



# A mathematical cooperative approach for understanding COVID-19

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# How the story begins...



Dec'2019: health crisis in Wuhan (China)

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31/01/2020: Italy confirms first cases

21/02/2020: 16 cases in Lombardía

22/02/2020: 60 cases in Lombardía

02/03/2020: +2000 cases, 22 deceased

08/03/2020: lockdown in the north

09/03/2020: global lockdown

# How the story begins...



31/01/2020: Spain confirms first case

13/02/2020: 1st deceased in Spain (not confirmed until March!)

24/02/2020: 5 cases (all imported from Italy)

26/02/2020: 1st local case

29/02/2020: 50 cases

01/03/2020: 83 cases and first restrictions

14/03/2020: lockdown

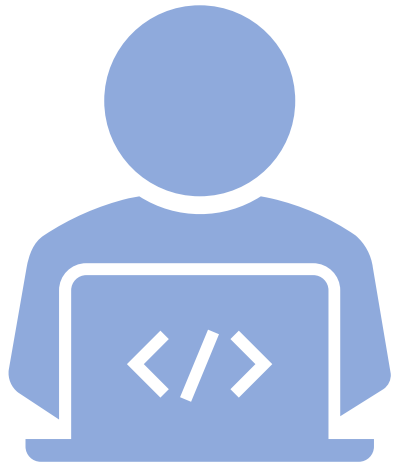
177.633 confirmed  
cases in Spain

968.448 confirmed  
cases in Europe

1.848.489 confirmed  
cases in the World

18.579 deceased  
70.853 recovered

... at that point



Mathematicians “playing” with numbers at home

Contact through social networks...

- Explaining the classical models
- Visualizing data
- Predicting
- ...

CEMat

16/03/2020: an open call for the mathematical community to contribute using our analysis and modelling skills in order to create a better understanding of the COVID-19 health crisis



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How? “Mathematical Action Against Coronavirus”

<http://matematicas.uclm.es/cemat/covid19/en/>



- Collecting links and contributions of the Spanish mathematical community about the virus spread on the website.
- Promoting discussion in the community using the contributions from researchers and groups and involving a variety of models and techniques.
- Establishing a Committee of Experts to evaluate the collaborations and, eventually, will report conclusions and suggestions to the authorities.

# CEMat



26/03/2020: proposal from the Experts Committee → sent to the government and regional authorities



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**Positive response!**

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**Positive response!**

**We were asked to do something!**

# First task: a cooperative predictor

- First priority: obtain accurate predictions for:
  - Cases and new cases
  - Hospitalizations and hospitalizations discharges
  - Patients requiring intensive care
  - Deaths

Actualización nº 76. Enfermedad por el coronavirus (COVID-19).

15.04.2020 (datos consolidados a las 21:00 horas del 14.04.2020)

## 1. SITUACIÓN ACTUAL

### Situación en España:

En España, hasta el momento se han notificado un total de 177.633 casos confirmados de COVID-19, 18.579 fallecidos y 70.853 curados (Tabla 1, Figura 1 y Figura 2). Esto supone 4.978 casos nuevos, 523 fallecidos nuevos y 3.349 nuevos curados notificados en las últimas 24 horas. Las Comunidades Autónomas con una mayor incidencia acumulada en los últimos 14 días son La Rioja, Castilla La Mancha, Madrid, y Castilla y León (Figura 3 y Figura 4). La distribución por grupos de edad de casos hospitalizados, ingresados en UCI y fallecidos se recoge en la Tabla 2. El incremento diario medio de la semana del 13 al 19 de abril es de 2,4% para casos confirmados, 1,7% para los casos que han precisado hospitalización, 1,5% para los que han ingresado en UCI y 3,1% para los fallecidos (Tabla 3).

Tabla 1. Casos COVID-19, incidencia acumulada (IA) en los últimos 14 días, ingreso en UCI y fallecidos por Comunidades Autónomas en España, 15.04.2020 (datos consolidados a las 21:00 horas del 14.04.2020).

