IMMC-SPAIN: AN OPPORTUNITY TO INTRODUCE MATHEMATICAL MODELLING IN THE CLASSROOMS

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Outline

- Mathematical modelling in Spanish education programs
- IMMC-Spain: how it started and how we organise the national contest
- IMMC-Spain: results from the last 4 years
- Teacher training on modelling
- Creating an opportunity to bring modelling into the classroom

Mathematical modelling in Spanish programs

- In the last year, a new syllabus has been designed for primary and secondary education.
- Modelling appears explicitly in the educational programs are applicable in Spain from last September.
- Despite this, Cabassut and Ferrando's (2017) research shows that teachers have difficulties in bringing modelling tasks into the classroom. The greatest difficulties stem from lack of resources, time and training.

IMMC-Spain

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- Manel Sol Puig, Grup Vilatzara
- Salvador Guerrero Hidalgo, Presidente Sociedad THALES
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Institutional support…  It is SCARCE!!

No financial funding!

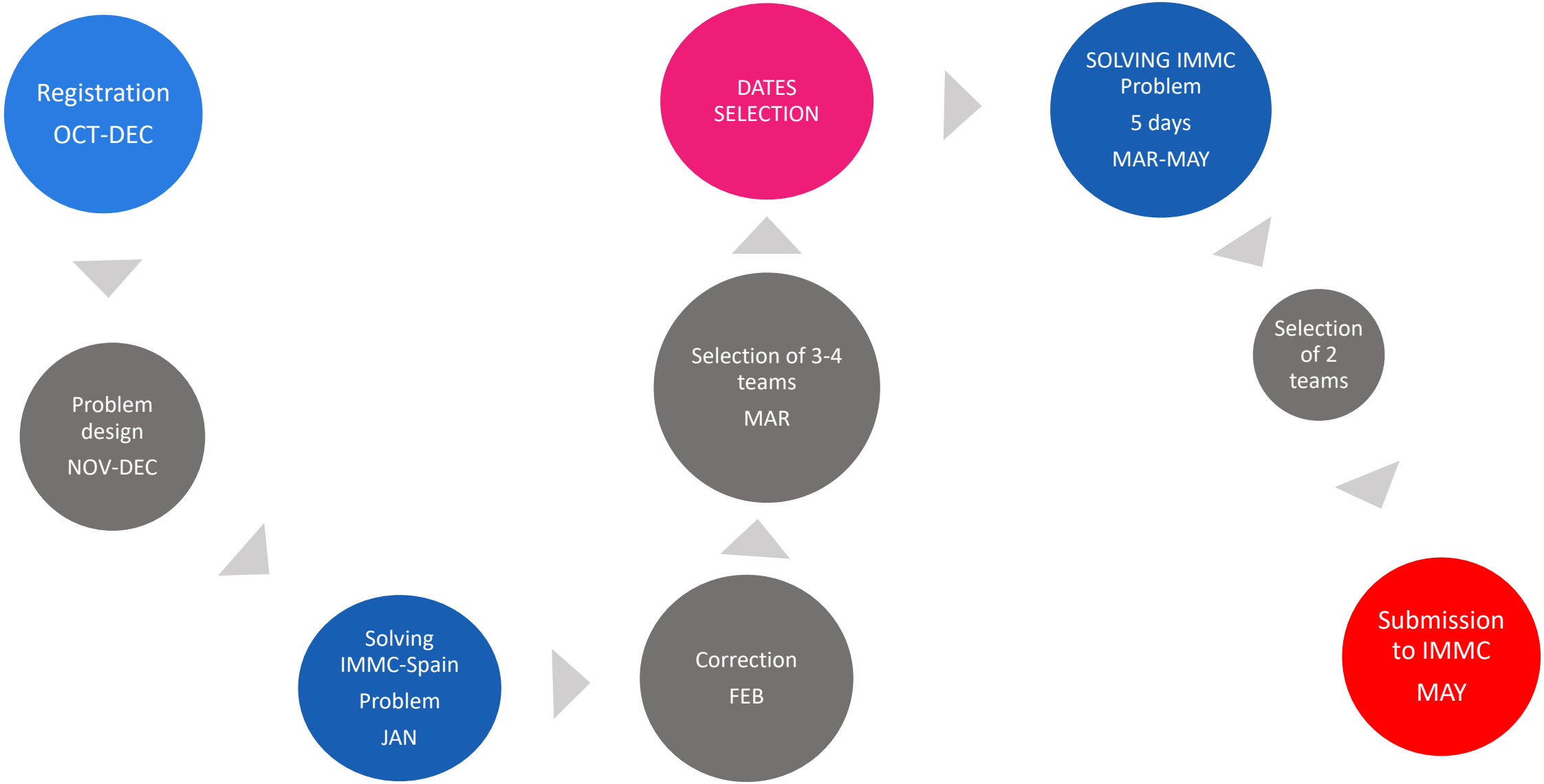
We have only received support for the web platform (Universitat de València) and for dissemination.

