



Covid-19 forecasting in Morocco using FBprophet Facebook's Framework in Python

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ABSTRACT

Coronavirus Disease COVID-19 is a virus identified as the cause of an outbreak of severe acute respiratory syndrome detected first in Wuhan, China, On 31 December 2019. It has already taken a pandemic form, affecting over 200 countries in a few months. On March 3rd, 2020, the Moroccan Minister of Health announced the first case of coronavirus on March 2nd in Morocco, which was a Moroccan citizen who was returning from a trip to Italy. Then the pandemic spread has grown exponentially with more than 100,000 confirmed cases as of September 23th, 2020. After the partial lifting of containment in Morocco, the number of new cases reported daily is rising day by day. This study gives an indication of forecasting the spread of COVID-19 in the coming 4 months by Facebook Framework (FBprophet) using in python. This might be helpful for decision-makers and health authorities to evaluate risks and take proper precautions and strategies to minimize the spread of infectious diseases.

Key words: COVID-19, Framework, Prediction, Morocco, FBprophet

1. INTRODUCTION

Coronavirus is one of the major microorganisms that targeted primarily the human respiratory system with a high public health treat. It was responsible for two outbreaks including the severe acute respiratory syndrome (SARS)-CoV and the Middle East respiratory syndrome (MERS)-Cov [1].

On December 31st, China has reported to the World Health Organization (WHO) a severe acute respiratory syndrome of unknown etiology in Wuhan [2, 3], which later turned to be Coronavirus SARS-CoV-2, the most contagious and quickly spreading entity of the Corona Virus family[1] which is locking up billions of people[4]. Coronavirus disease (COVID-19) as scientifically named by the World Health Organization in Feb [5] The first cases of Coronavirus was

identified in Wuhan in December 2019 [6] in a cluster of patients sharing a history of visiting the seafood and wet animals market of Wuhan [7], which suggest the likely zoonotic origin of this disease [1]. after incubation of 5,2 days approximatively, symptoms appear and are dominated by fever, cough, and fatigue, while other symptoms include respiratory involvement such are sputum production, head-ache, hemoptysis dyspnea, diarrhea, and hematological involvement(lymphopenia)[8-10]. Most people affected with the COVID-19 are elderly [11], patients with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease. Those people are more likely to develop serious illnesses.

With 37,756,558 world confirmed cases and 1,081,528 confirmed deaths (~3%) as on 12th October 2020 [12], COVID-19 has already surpassed the previous records for two coronaviruses SARS-CoV and MERS-CoV, which represents the biggest threat to the health and world economy after the second world war [13].

Morocco is not far behind the pandemic. On March 3rd, 2020, the Minister of Health announced the first case of coronavirus detected on March 2nd in Morocco [14]; a Moroccan citizen who was returning from a trip to Italy. Then, On March 16th, 2020, the Moroccan Government was implemented measures to slow and limit the spread of viral transmission of COVID-19 by adopting the following measures:

School closures

Maintaining social distancing

Bans on events and gatherings

Suspension of cultural, educational, sporting activities

Suspending all public traffics within the city on 21th March 2020 except for freight transport

Despite the best efforts, certainly important, on September 23th, 2020 the Moroccan ministry of public health [15] and Maghreb Arab Press of Morocco (MAP) [16] announced a total of 107,743 confirmed cases of infection with COVID-19 and a total of 1918 deaths (~2%).

A few days after the announcement, on June 19th, 2020, of the lifting of containment, several epidemiological foci of the coronavirus appeared in certain units specializing in the packaging of fruits in the province of Kenitra, as well as in

industrial circles in Tangier as the biggest number of the confirmed case till now, more than 500 cases have been recorded in one fell swoop, compared to an average of about 100 in containment. This is the highest daily toll since the announcement of the first contamination. For the moment, the situation is not worrying because they are not scattered cases. But the second wave is not immune, because the number of tests increased, the factories are opened, economic activity is resuming, so it would not be surprising. There is a risk of a relapse and a second wave of the pandemic's spread given the current unprecedented health crisis. The second wave could, in theory, be more important than the first, since many people are still sensitive. The prospect of a second wave of Covid-19 in Morocco is not excluded.

Daily information about affected people can provide valuable information[17] when it is made available for the data scientist community to analyze and provides forecasting for decision-makers, which will allow them to deal with the situation properly. Indeed, the model used in this prediction study presents a margin of error due to the influence of the presence of effective treatment and/or vaccine can influence this prediction.

