

Predicciones sobre CoViD-19

Manuel Febrero-Bande

Dpt. de Estadística, Análisis Matemático y Optimización
Univ. de Santiago de Compostela

March 30, 2020



DEPARTAMENTO DE ESTADÍSTICA,
ANÁLISE MATEMÁTICA E OPTIMIZACIÓN



- Predicciones

- Predicciones

Datos

Número de datos funcionales: 2386

Países/Regiones distintos incorporados: 106

Predicciones:

▶ España

► Andalucía

► Aragón

► Asturias

► **Baleares**

► **Canarias**

► Cantabria

▶ Catalunya

► Castilla-La Mancha

▶ Castilla y León

▶ C. Valenciana

► Extremadura

► Euskadi

▶ Galicia

► Madrid

► Murcia

▶ Navarra

► **La Rioja**

► Mod Lineal

- ▶ Mod NP

► Mod Aditivo

Horiz	Medida	FLM	NP	SAM
H1	σ_R^2	0.032	0.021	0.028
H1	$\sigma_R^2(rob.)$	0.018	0.006	0.017
H1	r^2	0.199	0.605	0.282
H2	σ_R^2	0.128	0.085	0.11
H2	$\sigma_R^2(rob.)$	0.066	0.023	0.058
H2	r^2	0.227	0.614	0.33
H3	σ_R^2	0.376	0.279	0.331
H3	$\sigma_R^2(rob.)$	0.171	0.059	0.163
H3	r^2	0.212	0.561	0.304

Último dato: 2020-03-29 21:00 que se publica 2020-03-30 12:00.

Tabla Modelo Lineal.

	Last	N:H1-lw	N:H1-fit	N:H1-up	N:H2-lw	N:H2-fit	N:H2-up
España	85195	85195	93454	107394	85195	100903	129536
Andalucía	5405	5405	6103	6831	5408	6921	8434
Aragón	2078	2086	2365	2645	2133	2715	3297
Asturias	1158	1158	1293	1449	1158	1445	1770
Baleares	1000	1004	1138	1273	1023	1303	1583
Canarias	1204	1204	1359	1521	1206	1543	1881
Cantabria	1100	1135	1283	1431	1180	1488	1796
Cataluña	16157	16173	18371	20569	16474	21040	25606
Castilla.La.Mancha	5858	5871	6660	7450	5915	7556	9197
Castilla.y.León	5801	5870	6652	7434	6000	7625	9251
C..Valenciana	5110	5110	5787	6475	5161	6592	8022
Extremadura	1560	1578	1788	1998	1632	2068	2505
Euskadi	6057	6057	6824	7639	6057	7727	9423
Galicia	3723	3753	4255	4756	3841	4883	5925
Madrid	24090	24090	26580	29872	24090	29460	36296
Murcia	939	940	1066	1193	958	1221	1484
Navarra	2146	2146	2413	2702	2146	2723	3324
La.Rioja	1733	1733	1925	2158	1733	2156	2641

Table: Previsión número de casos confirmados: Modelo lineal - Horizonte 1 y 2 días.

Tabla Modelo Aditivo.

	Last	N:H1-lw	N:H1-fit	N:H1-up	N:H2-lw	N:H2-fit	N:H2-up
España	85195	87096	96129	105163	92064	109486	126907
Andalucía	5405	5595	6167	6739	5977	7081	8185
Aragón	2078	2208	2429	2650	2402	2828	3253
Asturias	1158	1159	1283	1407	1187	1426	1666
Baleares	1000	1024	1131	1237	1056	1261	1467
Canarias	1204	1229	1356	1484	1286	1533	1779
Cantabria	1100	1187	1306	1425	1309	1538	1768
Cataluña	16157	16775	18497	20218	17987	21312	24636
Castilla.La.Mancha	5858	6022	6649	7275	6369	7579	8789
Castilla.y.León	5801	6020	6638	7255	6436	7630	8824
C..Valenciana	5110	5223	5765	6307	5485	6531	7576
Extremadura	1560	1663	1829	1994	1837	2158	2478
Euskadi	6057	6253	6894	7536	6626	7864	9101
Galicia	3723	3859	4256	4652	4061	4826	5592
Madrid	24090	24405	26958	29511	25776	30698	35620
Murcia	939	976	1076	1176	1039	1231	1424
Navarra	2146	2179	2406	2633	2279	2718	3156
La.Rioja	1733	1775	1958	2141	1875	2227	2580

Table: Previsión número de casos confirmados: Modelo Aditivo - Horizonte 1 y 2 días.

Tabla Ratio Incremento Modelo Lineal.

	Last	RI:H1-lw	RI:H1-fit	RI:H1-up	RI:H2-lw	RI:H2-fit	RI:H2-up
España	0.081	0.000	0.097	0.261	0.000	0.184	0.520
Andalucía	0.154	0.000	0.129	0.264	0.001	0.280	0.560
Aragón	0.118	0.004	0.138	0.273	0.027	0.306	0.586
Asturias	0.064	0.000	0.116	0.251	0.000	0.248	0.528
Baleares	0.044	0.004	0.138	0.273	0.023	0.302	0.582
Canarias	0.070	0.000	0.128	0.263	0.002	0.282	0.561
Cantabria	0.075	0.031	0.166	0.301	0.072	0.353	0.633
Cataluña	0.075	0.001	0.137	0.273	0.020	0.302	0.585
Castilla.La.Mancha	0.117	0.002	0.137	0.272	0.010	0.290	0.570
Castilla.y.León	0.071	0.012	0.147	0.282	0.034	0.314	0.595
C..Valenciana	0.068	0.000	0.132	0.267	0.010	0.290	0.570
Extremadura	0.071	0.012	0.146	0.281	0.046	0.326	0.605
Euskadi	0.055	0.000	0.127	0.261	0.000	0.276	0.556
Galicia	0.186	0.008	0.143	0.277	0.032	0.312	0.591
Madrid	0.062	0.000	0.103	0.240	0.000	0.223	0.507
Murcia	0.077	0.001	0.135	0.270	0.020	0.300	0.580
Navarra	0.067	0.000	0.124	0.259	0.000	0.269	0.549
La.Rioja	0.064	0.000	0.111	0.245	0.000	0.244	0.524

Table: Previsión Ratio incremento casos confirmados: Modelo lineal - Horizonte 1 y 2 días.

