NEWS *FALL 2020*

COMPLEXITY SCIENCE HUB VIENNA

We live in turbulent times. Turn the page to find out why, according to Hub research, political polarization is on the rise. © Shutterstock

Research beyond corona? Yes, we can!

The virus really dominated all our activities during the last six months. Here are some highlights from the recent past:

Our "structured open dataset of government interventions in response to COVID-19"—the so called CSH COVID-19 Control Strategies List (CCCSL), vigorously edited over months by our dear **Amélie Desvars-Larrive**—was published at the end of August in the *Nature* journal *Scientific Data*. Side by side, we are proud to say, with the dataset of Johns Hopkins University.

Based on this collection, **Nils Haug, Peter Klimek,** and others investigated which governmental measures against the coronavirus spread really worked. The preprint was out in July. The final version, much awaited not only by the press, is currently under review. Stay posted!

In September, our visualization team considerably refined and extended the Hub's worldwide **CSH Corona Traffic Light.** The map now shows infection numbers in EU countries in a much more detailed resolution. **Johannes Sorger** and **Wolfgang Knecht** also added a new map, called "Trends." It shows whether infection rates in a region are constant, are rising or are falling. The dominant color at the moment is purple. To find out what that means, check the Corona Traffic

Light on the CSH COVID-19 subpage. Both of our Corona Traffic Lights, the Austrian version and the worldwide one, are work in progress. Expect new features to come!

In "A network-based explanation of why most COVID-19 infection curves are linear," recently published in *PNAS*, **Rudi Hanel, Peter Klimek,** and **Stefan Thurner** seek an explanation for the unusual shape of coronavirus curves. Instead of the typical S-form expected by epidemiological models, most countries exhibit linear growths after the first peak. Why is that? Rudi, Peter, and Stefan investigated contact networks and found that the spread of this specific virus happens in small, limited clusters rather than by superspreading events. "People have fewer corona-relevant contacts than one would think," Stefan explains. "If we behave reasonably, we only meet up to five people on average." As long as people follow the rules of social distancing and stay within their small contact worlds, curves are linear. If they start partying though, the curves could quickly turn into exponential growth again.

And that was it with corona-related news this time! Turn the page to see what is going on at the Hub beyond COVID-19.

Verena Ahne, Head of Knowledge Transfer

VISIONS FOR COMPLEXITY

How much safer can financial networks be?

Hub researchers were investigating the maximum possible reduction in collapse damage. It could be as high as 70 percent!

In networks with high systemic risk, the failure of a single knot has the potential to affect and eventually crash the whole system. The result could be a major crisis like the banking crash in 2008. What is the best approach to make such a system safer? Re-arrange it's links!, claim **Christian Diem, Anton Pichler,** and **Stefan Thurner,** part of the economic team at the Hub.

They recently investigated how much they could reduce the average damage of a systemic crash in financial systems by re-allocating its links, more concretely: its banking loans. To avoid possible negative effects through the re-allocation, they added special conditions to their algorithms. "They assure that the individual risk of a bank does not increase, and that the total amount of loans in the network does not decline," Anton explains.

And indeed: The newly emerging networks show a considerably lower risk for systemic failure, while the amount of money lent and borrowed in the network remains the same. "The optimization potential was surprisingly high: up to 70 percent!" Christian points out. Bank equity would have to be raised by an incredible 230 percent to achieve a comparable safety level.

**Avoid close links between big banks**
To test their approach, Christian, Anton, and Stefan ran their algorithms on an anonymized data set of the 70 largest banks in Austria. Together, these banks covered 71 percent of the country's interbank market volume in the years 2008 to 2010. The systemic risk was especially high when large banks were closely linked.

The findings have far-reaching implications for regulators and supervisory bodies such as the European Central Bank. "More safety without economic decline—what else would you want as a regulator?" says Stefan. "With our approach we could not only monitor existing regulations—do they really make the financial system safer? We could even create new incentives to influence decision-making processes in the banks, designed in a way that automatically leads to safer financial networks."