CCAA	TOTAL confirmados*	IA (14 d.)	Casos que han precisado hospitalización	Casos que han ingresado en UCI	Fallecidos	Curados	Nuevos
Andalucía	10.595**	49,95	5.147	665	865	2.224	289**
Aragón	4.338	140	2.006	282	514	1.012	93
Asturias	2.096	75,67	1.387	114	166	487	45
Baleares	1.606	41,32	857	149	125	881	35
Canarias	1.975	27,63	781	152	104	622	17
Cantabria	1.823	104,98	873	76	132	363	27
Castilla La Mancha	14.680	375,48	7.896	495	1.755	2.998	351
Castilla y León	13.697	285,47	6.306	306 <sup>a</sup>	1.337	4.521	517
Cataluña	36.505	215,16	23.372	2.789	3.756	16.651	1.308
Ceuta	98	55,44	9	4	4	30	2
C. Valenciana	9.424	69,99	4.465	588	945	3.360	211
Extremadura	2.762	101,43	1.155	109	342	615	78
Galicia	7.708	121,36	2.471	128 <sup>a</sup>	299	1.298	111
Madrid	49.526	295,44	10.116 <sup>a</sup>	1.244 <sup>a</sup>	6.724	27.433	1.478
Melilla	102	46,25	43	3	2	24	1
Murcia	1.520	32,06	574	97	109	513	33
Navarra	4.246	267,34	1.731	124	252	808	96
País Vasco	11.475	210,03	5.750	471	902	5.428	249
La Rioja	3.457	472,54	1.182	75	246	1.585	37
ESPAÑA	177.633	160,54			18.579	70.853	4.978

IA (14 d.): Incidencia acumulada (casos acumulados por 100.000 habitantes notificados en los últimos 14 días).

Los datos de las CCAA están en continua revisión y ciertas oscilaciones diarias pueden deberse a procesos de depuración de datos y no a variaciones reales acontecidas de un día a otro.

\* Los casos confirmados no provienen de la suma de pacientes hospitalizados, curados y fallecidos, ya que no son excluyentes. Pacientes fallecidos y curados pueden haber precisado hospitalización y por tanto computar en ambos grupos. Los pacientes que han precisado UCI también computan en los pacientes que han requerido hospitalización.

\*\*Andalucía ha notificado un total de 169 positivos asintomáticos incluidos en el total de confirmados, los casos nuevos de hoy se han calculado teniendo en cuenta los 114 nuevos asintomáticos de ayer.

<sup>a</sup> Los datos de estas comunidades son datos de prevalencia (personas ingresadas a fecha de hoy). No reflejan el total de personas que han sido hospitalizadas o ingresadas en UCI a lo largo del periodo de notificación por lo que no se puede realizar el sumatorio de todas las personas que han requerido hospitalización o ingreso en UCI en España.

Fuente: elaboración propia

# First task: a cooperative predictor

- 37 groups from different áreas (applied mathematics, mathematical analysis and statistics)
- Results available at: <https://covid19.citic.udc.es/>

COVID-19 - España

COVID-19

Gráficas por comunidades

Gráficas por edades

Predicción cooperativa:  
Información

Predicción cooperativa:  
Predicciones

Predicción cooperativa:  
Resultados

Acción matemática contra el coronavirus



Selecciona variable:

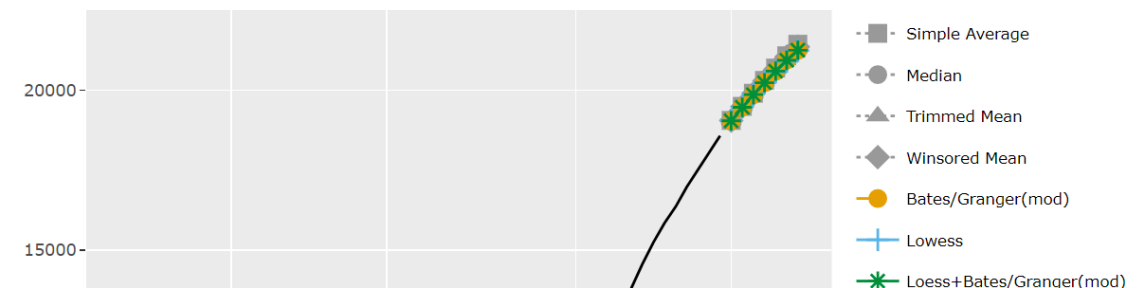
Fallecidos

Comunidad autónoma:

