





Shadow Profile © Shutterstock

Dear friends of the Hub!

We proudly present the first issue of *Visions for Complexity*, the new newsletter of the Complexity Science Hub Vienna. Thanks to artist and graphic designer Olaf Osten, whose work was the first we had the pleasure to present in our *Art at the Hub program*, it became a small piece of art itself.

And the content of course: Apart from the art part of our activities, the Hub has become a truly vibrant place of scientific exchange since it first opened its doors in May 2016. Not even two years – and what a development!

We would be happy if you accompanied us on a little journey through these pages and thus through the past months of Hub life. It can't be more than glimpses – too much has been happening since the Hub's early days. But as there are more newsletters to come, there are more opportunities to get to know us. In the meantime you'll find information on all our activities, on research results, visitors, events, press coverage, et cetera, on our (almost as new!) website → www.csh.ac.at, on  and .

We wish you a pleasant read!

Verena Ahne
Head of Knowledge Transfer



The long shadow of your friends

Data privacy is a major concern in today's internet use. Some people are worried enough not to use social media in order to protect their private sphere. Possibly in vain, as research by David Garcia suggests: "Individuals have little power to ensure that they are not being profiled without their knowledge or consent."

Last year, the complexity scientist used data recovered from Friendster, a social network that got wiped out when Facebook appeared, → to show that the communication of friends can improve the estimation of sexual preferences of people who were not on Friendster themselves.

This finding backs the so-called "shadow profile hypothesis." It maintains that it is possible to profile people who don't use social media simply by putting together the indirect information provided by their friends.

→ In a more recent paper, David and his colleagues tested the hypothesis for the first time with Twitter data. They constructed a dataset with more than 150 million tweets of 1,000 users and their friends. The data included biographical and location information, as well as bidirectional friendship links.

And again: information shared by users inside Twitter enabled the location of individuals outside the social network to be predicted. Moreover, it considerably raised the predictability of the biographical information of non-users. This means that the very moment we've got friends communicating about us on social media, we are open books to data leeches. "I don't claim that shadow profiles exist," David concludes, "but if companies are up to creating them, they won't have problems doing so."

Let's our president have a say...

Initially, a long time ago, it needed a bit of patience and persistence to get the Complexity Science Hub Vienna up and running. But since the project officially started in 2016 it has been developing its own momentum. I am very happy about the progress we've made so far. Our basic concept is simple: only scientific excellence will bring us forward.

The Hub will only be successful if we are able to attract, to train and to work together with the most creative, sparkling, brilliant people; to leave the beaten tracks together, daring to enter new scientific grounds; in particular to re-phrase every project, every publication until it has its unique, distinctive "story." Efforts like these, which make science extremely rewarding, are the foundation upon which we build the Hub.

But it is a lot more than science that make my days at the Hub: the well-organized workshops; happy guests acknowledging the support they received during their stay; the Hub team that seems to enjoy its work – and being with each other; our new webpage; the beauty of the location, highlighted by art on the 18th century walls that contrast and complement 21st century science ...

What a privilege to be part of this journey! A big "thank you" to all those on board striving to understand and explore our complex world. With this newsletter we send a postcard from our exploration.

Unfold it. Scroll through it. And hopefully enjoy it.



Best,
Stefan Thurner
President of the CSH

Bali: Harvest at its best

In natural ecosystems, spatial patterning is a common condition: Fractal structures emerge through feedback loops between organisms and their environment. Man-made systems rarely develop such patterns.

Things are different in Bali: From the air, the Balinese rice paddies in their different states of planting – newly watered paddies shining silvery, fields with growing rice glowing in the brightest green, harvested paddies going brown – show a fractal structure.