"What is the minimal systemic risk in financial exposure networks?" appeared in the *Journal of Economic Dynamics and Control.*

By re-arranging network links, the damage size in a collapsing financial system can be reduced by up to 70 percent, Hub researchers find. © Shutterstock
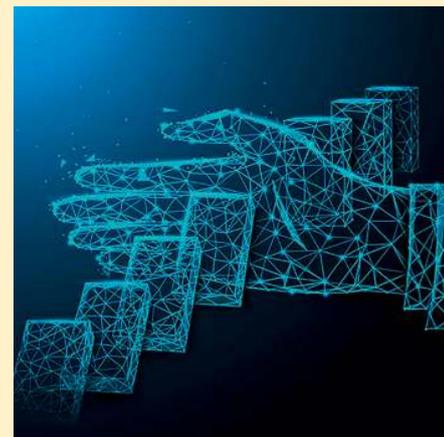
Polarization in societies is growing. Why?

The extent to which people like or dislike each other affects their political views and vice versa, Hub research finds.

A certain degree of polarization of political opinions is considered normal—and even beneficial—to the health of democracy. Currently, however, conservative and liberal views are drifting apart. When too much polarization hampers a nation's ability to combat threats, such as the current pandemic in the US, this can be detrimental to a society.

According to the "Weighted Balance Theory" (WBT) developed under Hub lead, the driving force for "hyperpolarization"—that is, the combination of extremeness and correlation—are social emotions.

How do extreme positions evolve?
"We feel high balance when dealing with someone we like and with whom we agree in all political issues," **Simon Schweighofer,** a former PostDoc at the Hub who now works in China, explains the approach. "We also feel high balance towards those we hate and with whom we disagree." This human tendency to maintain emotional balance was first described in 1946.
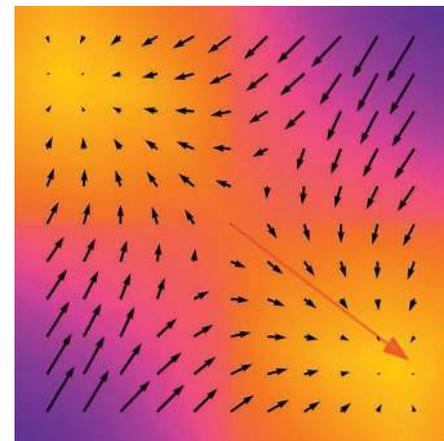
Yet, when individuals disagree with others they like, or agree with others they dislike, "they will try to overcome this imbalance: They adapt their opinions in order to increase balance with their emotions," Simon claims. Increasingly intense emotions and opinions gradually replace moderate positions until most issues are seen in the same—often extremely polarized—way as one's political allies.

A vicious cycle that leads to hyperpolarization
"This vicious cycle ultimately ends in total polarization," says **David Garcia.** Not only do people then categorically favor or oppose single issues like abortion or same-sex marriage. "If they are pro-choice, they are at the same time highly likely to be for gay marriage, the legalization of marijuana, against nuclear energy and so on." A possible variety of opinions is reduced to black and white—the split between left and right we see everywhere.

An interdisciplinary approach
"Hyperpolarization has so far been overlooked in social theories on opinion formation," concludes Simon. The WBT—an interdisciplinary effort that integrates research in psychology, political science and opinion dynamics into an overarching theoretical framework—offers a new perspective on the emergence of political conflict.

The study, entitled "A Weighted Balance Model of Opinion Hyperpolarization," appeared in the *Journal of Artificial Societies and Social Simulation.*

The driving force behind "hyperpolarization," that is, a combination of extremeness and correlation, could be social emotions. © David Garcia

New method to fight corruption

A dashboard scans government contracts for corruption risk.