2. MATERIALS AND METHODS

2.1 Experimental Data

The dataset has daily level information on the number of affected cases by COVID-19, the period starts on the 02nd of March 2020 and ends on the 29th of August 2020. It must be noted that this period was characterized by daily data regarding confirmed cases in Morocco on any given day which is a cumulative number. The data is freely available and has been extracted through the data repository maintained by the Johns Hopkins University[18].

2.2 FBprophet framework

FBProphet is an open-source forecasting framework developed by Facebook's team data scientist. It is used for forecasting time series data based on an additive model which can make the task of forecasting more accessible and easier to carry out. It works best with time series that have strong seasonal effects and several seasons of historical data[19]. FBProphet uses ARIMA, exponential models, and other similar regressive models.

The time series which is wanted to be predicted by using FBprophet [19] in Python is the number of accumulated confirmed cases (C) of COVID-19 in Morocco. The idea is that historical time series records can be used to forecast the values of the four coming months. Moreover, the FBprophet is based on decomposable time-series combined in this equation

$$y(t) = g(t) + s(t) + h(t) + \epsilon t$$

and which consists of three main components:

- $g(t)$: represents the trend function; piecewise linear or logical growth to fit non-periodic changes in the value of the time series

- $s(t)$: represents the periodic changes as a week and/or year seasonality
- $h(t)$: represents the effects of holidays that occur on irregular schedules over a day or more.
- ϵt : represents any unusual change which is not accommodated by the model.

2.3 Solution method

Open source tools in optimization and performance have grown in popularity over the last years[20, 21] and can be observed in works like the optimization process in supply chain management [20, 22] and machine learning applications. The approach adopted for forecasting the spread of COVID-19 in Morocco using open-source is represented in this study by BFprophet. The basics steps of the prediction procedure method of our model are shown in figure 1:

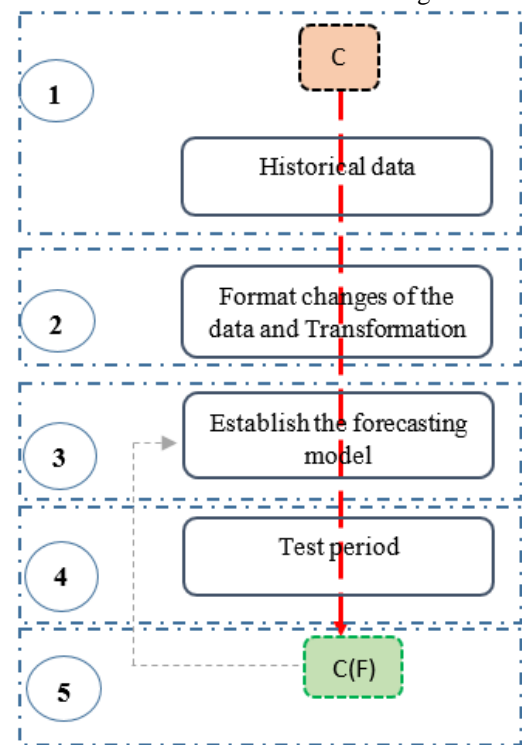


Figure 1: prediction procedure method

- 1- Daily collect historical time series records announced by the Ministry of Public Health of Morocco [15] and Maghreb Arab Press of Morocco (MAP)[16].
- 2- Since the dataset is made of daily records, they need to be converted to date instead of a string format. Then the transformation of the Confirmed cases should be applied by logarithmic function to be linear.
- 3- Based on the historical dataset, the model will be fitted by the framework of FBprophet.
- 4- According to the forecasting model fitted a suitable algorithm generated to predict the defined period.

5- The results of Confirmed cases forecasting C(F) depend on the quantity and quality of the dataset injected and fitted in the model to forecast. In particular, we assume that the average frequency and magnitude of trend changes in the future will be the same as that which we observe in the historical time series.

3. RESULTS

The predicted fit model based on the transformed number of confirmed cases by the logarithm(C), has generated a quite well plot prediction (figure 2) for the coming days.