VNIVERSITAT DE VALÈNCIA

Real Sociedad Matemática Española

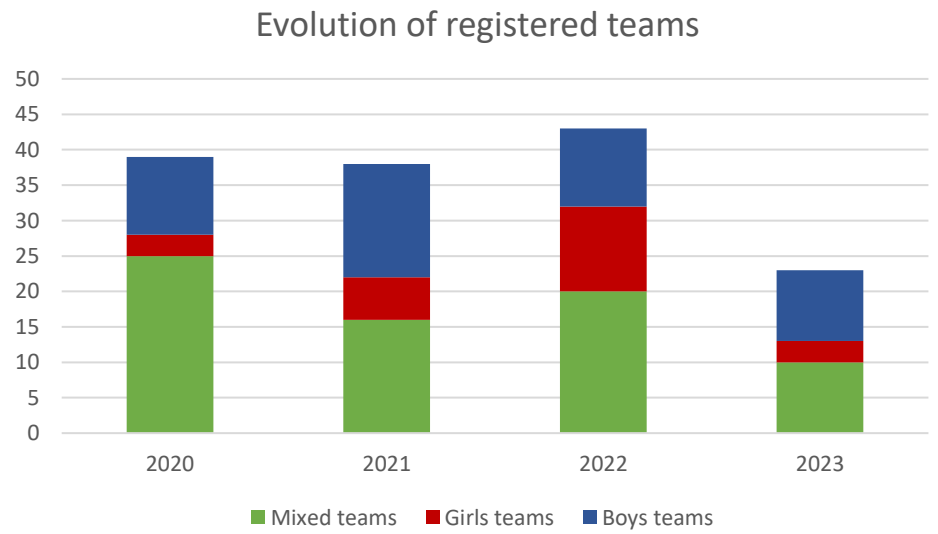
Federación Española de Sociedades de Profesores de Matemáticas

HOW WE ORGANIZE IMMC-Spain?



Registration in the last years

	TEAMS	REGISTERED PARTICIPANTS	GIRLS %	BOYS %
2019-20	39	154	34%	66%
2020-21	35	133	36%	64%
2021-22	43	160	48%	52%
2022-23	23	84	36%	64%



IMMC-Spain problems: how we design the task?

- Realistic
- Open-ended
- Involving different mathematical contents
- Accesible for students from grade 9 to 12
- Related to students interest
- Related to social issues

Rules & Recommendations



Cooperative work

None external help



20-pages report

Clarity & organisation



Accuracy

Reflection

IMMC-Spain: how we review and score solution proposals?



1st ROUND

Proposals not meeting the minimum quality standards were discarded. We made sure that the proposal was understandable, that the assumptions were well justified and that the solution was clear.



2nd ROUND

each pre-selected production is reviewed by (at least) 2 reviewers on the basis of a **correction rubric.**

Correction rubric

Formal aspects

- Abstract — 10 pts
- Format & Clarity — 10 pts

Modelling

- Problem definition — 20 pts
- Mathemati-sation — 30 pts
- Validation — 15 pts

Reflection

- Strenghts & weaknesses — 5 pts
- Solution — 10 pts

2019-20 IMMC-Spain problem *"Best city to live in"*

Which city is the best place to live?

If we had to choose which city is the best to live in, we would certainly have to consider different factors when making our decision. The entertainment and cultural offer, green areas and sports facilities, health and education infrastructures, transport, public safety may be elements to consider, but also others, such as the cost of housing or services.

We propose that you develop an algorithm that allows you to decide which is the best city to live in. This algorithm should include the factors that you consider relevant (including those mentioned above and others that you add) when making this decision.

