Estudios de Ingeniería en Informática

SUBJECT:	**SIMULACIÓN (M0.500)**		
PAC Num.:	**2**		
Date of proposal:	**19/12/2022**	**Date of delivery:**	**≤ 31/01/2023**
Observations:	• The answers will be on this document, keep the original text and take care on the final **presentation**. • It is needed to **justify** all the answers. • The name of the file must be **Surname1_Surname2_Name.RTF** (o .DOCX o .PDF)		
Evaluation:	All the exercices indicates its weith.		

EXERCICES

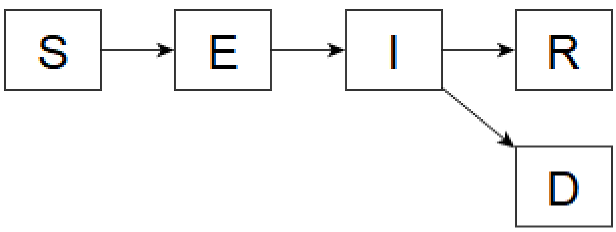
This is the practical of this course. Select **ONE** of the two proposed exercises.

FIRST proposal: The COVID-19 pandemic.

We want to analyze and reproduce the current pandemic spread in a CCAA of Spain or a country. To do so first we will obtain information regarding the number of cases. One can access generally: https://ourworldindata.org/coronavirus or https://srv1.worldometers.info/coronavirus/
Also, to the local Open Data sources of the selected country or CCAA.

We will be focused on the analysis of the "new cases" variable, understanding that hospitalizations and deaths can be inferred from this value considering, among others, the vaccination level of the population, the age pyramid, and the health system infrastructure of the country.

Develop a model that allows represents the propagation of the Sars-CoV-2 in a specific geographical area. You can start reviewing the information at https://pand.sdlps.com (the pandemic digital twin for Catalonia).
The model will be based on a SEIRD model where the population moves from one state (buffer) to another, Susceptible, Exposed, Infective, Death, and Recovered.



The equations that rule the model behavior are

$$S' = \frac{-\beta S I}{N} \quad (1)$$

$$E' = \frac{\beta S I}{N} - \alpha E \quad (2)$$

$$I' = \alpha E - \gamma I \quad (3)$$

$$R' = \gamma (1 - \mu) I \quad (4)$$

$$D' = \gamma \mu I \quad (5)$$

$$N = S + E + I + R + D \quad (6)$$

The usual approach implies using an entity to represent the time (usually with $\Delta_t = day$) and modify the values for the "buffers". The latency rate (α) and recovery rate (γ) parameters will be considered constant, and N will be the total population, assuming that there is no pre-existing level of immunization to SARS-CoV-2 and that therefore the whole population is initially susceptible ($S_0 = N$). Hence every day we recalculate the number of people that exist in each buffer.

In a discrete simulation, one can also consider another approach. Working with a finite population (entities) that are in a specific state (SEIRD) that due to the interaction spread the virus, moving the entities from one state to another.

We can apply a combination of both approaches.

SECOND proposal: The hospital.

A hospital, that is open 24 hours, is providing service for **planned** visits and **urgent** visits.
The urgent visit arrivals follow an exponential distribution of 10 minutes, while the planned visits follow a constant distribution of 20 minutes.
There are two types of doctors, those that are in the urgent service and those who are in the planned visits service. The time needed to attend to the patients is about 10 minutes following an exponential distribution. The planned visits last from 10:00 to 20:00,

We are analyzing the behavior of the hospital in two situations:

1) A saturation scenario due to the increase in the number of visits. Consider an increase in the number of patients proportional to the number of urgent visits we have in the base scenario.
2) A saturation scenario due to the increase in the number of medical leave of health personnel.

We want to test the robustness of the system to understand at what level this saturation will cause disfunction in the hospital. To do so first analyze the number of doctors needed to support the stationary process, then from this baseline, do the analysis.

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Questions

Q1 (20%). Define clearly the goals of the analysis, explain why you will develop the model, and prepare the Validation and Verification process you will follow.

Q2 (30%). Develop a conceptual model of the proposed system. Define the hypotheses you use, and simplify the model if needed. The goal is to analyze the status of the hospital. We want to optimize the number of doctors in all the services to provide a good service. What if the doctors can provide service to any patient?

Note: the information provided in the system description may be incomplete, use hypotheses.

Q3 (50%). Use SIMIO to code the model. Prepare an experiment and analyze the results obtained.