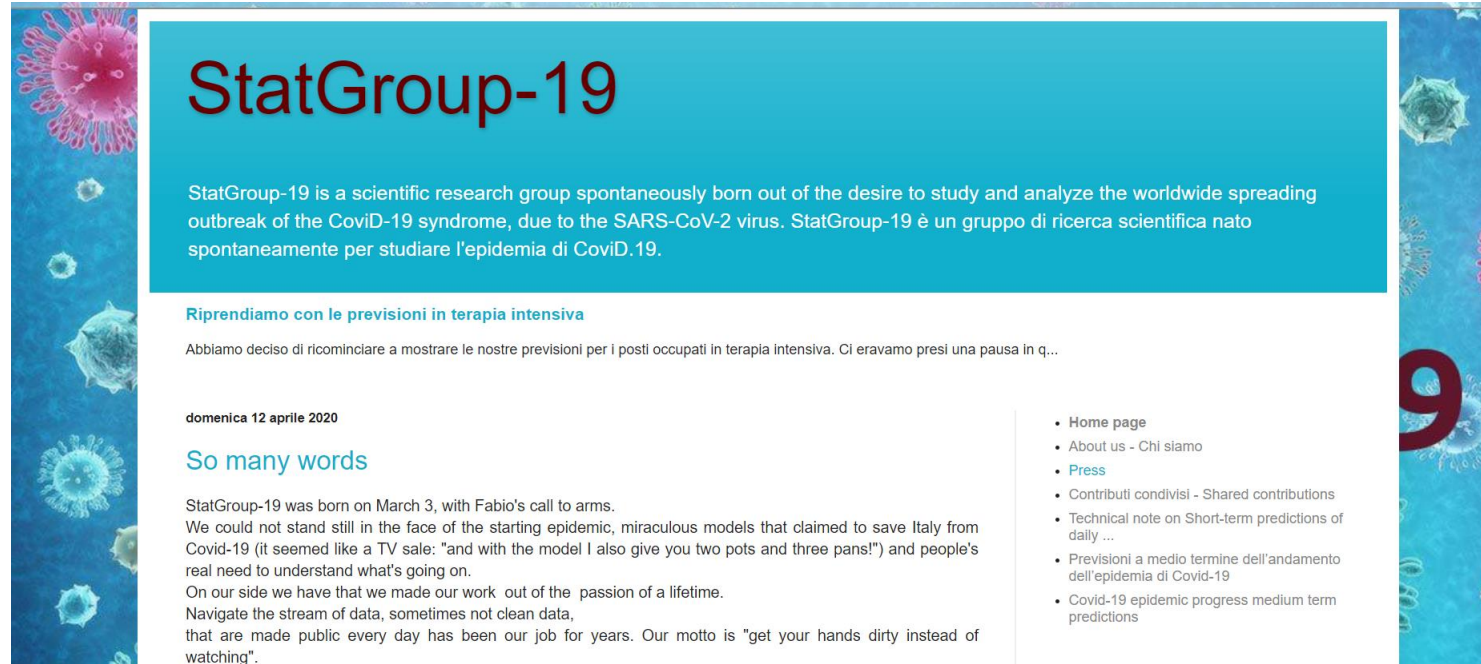
España

Gráfica

Predicciones



# Our approach... jointly with StatGroup-19 and Jose Ameijeiras-Alonso (KU Leuven)

A screenshot of the StatGroup-19 website. The header is a solid blue bar with the text 'StatGroup-19' in a large, bold, dark red font. Below the header, the text describes the group's mission: 'StatGroup-19 is a scientific research group spontaneously born out of the desire to study and analyze the worldwide spreading outbreak of the Covid-19 syndrome, due to the SARS-CoV-2 virus. StatGroup-19 è un gruppo di ricerca scientifica nato spontaneamente per studiare l'epidemia di Covid-19.' The main content area has a white background with a large, faint, dark red number '9' on the right side. The text continues with 'Riprendiamo con le previsioni in terapia intensiva' and 'Abbiamo deciso di ricominciare a mostrare le nostre previsioni per i posti occupati in terapia intensiva. Ci eravamo presi una pausa in q...'. Below this, the date 'domenica 12 aprile 2020' is shown, followed by the section title 'So many words'. The text describes the group's origin: 'StatGroup-19 was born on March 3, with Fabio's call to arms. We could not stand still in the face of the starting epidemic, miraculous models that claimed to save Italy from Covid-19 (it seemed like a TV sale: "and with the model I also give you two pots and three pans!") and people's real need to understand what's going on. On our side we have that we made our work out of the passion of a lifetime. Navigate the stream of data, sometimes not clean data, that are made public every day has been our job for years. Our motto is "get your hands dirty instead of watching".' A sidebar on the right contains a list of links: 'Home page', 'About us - Chi siamo', 'Press', 'Contributi condivisi - Shared contributions', 'Technical note on Short-term predictions of daily ...', 'Previsioni a medio termine dell'andamento dell'epidemia di Covid-19', and 'Covid-19 epidemic progress medium term predictions'. The website is decorated with vertical borders on the left and right sides featuring microscopic images of viruses and cells. The overall design is clean and professional, with a focus on scientific communication.

## StatGroup-19

StatGroup-19 is a scientific research group spontaneously born out of the desire to study and analyze the worldwide spreading outbreak of the Covid-19 syndrome, due to the SARS-CoV-2 virus. StatGroup-19 è un gruppo di ricerca scientifica nato spontaneamente per studiare l'epidemia di Covid-19.

