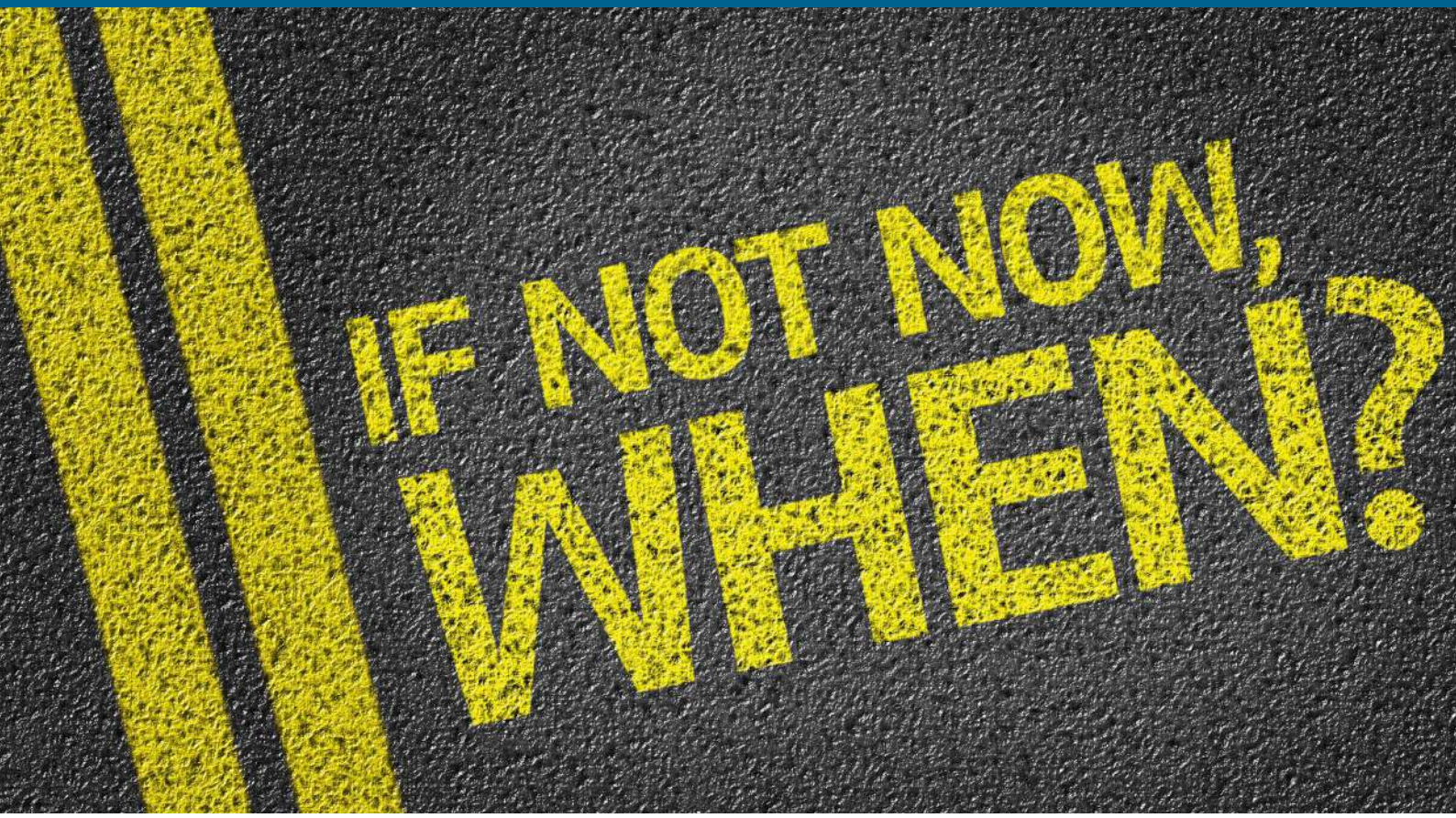
NEWS 3/2018

COMPLEXITY SCIENCE HUB VIENNA



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Dear friends of the Hub!

While I am writing this text, thousands of people in Katowice are ruminating over phrases of an agreement aimed at finally bringing our species to its senses. While this newsletter will be running through the printing press, we will very likely have another declaration reading "*If if if* we don't act *now*, climate change could, maybe, under these and those circumstances, threaten human life on Earth. We still could fight it, *if if if* only ..." and so on.

