Functional Data Analysis: Transition from Daily Observation of COVID-19 Prevalence in France to Functional Curves

Presented by:
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Main Objectives

- Modeling the prevalence of the COVID-19 in France
- Analysis of COVID-19 Dynamics

Material and methods

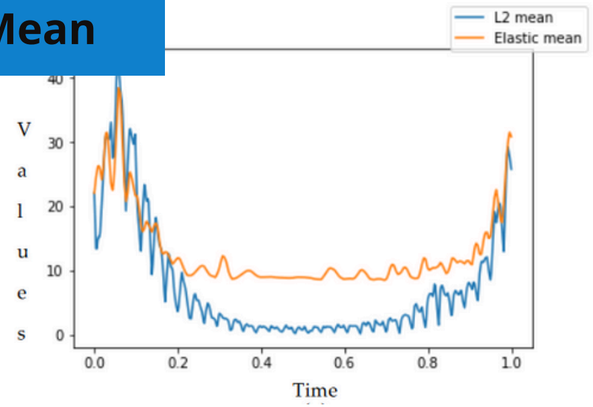
Fuctional Variables	Response variables	FDA techniques	Software
-Daily hospitalization -Daily deceased -Numbers of ICU cases -Daily return home	-Number of recoveries -Deaths -Infections -Vaccinations -Vaccination per 1000 population -Number of tests	-Smoothing techniques(Bspline Kernel,..) -FCCA -FPCA -K-means /Fuzzy K-means clustering	-Python and R

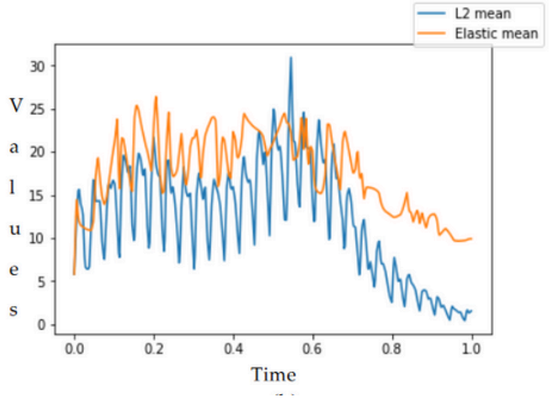
Functional Data preparation

Data smoothing :

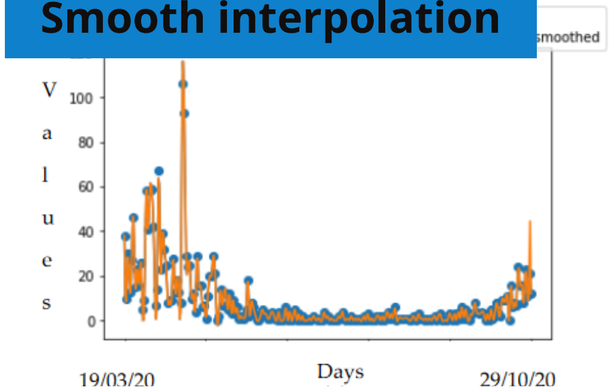
Hospitalized cases: H
Hospitalized when vaccination has started: HV