### Riprendiamo con le previsioni in terapia intensiva

Abbiamo deciso di ricominciare a mostrare le nostre previsioni per i posti occupati in terapia intensiva. Ci eravamo presi una pausa in q...

domenica 12 aprile 2020

### So many words

StatGroup-19 was born on March 3, with Fabio's call to arms. We could not stand still in the face of the starting epidemic, miraculous models that claimed to save Italy from Covid-19 (it seemed like a TV sale: "and with the model I also give you two pots and three pans!") and people's real need to understand what's going on. On our side we have that we made our work out of the passion of a lifetime. Navigate the stream of data, sometimes not clean data, that are made public every day has been our job for years. Our motto is "get your hands dirty instead of watching".

- Home page
- About us - Chi siamo
- Press
- Contributi condivisi - Shared contributions
- Technical note on Short-term predictions of daily ...
- Previsioni a medio termine dell'andamento dell'epidemia di Covid-19
- Covid-19 epidemic progress medium term predictions

A generalized logistic model for count variables (Richards' model).

Allows to identify:

- The inflection point
- The asymptote value

# A shiny-app to check!

<https://jose-ameijeiras.shinyapps.io/StatGroup-19-SP/>

## StatGroup-19-SP

**Employed data:**

☒ Acumulated  
☐ Daily changes

**Database:**

Spain ▼

**Country/Region:**

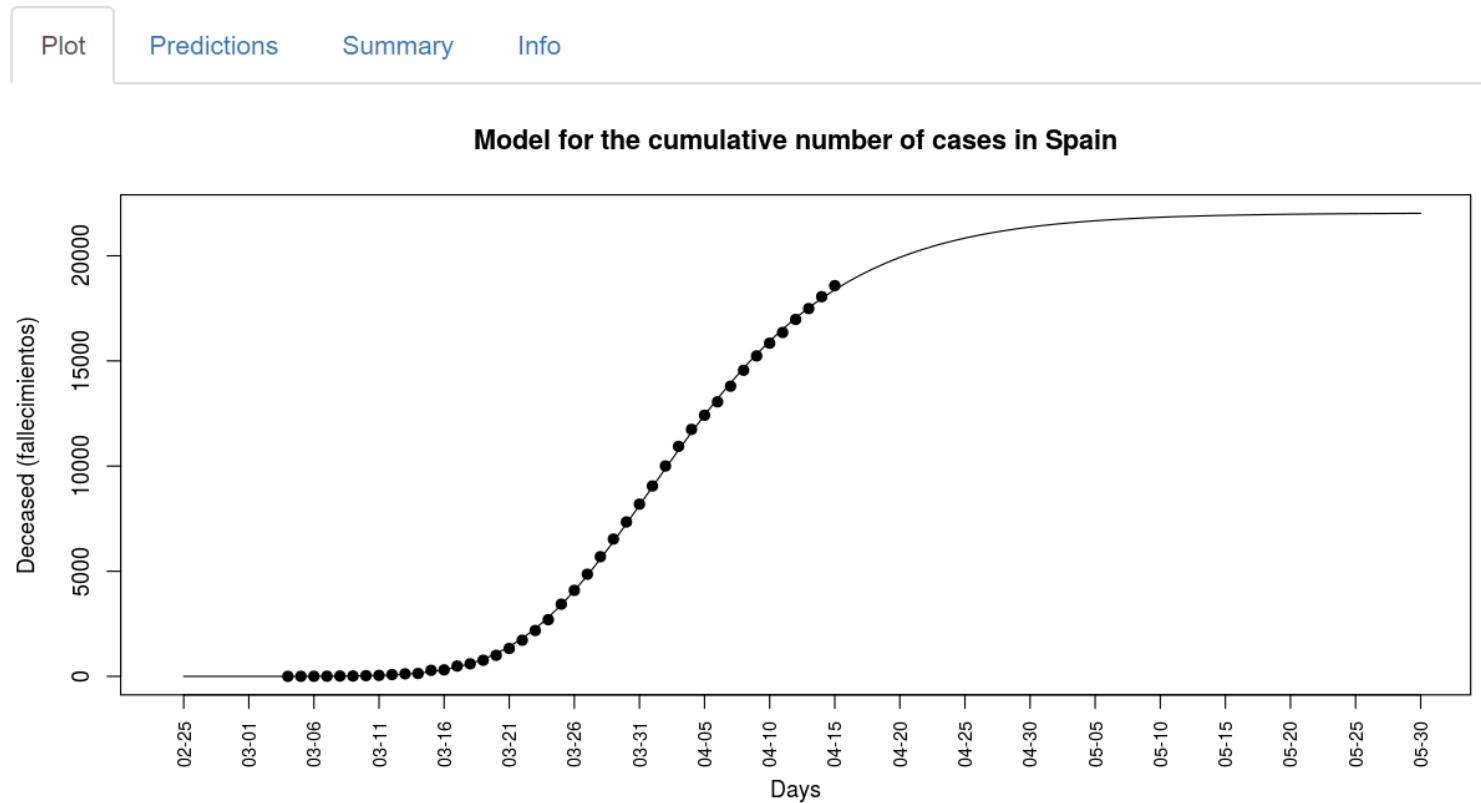
Spain ▼

**Variable:**

Deceased ▼

☐ Add date of the political measures

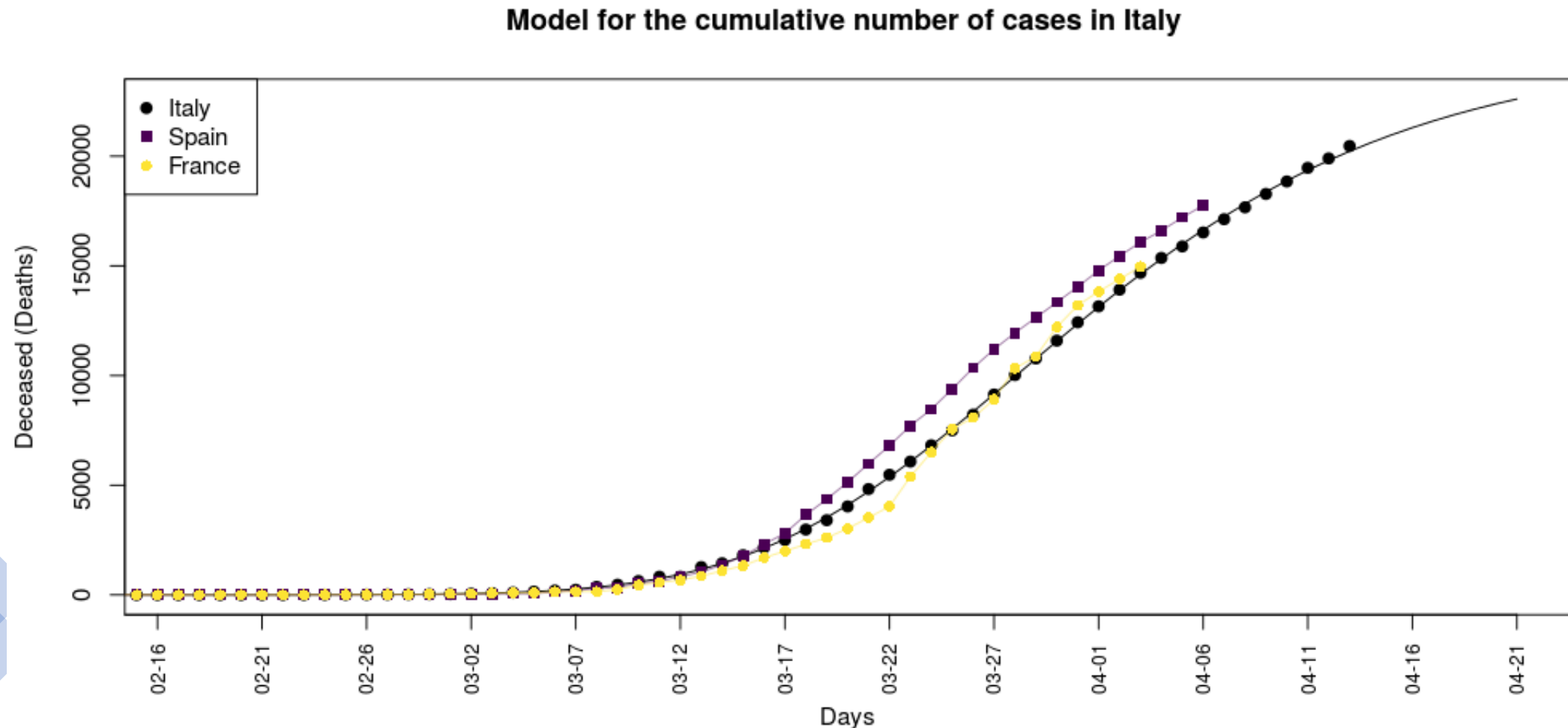
☐ Compare with other region(s) on the graph



- Double-click to see the value of a point in the graph.
- Double-click in the left part of the graph to remove the value of the point.
- Brush to select an area and double click to zoom.
- Double-click to zoom out.

