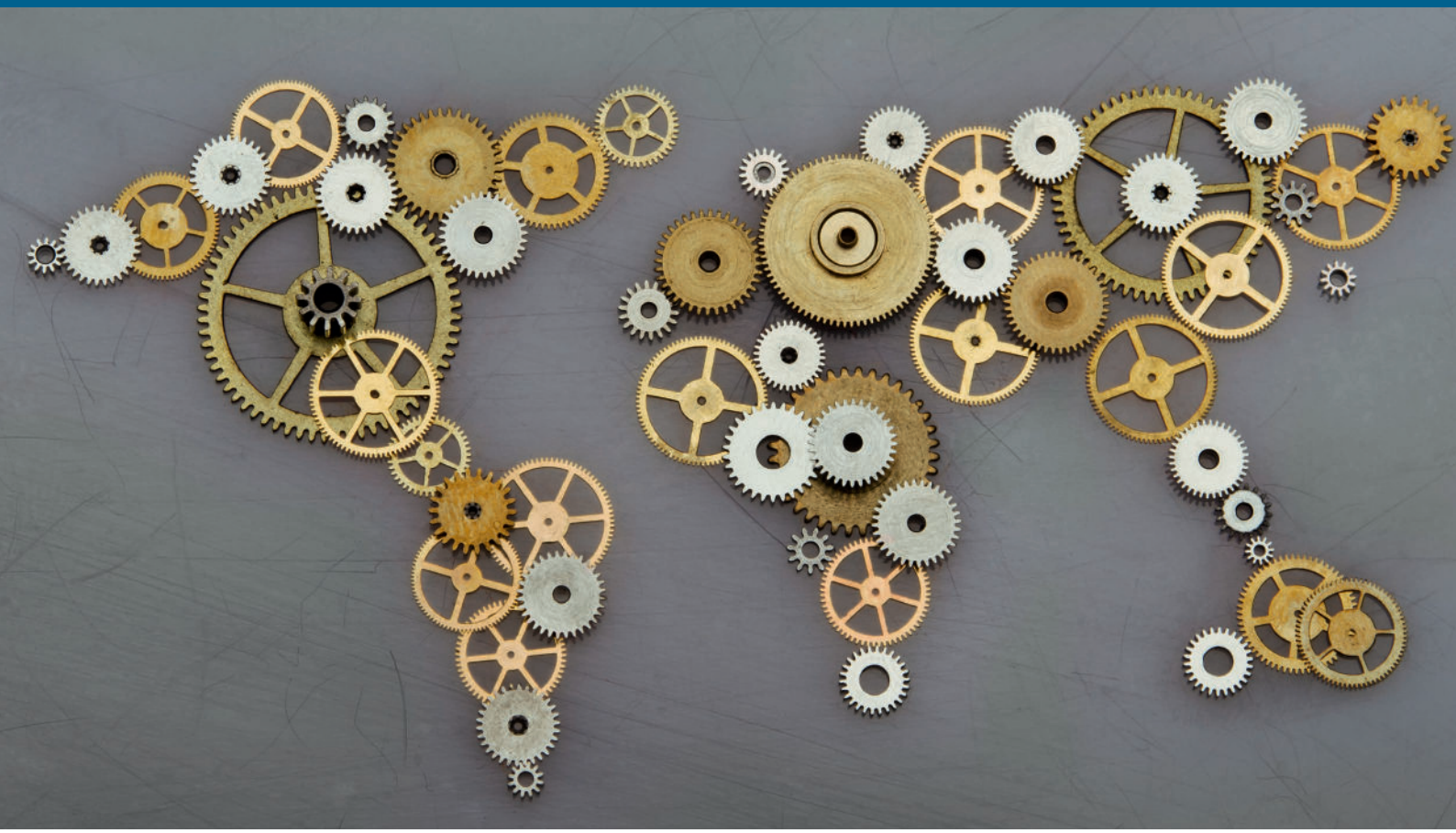
NEWS 1/2019

COMPLEXITY SCIENCE HUB VIENNA



What is not a complex system in this world? © Shutterstock

Dear friends of the Hub!

Earlier this year, three economists started a discussion in the American quarterly *Boston Review*. How should "Economics after Neoliberalism" look like?, they asked. A group of complexity economists contributed with a response called → "Economics needs to embrace a transdisciplinary approach." The scientists—among them our dear friends → Brian Arthur and → Doyne Farmer, both CSH External Faculty—criticize classical economics for falling short in a number of ways.