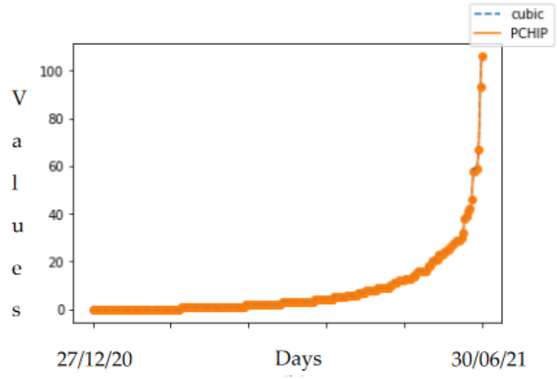
Mean



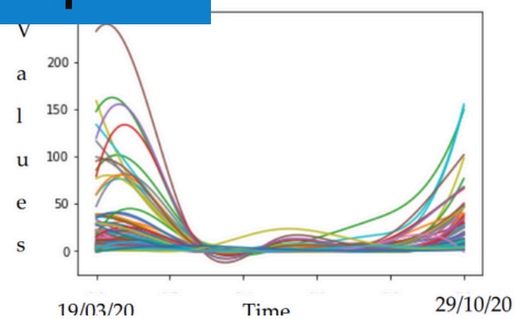


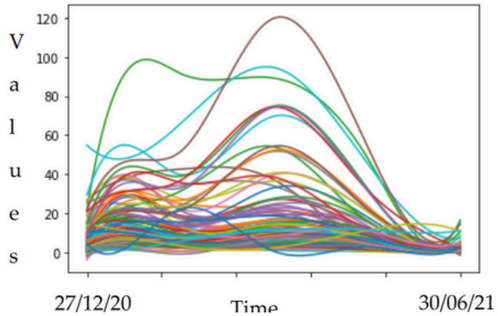
Smooth interpolation



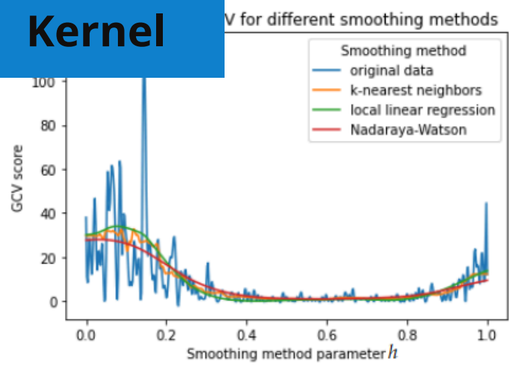


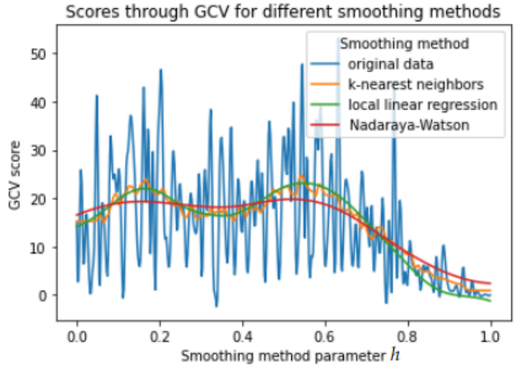
B-Spline





Kernel



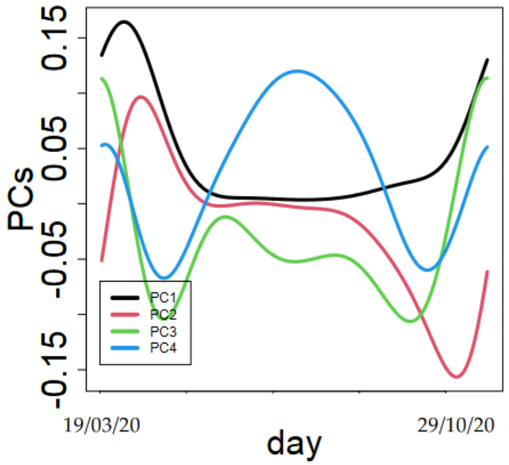


H **HV** **H** **HV**

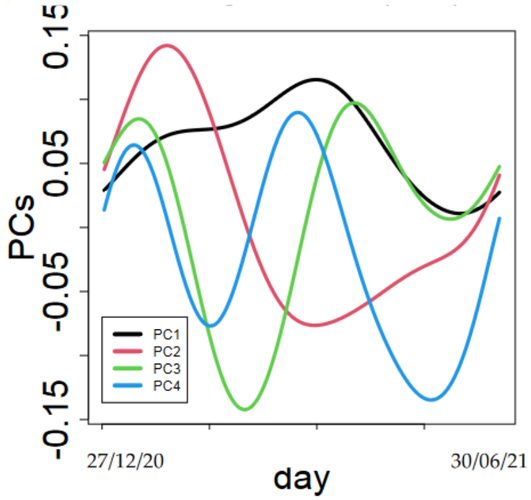
Analysis of COVID-19 Dynamics

Dynamic Analysis with FPCA:

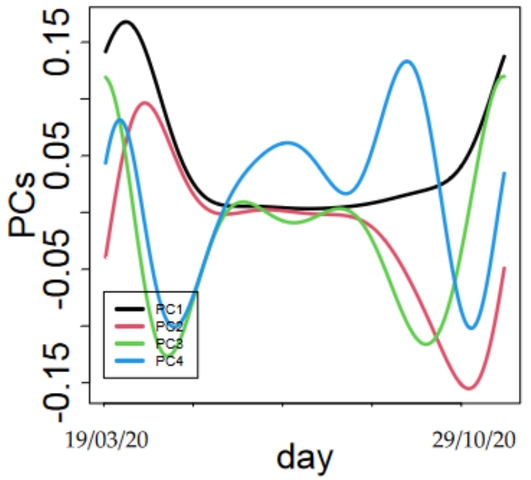
- Capture the main modes of variation in the COVID-19 data over time, providing insights into the dynamics of the pandemic in French departments before and after vaccination started.



