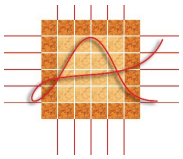

AMASES XLV
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45th Annual Meeting of the AMASES
Reggio Calabria, September 13-18,2021

Parallel session
"Pandemic issues and crisis management: modeling by artificial intelligence, machine learning and dynamical systems"

BOOK OF ABSTRACTS

Fuzzy fractional-order model and COVID-19 dynamics

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Extended Abstract[1]

In this work, a novel COVID-19 infection system with a fuzzy fractional differential equation (FDEs) defined in Caputo's sense is developed. By using the fuzzy Laplace method coupled with Adomian decomposition transform, numerical results are obtained for better understanding of the dynamical structures of the physical behavior of COVID-19. Such behavior on the general properties of RNA in COVID-19 is also investigated for the governing model. The results demonstrate the efficiency of the proposed approach to address the uncertainty condition in the pandemic situation. Some researchers put their focus on the transmission of 2019-nCoV virus among humans and its identification. It's well accepted that human-to-human transmission is leading to the rapid growth of infections. Ahmed claimed that viral strains from the infected people of the area have been sequenced; but only little genetic variation was found, implying that they have descended from a common ancestor. On the other hand, Zhou argued that sequences of the seven conserved viral replicase domains in ORF 1ab show 94.6 percent similarity in 2019-nCoV and SARS-CoV. Chaudhury et al. proved that computational protein–protein docking with accurate, physics-based energy functions is able to reveal the native-like, low-energy protein–protein complex from the unbound structures of two individual, interacting protein components. In our work we try to investigate 2019-nCoV infection system mathematically.

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In the last part of the work, it will be issued some new addressing research fields strictly related to the FDEs and related developments involved in ongoing studies.

Keywords
Approximate solutions; Fuzzy number; Fuzzy fractional order derivate; Coronavirus infection system; Adomian decomposition method.

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On Treating a Fractional Order Mathematical Model of COVID-19 and its variants Via Haar Wavelet Method

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Extended Abstract[1]

The human society, facing of having modern and complicated technologies in each stage of life, is determined to fight a dangerous enemy, know as novel COVID-19. As compared to developing world this virus affected more extremely the developed countries. This virus was for the first time come into view in city of China, Wuhan [1]. The statistics provided by World Health Organization (WHO) on 6th November 2020, COVID-19 affected great part of countries and territories around the globe [2].
If anyone with contact with the droplets emitted during the sneeze or cough of effected person is at risk to the virus attack. In order to prevent the transmission of spreading disease, all around the globe lock-down policy are implementing by

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all governments in their respective countries to ensure the safety of their citizens. In this circumstance, a lot of doctors, nurses and paramedics doctors and paramedics have committed themselves to provide services against the nCovid-2019. Experts compared the current virus with MERS and SARS to identify family of the virus to which it belongs so as to handle the current virus with the help of the studies done to deal with SARS and MERS in the past. Lu argued that the current nCovid-2019 relates to Beta-corona virus genus, like SARS-Cov and MERS-Cov [4].
This paper is devoted to investigate a fractional order mathematical model of the current novel Corona virus-19 infectious disease (COVID-19). Our investigation is devoted to existence theory and numerical approximation. For the required result of existence theory fixed point due to Shaufer's and Banach are used. Also for numerical analysis, Haar collocation (HC) techniques is used to handle the model under our consideration. Furthermore, it is noted that the derivative is taken in Caputo sense. For the respective numerical verification some available real data is used. Graphical interpretations corresponding to different compartments of the considered model against various fractional orders are given.

Keywords
COVID-19, Fractional operator, Existence theory, Haar wavelet.

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COVID-19 effects on the Canadian term structure of interest rates

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Extended abstract [1]

In Canada, COVID-19 pandemic triggered exceptional monetary policy interventions by the central bank, which in March 2020 made multiple unscheduled cuts to its target rate: from 1.75% to 0.25%. It is apparent that the monetary policy intervention of the Bank of Canada affects short-term yields. However, the impact on long-term yields is not straightforward. The goal of the paper is to assess the extent to which the Bank of Canada interventions affected the determinants of the term structure of bond yields during the first wave of COVID-19 pandemic.