What is usually called "the economy," they write, is rather "a highly complex, multi-level system that encompasses human biology, human behavior, group behavior, institutions, technologies, and culture, all mutually entangled in networks of nonlinear, dynamic feedback. Each of these levels in the system is subject to learning, adaptation, evolutionary, and co-evolutionary processes which means that the system is constantly changing, self-creating, and never at rest." So forget about equilibria, systems at rest, and all the other concepts macroeconomics is based on. Even forget about economics as a field on its own.

What is needed, the complexity economists argue, is a fast and radical transformation in economic thinking towards a broader approach: towards a transdisciplinary one.

How fruitful such a change of perspectives can be was recently shown in a Hub paper. The CSH researchers applied a concept from classical physics to macroeconomics and found, among other things, that their method substantially outperformed all standard econometric forecasting methods. Shocking economics, indeed! (See page 3).

Adding such new ideas and methods to economics certainly is a core competence at the Hub. But the expertise of our scientists streches far beyond single fields. Complexity science in the form pursued at the Hub is, by its very nature, a discipline that combines, connects and unites ivory tower knowledge. It is lived transdisciplinarity.

This makes it quite suitable for dealing with the challenges that are currently shaking our world, on top of the climate (and let me add: ecosystems) crisis—Brian, Doyne and the other authors call it "the mother-of-all disequilibrium problems" in their aforementioned article.

Verena Ahne, Head of Knowledge Transfer

VISIONS FOR COMPLEXITY

RESEARCH SELECTION

Fashion styles: It's all about protesting

Give our scientists data, and they will find an answer on a century-old debate: Why do new styles develop?

Coffee breaks often trigger new research. When Robert Kreuzbauer, a marketing expert at the University of Surrey, expressed his hunch that new styles are driven by protest, CSH's → Stefan Thurner offered to test this idea with data. "Big Data analytics can be used to come to a better understanding of the many layers of complex dynamics in human society," Stefan is convinced.

The scientists decided to go for musical styles. They derived data on almost 8 million musical albums, starting in the '50s, from Discogs, a crowdsourced online music database. Discogs users provide detailed information on albums, such as artists or instrumentation, and assign each record to one or several of the 422 different musical styles.

A slap in the face

The researchers saw Robert's hypothesis confirmed: Fashion cycles in music were indeed driven by outsider groups. "Outsiders challenge the dominant music style by strongly contrasting the preferences of the current elite," says Stefan, "for instance, by using different instrumentation or new rhythms." The scientists defined elites as social groups with disproportionate access to certain resources; in music, those people who dominate the most popular music style at a given time. Scientifically, such elite competition in the form of opposition is called counter-signaling. In other words: With a new style, music producers try to slap the old one in the face.

Nirvana vs. Queen

The grunge rock of Nirvana, for instance, thumbed its nose at the highly polished stadium rock of the '80s with bands like Queen or Guns N' Roses; punk was a counter-signal to the hugely popular soft rock of the '70s with musicians like Elton John, Simon & Garfunkel or Tina Turner leading the charts. Once the new style is adopted by a sufficiently large number of followers, its representatives become the new elite and the cycle starts from the beginning.

→ *"Fashion and art cycles are driven by counter-dominance signals of elite competition: Quantitative evidence from music styles," appeared in February in the Journal of the Royal Society Interface.*

Punk was a counter-signal to the popular soft rock of the '70s. © Shutterstock

Big gods: a product of complex societies

Big Data analyses suggest that moralizing gods are rather the product than the drivers of social complexity.

Until recently it was impossible to distinguish between cause and effect in social theories and history, as standardized quantitative data from the epochs of world history were missing. To address this problem, → Peter Turchin, a member of the CSH External Faculty, together with Harvey Whitehouse and Pieter François from the University of Oxford, founded *Seshat: Global History Databank* in 2011.

Searching for patterns in Big Data: A new approach to social theories

Seshat is a constantly growing, multidisciplinary, open-access database. To date it has assembled about 300,000 records on social complexity, religious beliefs and practices, as well as other characteristics of 500 past societies. Spanning 10,000 years of human history—beginning with Neolithic Anatolians, in 9600 BCE—, it already is the most comprehensive collection of historical and prehistorical data. *Seshat* will allow all kinds of theories about human history to be tested.

Big god hypothesis revisited

An interdisciplinary team of scientists including Peter Turchin made a start by investigating the role of "big gods" in the rise of complex, large-scale societies. "A debate has been raging for centuries as to why humans, unlike other animals, cooperate in large groups of genetically unrelated individuals," Peter stresses. One prominent theory—the big or moralizing gods hypothesis—assumes that religious beliefs were key. According to this theory, people are more likely to cooperate fairly if they believe in so-called "big gods": moralizing deities who will punish all sorts of misbehavior.

