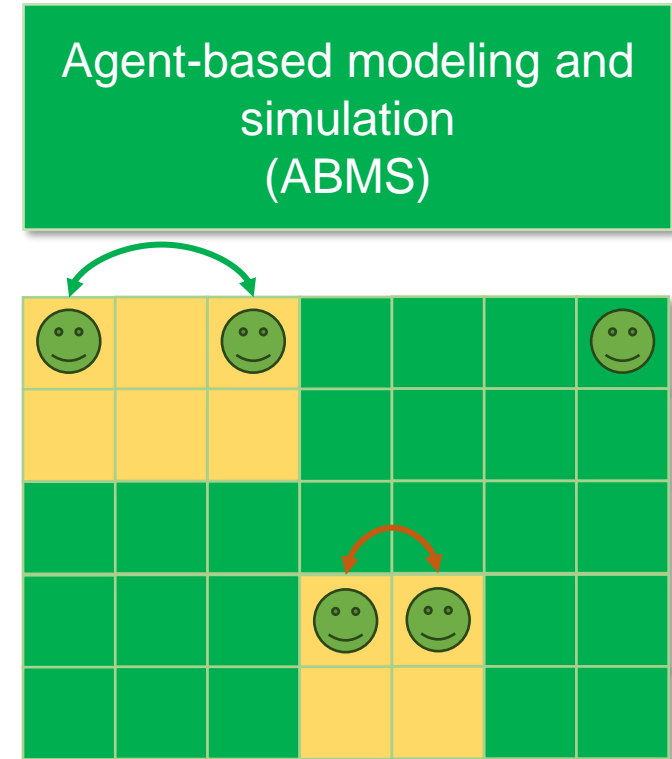
Example of use – Patients 4 and 5



Conclusions

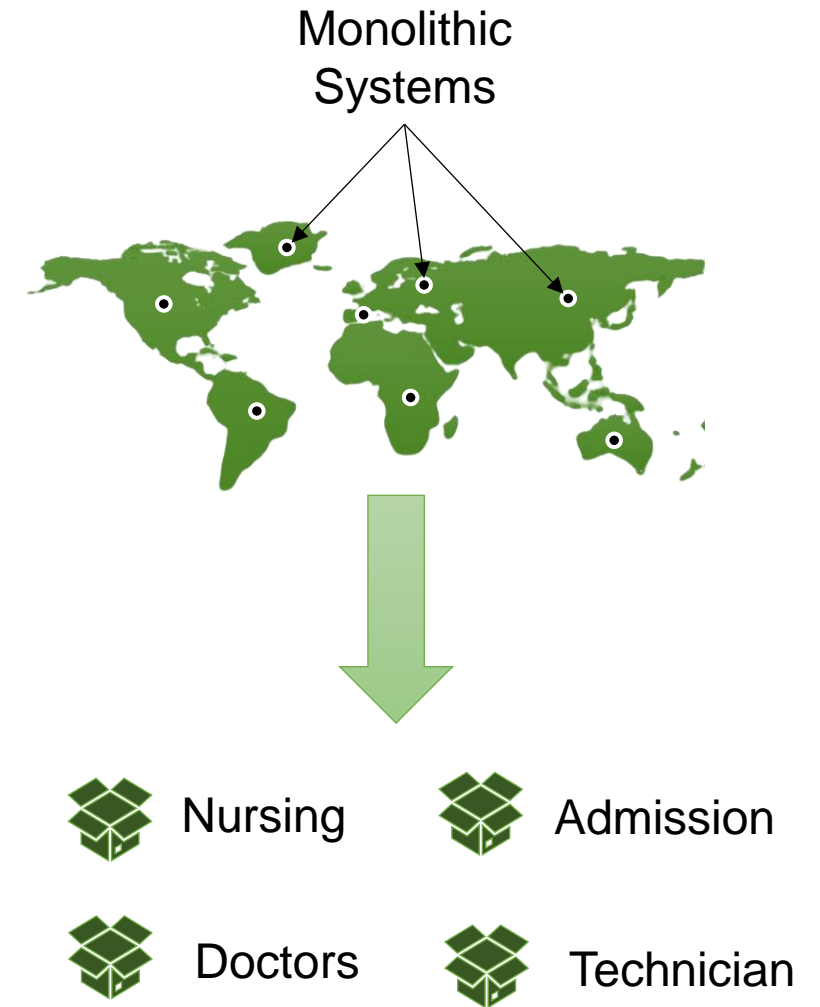
Conclusions

- The **ABMS** allows this **individual analysis** to be performed on each element that interacts in the system.