How does this pattern emerge? Stephen Lansing and his team from Nanyang University in Singapore and CSH External Faculty modeled the Balinese watering-planting-harvesting system. Their findings, published in *PNAS*, showed the following: The sophisticated system that produces an almost optimal harvest for each farmer develops in an

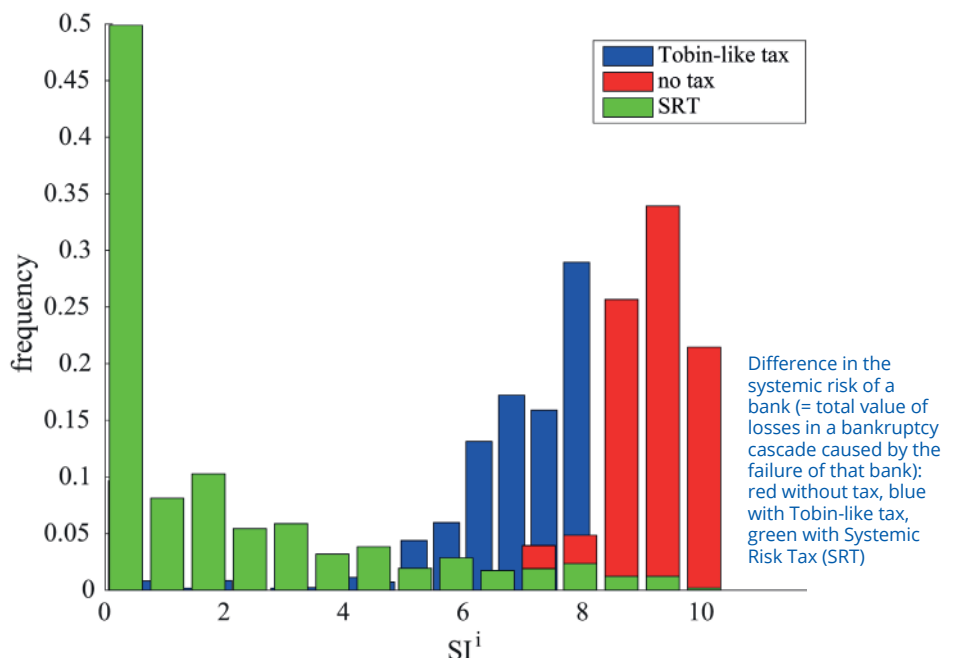
A clever tax that wipes out the inter-bank collapse risk

What if there were a truly fair transaction tax? A tax only levied on high-risk behavior while not burdening the economic performance of the whole system? A tax that changed the system to make it more resilient – and disappeared by itself once the network became risk-free?

That is the idea of the Systemic Risk Tax (SRT), developed and tested in various ways by researchers working with Sebastian Poledna and Stefan Thurner.

Systemic risk taxing follows a new concept: It "punishes" only those transactions that pose a systemic risk to the system as a whole. In the past it was impossible to determine the systemic risk of networks – too many variables were to be taken into account for the calculating capacity of humans or even earlier computers. "However, with supercomputers and a few new, clever mathematical ideas, we can obtain such information from Big Data," Stefan points out.

Knowing the systematic risk (SR) of each bank and even each single transaction between banks, the scientists can calculate the SRT as a surcharge on systemically risky financial transactions.



The higher the systemic risk of the transaction, the higher the tax.

As banks from now on would systematically choose lower taxed – that is, lower risk transactions, the systemic risk will redistribute, diminish and eventually disappear. "The re-shaped banking network would be much less vulnerable to crises like the collapse in 2008," says Sebastian. The new tax automatically leads to a much more resilient system – in contrast to the new Basel III banking

regulation, for instance, which was set up to reduce the risk but fails to do so, as the team showed in *a recent paper*.

Another advantage of the SRT: Implementing the tax won't reduce the economic performance and efficiency of the financial system of countries or the overall quantity of inter-banking transactions – again in contrast to another transaction tax (the "Tobin" tax) or the *Basel III regulation*.

RESEARCH SELECTION

entirely self-organized way when the farmers follow a few simple rules. "To grow rice, you need water and you don't want pests," Stephen explains. "Uphill farmers have an advantage with the water. If they try to maximize their harvest by keeping most of the water for their own fields, their neighbors downhill cannot plant at similar times."

This poses a risk for all of them: Pests can spread much more easily from field to field when paddies are planted at different times. To avoid the destruction of their harvest by pests, farmers will look at what their neighbors do and synchronize the planting.

"They make free decisions to optimize their own yield," Stephen adds.