Tabla Ratio Incremento Modelo No Paramétrico.

	Last	RI:H1-lw	RI:H1-fit	RI:H1-up	RI:H2-lw	RI:H2-fit	RI:H2-up
España	0.081	0.000	0.067	0.138	0.000	0.143	0.303
Andalucía	0.154	0.000	0.068	0.139	0.000	0.146	0.306
Aragón	0.118	0.011	0.081	0.152	0.015	0.175	0.335
Asturias	0.064	0.000	0.057	0.128	0.000	0.122	0.282
Baleares	0.044	0.019	0.090	0.160	0.029	0.189	0.349
Canarias	0.070	0.000	0.069	0.140	0.000	0.148	0.308
Cantabria	0.075	0.048	0.119	0.189	0.094	0.254	0.415
Cataluña	0.075	0.025	0.095	0.166	0.040	0.200	0.360
Castilla.La.Mancha	0.117	0.009	0.079	0.150	0.008	0.168	0.328
Castilla.y.León	0.071	0.028	0.099	0.169	0.045	0.205	0.365
C..Valenciana	0.068	0.008	0.078	0.149	0.006	0.166	0.326
Extremadura	0.071	0.018	0.088	0.158	0.026	0.186	0.346
Euskadi	0.055	0.000	0.068	0.138	0.000	0.144	0.305
Galicia	0.186	0.020	0.091	0.161	0.033	0.193	0.353
Madrid	0.062	0.000	0.053	0.123	0.000	0.114	0.274
Murcia	0.077	0.008	0.078	0.148	0.006	0.166	0.326
Navarra	0.067	0.000	0.064	0.135	0.000	0.136	0.297
La.Rioja	0.064	0.000	0.053	0.123	0.000	0.115	0.275

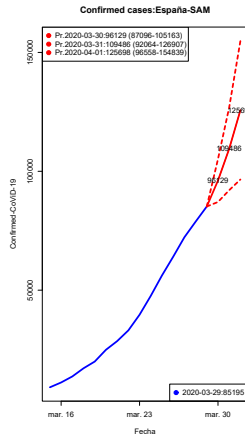
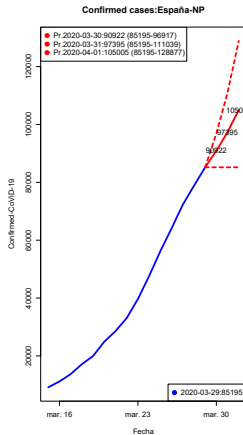
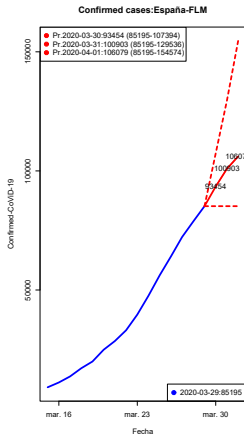
Table: Previsión Ratio incremento casos confirmados: Modelo No Paramétrico
- Horizonte 1 y 2 días.

Tabla Ratio Incremento Modelo Aditivo.

	Last	RI:H1-lw	RI:H1-fit	RI:H1-up	RI:H2-lw	RI:H2-fit	RI:H2-up
España	0.081	0.022	0.128	0.234	0.081	0.285	0.490
Andalucía	0.154	0.035	0.141	0.247	0.106	0.310	0.514
Aragón	0.118	0.063	0.169	0.275	0.156	0.361	0.565
Asturias	0.064	0.001	0.108	0.215	0.025	0.232	0.438
Baleares	0.044	0.024	0.131	0.237	0.056	0.261	0.466
Canarias	0.070	0.021	0.127	0.233	0.068	0.273	0.477
Cantabria	0.075	0.079	0.187	0.295	0.189	0.398	0.607
Cataluña	0.075	0.038	0.145	0.251	0.113	0.319	0.525
Castilla.La.Mancha	0.117	0.028	0.135	0.242	0.087	0.294	0.500
Castilla.y.León	0.071	0.038	0.144	0.251	0.110	0.315	0.521
C..Valenciana	0.068	0.022	0.128	0.234	0.073	0.278	0.482
Extremadura	0.071	0.066	0.172	0.278	0.178	0.383	0.588
Euskadi	0.055	0.032	0.138	0.244	0.094	0.298	0.503
Galicia	0.186	0.036	0.143	0.250	0.091	0.296	0.502
Madrid	0.062	0.013	0.119	0.225	0.070	0.274	0.479
Murcia	0.077	0.040	0.146	0.252	0.107	0.311	0.516
Navarra	0.067	0.015	0.121	0.227	0.062	0.266	0.471
La.Rioja	0.064	0.024	0.130	0.235	0.082	0.285	0.489

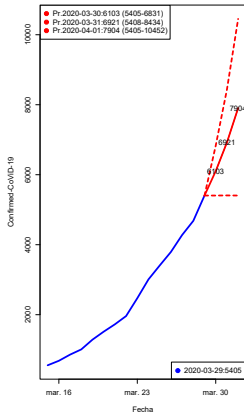
Table: Previsión Ratio incremento casos confirmados: Modelo Aditivo - Horizonte 1 y 2 días.