# A shiny-app to check!

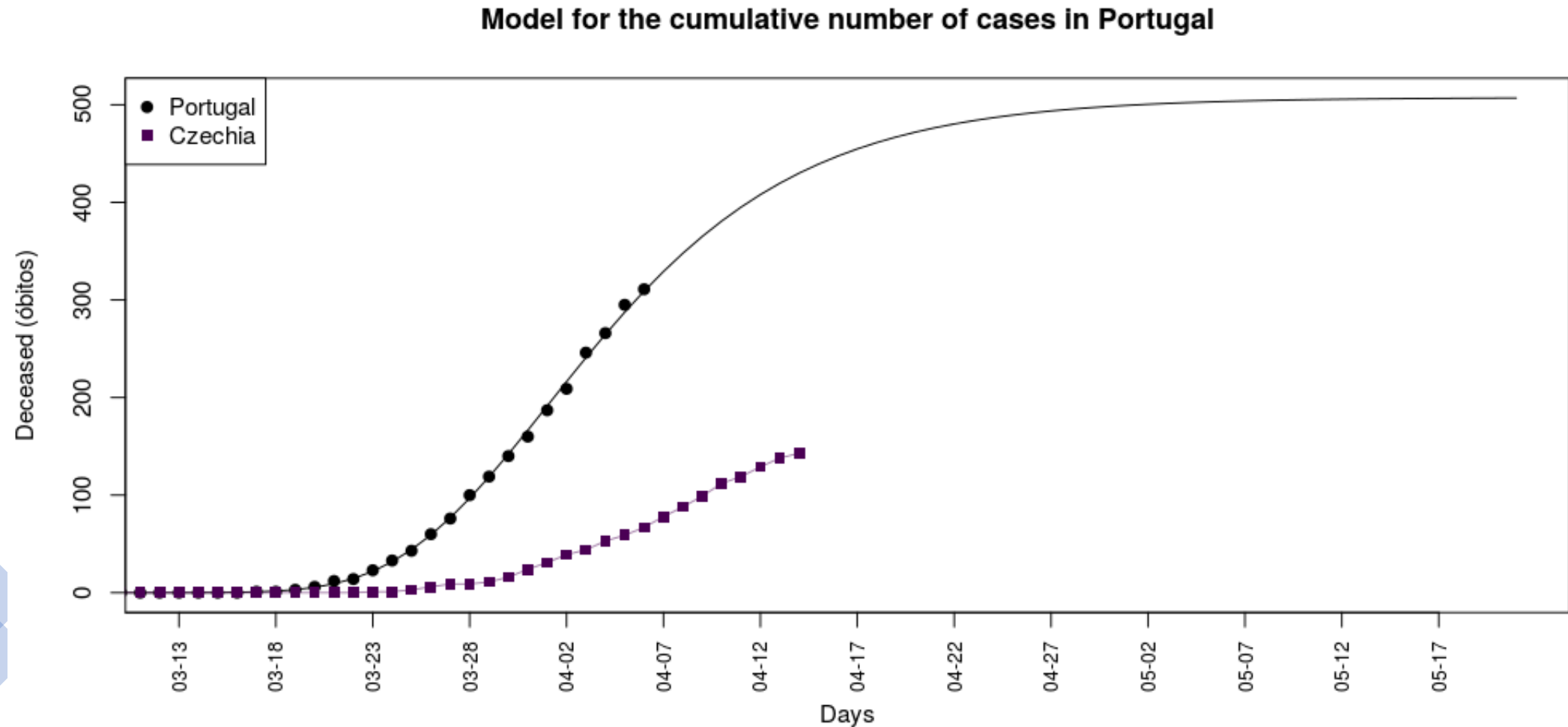
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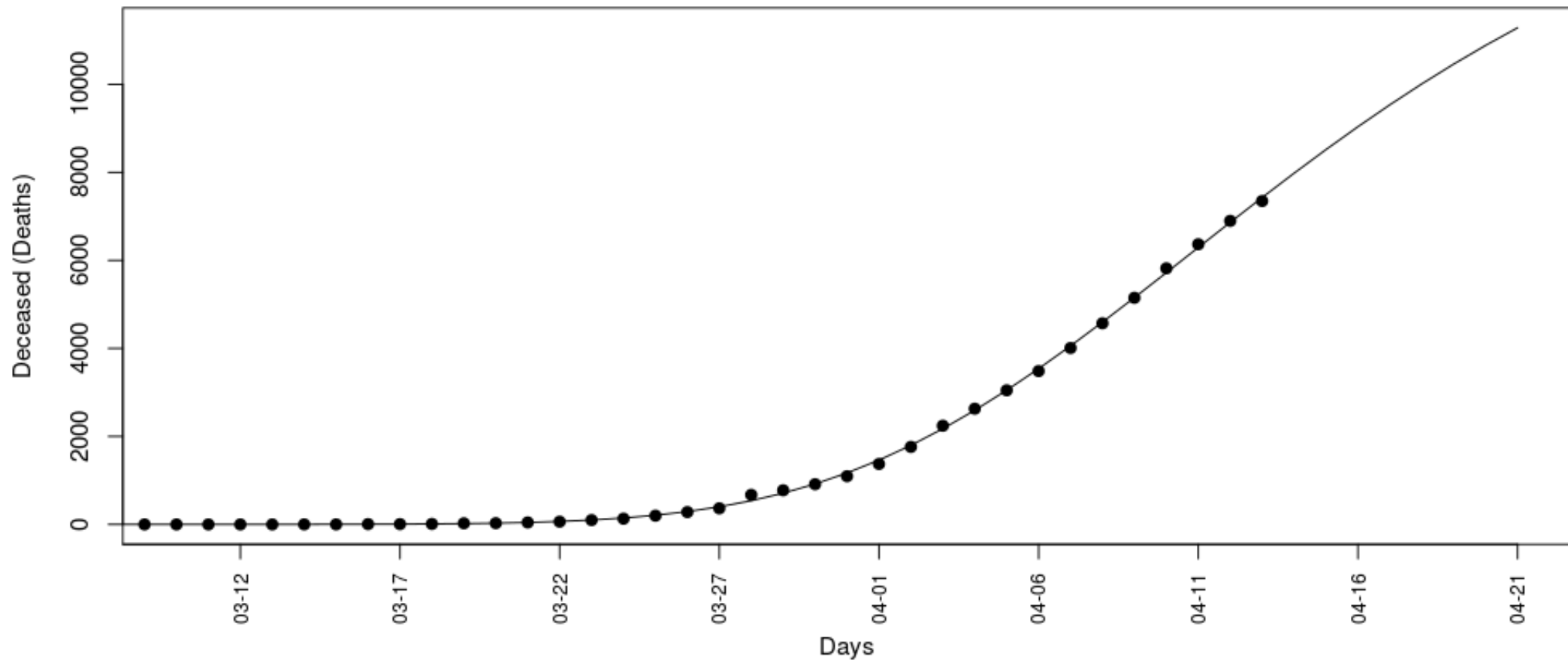