"Interestingly and without any central planning, this leads to an optimal distribution of the finite resource of water, an almost optimal harvest, and a maximal reduction of pest spreading." The finding is in sharp contrast to the tragedy of the commons, where an optimum for all individuals cannot be reached when each farmer tries to maximize his or her profit.

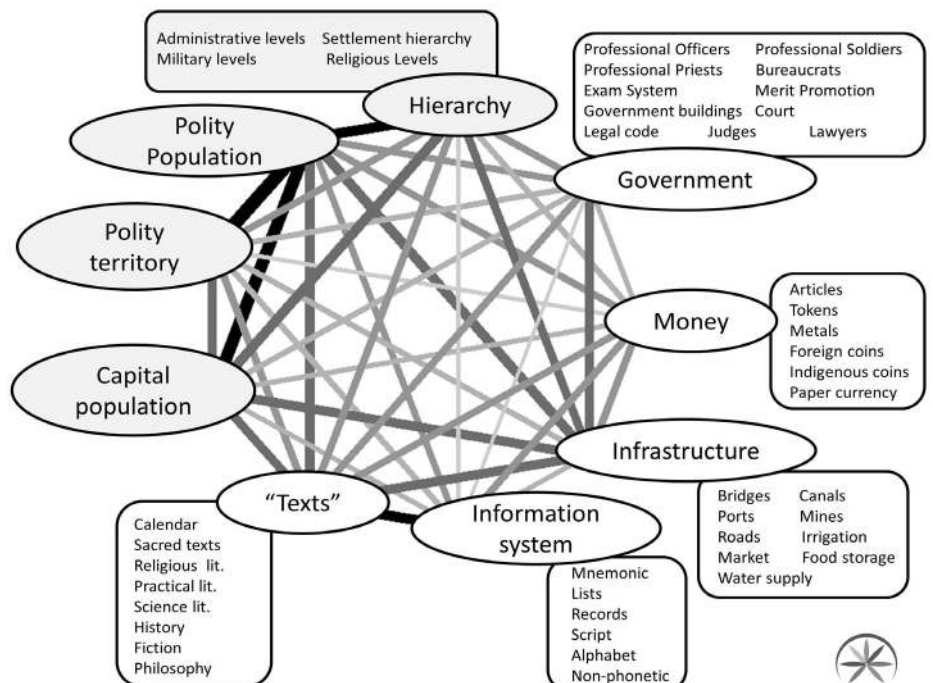
Adjusting the rice planting time schedule to direct neighbors and environmental conditions leads to an optimal harvest – and to fractal structures. © Shutterstock



How societies become complex

Using big datasets to gain new insights has become increasingly attractive within the social sciences as well. One of those who emphasize social sciences on a more quantitative basis is the Russian-American scientist Peter Turchin from the University of Connecticut. Peter, who became a CSH External Faculty member last year, founded the new transdisciplinary field of "Cliodynamics," which uses the tools of complexity science and cultural evolution to study the dynamics of historical empires, as well as modern nation-states. He also initiated the Seshat: Global History Databank. This constantly growing open access database – it can be downloaded for statistical analyses by anybody interested in this field – unites archaeological, historical and anthropological data from more than 30 regions and all kinds of societies worldwide and through periods, beginning with small hunter-gatherer groups and kinships, up to large empires.

The first article created with Seshat data (published in →PNAS in December) looked for the driving forces behind growing social complexity in different historical societies. It compared the history and trajectory of 414 "polities," some of them as old as 10,000 years. Was it, for



Turchin P., et al. 2017, Quantitative historical analysis uncovers a single dimension of complexity that structures global variation in human social organization. *PNAS*. <http://www.pnas.org/content/early/2017/12/20/1708800115.full>


Seshat

instance, the development of agriculture that made societies more complex? Was it long-distance trade or rather the concept of private property?

Peter admits that the question could not be answered directly: "We first have to define what social complexity is before we can go about tracing its evolution." Nevertheless, nine key characteristics

that usually co-evolve were identified (see figure), as Peter opposes one- or two-aspect explanations. "After having taken these first steps to quantify the evolution of social complexity, we can now start to answer more interesting questions, for example, what causes societies to gain or lose complexity." More publications are on the way.