Confirmed cases: España

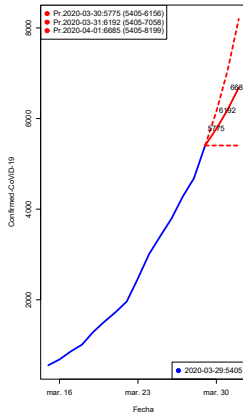

[← Confirmados](#)
[← Fallecidos](#)

Confirmed cases: Andalucía

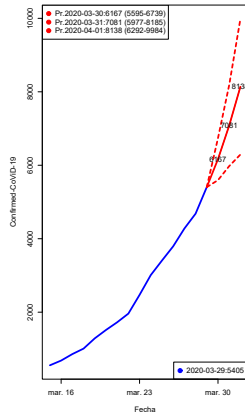
Confirmed cases:Andalucia-FLM



Confirmed cases:Andalucia-NP



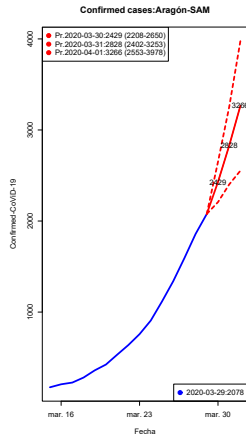
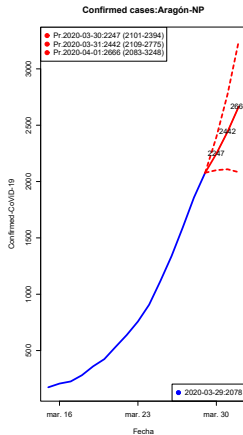
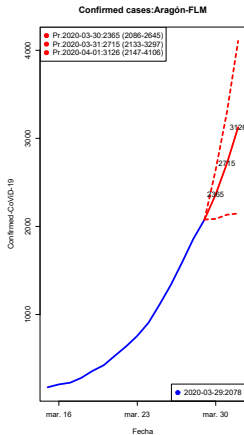
Confirmed cases:Andalucia-SAM



◀ Confirmados

◀ Fallecidos

Confirmed cases: Aragón

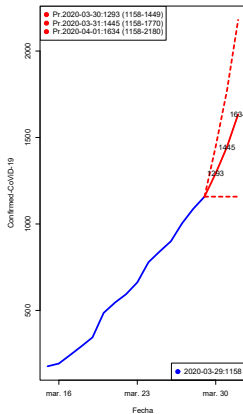


◀ Confirmados

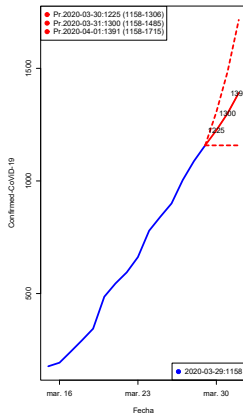
◀ Fallecidos

Confirmed cases: Asturias

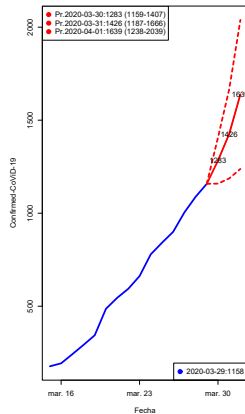
Confirmed cases:Asturias-FLM



Confirmed cases:Asturias-NP



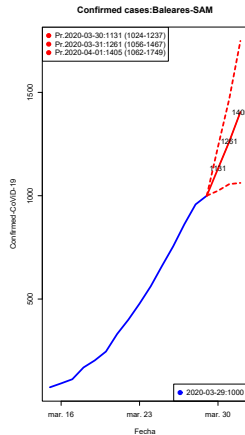
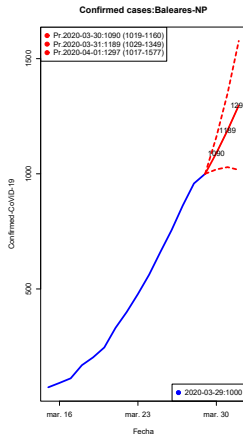
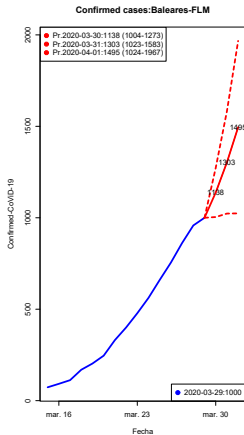
Confirmed cases:Asturias-SAM



