CONCO-Team: CONtrol COvid19 Team

June 25, 2020

1 Introduction

CONCO-Team[1] is composed of different researches from universities and non-profit organizations of Spain, Italy, France, Germany, United Kingdom and Argentina. It was founded in March 2020. The main goals of CONCO-Team are:

(i) To join the efforts of different research groups to provide a coordinated and interdisciplinary response to Covid-19 pandemic.

(ii) To analyze state of the art in terms of availability of open data resources, and data-driven methodologies.

(iii) To develop methodologies and algorithms to generate consolidated data series to monitor and model the pandemic.

(iv) To develop epidemic models for the better understanding and control of the pandemic.

2 CONCO-Team members

Different researchers, from different countries and backgrounds, have already joined the team[2]:

- Spain:
  - University of Seville:
    - Dep. Ingeniería de Sistemas y Automática: Teodoro Alamo, Daniel Limón, Daniel Rodríguez, David Muñoz de la Peña, Daniel Carnerero, Pablo Krupa, David Soto, Juan Garrido.
    - Dep. Ingeniería Electrónica: Daniel G. Reina, Sergio Toral.
  - Universidad de Loyola Andalucía. Dep. of Engineering : Pablo Millán.
  - University of Almería. Department of Informatics. Automatic, Robotics and Mechatronics research group: Manuel Berenguel, Jose Luis Guzmán and Pablo Otálora.

[1] Conco is a little village in Veneto region, north Italy.

[2] If you are interested in joining the team, please contact Teodoro Alamo at conco.team@gmail.com

  - University of Huelva. Dep. of Economics: Emilio Congregado and Antonio Golpe.

- Italy:
  - National Research Council of Italy, Turin: Fabrizio Dabbene, Martina Mammarella and Chiara Ravazzi.
  - University of Trento:
    * Department of Industrial Engineering : Giulia Giordano.
    * Centre for Computational and Systems Biology (COSBI): Luca Marchetti.
  - Division of Infectious Diseases I, Fondazione IRCCS Policlinico San Matteo, Pavia: Marta Colaneri and Alessandro Di Filippo.

- Germany:
  - Technische Universität Berlin: Sergio Lucia.
  - Fiware Foundation: Alberto Abella.
  - Otto-von-Guericke University. Magdeburg: Rolf Findeisen, Anton Savchenko and Eric Bullinger.

- United Kingdom:
  - University of Oxford: Mark Cannon and Paul Goulart.

- France:
  - LAAS, Toulouse: Sophie Tarbouriech and Isabelle Queinnec.
  - Gipsa-Lab, Grenoble: Mirko Fiacchini, Mazen Alamir, Paolo Frasca and Federica Garin.

- Argentina:
  - CONICET, Santa Fe: Antonio Ferramosca.

- Brazil:
  - Departamento de Automação e Sistemas. Universidad Federal de Santa Catarina: Marcelo Menezes Morato, Julio Normey and Nestor Roqueiro.
  - Department of Chemical Engineering. Federal University of Bahia: Marcus V. Americano da Costa.

3 Covid19 initiatives organized or participated by CONCO-Team members

We enumerate here some of the initiatives that have been led, coordinated, or participated by members of CONCO-Team in the context of Covid-19. The list is not exhaustive, and some of the initiatives have also been promoted by other research groups or institutions.

3.1 Publications

1. **Modelling the COVID-19 epidemic and implementation of population-wide interventions in Italy** [5]: `https://www.nature.com/articles/s41591-020-0883-7`

   Abstract: In Italy, 128,948 confirmed cases and 15,887 deaths of people who tested positive for SARS-CoV-2 were registered as of 5 April 2020. Ending the global SARS-CoV-2 pandemic requires implementation of multiple population-wide strategies, including social distancing, testing and contact tracing. We propose a new model that predicts the course of the epidemic to help plan an effective control strategy. The model considers eight stages of infection: susceptible (S), infected (I), diagnosed (D), ailing (A), recognized (R), threatened (T), healed (H) and extinct (E), collectively termed SIDARTHE. Our SIDARTHE model discriminates between infected individuals depending on whether they have been diagnosed and on the severity of their symptoms. The distinction between diagnosed and non-diagnosed individuals is important because the former are typically isolated and hence less likely to spread the infection. This delineation also helps to explain misperceptions of the case fatality rate and of the epidemic spread. We compare simulation results with real data on the COVID-19 epidemic in Italy, and we model possible scenarios of implementation of countermeasures. Our results demonstrate that restrictive social-distancing measures will need to be combined with widespread testing and contact tracing to end the ongoing COVID-19 pandemic.