Therefore, once it has been designed, you should test it in at least three situations:

(a) Case 1: Make a comparison between at least 10 Spanish cities.
(b) Case 2: Make a comparison between at least 10 European cities.
(c) Case 3: Comparing at least 10 cities worldwide.

In these cases, the algorithm should allow us to establish a unique score for each city and a ranking from which we can make the final decision.

The solution report should contain a detailed explanation of the algorithm and its practical application in the three cases described.

Some extracts from students solutions

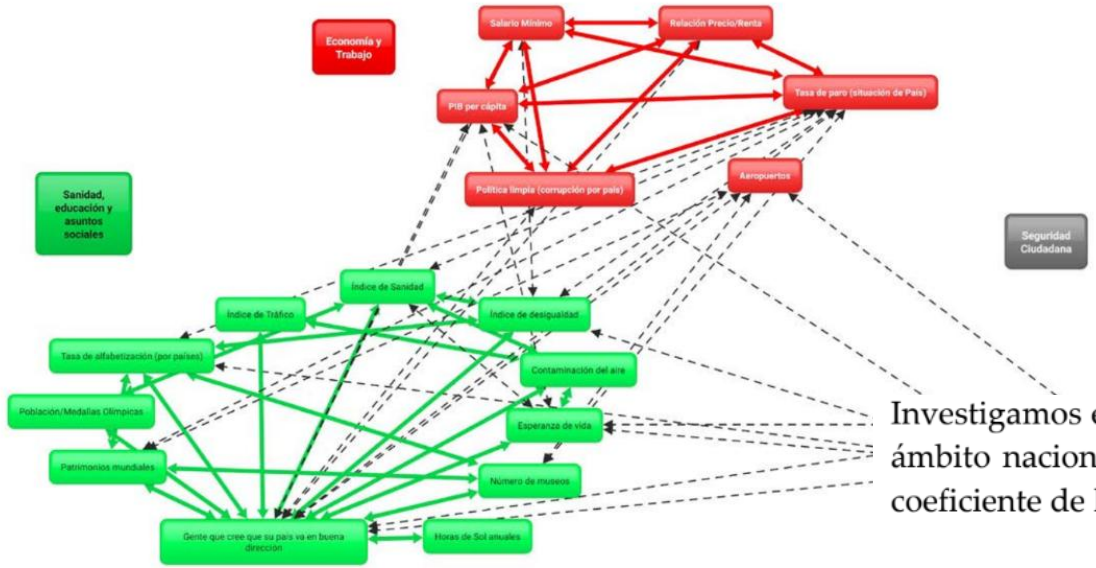


Gráfico 4. Conexiones de los grafos asociados a los indicadores de las ciudades en e

Investigamos el valor máximo y mínimo de los indicadores según el conjunto de ciudades de cada ámbito nacional, europeo o mundial. Seleccionamos 10 ciudades de cada ámbito y calculamos el coeficiente de los indicadores en esas 10 ciudades. En primer lugar, según una **interpolacion lineal**:

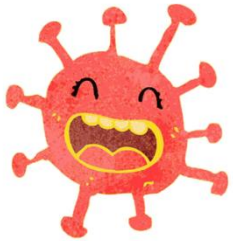
$$coeficiente\ del\ indicador\ para\ una\ ciudad = \frac{indicador_{ciudad} - indicador_{mínimo}}{indicador_{máximo} - indicador_{mínimo}}$$

Sobre este ajuste lineal fuimos **modificando los valores de los porcentajes de cada bloque y/o los pesos relativos de cada indicador**, para mostrar los resultados del ranking con ayuda de un algorimo en **EXCEL** y en **Python,** y representado gráficamente con **Geogebra**. **Comparamos los resultados**

Participation results in 2019-20

- We received the solution of 16 teams (41% of registered teams)
- We finally selected 3 teams that were invited to solve the problem posed in the international phase.
- MARCH –APRIL 2020: Confinement due to the global pandemic forced us all to stay at home, although for many it was a nuisance, for the student teams it was an OPPORTUNITY!!!