◀ Confirmados

◀ Fallecidos

Confirmed cases: Baleares

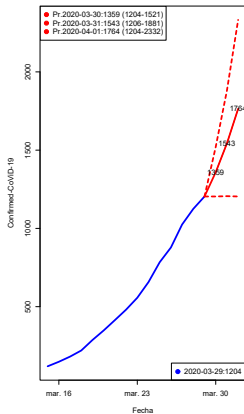


◀ Confirmados

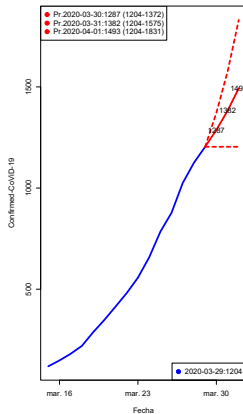
◀ Fallecidos

Confirmed cases: Canarias

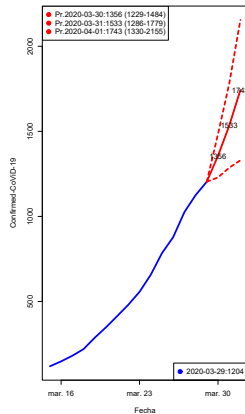
Confirmed cases:Canarias-FLM



Confirmed cases:Canarias-NP



Confirmed cases:Canarias-SAM

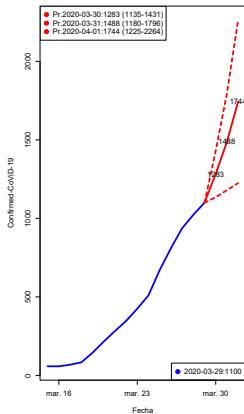


◀ Confirmados

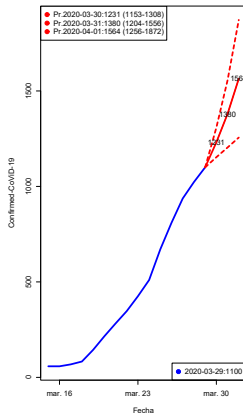
◀ Fallecidos

Confirmed cases: Cantabria

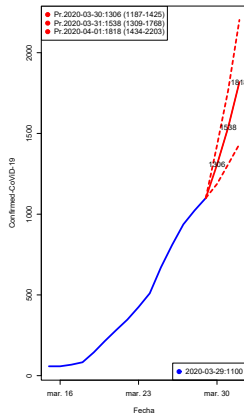
Confirmed cases:Cantabria-FLM



Confirmed cases:Cantabria-NP



Confirmed cases:Cantabria-SAM

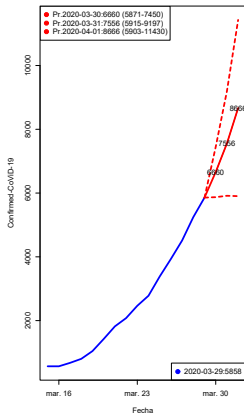


◀ Confirmados

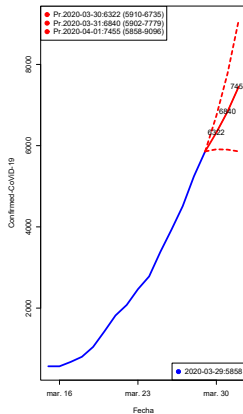
◀ Fallecidos

Confirmed cases: Castilla-La Mancha

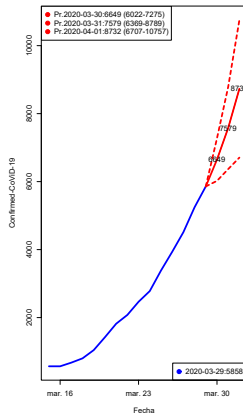
Confirmed cases:Castilla.La.Mancha-FLM



Confirmed cases:Castilla.La.Mancha-NP



Confirmed cases:Castilla.La.Mancha-SAM

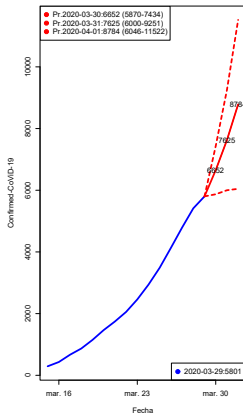


◀ Confirmados

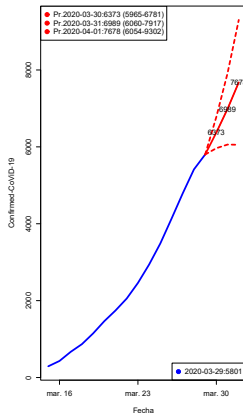
◀ Fallecidos

Confirmed cases: Castilla y León

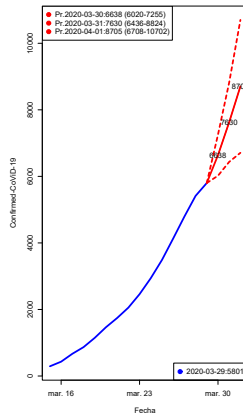
Confirmed cases:Castilla.y.León-FLM



Confirmed cases:Castilla.y.León-NP



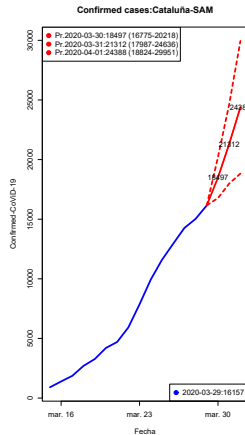
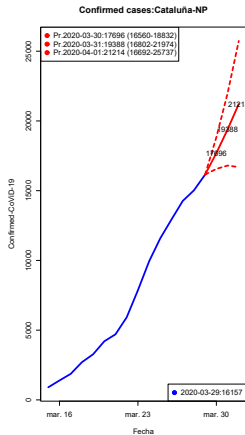
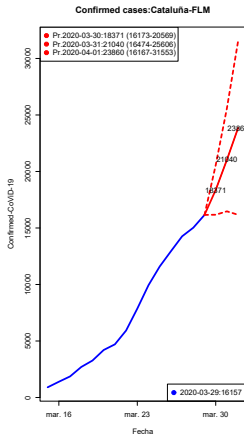
Confirmed cases:Castilla.y.León-SAM



◀ Confirmados

◀ Fallecidos

Confirmed cases: Cataluña

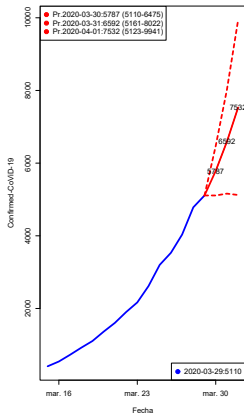


◀ Confirmados

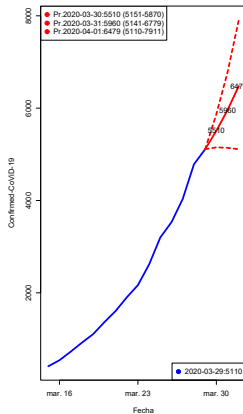
◀ Fallecidos

Confirmed cases: C. Valenciana

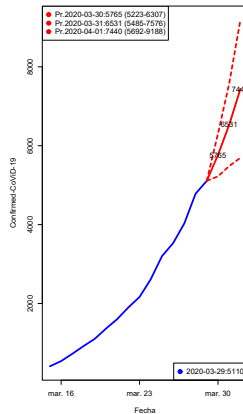
Confirmed cases:C..Valenciana-FLM



Confirmed cases:C..Valenciana-NP



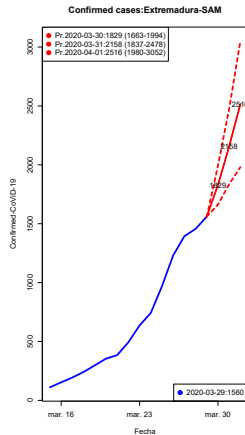
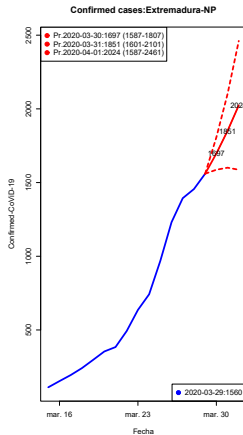
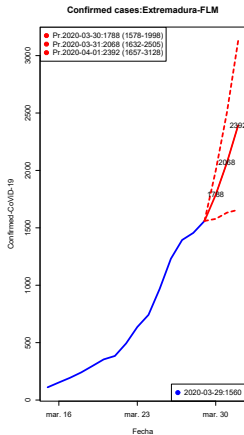
Confirmed cases:C..Valenciana-SAM