Rituals as social glue

The *Seshat* data strongly contradict this hypothesis. "In almost every world region for which we have data, moralizing gods tended to follow, not precede, increases in social complexity," explains Peter. It seems as if "complex" gods are the product of, not the reason for, the development of complex societies. Even more so, standardized rituals tended to appear hundreds of years before gods who cared about human morality, the study found. Rituals create a collective identity and feelings of belonging so that people behave more cooperatively. The researchers therefore assume that collective identities are more important to facilitate cooperation in societies than religious beliefs.

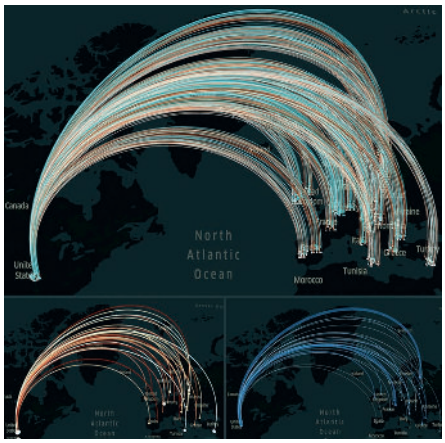
→ *"Complex societies precede moralizing gods throughout world history" was published in March in the journal Nature*

The development of punishing gods seems to be an outcome of growing complexity in social structures, a new study finds. © Shutterstock

Shocking economics!

Hub researchers derived a method from Linear Response Theory (LRT) that allows the prediction of how economies worldwide respond to major disturbances such as the 2008 Great Recession.

→ Our visualization tool will eventually show dependencies of economic sectors throughout the world. © Johannes Sorger



In classical physics, LRT explains, e.g., how electric or magnetic substances react to strong electrical or magnetic fields. "We show that LRT applies just as well to input-output economics," says → Peter Klimek. The new theory complements current economic models in several ways.

First: Calculating resilience
"We can determine the resilience of an economy," Peter explains. Each country has different industries, and depends on various imports and exports. These interdependencies can be seen in easily available data sets. The scientists can calculate how susceptible a country and its different production sectors are to disturbances such as Trump tariffs on EU steel and aluminum.

Second: Modeling outputs
Furthermore they can quantify how much a shock in one corner of the world affects the production of a given sector far across the globe. Modeling responses to shocks helps answer questions like why it took economies so long to recover from the 2008 recession. "A shock does not evaporate," Peter points out. Just like a rock that is thrown into a still pond, shocks produce waves that will run through the whole system, following each of its interdependent connections. The scientists found that it typically takes six to ten years before all sectors of an economy have fully digested a shock.

Third: Testable predictions
Using the input-output data of 56 industrial sectors in 43 OECD countries from the years 2000 to 2014, the scientists then tested the accuracy of different economic projections that were dealing with the aftermaths of 2008. Their method outperformed all standard econometric forecasting methods—most of them substantially. The vision is to eventually be able to calculate global effects of all kinds of shock scenarios that can happen anywhere.

→*"Quantifying economic resilience from input–output susceptibility to improve predictions of economic growth and recovery" appeared in April in the journal Nature Communications*.

Successful first CSH Winter School

27 young scientists from Mexico to Italy, from England and Germany to Austria and France, followed our invitation to Obergurgl, Tyrol, for the first CSH Winter School.

These were five great days indeed! Getting up early admittedly was the hardest part—the morning lectures started at 8 o'clock already. Whew! But the long afternoon breaks made up for this. Time enough for skiing, walking or getting swallowed up by deep snow. Some hungry ones were chasing typical Austrian specialties (Kaiserschmarren! Käsespätzle!), while others got involved in literally hot discussions during extended sauna sessions, before they all came back together for the afternoon lectures.

With mountains and glaciers gleaming outside the window, the young men and women learned about network theory from → Vito Latora (London School of Economics) and microbial terraforming from → Ricard Solé (Universitat Pompeu Fabra in Barcelona). They were introduced to complex biology by Eörs Szathmáry (Eötvös Loránd University, Budapest) and the theory of complex systems by our president, Stefan. → Roberta Sinatra, currently a freelance scientist in Copenhagen, finally introduced them to the science of success.

After the truly delicious dinners, we then had the chance to experience → Constantino Tsalli's humorous "fireside chatting" (without fire though)—thanks, Constantino, for skipping Samba and carnival for that!