To study the yield curve behavior across different time periods, we use a data set of Canadian 45 government bond yields ranging from May 1, 2018 to October 30, 2020, and we analyze these data employing a non-parametric approach within the framework of Functional Data Analysis (FDA). Specifically, we provide a comparative study on three sub-periods of the data set

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(the latter including COVID-19 outbreak). We employ depth-based functional boxplots to visualize the curve distribution in each period, and apply Functional Principal Component Analysis (Chapters 8 and 9 in [1]) to each sample of yield curves in order to elicit the components explaining the most variability in each period. In line with [3], we interpret such components as *level*, *slope* and *curvature*. The FDA analysis is complemented by the estimation of Nelson and Siegel (1987) exponential regression model ([2]) for the yield curve in each day – which allows us to describe the three factors from a different angle.

In a nutshell, we find that, during the pandemic, the long-run dependence of level and slope components of the yield curve is unchanged with respect to previous months, although the shape of the mean yield curve completely changed after target rate cuts. Bank of Canada was effective in lowering the whole yield curve and correcting the inverted hump of previous months, but it was not able to reduce the exposure to already existing long-run risks.

Keywords
Canadian yield curve; COVID-19; monetary policy; Functional Principal Components Analysis; smoothing.

Organized session
Pandemic issues and crisis management: modeling by artificial intelligence, machine learning and dynamical systems (Massimiliano Ferrara).

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Should the COVID-19 lockdown be relaxed or intensified in case a vaccine becomes available?

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Extended abstract [1]

Immediately after the start of the COVID-19 pandemic in Early 2020, most affected countries reacted with strict lockdown to limit the spread of the virus. Since that time, the measures were adapted on a short time basis according to certain measures (i.e. number of infected, utilization of intensive care units). Implementing a long-term optimal strategy was not possible since it was not possible to forecast when R&D will succeed in developing an effective vaccination. This paper closes this gap by assuming a stochastic arrival rate of the COVID-19 vaccine with the corresponding change in the optimal policy regarding the accompanying optimal lockdown measures. The first main finding is that the lockdown should be intensified after the vaccine approval if speed of the vaccination campaign is not very high. Secondly, anticipation of the vaccination arrival also leads to a stricter lockdown in the period without vaccination. For both findings an intuitive explanation is offered.

We use a standard SIR model and include lockdown intensity as a policy measure (presented in [1]), that has to be chosen optimally, as well as a stochastic arrival time of an efficient vaccination that subdivides the time horizon into two stages. We apply the novel approach of multi-stage optimal

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control models with random switching time presented in [3]. Based on the deterministic formulation (see [2]), the problem is transformed into an age-structured optimal control problem and solved numerically with established methods (see [4]). This approach allows to treat both stages simultaneously implying a detailed characterization of the link between the two stages.

Keywords
COVID-19; SIR; optimal control; stochastic switch; multi-stage.

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A novel Fuzzy dynamic expert system applied in economic with pandemic situations

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Extended abstract [1]

This study proposes a new fractional dynamic differential-based cobweb model that is built under fuzzy concept with pandemic parameter to make it well-adapted with this pandemic situation and make the model more efficiently dynamic in practice. The general solution of this new model is obtained using Laplace transform method. Considering the current uncertain conditions and the fact that using random, stochastic and other similar parameters are complex and increase the cost of computation which is critical in economic models, we employ fuzzy concept to address the uncertainty of parameters appearing in the cobweb model. The theoretical foundations of this letter is supported by a toy model in the last part where we exemplify the proficiency of the new model in terms of proposed pandemic parameter and investigate the unbalancing between demand and supply which is considered in the new model based on the current fact of world economy. Besides, this report analyzes the value of fuzzy equilibrium price by changing the values of pandemic parameter under different conditions. This new approach can be easily expanded to other economic models and approach to make them suitable, flexible and easily adaptable with similar situation which may be happen in near future.

Keywords Pandemic; Cobweb dynamical model; Uncertainty; Fractional derivative; Expert system.

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