◀ Confirmados

◀ Fallecidos

Confirmed cases: Extremadura

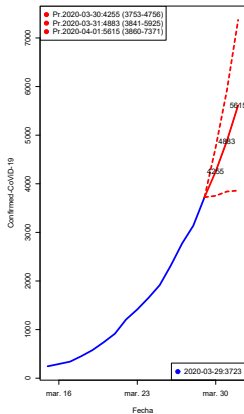


◀ Confirmados

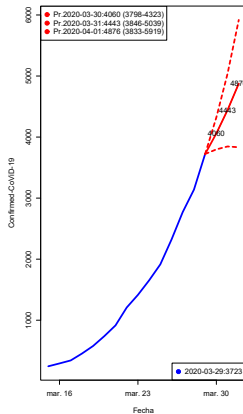
◀ Fallecidos

Confirmed cases: Galicia

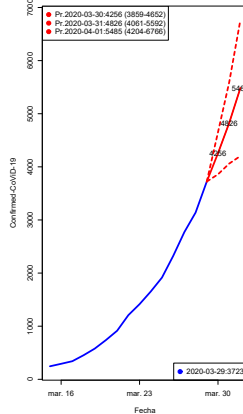
Confirmed cases:Galicia-FLM



Confirmed cases:Galicia-NP



Confirmed cases:Galicia-SAM

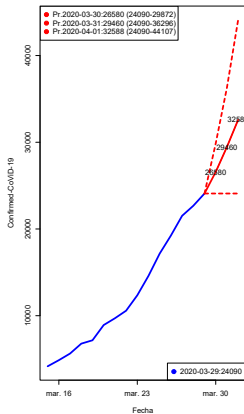


◀ Confirmados

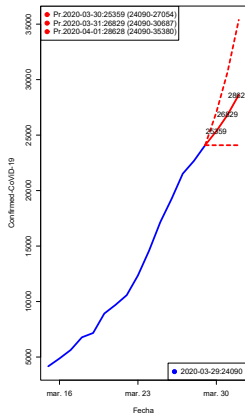
◀ Fallecidos

Confirmed cases: Madrid

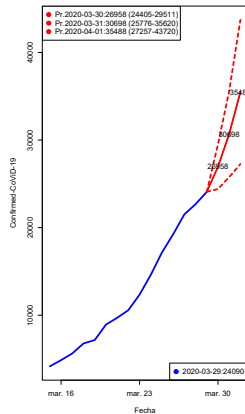
Confirmed cases:Madrid-FLM



Confirmed cases:Madrid-NP



Confirmed cases:Madrid-SAM

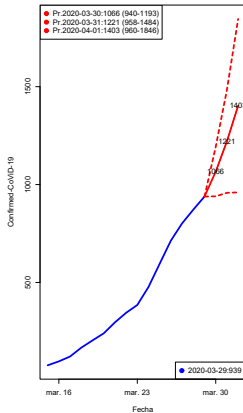


◀ Confirmados

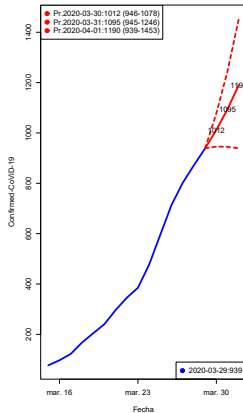
◀ Fallecidos

Confirmed cases: Murcia

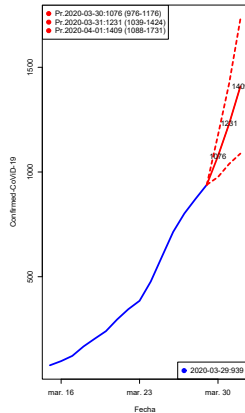
Confirmed cases:Murcia-FLM



Confirmed cases:Murcia-NP



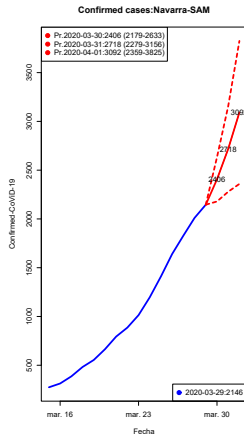
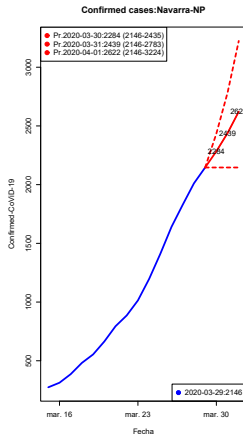
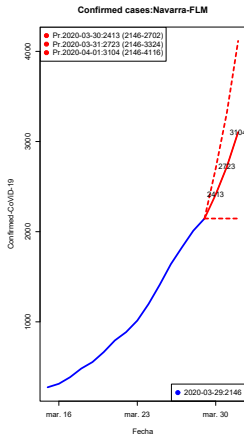
Confirmed cases:Murcia-SAM