The dashboard developed by Johannes Wachs et al. just won the IMF Anti-Corruption-Challenge and can now be extended by another 40 countries. © GTI
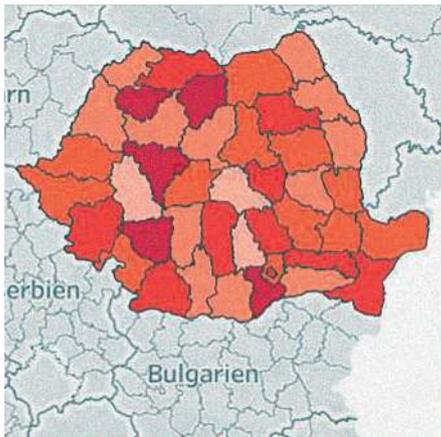
When **Johannes Wachs,** a computational social scientist who joined the Hub in April, began his PhD, he was surprised how little Big Data research was done on corruption. To address this gap, he started collaboration with the Government Transparency Institute (GTI), a "non-partisan think tank researching and advocating good governance" founded in Hungary in 2015.

Dashboard tracks red flags in contracting at multiple scales

As part of that group, Johannes is working to find clever ways to measure corruption risks in public procurement processes. Recently the team launched a pilot project for the International Monetary Fund (IMF). "We created a dashboard that monitors red flags for corruption risk in procurement procedures," Johannes explains.

Their software scans thousands of calls for proposals and tenders for signs that a free and fair competition may have been restricted. "If, for instance, only one bidder submits a bid, it suggests that the procedure was unfair," Johannes points out. Other red flags track whether contract winners are registered in tax havens, or if the time to submit a bid was exceptionally short. The method does not prove that corruption has taken place—it rather highlights patterns that deserve a second look.

A winning team!

So far, the dashboard is tracking over 1.5 million contracts from five countries (Uganda, Georgia, Indonesia, Romania, and Paraguay). "There are differences in the data from each country, and it is a lot of work to gather and clean the data, but once that is done, the method offers a fast and inexpensive complement to traditional tools in the anti-corruption policymaker's toolkit, such as surveys and case studies," says Johannes, highlighting another major strength of the dashboard: "It works on small scales, too: in certain regions or specified to subjects like public procurement or construction."

While this text was written, the project won the IMF Anti-Corruption-Challenge! The dashboard will now be extended by 40 countries, helping policy makers worldwide to combat corruption early on.

Nice 'n' crazy workshop

What is the craziest idea you never dared to investigate? The first CSH Crazy Workshop offered a safe space to present, discuss, and fight for the craziest idea of all.

Researchers, probably like most humans, from time to time have ideas that seem too crazy to be pursued and therefore stay carefully hidden. But what if such an idea was a treasure, worth a further investigation? This thought drove Vito Servedio, data scientist and culinary magician of the Hub, crazy. Let's dare to let our hidden ideas out, Vito thought— and initiated a crazy workshop. In early summer, when corona cases were low in Austria, Hub people traveled to beautiful Helenental in Lower Austria to put their heads together (not literally!) and eventually choose the best of all crazy ideas.

The workshop started with some crazy (and some not-really-crazy) presentations. **Anna di Natale** wondered if blackouts lead to higher birth rates. **William**

Schueller asked if language could be seen as an efficient cognitive cheating system. **Rudi Hanel** spun ideas around "cognitomics—notions in motion"...

In the evening, after a frugal meal, brains were challenged with a nearly unsolvable pub quiz. Our physical condition was tested with swimming, cheerful ball games and an extremely exhausting 25-minute walk around the hotel. The highlight was the crazy battle in the end, won by **Andrew Ringsmuth.** Although nobody really understood what he was

up to (he argued that the first economic system may have appeared around one billion years ago, when photosynthetic microorganisms began to cooperate, or the like), Andrew went home with a precious book voucher.

It can surely be said that the first CSH retreat and first ever Crazy Workshop & Battle was a great success. After months of lockdown with hardly any physical interaction at work or socially, we returned inspired, motivated, and crazily refreshed.

UPCOMING

Working at the Hub usually goes along with a lot of interesting encounters, events, workshops, guests, and visitors from Austria and abroad. But in corona times, everything is different.