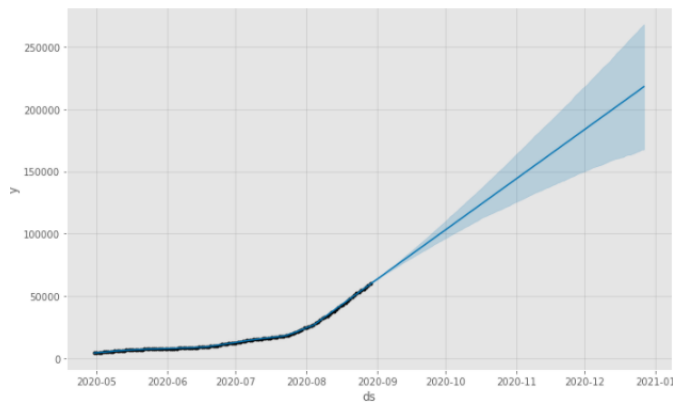


Figure 2: Forecasting Plot of the coming days by Log

Moreover, the framework of FBprophet will create a new dataset (APPENDIX 1) assigned to the forecast variable that contains the forecasted values for future dates under the column yhat which represent forecasting based on linear regression, as well as an interval in both ways’, a sigmoid (yhat_lower) curve as the second and desirable scenario if the citizens respect the instructions of the Moroccan authorities, otherwise, an exponential (yhat_upper) curve will be followed as the third no desirable scenario. This means that many confirmed cases can vary from lowest to highest.

The forecast plot (figure 3) draws the original data (red dots and line), the forecasting model (blue dots and line), and the two scenarios of the forecast (shaded blue area).

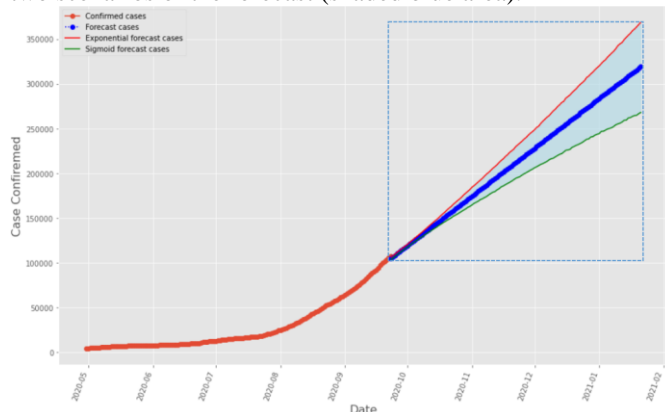


Figure 3: Forecast plot including Confirmed cases, forecast confirmed cases and uncertainty intervals

The forecasting model and component (figure 4) visualizations show the underlying trend in the predicted trend as a linear trend, while also accurately modeling weekly seasonality (e.g. upper confirmed cases on Saturday and Sunday). This trend analysis can be used to effectively shows where to led resources up to weeks and months in the future on the pandemic.

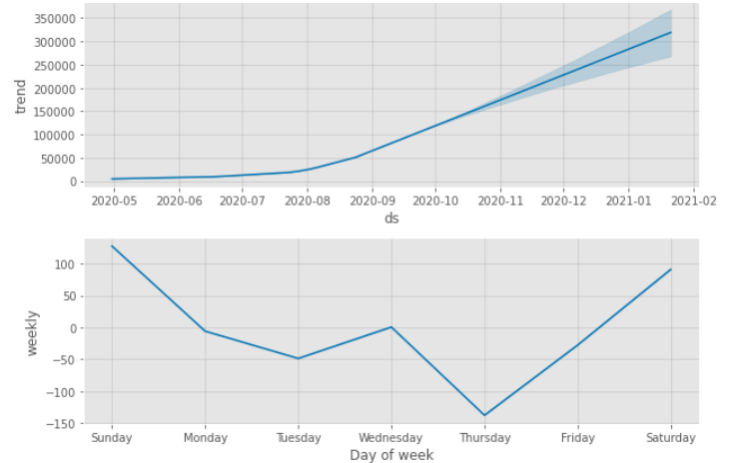


Figure 4: The trend and the weekly seasonality plot

4. MODEL VALIDATION

In order to find out how the model performs some form of validation was needed. Fortunately, the Prophet library makes it possible to divide our historical data into training data and testing data for cross validation.

The resulting dataset can now be used to compute error measures of yhat aforementioned, which was plotted as a chart with some legend to help understanding in a more visual way and gives as a results of validation (Table 1) using the statistics computed are mean squared error (MSE), root mean squared error (RMSE), mean absolute error (MAE), mean absolute percent error (MAPE), and coverage of the yhat_lower and yhat_upper estimates.

