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Understanding the current COVID-19 epidemic: one question, one model

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By *the CoVprehension Collective*

(A contribution to the: JASSS-Covid19-Thread)

On the evening of 16th March 2020, the French president, Emmanuel Macron announced the start of a national lockdown, for a period of 15 days. It would be effective from noon the next day (17th March). On the 18th March 2020 at 01:11 pm, the first email circulated in the MicMac team, who had been working on the micro-macro modelling of the spread of a disease in a transportation network a few years. This email was the start of CoVprehension. After about a week of intense emulation, the website was launched, with three questions answered. A month later, there were about fifteen questions on the website, and the group was composed of nearly thirty members from French research institutions, in a varied pool of disciplines, all contributing as volunteers from their confined residence.

CoVprehension in principles

This rapid dynamic originates from a very singular context. It is tricky to analyse it given that the COVID-19 crisis is still developing. However, we can highlight a few fundamental principles leading the project.

The first principle is undeniably a **principle of action**. To become an actor of the situation first, but this invitation extends to readers of the website, allowing them to run the simulation and to change its parameters; but also more broadly by giving them suggestions on how to link their actions to this global phenomenon which is hard to comprehend. This empowerment also touches upon principles of social justice and, longer term, democracy in the face of this health crisis. By accompanying the process of social awareness, we aim to guide the audience towards a free and informed consent (cf. code of public health) in order to confront the disease. Our first principle is spelled out on theCoVprehension website in the form of a list of objectives that the CoVprehension collective set themselves:

- **C**omprehension (the propagation of the virus, the actions put in place)
- **O**bjectification (giving a more concrete shape to this event which is bigger than us and can be overwhelming)
- **V**isualisation (showing the mechanisms at play)
- **I**dentification (the essential principles and actions to put in place)
- **D**o something (overcoming fears and anxieties to become actors in the epidemic)

The second founding principle is that of an **interdisciplinary scientific collective formed on a voluntary basis**. CoVprehension is self-organised and rests on three pillars: volunteering, collaborative work and the will to be useful during the crisis by offering a space for information, reflection and interaction with a large audience.

As a third principle, we have **agility and reactivity**. The main idea of the project is to answer questions that people ask, with short posts based on a model or data analysis. This can only be done if the delay between question and answer remains short, which is a real challenge given the complexity of the subject, the high frequency of scientific literature being produced since the beginning of the crisis, and the large number of unknowns and uncertainties which characterise it.

The fourth principle, finally, is the **autonomy of groups** which form to answer the questions. This allows a multiplicity of perspectives and points of view, sometimes divergent. This necessity draws on the acknowledgement by the European simulation community that a lack of pluralism is even more harmful to support public decision-making than a lack of transparency.

A collaborative organisation and an interactive website

The four principles have lead us, quite naturally, to favour a functioning organisation which exploits short and frequent retroactions and relies of adapted tools. The questions asked online through a Framasoft form are transferred to all CoVprehension members, while a moderator is in charge of replying to them quickly and personally. Each question is integrated into a Trello management board, which allows each member of the collective to pick the questions they want to contribute to and to follow their progression until publication. The collaboration and debate on each of the questions is done using VoIP application Discord. Model prototypes are mostly developed on the Netlogo platform (with some javascript exceptions). Finally, the whole project and website is hosted on GitHub.

The website itself (https://covprehension.org/en) is freely accessible online. Besides the posts answering questions, it contains a simulator to rerun and reproduce the simulations showcased in the posts, a page with scientific resources on the COVID-19 epidemic, a page presenting the project members and a link to the form allowing anyone to ask the collective a question.

On the 28th April 2020, the collective counted 29 members (including 10 women): medical doctors, researchers, engineers and specialists in the fields of computer science, geography, epidemiology, mathematics, economy, data analysis, medicine, architecture and digital media production. The professional statuses of the team members vary (from PhD student to full professor, from intern to engineer, from lecturer to freelancer) whereas their skills complement each other (although a majority of them are complex system modellers). The collective effort enables CoVprehension to scale up on information collection, sharing and updating. This is also fueled by debates during the first take on questions by small teams. Such scaling up would otherwise only be possible in large epidemiology laboratories with massive funding. To increase

visibility, the content of the website, initially all in French, is being translated into English progressively as new questions are published.

Simple simulation models

When a question requires a model, especially so for the first questions, our choice has been to build simple models (cf. Question 0). Indeed, the objective of CoVprehension models is not to predict. It is rather to describe, to explain and to illustrate some aspects of the COVID-19 epidemic and its consequences on population. KISS models ("Keep It Simple, Stupid!" cf. Edmonds & Moss 2004) for the opposition between simple and "descriptive" models) seem better suited to our project. They can unveil broad tendencies and help develop intuitions about potential strategies to deal with the crisis, which can then be also shared with a broad audience.

By choosing a KISS posture, we implicitly reject KIDS postures in such crisis circumstances. Indeed, if the conditions and processes modelled were better informed and known, we could simulate a precise dynamic and generate a series of predictions and forecasts. This is what N. Ferguson's team did for instance, with a model initially developed with regards to the H5N1 flu in Asia (Ferguson et al., 2005). This model was used heavily to inform public decision-making in the first days of the epidemic in the United Kingdom. Building and calibrating such models takes an awfully long time (Ferguson's project dates back from 2005) and requires teams and recurring funding which is almost impossible to get nowadays for most teams. At the moment, we think that uncertainty is too big, and that the crisis and the questions that people have do not always necessitate the modelling of complex processes. A large area of the space of social questions mobilised can be answered without describing the mechanisms in so much detail. It is possible that this situation will change as we get information from other scientific disciplines. For now, demonstrating that even simple models are very sensitive to many elements which remain uncertain shows that the scientific discourse could gain by remaining humble: the website reveals how little we know about the future consequences of the epidemic and the political decisions made to tackle it.