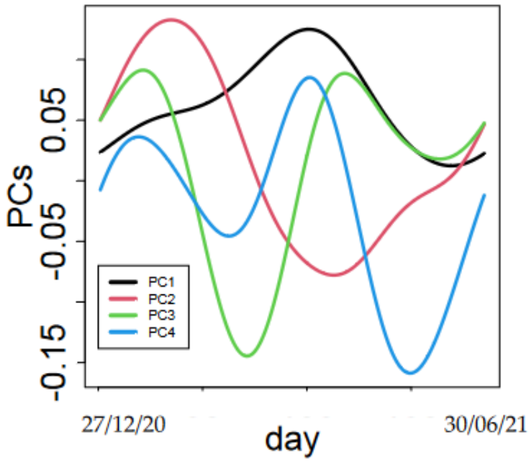
Hospitalized cases



Hospitalized cases when vaccination has started



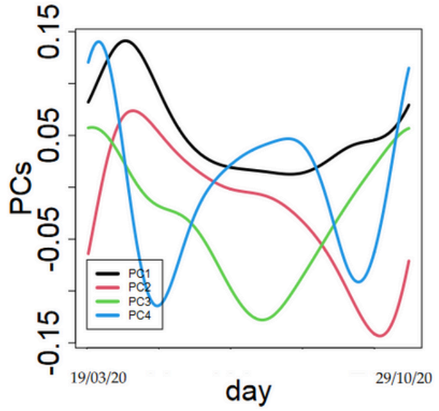
ICU cases



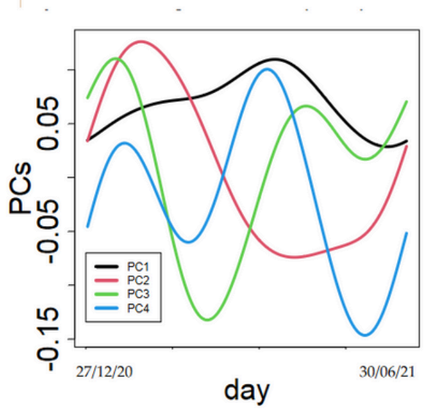
ICU cases when vaccination has started

Analysis of COVID-19 Dynamics

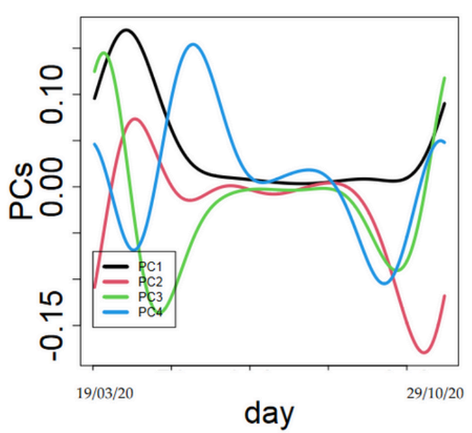
Dynamic Analysis with FPCA:



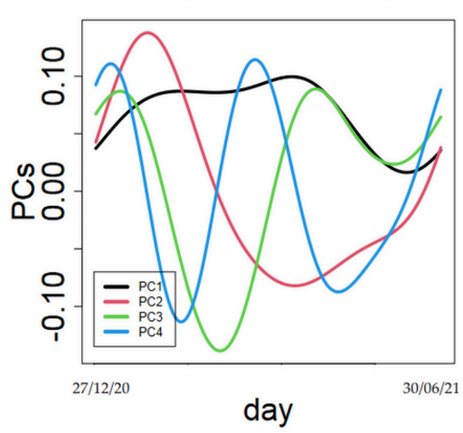
Daily return home



Daily return home when vaccination has started



Daily deceased

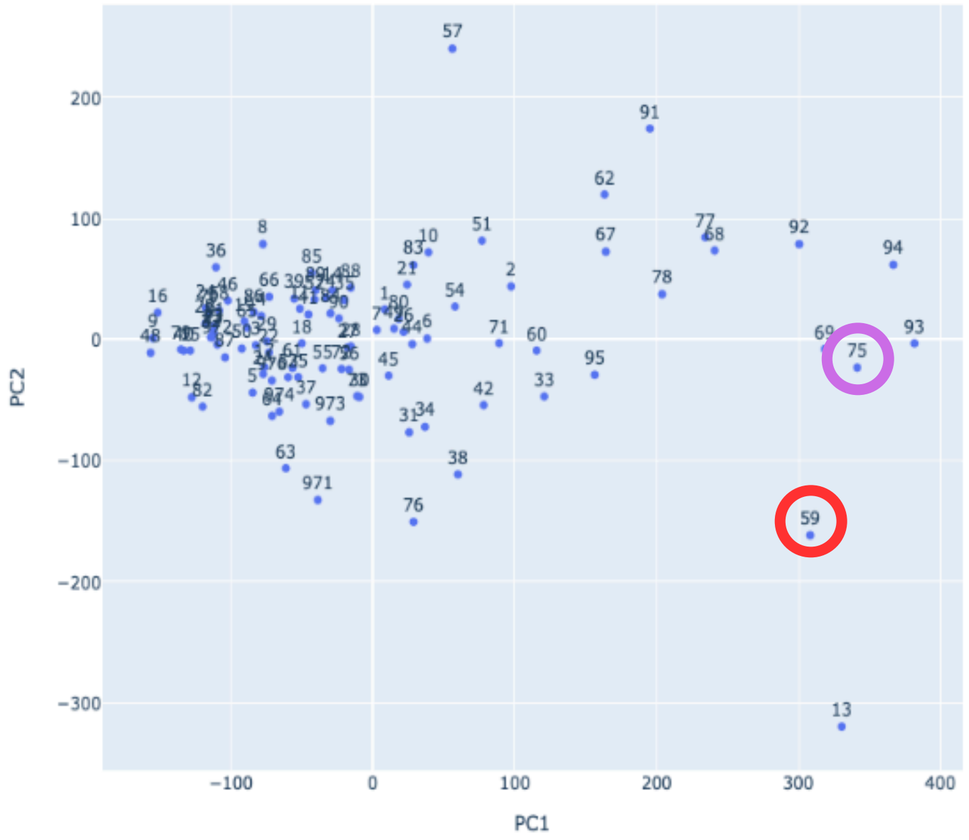


Daily deceased when vaccination has started

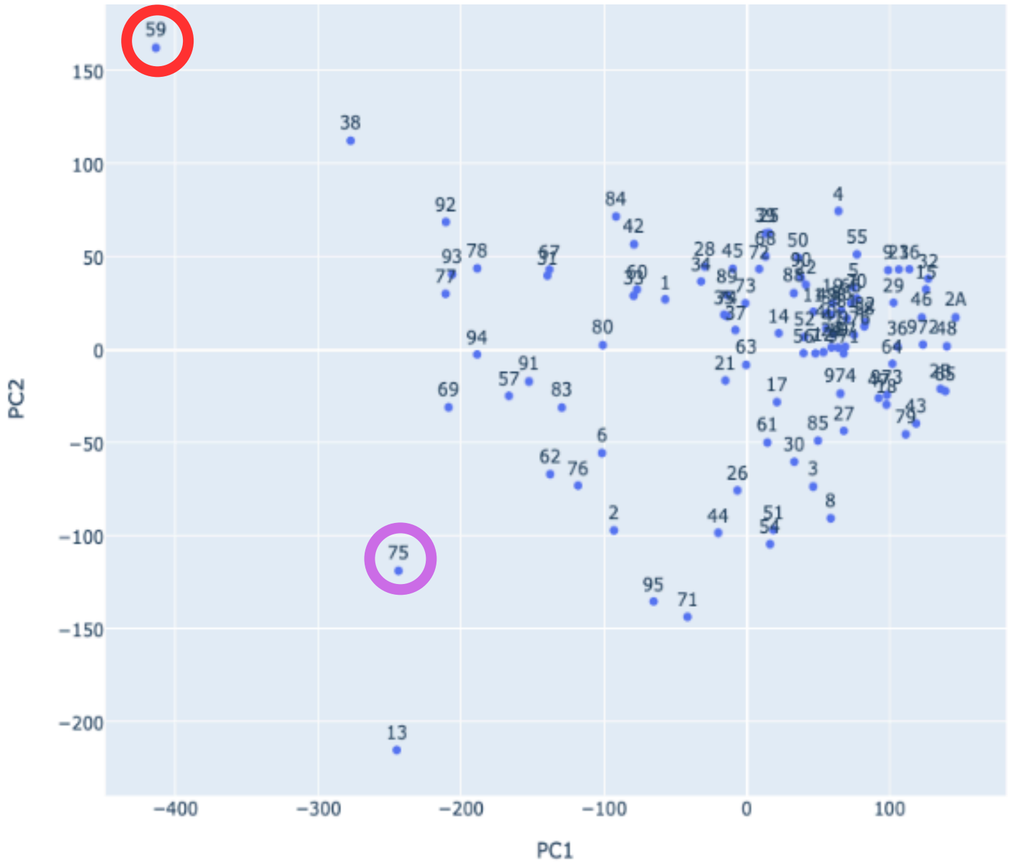
	Before vaccination started				After vaccination has started			
	PC1	PC2	PC3	PC4	PC1	PC2	PC3	PC4
Hospitalized	0.945	0.039	0.008	0.005	0.938	0.041	0.012	0.004
ICU	0.960	0.028	0.009	0.001	0.962	0.023	0.008	0.004
Daily return home	0.925	0.045	0.015	0.007	0.953	0.030	0.009	0.004
Daily deceased	0.965	0.017	0.013	0.003	0.914	0.055	0.016	0.010