Table 1: Listing the performance data frame gives us the following

Horizon	Mse	Rmse	Mae	Maape	Mdape	Coverage
9 days	6.405898e+05	800.368528	776.513857	0.061254	0.056904	0.0
10 days	8.424479e+05	917.849624	873.389707	0.067018	0.060468	0.0
11 days	1.031520e+06	1015.637489	963.423658	0.072229	0.061642	0.0
12 days	1.239342e+06	1113.257587	1059.578427	0.077767	0.069815	0.0
13 days	1.419011e+06	1191.222471	1143.122350	0.082361	0.090917	0.0
14 days	1.623446e+06	1274.145392	1230.728643	0.087015	0.098249	0.0
15 days	1.873432e+06	1368.733902	1340.182119	0.093153	0.101200	0.0
16 days	2.105210e+06	1450.934258	1435.655411	0.098183	0.103522	0.0

5. CONCLUSION

This study provides a trend mechanism as seen by FBprophet of pandemics of coronavirus (COVID-19) spread from 23th September 2020 to 21th January 2020, which can provide valuable insight for the national competent authorities; In future research, we plan to pair this research with Deep Learning models such as the Deep Sequential Prediction Model (DSPM) and compare it with the FBprophet result's to refine the prediction models to further improve the prediction of the spread of this disease.

APPENDIX

APPENDIX 1: Evolution of the coronavirus in the coming days in morocco

OBSERVATION	YHAT	YHAT_LOWER	YHAT_UPPER
23/09/2020	104841.782	103409.859	106359.748
24/09/2020	106490.238	105160.897	107888.699
25/09/2020	108387.162	106883.298	109704.035
26/09/2020	110292.612	108796.223	111738.901
27/09/2020	112115.975	110650.907	113493.245
28/09/2020	113769.399	112300.570	115267.931
29/09/2020	115513.375	114090.874	117134.935
30/09/2020	117349.409	115808.327	118882.885
01/10/2020	118997.865	117374.465	120582.509
02/10/2020	120894.789	119027.173	122634.255
03/10/2020	122800.239	121034.147	124592.609
04/10/2020	124623.602	122700.594	126522.325
05/10/2020	126277.026	124263.612	128426.091
06/10/2020	128021.002	125762.357	130277.609
07/10/2020	129857.036	127632.299	132320.793
08/10/2020	131505.492	128892.723	134185.742
09/10/2020	133402.416	130700.969	136289.392
10/10/2020	135307.866	132366.024	138233.193
11/10/2020	137131.229	133945.821	140386.130
12/10/2020	138784.653	135419.031	142397.426
13/10/2020	140528.629	136921.732	144312.403
14/10/2020	142364.663	138389.758	146401.699
15/10/2020	144013.119	139766.206	148275.560
16/10/2020	145910.043	141575.488	150274.648
17/10/2020	147815.493	142962.352	152687.827
18/10/2020	149638.856	144580.887	154723.427
19/10/2020	151292.280	145908.213	156668.895
20/10/2020	153036.256	147466.855	159045.002
21/10/2020	154872.290	148799.002	161086.628
22/10/2020	156520.746	150206.366	162877.521
23/10/2020	158417.670	151990.569	165329.782
24/10/2020	160323.120	153163.108	167224.483
25/10/2020	162146.483	154488.205	169381.452
26/10/2020	163799.907	155971.124	171179.968
27/10/2020	165543.883	157467.571	173310.752
28/10/2020	167379.917	158865.892	175840.639
29/10/2020	169028.373	160199.616	177808.744
30/10/2020	170925.297	161936.506	179856.523
31/10/2020	172830.747	163022.125	181939.429
01/11/2020	174654.110	164597.725	184474.878
02/11/2020	176307.534	166421.475	186231.893
03/11/2020	178051.510	167541.162	188283.175
04/11/2020	179887.544	168853.149	190254.363
05/11/2020	181536.000	170532.590	192373.442
06/11/2020	183432.924	171512.309	194421.214
07/11/2020	185338.374	172859.098	196859.689
08/11/2020	187161.737	174086.704	199179.796
09/11/2020	188815.161	175885.656	200983.551
10/11/2020	190559.137	177405.943	203201.808
11/11/2020	192395.171	178797.944	205581.850
12/11/2020	194043.627	179577.650	207464.020
13/11/2020	195940.551	181483.788	209503.974
14/11/2020	197846.001	182777.821	212126.505
15/11/2020	199669.364	184808.046	214330.795
16/11/2020	201322.788	185821.159	216141.510
17/11/2020	203066.764	187268.111	218738.453
18/11/2020	204902.798	188496.861	220620.904
19/11/2020	206551.254	189778.696	223185.077
20/11/2020	208448.178	191139.084	225089.103
21/11/2020	210353.628	192805.465	226888.411
22/11/2020	212176.991	194379.732	229824.296
23/11/2020	213830.415	195286.240	231834.075
24/11/2020	215574.391	196252.199	233950.234
25/11/2020	217410.425	197968.887	235856.233
26/11/2020	219058.881	199410.855	238220.539
27/11/2020	220955.805	200650.466	240048.316
28/11/2020	222861.255	202018.203	242586.457
29/11/2020	224684.618	203404.451	244733.000
30/11/2020	226338.042	204620.075	246507.643
01/12/2020	228082.018	206153.233	248598.661
02/12/2020	229918.052	207295.588	251161.416
03/12/2020	231566.508	208603.097	252648.516
04/12/2020	233463.432	209931.148	255713.808
05/12/2020	235368.882	210863.513	258193.683
06/12/2020	237192.245	212081.015	260498.129
07/12/2020	238845.669	213265.507	262677.434
08/12/2020	240589.645	215077.418	264402.432
09/12/2020	242425.679	216200.580	267132.823
10/12/2020	244074.135	216835.261	269690.895
11/12/2020	245971.059	218366.675	271631.370
12/12/2020	247876.509	219747.382	274380.221
13/12/2020	249699.872	221128.410	276441.660
14/12/2020	251353.296	221822.866	278955.483