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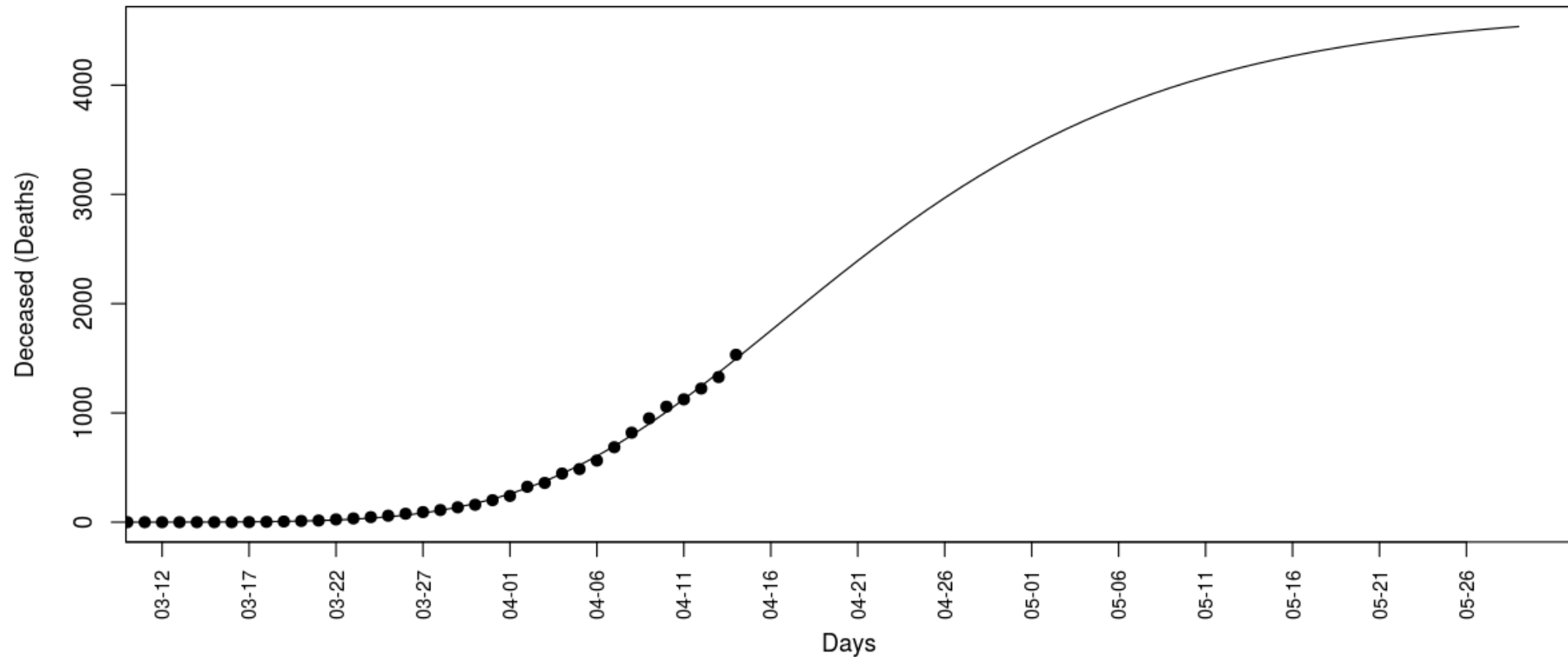
**Model for the cumulative number of cases in New York City, New York, US**