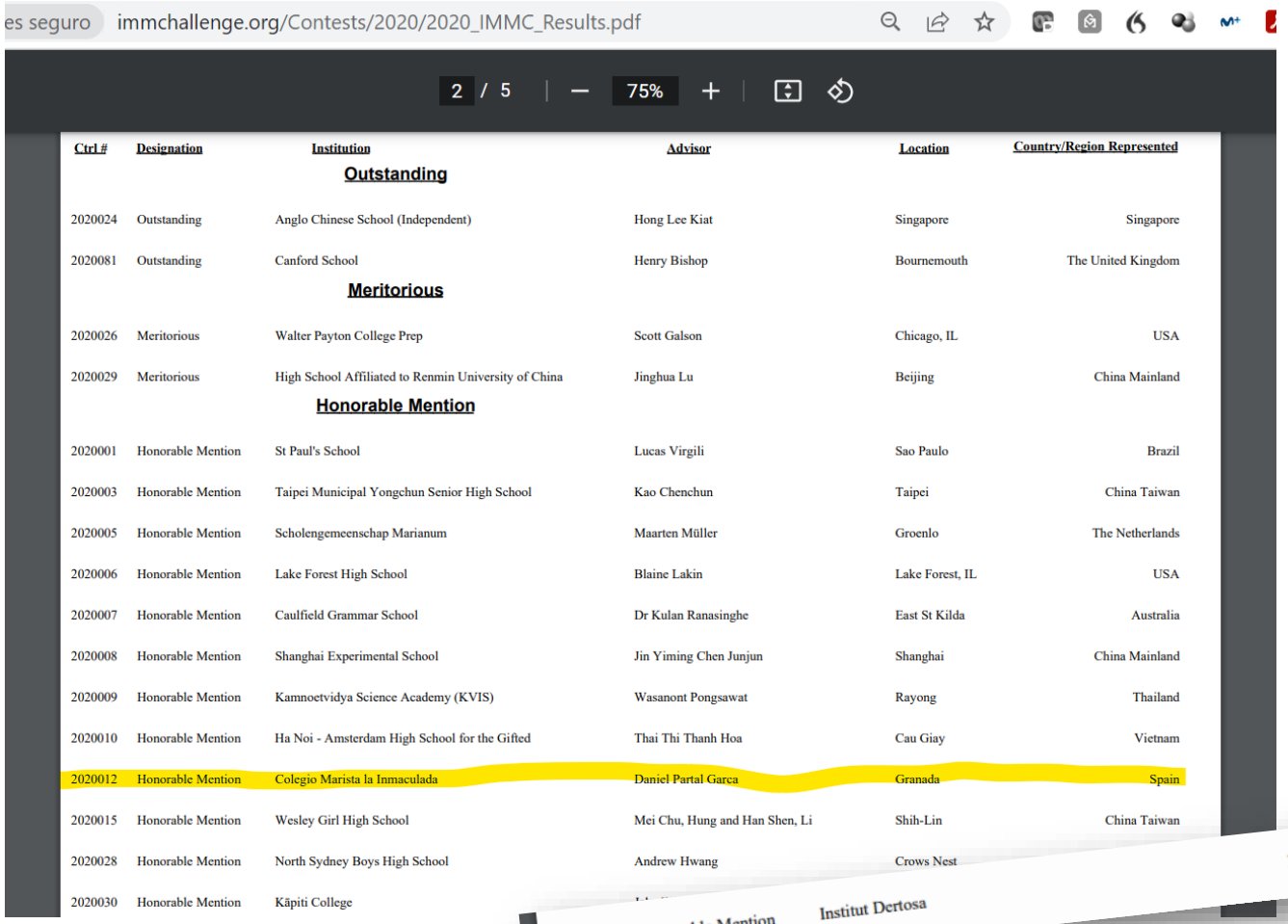
For the solvers, who at the time could not leave the house, it was very stimulating (and curious) to face a problem in which they had to organise the products in a shop in order to avoid material damage during compulsive shopping by the consumerist hordes.