Founded on paper in 2015, the Hub was a rather virtual institution for about a year. After months of intensive searching, it finally found its home in the baroque Palais Strozzi in downtown Vienna. Ever since we opened our doors in May 2016, the Hub has been growing and brimming with scientific excellence. In 2017 alone we had 36 lectures from CSH researchers and international guests, 11 workshops, numerous public events, and dozens of guests, from young fellow researchers up to well-known complexity scientists from all around the globe.



Dirk Helbing (ETH, CSH) wants a more visionary and imaginative society. © Christine Knoll

In May 2017, the Hub, together with Dirk Helbing, ETH Zurich & CSH External Faculty, hosted the CSH Workshop "Re-inventing Society in the Digital Age." The aim of the event was to critically reflect upon the impact of digital technology on individual lives. As Dirk summarized: "One thousand years from now, what will remain of what we invent and create today? We have to address questions like this if we are to accomplish anything that lifts humanity to the next level. We have to be more imaginative and visionary. Otherwise we will not be co-designers or creators of this new world, but only consumers."

The public talks of the workshop that were heard by more than 80 visitors can be seen at <http://bit.ly/2rhj224>.

In December, we featured network scientist [Shlomo Havlin](#) from Bar-Ilan University on "Cascading Failures and Recovery in Interacting Networks." One of Shlomo's insights on "networks of networks," be it power grids, the functioning of the human body, or climate change, was that "our world is extremely unsafe." To a certain point networks are stable and resilient, even if some of their links break down, Shlomo explained. But remove one more link and the change can be dramatic: The network will collapse abruptly, with the

Art at the Hub

When we first saw the big, white walls of Palais Strozzi we knew: This place is crying for art. So it was decided to start the [Art at the Hub](#) program that is now curated by Laura Stöger. Every four months an artist with an interest in science is invited to present his or her work in our premises.

We started the program with a vernissage of pieces by the German-born and Vienna-based artist and graphic designer



Olaf Osten, *Fernsehen I-47*, Oil on canvas, 230 x 140 cm, 2003



Our colloquium guests from left to right: Geoffrey West, Roberta Sinatra, Kimmo Kaski, Filippo Menczer. © Michael Rausch-Schott

"crash" spreading through all the other networks related to it. The lecture is available on our [YouTube channel](#).

In January 2018, CSH External Faculty member Kimmo Kaski from Aalto University organized a workshop at the Hub that was preceded by the public CSH Colloquium "Life, Universe, and Everything - 42 is the answer to the ultimate question, 'What is the question?'" The highly entertaining talks by [Geoffrey West](#) from the Santa Fe Institute (on "The Future of the Planet"), [Roberta Sinatra](#) from Central European University in Budapest (on "The Science of Success") and [Filippo Menczer](#) from Indiana University (on "Social Bots and Fake News") are a pleasure to watch. Check them out on YouTube!

Olaf Osten in February 2017. His large-sized artworks, that kind of widen our view on time and space, enriched our rooms for almost a year.

Next in line was Uwe B. Sleytr. The former biotechnologist uses for instance mask-like sculptures "to visualize the intersection between science and the arts - in particular the unpredictability and mystery of scientific visions." The vernissage took place in January 2018 and was a great success.



Uwe B. Sleytr presenting his work at the opening. © Michael Rausch-Schott

Q+A

Q What on Earth is a “hub”?

People keep asking us what they should imagine a “hub” to be. Obviously, and although hubs spring up like mushrooms everywhere in the world, the concept is not entirely clear. Which is no surprise, since a final definition is still missing. So let’s cherry-pick a few definitions that best summarize the Complexity Science Hub Vienna’s hub concept.

1. In network science – which, by happy chance, is a central part of complexity science – a hub is a node with a huge number of links. Perfect match! → *Our vision* is to become the focal point of this vibrant and rather young research field in Europe, as well as to be one of the nodes in the world-spanning web of like-minded people. To this aim we constantly host and visit outstanding complexity researchers from all around the planet, many of them affiliated with us already

as Associate or External Faculty or as members of the Science Advisory Board, to discuss and develop ideas together.