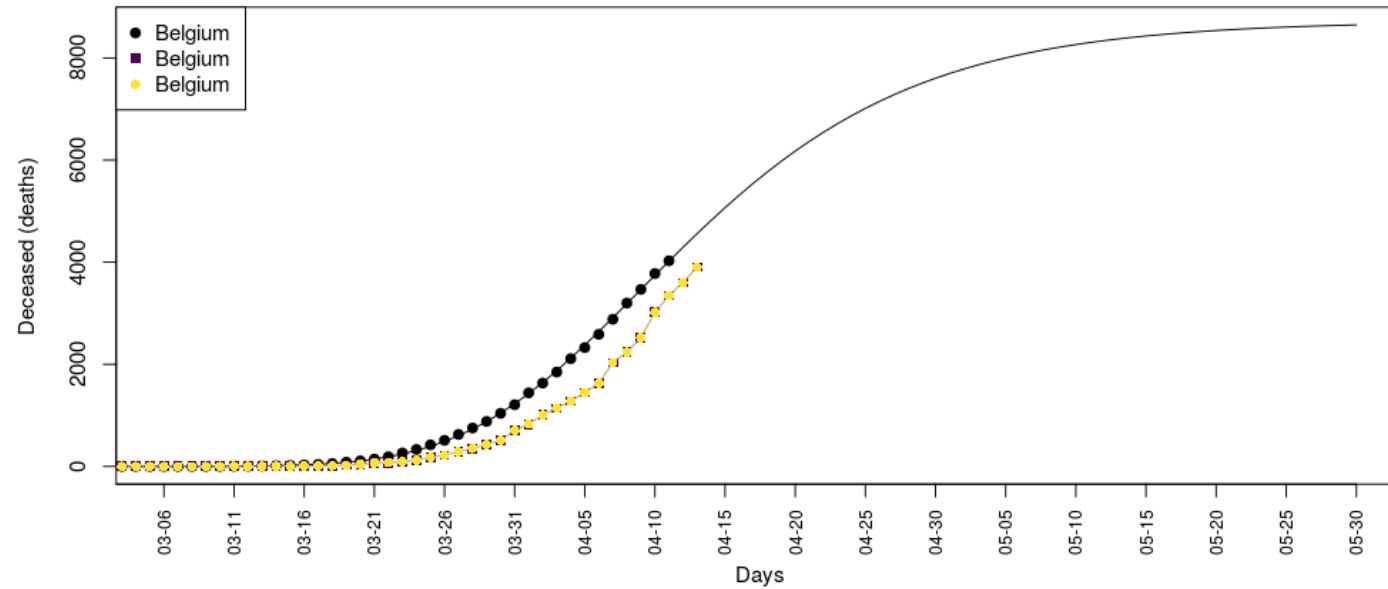
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**Model for the cumulative number of cases in Brazil**



Model for the cumulative number of cases in Belgium



## The problems...



Reliable data

Homogeneous across countries

Homogeneous along time

- We were listened! And they established some priorities
  - Back to normal life (working group)
  - Call for scientific literature (to produce a report to the government... in a single day!) about the effect of different measurements...
  - ...

## Other actions



# Conclusions



A lot of work to do:

- Geolocalization data?
- Spatio-temporal evolution?
- Incubation time?

# Conclusions



A lot of work to do:

- Geolocalization data?
- Spatio-temporal evolution?
- Incubation time?



Together... our voice sounds louder...



... is anyone out there to listen?



Thanks for your attention!  
Obrigada!

Rosa M. Crujeiras Casais

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