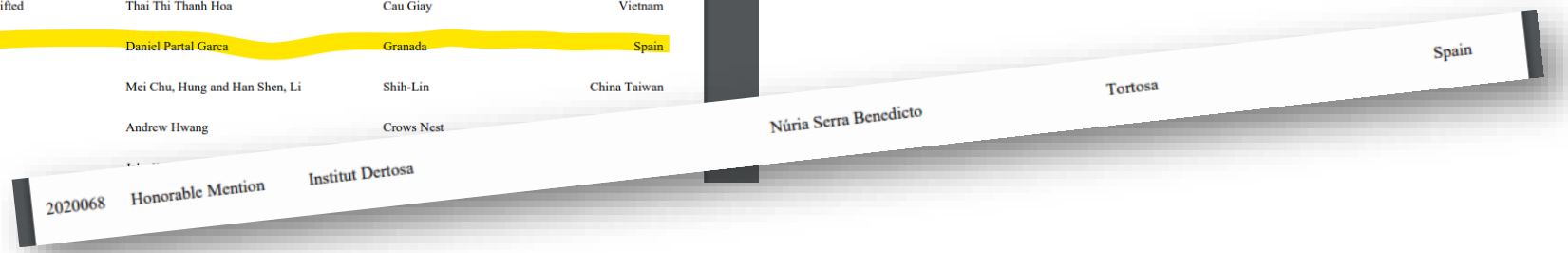
2020 IM^{2}C
Problem: Flash Sale



Great success in the first participation on International contest ☺



Ctrl #	Designation	Institution	Advisor	Location	Country/Region Represented
		Outstanding			
2020024	Outstanding	Anglo Chinese School (Independent)	Hong Lee Kiat	Singapore	Singapore
2020081	Outstanding	Canford School	Henry Bishop	Bournemouth	The United Kingdom
		Meritorious			
2020026	Meritorious	Walter Payton College Prep	Scott Galson	Chicago, IL	USA
2020029	Meritorious	High School Affiliated to Renmin University of China	Jinghua Lu	Beijing	China Mainland
		Honorable Mention			
2020001	Honorable Mention	St Paul's School	Lucas Virgili	Sao Paulo	Brazil
2020003	Honorable Mention	Taipei Municipal Yongchun Senior High School	Kao Chenchun	Taipei	China Taiwan
2020005	Honorable Mention	Scholengemeenschap Marianum	Maarten Müller	Groenlo	The Netherlands
2020006	Honorable Mention	Lake Forest High School	Blaine Lakin	Lake Forest, IL	USA
2020007	Honorable Mention	Caulfield Grammar School	Dr Kulan Ranasinghe	East St Kilda	Australia
2020008	Honorable Mention	Shanghai Experimental School	Jin Yiming Chen Junjun	Shanghai	China Mainland
2020009	Honorable Mention	Kamnoetvidya Science Academy (KVIS)	Wasanont Pongsawat	Rayong	Thailand
2020010	Honorable Mention	Ha Noi - Amsterdam High School for the Gifted	Thai Thi Thanh Hoa	Cau Giay	Vietnam
2020012	Honorable Mention	Colegio Marista la Inmaculada	Daniel Partal Garca	Granada	Spain
2020015	Honorable Mention	Wesley Girl High School	Mei Chu, Hung and Han Shen, Li	Shih-Lin	China Taiwan
2020028	Honorable Mention	North Sydney Boys High School	Andrew Hwang	Crows Nest	
2020030	Honorable Mention	Kāpiti College			



The Spanish teams ranked very well, both got an **honorable mention**, the team of students from a school in Granada was the third best ranked team in Europe, a great success!

2020-21 IMMC-Spain problem

Vaccination against COVID-19

Vaccination against COVID-19

The year 2020 has been truly horrific, the COVID-19 pandemic is sure to mark us for a long time to come. Our lives have been disrupted, many have been infected with the virus and some, too many, have died. Society as a whole has been strained by the challenges it has been facing. The ways in which we work, relate to each other, consume, spend our leisure time, etc., have been altered. The health authorities are giving guidelines on how to act in order to control the spread of the pandemic. When we began to prepare the problem of the competition, there was already talk of starting to vaccinate the population, with which it is hoped to be able to control the disease much better, and it seems that the beginning of the end of the pandemic is closer.

The organising team of the national phase of the IMMC thinks that the situation offers us an opportunity to propose a real modelling challenge: how to organise the vaccination of the population in your region in an efficient way?

Each team has to present its mathematical model, as complete as possible, detailing and justifying the decisions taken. Some aspects that could be addressed are, for example: how many vaccination points will be needed, where they should be located, who should be vaccinated and when, how much time and health personnel will be needed, how much the whole process will cost, how to distribute the vaccines, etc.