- It is possible to **transform current monolithic systems** into **modular systems**.



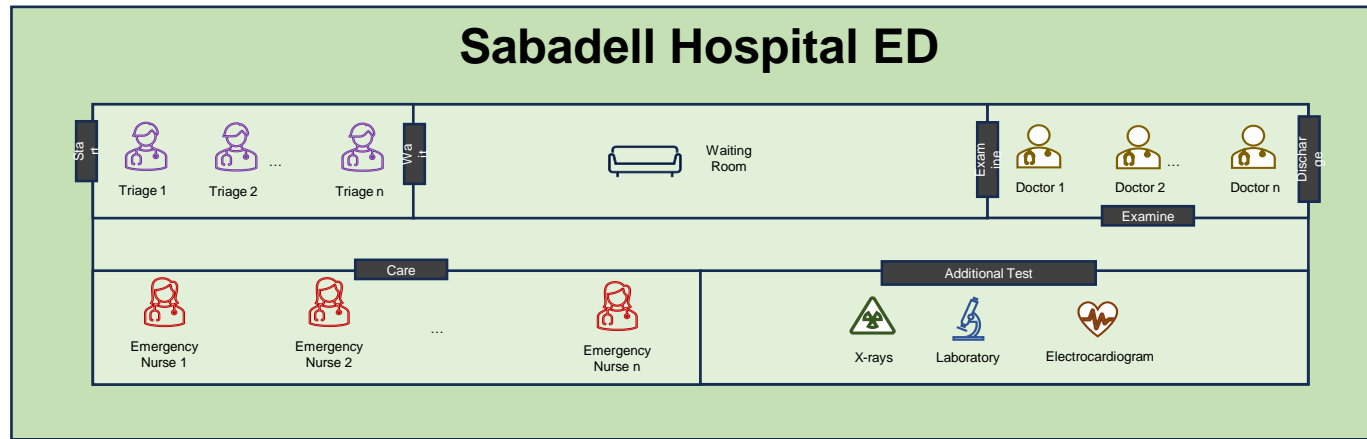
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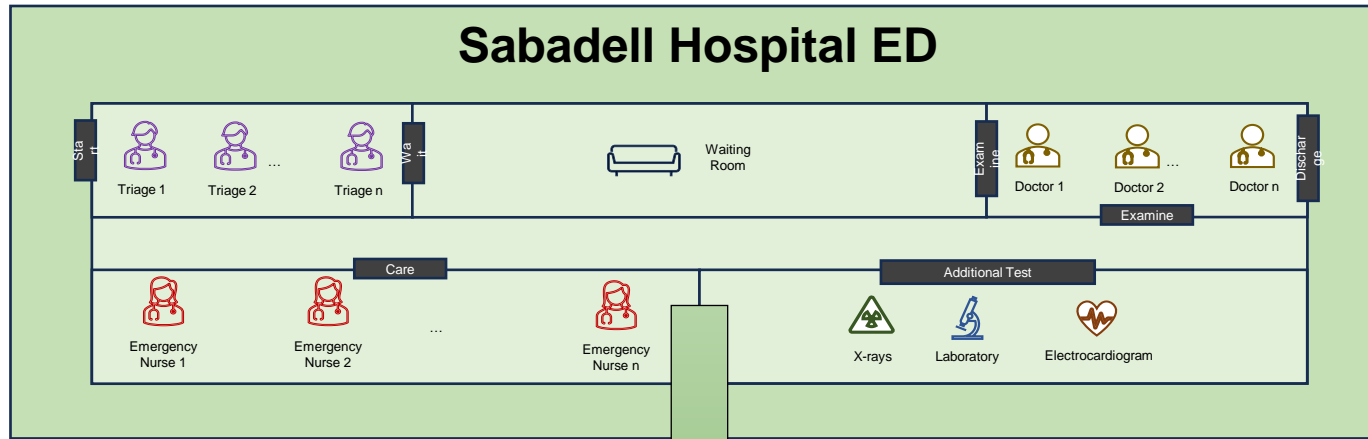
Future Work