Yes, it was intense. But great fun, too.
If you are interested: stay tuned.
→ We'll be back in 2020!

UPCOMING

CSH Workshop
→ ***"Towards a theory of health trajectories from longitudinal data"***
May 23–24, 2019

Patient health is typically characterized by a combination of clinical conditions and diseases. Often these diseases do not occur independently, but in specific temporal patterns. The increasing availability of large-scale observational healthcare data—electronic health records and claims data—triggered increasing interest into the problem of how to mine such data for temporal patterns and how to use this information to build predictive models for disease trajectories. With this workshop, organized by → Peter Klimek (CSH Faculty), the Hub aims to bring together the world's leading researchers working on these questions in order to discuss open problems and recent advances in an informal atmosphere.

CSH-KLI Workshop
→ ***"Sustainability as a problem of complexity: Past, present and future of sustainability science in the anthropocene"***
Sept 12–13, 2019

Popular ideas about sustainability are still largely guided by a techno-scientific ideal of control, even though limits and difficulties of this ideal have been obvious for some time. Often fueled by alarmist scenarios of destruction, the remnants of this ideal threaten to undermine the very notion of sustainability as well as our attempts to initiate and foster transformations towards more desirable and just futures.

Alternatives to a techno-scientific illusion, such as co-evolutionary processes within complex adaptive systems or participatory transdisciplinary conceptions of sustainability, have emerged, but have yet to gain wider acceptance outside of specific academic discourses. This workshop places current ideas about sustainability and related transformations in the context of interlinked histories of techno-science, cybernetics, complex systems theory and sustainability science. Participants will focus on detailed historical analyses of case studies, assessment of current trends and discourses, and the envisioning of future ones. A main focus will be placed on the shifting conceptual frameworks and on the role of modeling strategies, especially complex systems models, for sustainability transformations.

The workshop, organized by → Manfred Laubichler (CSH External Faculty) and Guido Caniglia (scientific director of the Konrad Lorenz Institute) will take place at the KLI.

For a regularly updated list with details on all talks, workshops and events at the Hub, please click:
→ ***www.csh.ac.at/events***

Art at the Hub

Our next vernissage within the → Art at the Hub program, called "The Abstraction of Simplicity," will present photographs by the Italian quantum chemist Roberto Cammi.

Roberto's research activity mainly concerns the development of new theories of the electronic structure of molecules in complex environments. In his art, he reduces the complexity of reality to its basic essence. His exploration of abstraction gives a unified framework to the several photographic techniques he uses.

Roberto has developed a highly personal photographic style, which has been recognized internationally.

Roberto Cammi uses various photographic techniques, ranging from analogue black and white pictures with different camera formats to a Polaroid Land camera. © Roberto Cammi

→ CSH Vernissage, May 23, 2019, 6 pm

PUBLICATIONS

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

J. Korbel, P. Jizba
→ *Maximum Entropy Principle in statistical inference: case for non-Shannonian entropies,* Physical Review Letters 122 (2019)

D. Wolpert
→ *The stochastic thermodynamics of computation,* J. Phys. A: Math. Theor. 52 (2019)

P. Turchin, H. Whitehouse, P. François, P.E. Savage, et al.
→ *Complex societies precede moralizing gods throughout world history,* Nature (2019)

D. Garcia, B. Rimé
→ *Collective emotions and social resilience in the digital traces after a terrorist attack,* Psychological Science March 13 (2019)

J. Fernández, F. Ekaputra, P. Aryan, A. Azzam, E. Kiesling
→ *Privacy-aware Linked Widgets,* In: Privacy-aware Linked Widgets, ACM Press, TDB (2019)

A. Hannak, A. May, J. Wachs
→ *Gender differences in participation and reward on Stack Overflow,* A. Empir Software Eng (2019)

P. Klimek, R. Kreuzbauer, S. Thurner
→ *Fashion and art cycles are driven by counter-dominance signals of elite competition: Quantitative evidence from music styles,* J. R. Soc. Interface Vol 16, Issue 151 (2019)

J. Korbel, R. Hanel, S. Thurner
→ *Information Geometric Duality of ϕ-Deformed Exponential Families,* Entropy 21, 112 (2019)

D. Garcia
→ *Privacy beyond the individual,* Nature Human Behaviour (2019)

B. Tadic
→ *Self-organised criticality and emergent hyperbolic networks: blueprint for complexity in social dynamics,* European Journal of Physics 40 (2019)

K. Wiesner, D. Garcia, et al.
→ *Stability of democracies: a complex systems perspective,* European Journal of Physics Vol. 40, No. 1 (2019))

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