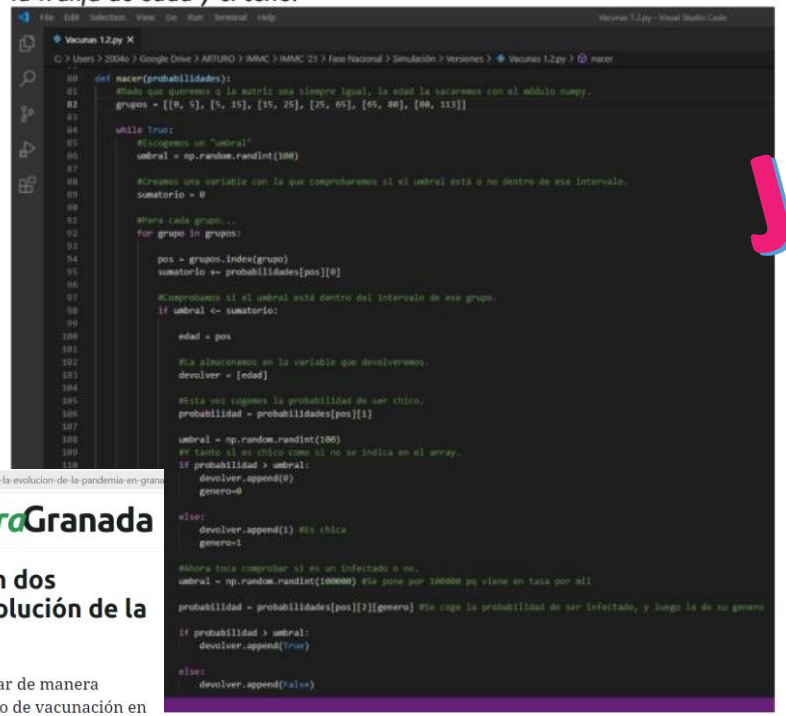
What did teams do when solving vaccination task?

Recorremos nuestra matriz desde el elemento (1,1) hasta el elemento (960,960) para crear cada habitante según el orden definido en la *Imagen 2*. Creamos una función Python denominada nacer() (ver *Imagen 3*), que recibe como argumentos las probabilidades de las franjas de edad y sexo de cada distrito, y crea un **array (una lista)** para cada celda.

Con el comando random() y con las probabilidades que recibe la función nacer() almacenamos en el array la franja de edad y el sexo del ciudadano.

Estamos
poblaciona
realizarem
nuestro mo

Imagen 3. *La función nacer() recibe como argumentos las probabilidades para generar a los ciudadanos de la provincia según su distrito sanitario, la franja de edad y el sexo.*



```
def nacer(probabilidades):
    #Dado que queremos q la matriz sea siempre igual, la edad la sacaremos con el módulo numpy.
    grupos = [[0, 5], [5, 15], [15, 25], [25, 65], [65, 80], [80, 113]]

    while True:
        #Escogemos un "umbral"
        umbral = np.random.randint(100)

        #Creamos una variable con la que comprobaremos si el umbral está o no dentro de ese intervalo.
        sumatorio = 0

        #Para cada grupo...
        for grupo in grupos:

            pos = grupos.index(grupo)
            sumatorio += probabilidades[pos][0]

            #Comprobamos si el umbral está dentro del intervalo de ese grupo.
            if umbral <= sumatorio:

                edad = pos

                #La almacenamos en la variable que devolveremos.
                devolver = [edad]

                #Esta vez cogemos la probabilidad de ser chico.
                probabilidad = probabilidades[pos][1]

                umbral = np.random.randint(100)
                #Y tanto si es chico como si no se indica en el array.
                if probabilidad > umbral:
                    devolver.append(0)
                    genero=0

                else:
                    devolver.append(1) #Es chica
                    genero=1

                #Ahora toca comprobar si es un infectado o no.
                umbral = np.random.randint(100000) #Se pone por 100000 pq viene en tasa por mil

                probabilidad = probabilidades[pos][2][genero] #Se coge la probabilidad de ser infectado, y luego la de su genero

                if probabilidad > umbral:
                    devolver.append(True)

                else:
                    devolver.append(False)
```



ahoragranada.com/noticias/alumnos-de-maristas-reciben-dos-premios-por-investigar-la-evolucion-de-la-pandemia-en-grana