   CONCO-Team co-authors:

   - **Giulia Giordano**. Department of Industrial Engineering. University of Trento. Italy.
   - **Alessandro Di Filippo and Marta Colaneri**. Division of Infectious Diseases I, Fondazione IRCCS Policlinico San Matteo, Pavia. Italy.

2. **Open Data Resources for Fighting COVID-19** [3]: `https://arxiv.org/abs/2004.06111` (journal version avalible at `https://www.mdpi.com/2079-9292/9/5/827/pdf`)

   Abstract: We provide an insight into the open data resources pertinent to the study of the spread of Covid-19 pandemic and its control. We identify the variables required to analyze fundamental aspects like seasonal behaviour, regional mortality rates, and effectiveness of government measures. Open data resources, along with data-driven methodologies, provide many opportunities to improve the response of the different

administrations to the virus. We describe the present limitations and difficulties encountered in most of the open-data resources. To facilitate the access to the main open-data portals and resources, we identify the most relevant institutions, at a world scale, providing Covid-19 information and/or auxiliary variables (demographics, mobility, etc.). We also describe several open resources to access Covid-19 data-sets at a country-wide level (i.e. China, Italy, Spain, France, Germany, U.S., etc.). In an attempt to facilitate the rapid response to the study of the seasonal behaviour of Covid-19, we enumerate the main open resources in terms of weather and climate variables.

CONCO-Team co-authors:

- **Teodoro Alamo**. Dep. Ingeniería de Sistemas y Automática. University of Sevilla. Spain.
- **Daniel G. Reina and Pablo Millán Gata**. Dep. Ingeniería Electrónica. University of Sevilla. Spain.
- **Martina Mammarella**. National Research Council of Italy, Turin.
- **Alberto Abella**. Fiware Foundation. Germany.

3. **Data-Driven Methods to Monitor, Model, Forecast and Control Covid-19 Pandemic: Merging Data Science, Epidemiology and Control Theory** [**2**]: `https://arxiv.org/pdf/2006.01731.pdf`

   Abstract: This document analyzes the role of data-driven methodologies in Covid-19 pandemic. We provide a SWOT analysis and a roadmap that goes from the access to data sources to the final decision-making step. We aim to review the available methodologies while anticipating the difficulties and challenges in the development of data-driven strategies to combat the Covid-19 pandemic. A 3M-analysis is presented: Monitoring, Modelling and Making decisions. The focus is on the potential of well-known data-driven schemes to address different challenges raised by the pandemic: i) monitoring and forecasting the spread of the epidemic; (ii) assessing the effectiveness of government decisions; (iii) making timely decisions. Each step of the roadmap is detailed through a review of consolidated theoretical results and their potential application in the Covid-19 context. When possible, we provide examples of their applications on past or present epidemics. We do not provide an exhaustive enumeration of methodologies, algorithms and applications. We do try to serve as a bridge between different disciplines required to provide a holistic approach to the epidemic: data science, epidemiology, control-theory, etc. That is, we highlight effective data-driven methodologies that have been shown to be successful in other contexts and that have potential application in the different steps of the proposed roadmap. To make this document more functional and adapted to the specifics of each discipline, we encourage researchers and practitioners to provide feedback[3]. We will update this document regularly.

   CONCO-Team co-authors:

[3] conco.team@gmail.com

- **Teodoro Alamo**. Dep. Ingeniería de Sistemas y Automática. University of Sevilla. Spain.
- **Daniel G. Reina**. Dep. Ingeniería Electrónica. University of Sevilla. Spain.
- **Pablo Millán Gata**. Dep. Ingeniería. Universidad de Loyola Andalucía. Spain.