FPCA scores and clusters

Hospitalized cases



Hospitalized when vaccination has started



There is a difference between the vaccination period in France and the period when measures like lockdown, social distancing etc. were only used to control the spread of the virus/ shift toward positive values of PC 1

Modeling the prevalence of the COVID-19 in France

Spatial Analysis with Clustering:

- **Regional differences in pandemic trends**

Hospitalized

Daily deceased

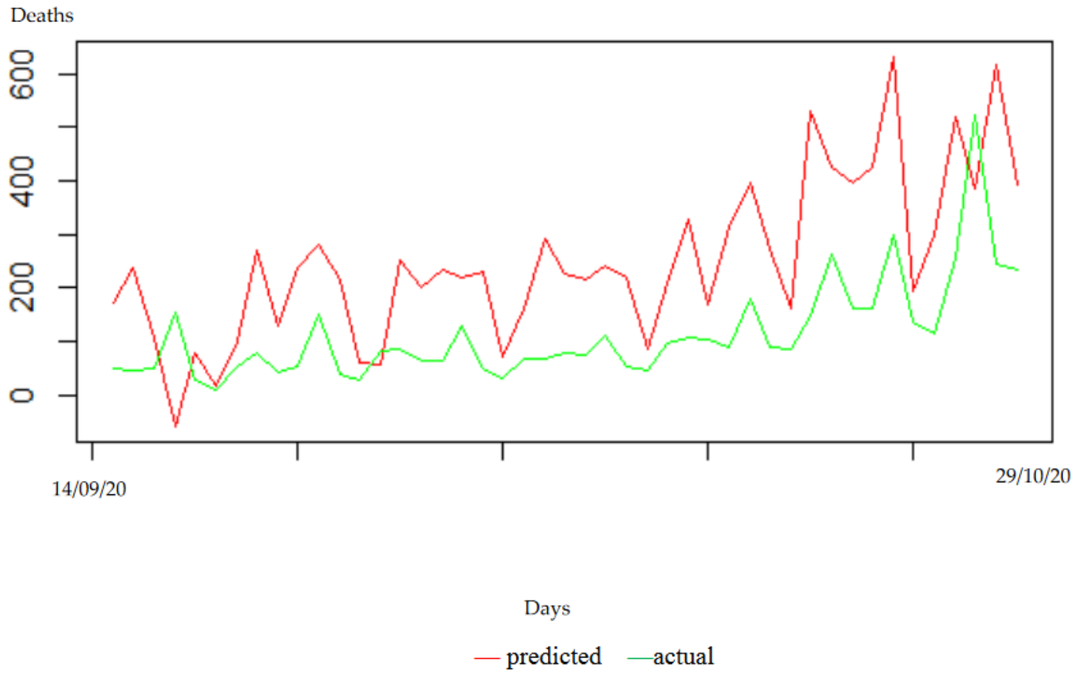
Daily return home when vaccination has started

ICU cases when vaccination has started

Making predictions about future trends

Predictive Modeling and Regression:

Discuss how function-on-function linear regression and predictive modeling techniques employed in FDA allow for making accurate predictions about future pandemic trends. Highlight the importance of these predictions for public health planning and intervention strategies.



Functional linear regression model prediction for number of deaths in France as response variable before vaccination begins

Conclusion

- Component 1: good predictor and close descriptor of the data
- Component 2: metric of effectiveness of pandemic regulation
- COVID 19 prevalence is different across french departments
- Visible patterns/differences between the period before vaccination and the period after vaccination