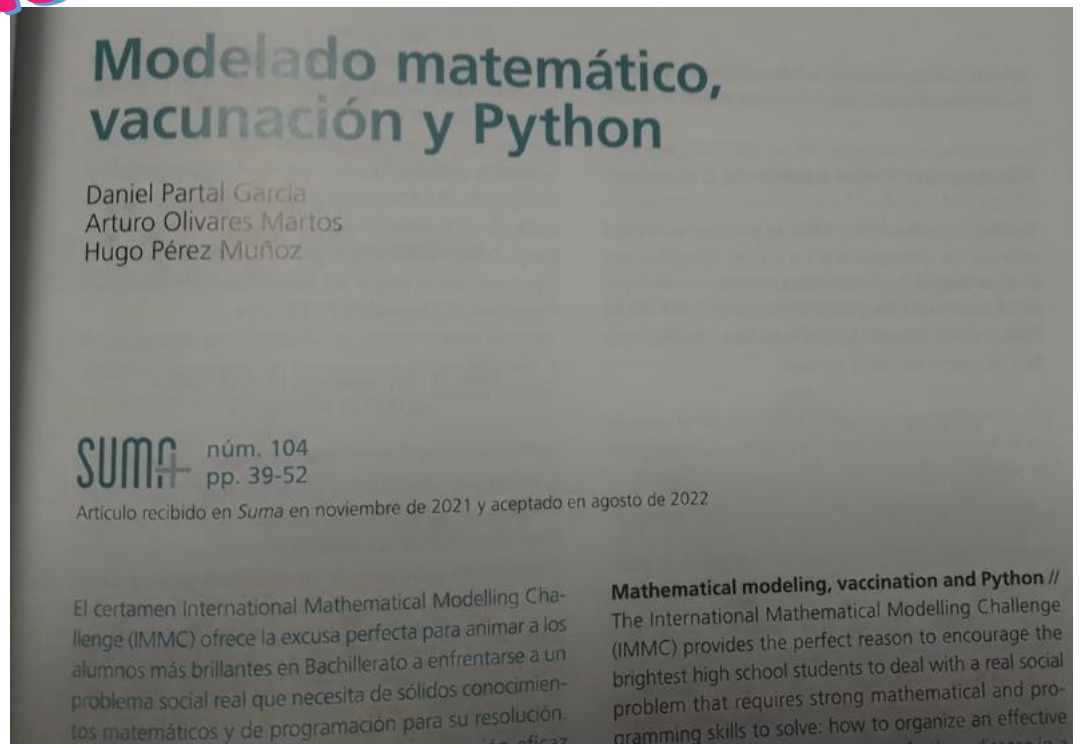
ahoraGranada

Alumnos de Maristas reciben dos premios por investigar la evolución de la pandemia en Granada

También se han enfrentado al reto de modelar de manera óptima y con criterios matemáticos el proceso de vacunación en la provincia



Just published!!



Modelado matemático, vacunación y Python

Daniel Partal García
Arturo Olivares Martos
Hugo Pérez Muñoz

SUMA núm. 104
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Artículo recibido en *Suma* en noviembre de 2021 y aceptado en agosto de 2022

El certamen International Mathematical Modelling Challenge (IMMC) ofrece la excusa perfecta para animar a los alumnos más brillantes en Bachillerato a enfrentarse a un problema social real que necesita de sólidos conocimientos matemáticos y de programación para su resolución.

Mathematical modeling, vaccination and Python //
The International Mathematical Modelling Challenge (IMMC) provides the perfect reason to encourage the brightest high school students to deal with a real social problem that requires strong mathematical and programming skills to solve: how to organize an effective

2022 and 2023 when the participants went even further...

A group of students at the American School of Valencia have organized an IMMC-inspired modelling competition for their younger schoolmates!!



IMMC-Spain highlights and future



Participation of IMMC-Spain students on a teacher training course on modelling



Importance of giving feedback to the teachers and the participants about their proposal!



Since the organization of this selections phase is complex, we are in contact with some friends from Sweden and also Chile to try to coordinate the problem design and the development of the national selections of teams.

Thanks for your attention!
ご清聴ありがとう！
¡Gracias por vuestra atención!

If you want more information about modelling in Spain, please do not hesitate to write me **immcspain@uv.es** or **irene.ferrando@uv.es**.

More information about IMMC-Spain in: **https://immcspain.blogs.uv.es/**