On March 15, the Hub stopped all its other research activities and switched to "corona mode." © Shutterstock

The Hub in "corona mode"!

When if not now, in this unprecedented crisis, could complexity science better prove its immense value? In mid-March, just after the Austrian government had imposed far reaching restrictions to our lives in order to limit the spread of "the virus," the Hub decided to bundle all its capacities and fully focus on corona-related topics. Based on big theories, many years of research practice, and armed with a lot (yet never enough!) data from various sources, the whole team engaged in the endeavor to support the public in these times of emergency.

Hub researchers became part of the expert pool advising the Austrian Health Minister. Together with friends and colleagues from other institutions, we created tools such as the **CSH Health Care Info Point** for doctors, a live tracker of emotions (the **Austria Social Media Emotions Dashboard),** the **"Corona-Ampel"** ("Corona Traffic Light System"), or a **Covid-19 Counting Dashboard**.

We forecast infection curves. We show the huge impact of the lockdown on the movement radius of Austrians. We developed a visualization of the country's imports and exports as a first step to a better understanding and **management of supply chains.**

Thousands of governmental measures in nations around the world were collected to estabilsh a database that eventually became part of a world-encompassing effort to find the best ways to stop the pandemic.

For an overview of and easy access to our corona-related content, the Hub team created a subpage to our main page: the **CSH Covid-19 Info Point**. It can be accessed via the Covid19 button in the top menu of the CSH page.

This newsletter gives a short summary of what we have achieved in these intense weeks of lockdown. So much more was and is still going on at the Hub.

No one knows what the months ahead will look like, not to speak of the future of human society after such an immense crisis. But speaking for us as an institution, we dare to say: The Complexity Science Hub Vienna has passed its test with flying colors. We proved the importance and the value of a real understanding and a responsible handling of data in order to benefit society in challenging times.

Verena Ahne
(Knowledge Transfer & Dissemination)

VISIONS FOR COMPLEXITY

Which measures work best?

**The CSH Covid-19 Control Strategies List CCCSL impressed *Nature* and the WHO.**

One of the first things we started after switching to corona mode was a collection of governmental measures taken by countries throughout the world against the coronavirus spread.

Nobody would have thought at first how much work lay ahead of us. While group leaders discussed how to best name, group and sub-group different kinds of measures, dozens of people started trawling the net, digging into publications and studies, checking hundreds of news items and reports in all sorts of languages—including such "exotic" tongues as Russian, Slovakian, Kazakh, Chinese, Hindi, or Icelandic (invaluable the help of virtual and human translators!)—in order to determine which country implemented what measure on which exact day. Our Faculty Member **Amélie Desvars-Larrive**, who eventually took over

project leadership, has done and is still doing an incredible job in harmonizing and updating the entries. To date, the CCCSL contains 77 countries plus the cruise ship *Diamond Princess* and nearly 4,600 entries in total.

Nature News featured the CCCSL at length, and we eventually became one of the few contributors to the WHO's global "Public health and social measures (PHSMs)" database (→ https://www.who.int/emergencies/diseases/novel-coronavirus-2019/phsm).

"The ultimate goal is to understand and differentiate the impacts of single
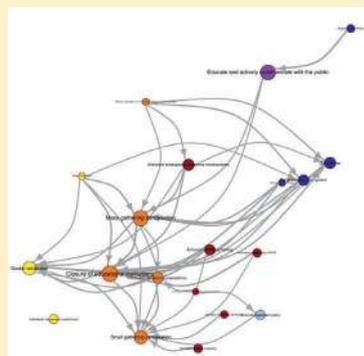
"The ultimate goal is to understand and differentiate the impacts of single measures," says Amélie. Is wearing a mask indispensable, or is its effect negligible compared, for instance, to closing down schools or universities? "We hope to develop ways of using these data to design better public health response strategies to similar diseases in the future," adds Amélie. Hub researchers are on it!

Movement data show effectiveness of Austrian lockdown
Another way of assessing whether measures work is to directly monitor the reactions of the population. With the help of various data sets, including aggregated and anonymized telecommunication data, **Georg Heiler** and **Tobias Reisch** showed dramatic changes in the radius of movement in Austria, or the frequentation of the Viennese subway during the lockdown.
The tables are continuously being updated and can be accessed via the **CSH Covid19 Info Point** → *(https://csh.ac.at/covid19 "How measures work").*