Feedback on the questions received and answered

At the end of April, twenty-seven questions have been asked to the CoVprehension collective, through the online form. Seven of them are not really questions (they are rather remarks and comments from people supporting the initiative). Some questions happen to have been asked by colleagues and relatives. The intended outreach has not been fully realised since the website seems to reach people who are already capable of looking for information on the internet. This was to be expected given the circumstances. Everyone who has done some scientific outreach knows how hard it is to reach populations who have not been been made aware of or are interested in scientific facts in the first place. Some successful initiatives (like "les petits débrouillards" or "la main à la pâte" in France) spread scientific knowledge related to recent publications in collaboration with researchers, but they are much better equipped for that (since

they do not rely mostly on institutional portals like we do). This large selection bias in our audience (almost impossible to solve, unless we create some specific buzz… which we will then have to handle in terms of new question influx, which is not possible at the moment given the size of the collective and its organisation) means that our website has been protected from trolling. However, we can expect that it might be used within educational programs for example, where STEM teachers could make the students use the various simulators in a question and answer type of game.

Figure 1 shows that the majority of questions are taken by small interdisciplinary teams of two or three members. The most frequent collaborations are between geographers and computer scientists. They are often joined by epidemiologists and mathematicians, and recently by economists. Most topics require the team to build and analyse a simulation model in order to answer the question. The timing of team formations reflects the arrival of new team members in the early days of the project, leading to a large number of questions to be tackled simultaneously. Since April, the rhythm has slowed, reflecting also the increasing complexity of questions, models and answers, but also the marginal "cost" of this investment on the other projects and responsibilities of the researchers involved.

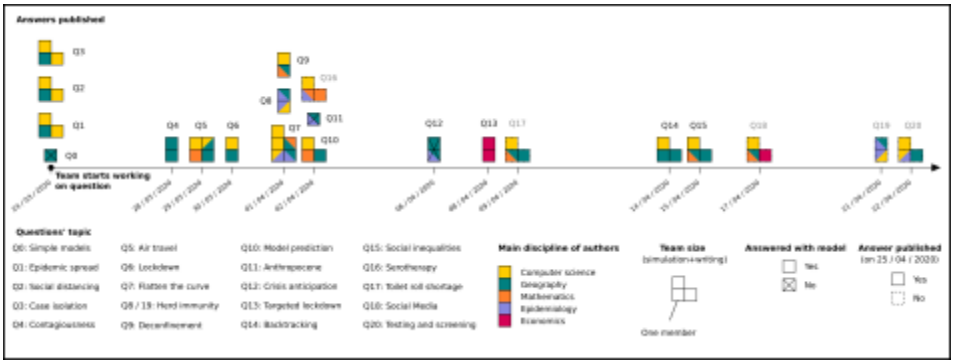

Figure 1. Visualisation of the questions tackled by Covprehension.

Initially, the website prioritised questions on simulation and aggregation effects specifically connected with the distribution models of diffusion. For instance, the first questions aimed essentially at showing the most tautological results: with simple interaction rules, we illustrated logically expected effects. These results are nevertheless interesting because while they are trivial to simulation practitioners, they also serve to convince profane readers that they are able to follow the logic:

- Reducing the density of interactions reduces the spread of the virus and therefore: maybe the lockdown can alter the infection curve (cf. Question 2 and Question 3).
- By simply adding a variable for the number of hospital beds, we can visualise the impact of lockdown on hospital congestion (cf. Question 7).

For more elaborate questions to be tackled (and to rationalise the debates):

- Some alternative policies have been highlighted (the Swedish case: Question 13; the deconfinement: Question 9);

- Some indicators with contradicting impacts have been discussed, which shows the complexity of political decisions and leads readers to question the relevance of some of these indicators (cf. Question 6);
- The hypotheses (behavioural ones in particular) have been largely discussed, which highlights the way in which the model deviates from what it represents in a simplified way (cf. Question 15).

More than half of the questions asked could not be answered through modelling. In the first phase of the project, we personnally replied to these questions and directed the person towards robust scientific websites or articles where their question could be better answered. The current evolution of the project is more fundamental: new researchers from complementary disciplines have shown some interest in the work done so far and are now integrated into the team (including two medical doctors operating in COVID-19 centres for instance). This will broaden the scope of questions tackled by the team from now on.

Our work fits into a type of education to critical thinking about formal models, one that has long been known as necessary to a technical democracy (Stengers, 2017). At this point, the website can be considered both as a result by itself and as a pilot to function as a model for further initiatives.

Conclusion

Feedback on the CoVprehension project has mostly been positive, but not exempt from limits and weaknesses. Firstly, the necessity of a prompt response has been detrimental to our capacity to fully explore different models, to evaluate their robustness and look for unexpected results. Model validation is unglamorous, slow and hard to communicate. It is crucial nevertheless when assessing the credibility to be associated with models and results. We are now trying to explore our models in parallel. Secondly, the website may suggest a homogeneity of perspectives and a lack of debates regarding how questions are to be answered. These debates do take place during the assessment of questions but so far remain hidden from the readers. It shows indirectly in the way some themes appear in different answers treated from different angles by different teams (for example: the lockdown, treated in question 6, 7, 9 and 14). We consider the possibility of publishing alternative answers to a given question in order to show this possible divergence. Finally, the project is facing a significant challenge: that of continuing its existence in parallel with its members' activities, with the number of members increasing. The efforts in management, research, editing, publishing and translation have to be maintained while the transaction costs are going up as the size and diversity of the collective increases, as the debates become more and more specific and happen on different platforms… and while new questions keep arriving!

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