15/12/2020	253097.272	223650.741	280333.650
16/12/2020	254933.306	225630.286	283847.729
17/12/2020	256581.763	226032.513	285617.843
18/12/2020	258478.686	226722.806	287474.265
19/12/2020	260384.136	228920.857	290100.326
20/12/2020	262207.499	229987.146	292361.787
21/12/2020	263860.923	231254.641	294437.568
22/12/2020	265604.899	232131.775	297244.287
23/12/2020	267440.933	233342.461	299496.881
24/12/2020	269089.390	234605.256	301372.064
25/12/2020	270986.313	236235.531	303547.666
26/12/2020	272891.763	237949.654	306943.131
27/12/2020	274715.126	238370.694	308568.291
28/12/2020	276368.550	240497.649	311039.729
29/12/2020	278112.526	240955.766	313058.461
30/12/2020	279948.560	242559.365	315630.300
31/12/2020	281597.017	243565.968	317870.422
01/01/2021	283493.940	244207.422	319868.880
02/01/2021	285399.390	246783.026	322512.274
03/01/2021	287222.753	246917.452	324959.543
04/01/2021	288876.177	248153.345	326734.513
05/01/2021	290620.153	249383.625	329642.885
06/01/2021	292456.187	250123.616	331928.797
07/01/2021	294104.644	250842.364	334234.272
08/01/2021	296001.568	252326.180	336366.330
09/01/2021	297907.017	254208.322	339145.222
10/01/2021	299730.380	255086.510	342577.714
11/01/2021	301383.804	255966.647	344570.466
12/01/2021	303127.780	257236.277	346052.128
13/01/2021	304963.814	259210.880	349321.921
14/01/2021	306612.271	259362.057	351743.900
15/01/2021	308509.195	261750.592	354237.187
16/01/2021	310414.644	262235.786	356354.743
17/01/2021	312238.007	263557.703	359269.981
18/01/2021	313891.431	264523.543	361172.635
19/01/2021	315635.407	264793.778	363535.168
20/01/2021	317471.441	266610.038	366196.311
21/01/2021	319119.898	267953.638	368726.952

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CONFLICT OF INTEREST STATEMENTS

The authors declare no competing interests.

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AVAILABILITY OF DATA AND MATERIAL

All data generated or analysed during this study are freely available through the data repository maintained by the Johns Hopkins University

AUTHORS' CONTRIBUTIONS

Authors contributed equally to this manuscript

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