Which measures come first? Which strategies follow? A visualization of CCCSL data by CSH PostDoc Elma Dervic.
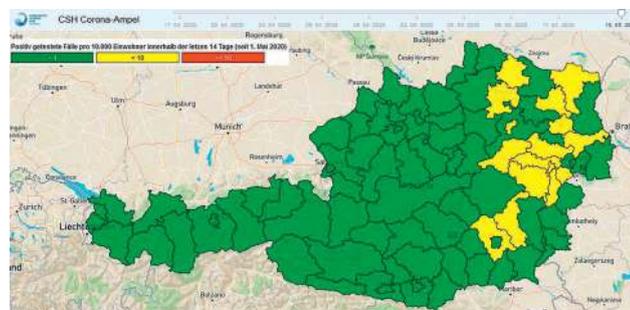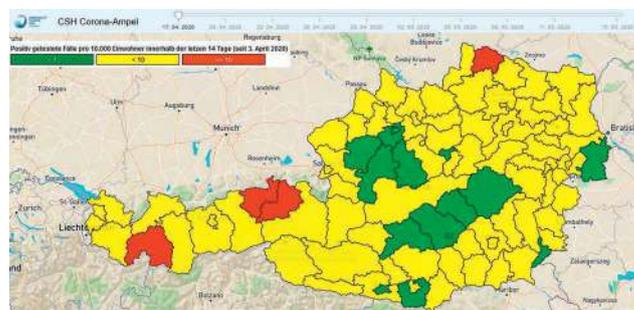
The "Corona-Ampel" shows confirmed infections in Austrian districts (left: April 17, right: May 15). By mid-May Austria was almost entirely green. © CSH Viennak

Corona and the health care system

The Hub was and is busy supporting decision makers, doctors or laypeople in Austria with relevant information during the current pandemic. Two examples of easy-to-comprehend tools from our medical team.

Important information should be easily accessible and understandable for the general public. This rule applies all the more in times of insecurity and fear. Visualizations are a great way to transform crude data into easily digestible information.

The CSH Health Care Info Point
CSH scientist **Peter Klimek** and his team developed a tool that provides Austrian doctors with detailed Covid-related information. The CSH Health Care Info Point offers

practitioners up-to-date information on confirmed coronavirus cases and growth rates in their district, displays the number of doctors in different medical fields, as well as the size of various risk groups per district.

"The next infection wave will come, and we have to be prepared," says Peter. "With all relevant information updated daily and gathered in one place, doctors can better prepare for a possible run on their practices."

Enhancing the resilience of the Austrian health care system
Peter would like to extend the service, for instance, by a patient behavior monitor. Why that? "When corona infections were on the rise, many people in need of a doctor were afraid to leave the house and seek the necessary medical help," explains Peter. "If health authorities had a tool

that showed them a sudden regional decline in consultation rates, they could take countermeasures to avoid undertreatment." However, there is a precondition for such a live monitor: "We would need better access to the relevant data," Peter points out.

**The "Corona-Traffic Light System"**
Another tool—and our most successful interactive one in terms of click rates—is the "Corona-Ampel" ("Corona Traffic Light System"), designed by our Visualization expert **Wolfgang Knecht** and his brother.
A map of Austria shows the newly confirmed cases of corona infection in each political district. With a slider, users can move back in time and see the changes in the past four weeks. The tool was designed to give the public a feeling for the situation in their region. It is in high demand and will be further developed.

Emotions in times of (corona) crisis

Which feelings does a crisis like the current corona pandemic evoke? Are people desperate? Are they afraid, or calm? Do they support the governmental measures—and when does a change of mood become apparent?

It is of great importance for politicians as well as psychosocial services to know about the mood and well-being of the people. The team headed by CSH's
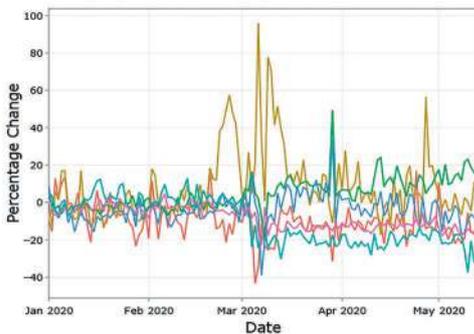
Change in the expression of emotions in the online forum of the Austrian daily *Der Standard.* © CSH Vienna

David Garcia investigated Tweets in different countries in March and found big changes in feelings such as anxiety and fear, but also a clearly visible increase in prosocial expressions (i.e., empathy or willingness to help each other).

Austria Social Media Emotions Dashboard
Subsequently, the team developed a live tracker for emotions. It records expressions of anger, fear, worry and sadness, positive emotions, words that express a prosocial attitude, as well as terms that describe social interactions and relationships in the broadest sense, such as "parents" or "care." Data come from Twitter, the online forum of the Austrian daily newspaper *Der Standard*, and from an app mainly used by youngsters. The curves clearly show peaks around major corona-related events like the first fatality case.