◀ Confirmados

◀ Fallecidos

Confirmed cases: Navarra

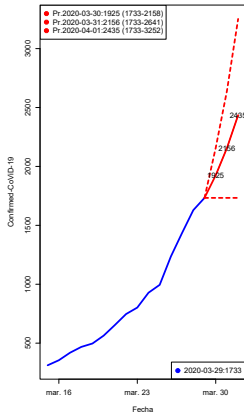


◀ Confirmados

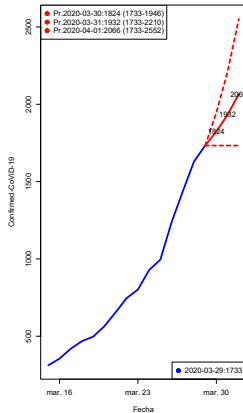
◀ Fallecidos

Confirmed cases: La Rioja

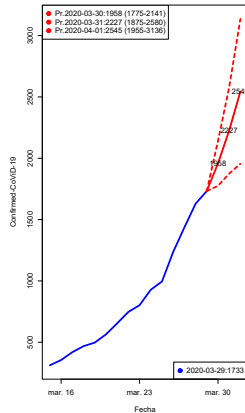
Confirmed cases:La.Rioja-FLM



Confirmed cases:La.Rioja-NP



Confirmed cases:La.Rioja-SAM



◀ Confirmados

◀ Fallecidos

Table of Contents

1 Casos Confirmados

- Predicciones

2 Fallecidos

- Predicciones

► Mod Lineal ► Mod NP ► Mod Aditivo

Horiz	Medida	FLM	NP	SAM
H1	σ_R^2	0.066	0.065	0.063
H1	$\sigma_R^2(rob.)$	0.038	0.012	0.037
H1	r^2	0.189	0.34	0.22
H2	σ_R^2	0.19	0.201	0.18
H2	$\sigma_R^2(rob.)$	0.15	0.098	0.137
H2	r^2	0.292	0.38	0.329
H3	σ_R^2	0.486	0.548	0.448
H3	$\sigma_R^2(rob.)$	0.368	0.13	0.288
H3	r^2	0.326	0.368	0.376

Tabla Fallecidos Ratio Incremento Modelo Lineal.

	Last	RI:H1-lw	RI:H1-fit	RI:H1-up	RI:H2-lw	RI:H2-fit	RI:H2-up
España	0.122	0.029	0.159	0.289	0.095	0.339	0.583
Andalucía	0.139	0.042	0.172	0.303	0.105	0.351	0.596
Aragón	0.019	0.038	0.167	0.295	0.130	0.372	0.614
Castilla.La.Mancha	0.154	0.064	0.197	0.329	0.145	0.394	0.642
Castilla.y.León	0.163	0.085	0.219	0.352	0.205	0.455	0.705
Cataluña	0.150	0.082	0.220	0.358	0.217	0.473	0.729
Euskadi	0.120	0.013	0.142	0.270	0.060	0.302	0.544
Extremadura	0.059	0.067	0.198	0.329	0.175	0.421	0.667
Galicia	0.098	0.058	0.188	0.318	0.170	0.414	0.658
Madrid	0.101	0.000	0.127	0.257	0.029	0.272	0.515
C..Valenciana	0.160	0.044	0.177	0.311	0.117	0.367	0.617
La.Rioja	0.043	0.005	0.135	0.265	0.046	0.290	0.534

Table: Previsión Fallecidos Ratio incremento: Modelo lineal - Horizonte 1 y 2 días.

◀ Confirmados

◀ Fallecidos

Tabla Fallecidos Ratio Incremento Modelo No Paramétrico.

	Last	RI:H1-lw	RI:H1-fit	RI:H1-up	RI:H2-lw	RI:H2-fit	RI:H2-up
España	0.122	0.072	0.106	0.140	0.105	0.239	0.372
Andalucía	0.139	0.102	0.136	0.169	0.153	0.286	0.419
Aragón	0.019	0.048	0.083	0.118	0.041	0.175	0.309
Castilla.La.Mancha	0.154	0.160	0.194	0.228	0.290	0.422	0.555
Castilla.y.León	0.163	0.158	0.192	0.225	0.266	0.399	0.532
Cataluña	0.150	0.365	0.399	0.434	0.617	0.750	0.883
Euskadi	0.120	0.028	0.063	0.097	0.007	0.141	0.274
Extremadura	0.059	0.156	0.190	0.224	0.245	0.378	0.511
Galicia	0.098	0.080	0.114	0.148	0.146	0.280	0.413
Madrid	0.101	0.045	0.079	0.113	0.048	0.181	0.314
C..Valenciana	0.160	0.171	0.204	0.237	0.283	0.416	0.548
La.Rioja	0.043	0.126	0.160	0.195	0.178	0.312	0.445

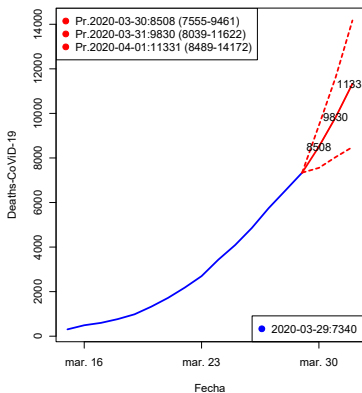
Table: Previsión Fallecidos Ratio incremento: Modelo No Paramétrico - Horizonte 1 y 2 días.