2. A second “match” is the definition of hubs as places where people with heterogeneous backgrounds and knowledge meet and exchange ideas. That’s exactly what we offer: In the past months the CSH Vienna has become a stomping ground for brilliant scientists from different fields, universities and research institutions – at the forefront researchers from our → *six member institutions* – who are keen on advancing complexity and Big Data science in theory and practice.

A The Hub is a node in the *WWcomplexityW*

The Complexity Science Hub Vienna found its home in the baroque Palais Strozzi, Vienna. © Philipp Marxgut



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PUBLICATIONS UPCOMING

This is only a small selection of the dozens of publications affiliated to the Hub. Many more can be found at →www.csh.ac.at/publications

P. Turchin et al.

→*Quantitative historical analysis uncovers a single dimension of complexity that structures global variation in human social organization*, PNAS 114 (2017)

J. Sakellariou, F. Tria, V. Loreto, F. Pachet

→*Maximum entropy models capture melodic styles*, Scientific Reports 7, Article number: 9172 (2017)

S. Poledna, S. Thurner

→*Elimination of systemic risk in financial networks by means of a systemic risk transaction tax*, Quantitative Finance Volume 16, Issue 10 (2016) 1599–1613

J. S. Lansing, S. Thurner et al.

→*Adaptive self-organization of Bali's ancient rice terraces*, PNAS 114 (2017) 6504–6509

S. Valverde, J. Piñero, B. Corominas-Murtra, J. Montoya, L. Joppa, R. Solé

→*The architecture of mutualistic networks as an evolutionary spandrel*, Nature Ecology & Evolution 2 (2018) 94–99

S. Thurner, B. Corominas-Murtra, R. Hanel

→*The three faces of entropy for complex systems – information, thermodynamics and the maxent principle*, Phys. Rev. E 96, 032124 (2017)

D. Garcia

→*Leaking privacy and shadow profiles in online social networks*, Science Advances Vol. 3, no. 8 (2017)

D. Garcia, M. Goel, A. K. Agrawal, P. Kumaragurum

→*Collective aspects of privacy in the Twitter social network*, EPJ Data Science (2018) 7:3

M. Beno, K. Figl, J. Umbrich, A. Polleres

→*Perception of Key Barriers in Using and Publishing Open Data*, eJournal of eDemocracy and Open Government (JeDEM) 9(2) (2017) 134–165

We will have a busy and exciting spring this year! For more activities or to sign-up for public events, please check out our →*event calendar*.

Improving Resilience in Complex Systems

Resilience is the capacity of a system to withstand shocks and the ability to recover from them. In this workshop organized by Frank Schweitzer, external faculty member, and Stefan Thurner, we discuss how resilience can be quantified and measured for complex systems, and to what extent disciplinary approaches on robustness, stability, and adaptation can be used and applied in a novel context.

June 7–9, 2018

Place: CSH Vienna

→*Please register via our website*

CSH Annual Conference & Meeting of the External Faculty

In May the Hub invites its External Faculty to debate pressing questions in complexity science, to plan future collaborations and joint projects, and to promote mutual relationships. This year we will discuss “Complexity – where do we go from here?”

On the first day our External Faculty will pitch its ideas to an interested public.

May 24–25, 10:00–17:00

Place: CSH Vienna

→*To listen to our External Faculty please register via our website.*

Third vernissage at the Hub: Wortkörper by Johann Berger

Our third vernissage will present the work of journalist and artist Johann Berger. In his series *Wortkörper* (Word Bodies), he exhibits a deep connection to the written word, and even more to the pillars of the texts: the characters. This is largely owed to his longtime teaching activity at the Academy of Fine Arts in Vienna.

The word bodies he is working with result from a discourse with Western intellectual history, whereas the technology to present them is strongly rooted in the present: 3D printing, CPI and laser cutting.

Vernissage (open to visitors):

May 24, 18:00–21:00

CSH Vienna, Josefstaedter Strasse 39



One of Johann Berger's *Wortkörper* as shown in an exhibition at Kunsthaus Muerz in 2017. © Peter Schmidt