Mental health apps can help
The team further investigated whether a well-designed science-based health app offers relief for people in times of

crisis. "Apps are inexpensive, and their use is not tied to place, time or therapists," says data scientist **Jana Lasser**.

But do they really help? The scientists received access to data from the American emotional health app Youper. This app queries the user's emotions and suggests activities derived from psychotherapy to help to deal better with negative feelings. Exercises such as mindfulness, goal setting and other proven problem-solving techniques are used. At the end of the interaction with the app, users are asked again about the intensity of their emotions. "We found that the app reduced feelings of anxiety in more than 80 percent of cases," explains Jana. "We think that well-designed science-based apps could be a valuable aid in providing psychological support to people suffering from psychological stress due to the corona crisis," Jana concludes.

Find "Corona&Emotions" content via → CSH Covid19 Info Point (https://csh.ac. at/covid19/)
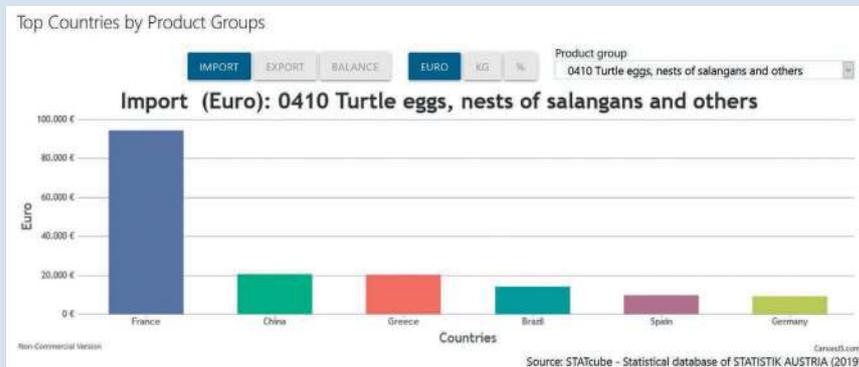
Access the CSH Import / Export Dashboard (German & English) via *https://csh.ac.at/covid19/* © CSH Vienna

Corona and economic resilience

The worldwide shutdown is an unprecedented shock for the economy. How will we cope with it?

Economic resilience has been a core question of CSH research for years. This expertise is a huge advantage in dealing with the current crisis. In "corona mode," we started to work on questions like how our economy will digest the Covid shock, how resilient are supply chains, or how we should reboot the system.

Crucial to a true understanding is having access to all kinds of data on various economic parameters. As a start, we purchased data on all Austrian imports

and exports in 2019 and had the CSH visualization team build the **CSH Import / Export Dashboard**. The STATcube data were carefully edited by our research collaborator and new Associate Faculty Member **Beate Conrady** (Pinior) from the University of Veterinary Medicine in Vienna.

Of swallow's nests and human hair
This tool is a surprise bag for curious people! Who would have thought, e.g., that Austria imported 5.5 tons of turtle eggs and swallow's nests from France last year? (Which are actually not swallow's nests at all, but rather those of Lady Swallow's bigger sisters, the salanganes.)

And the amount of human hair we seem to need! According to the Dashboard,

most of it comes from Italy and Singapore. Interestingly, the price difference is huge: 7.6 tons from our southern neighbor are worth € 4.1 Mio, while 5 tons of Asian hair cost € 9.6 Mio...

How sustainable can all those transports be?
Environmentalists might worry about sustainability issues. They might question, for instance, why a country has to import and export large amounts of the very same goods, sometimes even to and from the very same countries? Wool fat, as an example: exported from Austria to Germany (9.3 tons) and imported from Germany to Austria (> 42 tons).
Even worse are the large numbers of living creatures we ship around: Austria imported 35,000 tons of squealing future hams and sausages from Germany in 2019—to a country with, one would think, more than enough pig farms—, while we transported more than 420 tons of living pigs the other way around...

Visualizing such facts could be a first step in re-building the system to hopefully become more environmentally friendly, sustainable and resilient.

UPCOMING

PUBLICATION

Future events | Events for the future

Working at the Hub usually brings along a lot of interesting encounters, events, workshops, guests and visitors from Austria and abroad. Most of our usual activities, including our beloved teatime, were set on hold by the virus. Like institutions all around the world, the Hub had to cancel almost all social and scientific events that were planned to take place in the spring and summer.