After we spent kind of a relaxing summer, infection numbers are on the rise again in Austria as well as throughout the rest of the world.

As it might still be a long way to go before we have a successful cure or prevention, we decided—with a heavy heart indeed—to postpone the **CSH Winter School**, which had already been put off until 2021, one more time until 2022. Let's cross our fingers that things will get better soon.

In the fall, we plan to offer online talks again, usually on Fridays.

Please check out our event page from time to time to see what is happening in the virtual Hub world.

Work with us! We have some vacancies to fill.

(Social) Media surround us like a second skin, say the artists © Birgit and Peter Kainz. Their corona- and media-related work can be sseen at the Hub.

Art at the Hub

The virus also affected our Art and Science at the Hub program. On October 1st, the "artistic intervention" by Birgit and Peter Kainz, called **"Media—the second skin!?"** finally took place as a virtual event.

Birgit and Peter are socially critical digital photographers and pictorial scientists. During the lockdown they produced a great number of artworks like newspaper overpaintings and collages. They also formed impressive life-size paper dolls, all covered with a skin of "media." They will be our silent companions for the rest of the year.

The evening started with a podium discussion, led by our event manager **Stephanie Bourke-Altmann.** The artists and our guests **Michael Fanizadeh** (who works in development cooperation), **Martina Madner** (a journalist focusing on poverty and the situation of women), **Veronika Mickel-Göttfert** (the borough mayor of the Hub's district in Vienna and a supporter of the event), and CSH President **Stefan Thurner** talked about their experiences with and thoughts about the pandemic. After the debate, the "visitors" were taken on a virtual walk through the exhibition.

The evening was video-recorded and can be seen on our YouTube channel.

Don't miss the exhibition: Join a guided Hub tour!
If you are interested in meeting the artists and interacting with their beautiful work, take part in one of our corona-safe guided tours: every Thursday afternoon until the end of December; up to five persons per tour.

If you would like to attend an art tour at the Hub, please send an email to office@csh.ac.at

PUBLICATIONS

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

A. Desvars-Larrive, et al.
A structured open dataset of government interventions in response to COVID-19, *Scientific Data Vol 7 (2020) Art no. 285*

H. Krichene, H. Inoue, T. Isogai, A. Chakraborty
A model for indirect losses of negatives shocks in production and finance, *PLoS ONE 15(9) (2020) e0239293*

Ž. Tomovski, J. Dubbeldam, J. Korbel
Applications of Hilfer-Prabhakar operator to option pricing financial model, *Fractional Calculus and Applied Analysis, Band 23, Heft 4 (2020)*

J. Kertész, J. Wachs
Complexity science approach to economic crime, *Nature Reviews Physics (2020)*

S. Thurner, P. Klimek, R. Hanel
A network-based explanation of why most COVID-19 infection curves are linear, *PNAS Aug 24 (2020)*

P. Turchin, A. Korotayev
The 2010 structural-demographic forecast for the 2010–2020 decade: A retrospective assessment, *PLoS ONE 15 (8) (2020) e0237458*

M. Ferreira, N. Reisz, W. Schueller, V.D.P. Servedio, S. Thurner, V. Loreto
Quantifying exaptation in scientific evolution,
in: C. La Porta, S. Zapperi, L. Pilotti (eds.), *Understanding Innovation Through Exaptation (2020) Springer 55–68*

C. Diem, A. Pichler, S. Thurner
What is the minimal systemic risk in financial exposure networks?, *Journal of Economic Dynamics and Control Vol. 116 July (2020) 103900*

J. Lasser
Creating an executable paper is a journey through Open Science, *Communications Physics 3 (2020) Art. no. 143*

S. Schweighofer, F. Schweitzer, D. Garcia
A Weighted Balance Model of Opinion Hyperpolarization, *Journal of Artificial Societies and Social Simulation 23(3) (2020) 5*

P. Jizba, J. Korbel
When Shannon and Khinchin meet Shore and Johnson: Equivalence of information theory and statistical inference axiomatics, *Phys. Rev. E 101 (2020) 042126*