◀ Confirmados

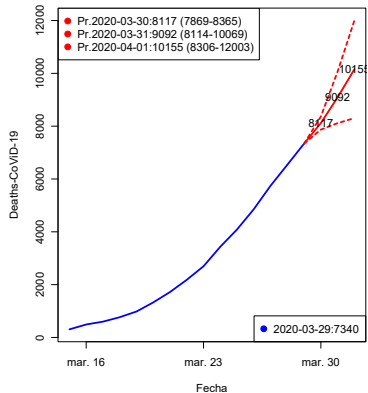
◀ Fallecidos

Fallecidos: España

Deaths cases:España-FLM



Deaths cases:España-NP

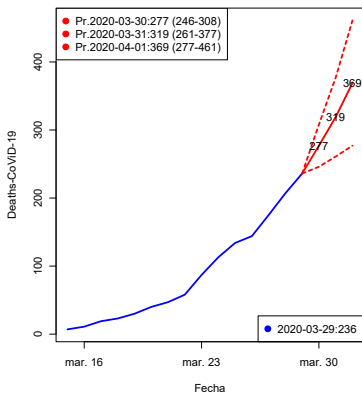


◀ Confirmados

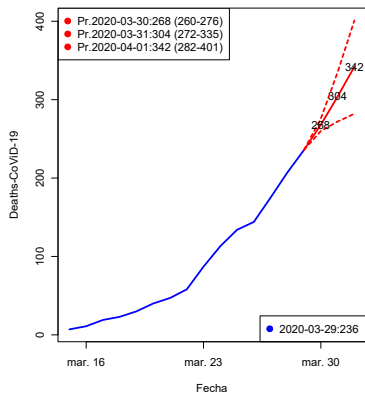
◀ Fallecidos

Fallecidos: Andalucía

Deaths cases:Andalucía-FLM



Deaths cases:Andalucía-NP

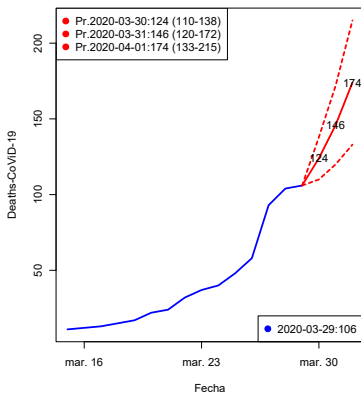


◀ Confirmados

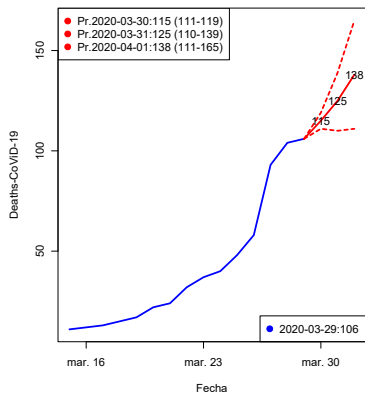
◀ Fallecidos

Fallecidos: Aragón

Deaths cases:Aragón-FLM



Deaths cases:Aragón-NP

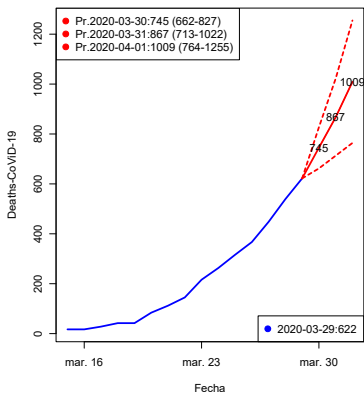


◀ Confirmados

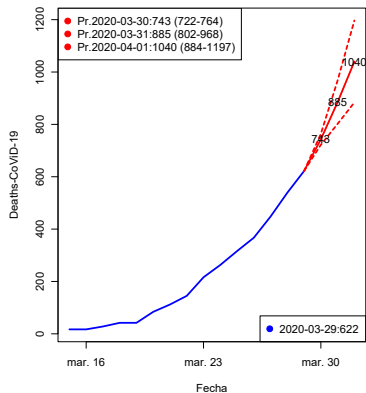
◀ Fallecidos

Fallecidos: Castilla-La Mancha

Deaths cases:Castilla.La.Mancha-FLM



Deaths cases:Castilla.La.Mancha-NP

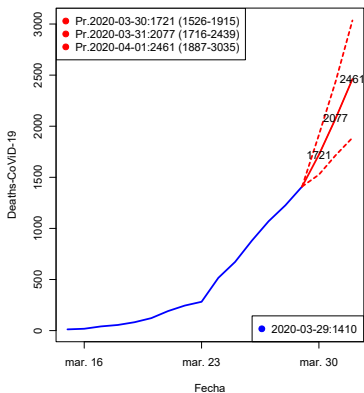


◀ Confirmados

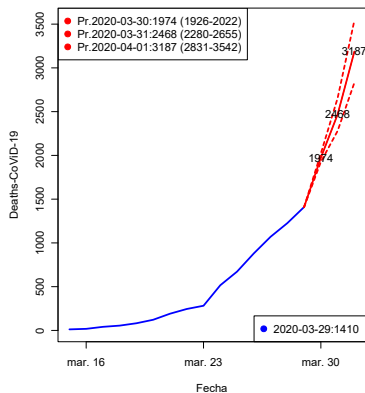
◀ Fallecidos

Fallecidos: Cataluña

Deaths cases:Cataluña-FLM



Deaths cases:Cataluña-NP

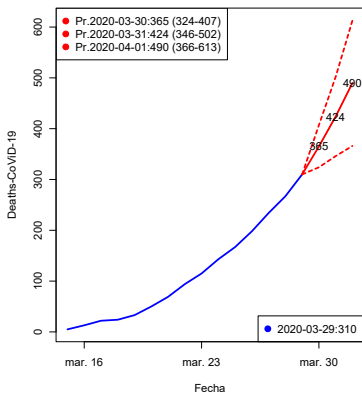


◀ Confirmados

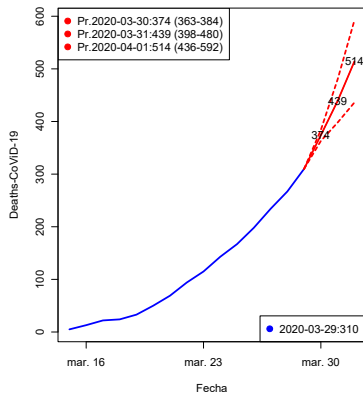
◀ Fallecidos

Fallecidos: C. Valenciana

Deaths cases:C..Valenciana-FLM



Deaths cases:C..Valenciana-NP

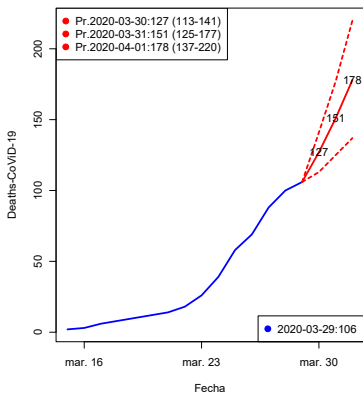


◀ Confirmados

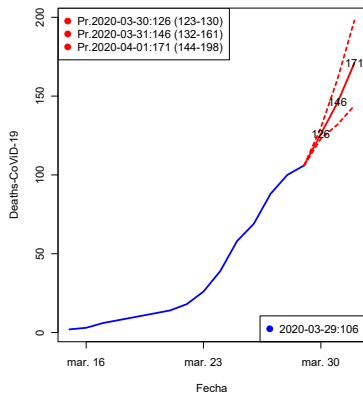
◀ Fallecidos

Fallecidos: Extremadura

Deaths cases:Extremadura-FLM



Deaths cases:Extremadura-NP

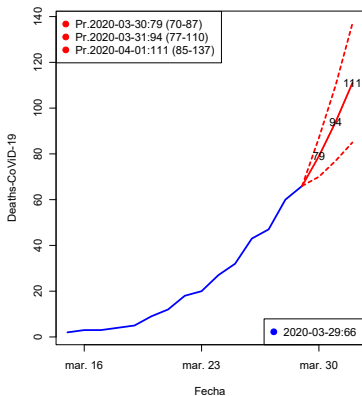


◀ Confirmados

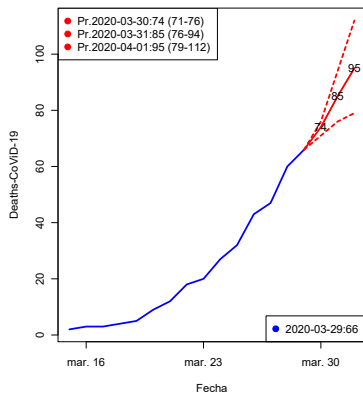
◀ Fallecidos