4. **An Optimal Predictive Control Strategy for COVID-19 (SARS-CoV-2) Social Distancing Policies in Brazil** [6]: `https://arxiv.org/abs/2005.10797`

Abstract:

The global COVID-19 pandemic (SARS-CoV-2 virus) is the defining health crisis of our century. Due to the absence of vaccines and drugs that can help to fight it, the world solution to control the spread has been to consider public social distance measures that avoids the saturation of the health system. In this context, we investigate a Model Predictive Control (MPC) framework to determine the time and duration of social distancing policies. We use Brazilian data in the period from March to May of 2020. The available data regarding the number of infected individuals and deaths suffers from sub-notification due to the absence of mass tests and the relevant presence of the asymptomatic individuals. We estimate variations of the SIR model using an uncertainty-weighted Least-Squares criterion that considers both nominal and inconsistent-data conditions. Moreover, we add to our versions of the SIR model an additional dynamic state variable to mimic the response of the population to the social distancing policies determined by the government that affects the speed of COVID-19 transmission. Our control framework is within a mixed-logical formalism, since the decision variable is forcefully binary (the existence or the absence of social distance policy). A dwell-time constraint is included to avoid harsh shifting between these two states. Finally, we present simulation results to illustrate how such optimal control policy would operate. These results point out that no social distancing should be relaxed before mid August 2020. If relaxations are necessary, they should not be performed before the beginning this date and should be in small periods, no longer than 25 days. This paradigm would proceed roughly until January/2021. The second peak of infections, which has a forecast to the beginning of October, can be reduced if the periods of no-isolation days are shortened.

CONCO-Team co-authors:

- **Marcelo Menezes Morato**. Departamento de Automação e Sistemas. Universidad Federal de Santa Catarina. Brazil.
- **Julio Normey**. Departamento de Automação e Sistemas. Universidad Federal de Santa Catarina. Brazil.

5. **Characterization of SARS-CoV-2 Dynamics in the Host** [1] : `https://arxiv.org/abs/2006.08447`

   Abstract:

   While many epidemiological models have being proposed to understand and handle COVID-19, too little has been invested to understand how the virus replicates in the human body and potential antiviral can be used to control the replication cycle. In this work, using a control theoretical approach, validated mathematical models of SARS-CoV-2 in humans are properly characterized. A complete analysis of the main dynamic characteristic is developed based on the reproduction number. The equilibrium regions of the system are fully characterized, and the stability of such a regions, formally established. Mathematical analysis highlights critical conditions to decrease monotonically SARS-CoV-2 in the host, such conditions are relevant to tailor future antiviral treatments. Simulation results show the potential benefits of the aforementioned system characterization.

   CONCO-Team co-author:

   - **Antonio Ferramosca**. CONICET, Santa Fe, Argentina.

3.2 Workshops

IEEE-CSS Italy Chapter has organized an online workshop entitled "*Modeling and Control of the Covid-19 Outbreak. How dynamical models can help control the epidemic*". The workshop took place on Friday, April 24, from 9.30 AM to 5.20 PM (Italian time). All talks[4] are posted separately on the YouTube Channel of IEEE-CSS Italy[5].

CONCO-Team participants:

- **Fabrizio Dabbene** (National Research Council of Italy, Turin) organized the workshop as chair of the IEEE-CSS Italy Chapter.
- **Giulia Giordano**, (Department of Industrial Engineering. University of Trento) presented the work *A new epidemiological model to understand and predict the Covid-19 outbreak: the Italian case*. A joint work with **Alessandro Di Filippo and Marta Colaneri** (Division of Infectious Diseases I, Fondazione IRCCS Policlinico San Matteo, Pavia) and other researches [4]. The presentation is available on the YouTube Channel of IEEE-CSS Italy[6].

[4] Final program available at `http://www.ieeecss.it/events/covid.html`.
[5] `https://www.youtube.com/channel/UCu9VNSqqvD2FrV6ieA__t1w`.
[6] `https://www.youtube.com/watch?v=_UQaanq1Fc0`

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