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Validated ED Simulator

Future Work




Validated ED Simulator

Decompose the different current agents.



With

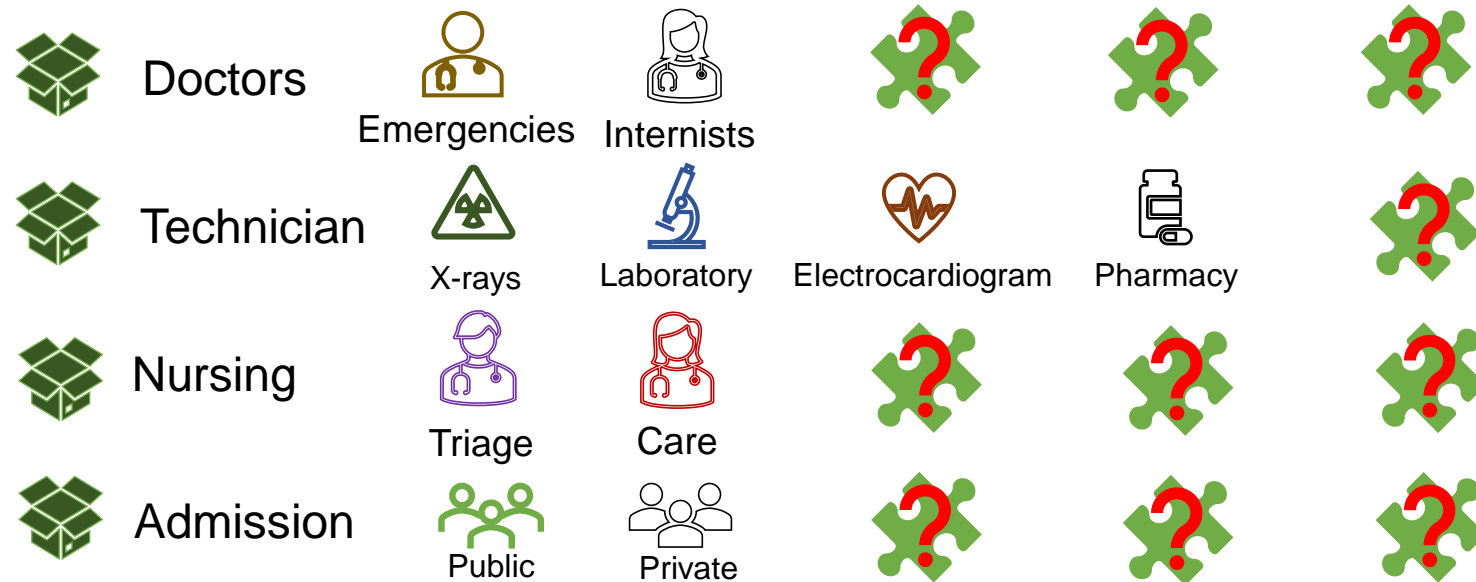
Communication capabilities

Functionality

Future Work

Decompose the different current agents.

Complete design of the modules from others ED.