Fallecidos: Galicia

Deaths cases:Galicia-FLM



Deaths cases:Galicia-NP

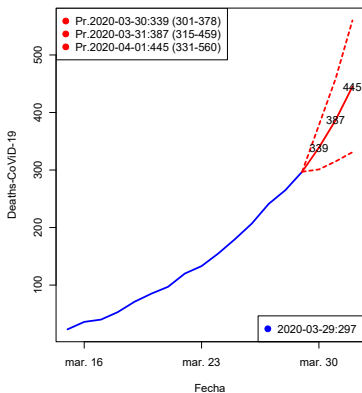


◀ Confirmados

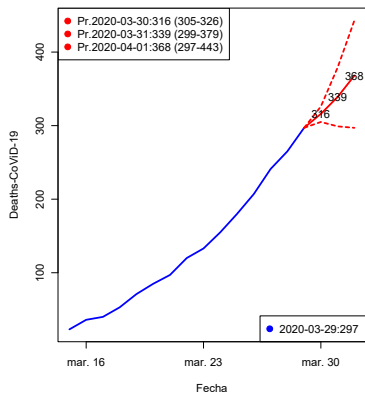
[◀ Fallecidos](#)

Fallecidos: Euskadi

Deaths cases:Euskadi-FLM

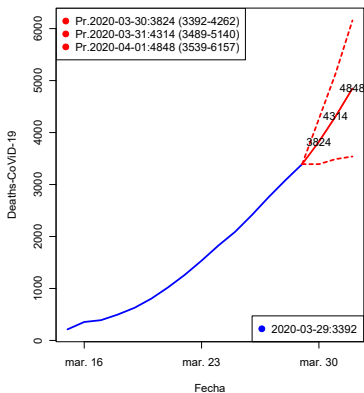


Deaths cases:Euskadi-NP

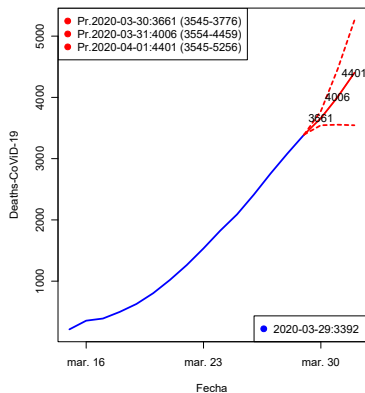


Fallecidos: Madrid

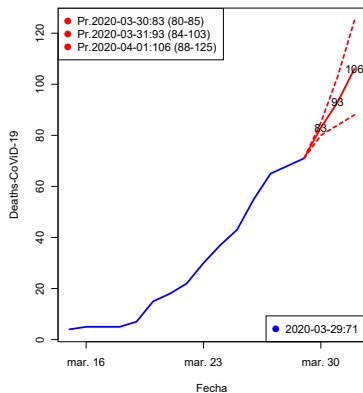
Deaths cases:Madrid-FLM



Deaths cases:Madrid-NP



Deaths cases:La.Rioja-NP



Breve descripción del Modelo de predicción

Objetivo: Predecir ratio de incremento a 1, 2, o 3 días: $r^{(k)}(t) = \frac{x_{t+k} - x_t}{x_t + 1}$

Información usada: Pasado de esta variable a un retardo durante los últimos 15 días: $R^{(1)} = \{r^{(1)}(-14), \dots, r^{(1)}(0)\}$.

Datos para alimentar el modelo:

https://github.com/CSSEGISandData/COVID-19/tree/master/csse_covid_19_data/csse_covid_19_time_series/. Algunas series de tiempo (como el Cruise Ship) son filtrados por inconsistencia, presunta falta de veracidad o por valores bajos. En la predicción final se reconstruye el número de casos esperado.

Se construyen tres modelos funcionales de la regresión general: $r^{(k)}(0) = f(R^{(1)}) + \epsilon$ donde la diferencia radica en la forma de la función f

- Lineal: $f(R^{(1)}) = \int_{-14}^0 R^{(1)}(t)\beta(t)dt$
- NP: f es una estimación no paramétrica tipo núcleo.
- SAM: f es una combinación aditiva de funciones suaves de las componentes principales.