The *CSH Winter School 2020,* for instance, had to be cancelled at the very last minute. But postponement is not abandonment! We already sent an invitation to all of this year's participants to announce their interest in a possible next *Winter School in 2021.* Let's cross our fingers!

More online workshops in the future? Our theoretician, **Jan Korbel,** decided to stick to the workshop he had planned together with External Faculty Member **David Wolpert** from the Santa Fe Institute. Why not use all the technology we have become so used to in the past couple of weeks, Jan thought, and try it online?

And so it has come to pass that people from all around the world will gather virtually from **May 27–29** to discuss → *"Stochastic thermodynamics of complex systems."*

It is our first online workshop, and we are very curious to see how it will work. For sure it will not only produce valuable results for stochastic thermodynamics, but also teach us a lot about the Do's and Don'ts of virtual gatherings.

This is of great value, as the Hub will probably organize more online workshops in the future. The reason is not only travel restrictions due to the current pandemic. As a far bigger crisis than Covid-19 is haunting the world, responsible earthlings might choose CO_2-neutral ways of scientific get-togethers more often in the future to reduce the carbon footprint of our travel-intensive profession.

We are currently discussing options for interesting Hub events that could take place until the end of the year. Please check out our → *Event Calendar* from time to time for updates.

Public Events
Two postponed public events will hopefully take place in October: Our next *vernissage* (see "Art at the Hub" below) will hopefully be held at the beginning of October.

And on October 9, 2020, the Hub intends to take part in the (Austrian-wide) public event *"Lange Nacht der Forschung"* ("Long Night of Research") for the first time.

This is a selection of publications affiliated to the Hub. Find more at → *www.csh.ac.at/publications*

S. Thurner, W. Liu, P. Klimek, S. A. Cheong
→ *The role of mainstreamness and interdisciplinarity for the relevance of scientific papers,* PLOS ONE 15 (4) (2020) e0230325

M. Pellert, S. Schweighofer, D. Garcia
→ *The individual dynamics of affective expression on social media,* EPJ Data Science 9 (1) (2020)

L. Horstmeyer, T.M. Pham, J. Korbel, S. Thurner
→ *Predicting collapse of adaptive networked systems without knowing the network,* Scientific Reports 10 1223 (2020)

T. Niederkrotenthaler, E. Mittendorfer-Rutz, S. Thurner, G. Endel, P. Klimek
→ *Healthcare utilization, psychiatric medication and risk of rehospitalization in suicide-attempting patients with common mental disorders,* Australian & New Zealand Journal of Psychiatry Vol 54, Issue 4 (2020)

F. Grandl, (...) F. Papst, O. Saukh, (...) C. Egger-Danner
→ *Opportunities and Challenges of New Technologies for Performance Recording with Focus on Claw Health and Metabolism,* in: Proceedings of ICAR Conference, ICAR Technical Series no. 24 (2019)

D. Garcia, V. Galaz, S. Daume
→ *EATLancet vs yes2meat: the digital backlash to the planetary health diet,* The Lancet 394, 10215 (2019) 2153–2154

D. Hoyer, J. Reddish (eds.)
→ *Seshat History of the Axial Age,* Beresta Books (2019)

J. Korbel, X Jiang, B. Zheng
→ *Transfer Entropy between Communities in Complex Financial Networks,* Entropy 21(11) (2019) 1124

D.R. Lo Sardo, S. Thurner, J. Sorger, G. Duftschmid, G. Endel, P. Klimek
→ *Quantification of the resilience of primary care networks by stress-testing the health-care system,* PNAS 116 (48) (2019) 23930–23935

B. Monechi, G. Pullano, V. Loreto
→ *Efficient team structures in an open-ended cooperative creativity experiment,* PNAS 116 (44) (2019) 22088–2209

Art at the Hub

Our next exhibition within the → *Art at the Hub program* will feature works of the artist duo Birgit and Peter Kainz. They are socially critical digital photographers and pictorial scientists whose works stand for freedom and equality and invite the audience to think freely.

Since 2009, the couple's work has centered around the word HUMAN. Their planned artistic intervention at the Hub will not only show works of the last ten years, but also offer visitors an opportunity to interact with the artists and the CSH. A blue and a red ribbon will span the halls of the Hub, inviting the public to add statements, pictures and other artefacts throughout the duration of the exhibition.

The next artist will be the Austrian photographer Peter Hassmann.

Coronavirus exhibition at Karlsplatz. April 2020
© Birgit and Peter Kainz

Initially, these two artists were invited for May. At the moment our plan is to open the vernissage on October 1, 2020.