With their:

Communication capabilities

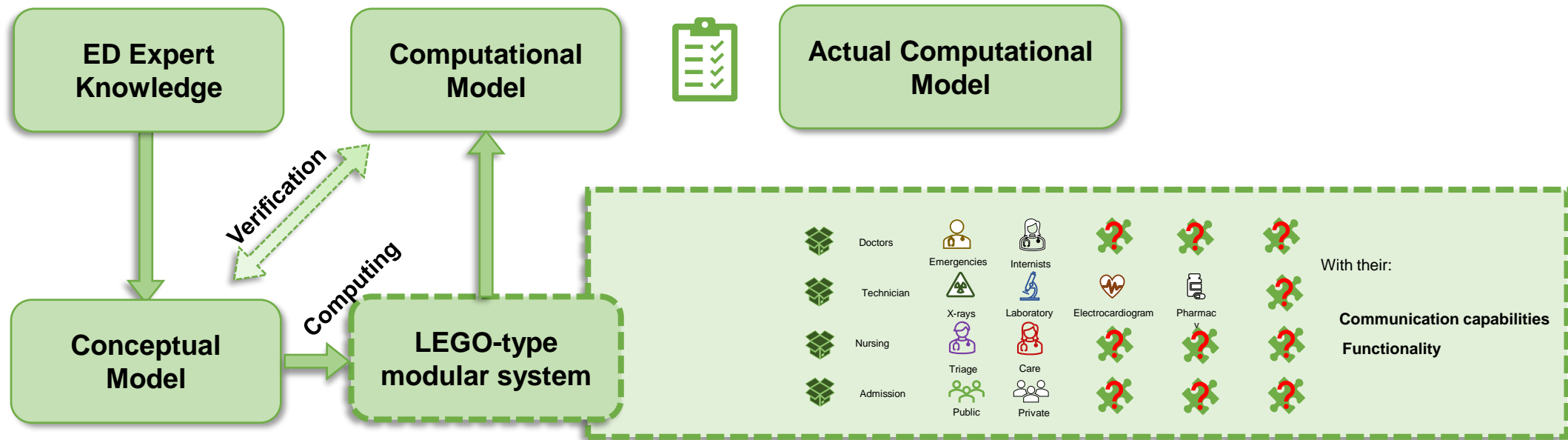
Functionality

Future Work

Decompose the different current agents.

Complete design of the modules from others ED.

Validation of the metasystem by comparing it with the existing validated model.



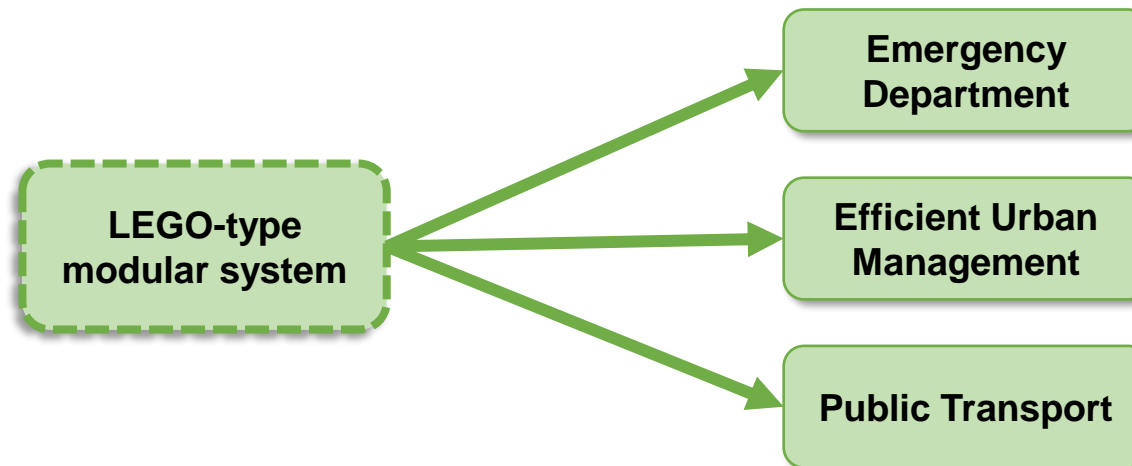
Future Work

Decompose the different current agents.

Complete design of the modules from others ED.

Validation of the metasystem by comparing it with the existing validated model.

Capability to have a modular system for other systems, efficiently adding modules.





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