The tremendous risks of heating up the planet have been known for decades. And even more so after 2018: This year not only produced a true tsunami of scientific papers with unprecedentedly alarming results, predictions and tones of voice. This year's extraordinary heat waves, fires, storms, draughts, floods, landslides, polar ice melting rates, etc., already gave us a first glimpse of what to expect in a not-so-very-distant future—and we haven't even reached the 1.5° C warming yet. We know the risks, but CO_2 emissions nonetheless climbed to an all-time high.

Why? There are certainly many reasons, but here is one more guess. People just do not catch an all-important property of complex systems: their in-built disposition to collapse, and particularly the way they collapse.

For me as a layperson (with a little bit of an insight), this is perhaps *the* message from complexity science: Complex systems keep an equilibrium, withstanding all squeezing and punching, for a surprisingly long time. Their resilience make us believe that we can handle it. But there is this point—a point we'd better not cross. If squeezing and punching proceeds beyond it, the system will eventually—"out of the blue"—abandon its steady state and change. Not in a gentle, linear way: A complex system is by no means like a machine; replacing single parts won't fix the thing. Once it gets started, there is no way to stop the process, nor to interfere with it. Shocks will cascade through the system's networks, destroying parts, rearranging and transforming the whole, and will not stop doing so until the system reaches a new, hitherto unknown equilibrium. This is what complexity people, in my opinion, should unceasingly be telling the world: Crossing the tipping point means "out of control!"

Telling alone is not enough, of course. We are teetering on the very edge of collapse. If our "leaders" fail to lead, we people have to do it. To that end, I call upon you to join me in my New Year's pledge: **In 2019, the *if if if's* have to become an ACT!**

Verena Ahne, Head of Knowledge Transfer

VISIONS FOR COMPLEXITY

RESEARCH SELECTION

Coloring by complex numbers

Art seems to be a singular, subjective matter. Nonetheless complexity scientists dare to approach art, and artists as they are, with the aim of squeezing out more general rules from big numbers.

An couple of papers with Hub affiliation that deal with art appeared in 2018. Two of them were co-authored by Roberta Sinatra (CSH External Faculty).

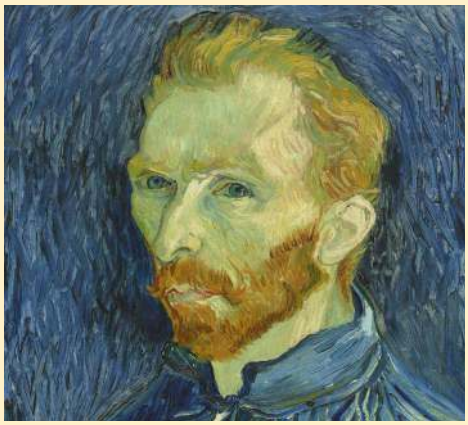
In summer the "Hot streak" paper published in →*Nature* gained a lot of attention, including →great media coverage. The research team worked with a dataset including the CVs of 3,480 artists, 6,233 film directors and 20,040 scientists. "In an earlier article based on these data, we found that there is no point in a career that is especially prone for success," Roberta explains. The most influential work can be the early painting of a young artist as well as her late work. And the encouraging message of that article: It is never too late for success! But are the next-successful works as randomly distributed? "No," Roberta replies. "The second and third best, that is, successful works are much closer in time to the most successful one." For instance Vincent van Gogh painted his most famous pictures, including the sunflowers, within a couple of months. On average, artists are "on a roll" for 5,7 years. This is a time that should be used well, Roberta points out: "Most creative people experience such 'hot streaks' only once in their lives."

Pick the right gallery for success

And the researcher's focus remained in the realm of art: Recently she co-authored a →Science paper that analyzed exhibitions and auction results of half a million artists between the years 1980 and 2016. The team found an old wisdom to be proven: Networking is about everything in art, too. "Artists whose works are exhibited early on in one of the world's top 100 galleries are much more likely to be—and to stay—successful," Roberta says. Bad news for the less fortunate ones: The paper found that it is nearly impossible to enter these elitist circles later in life.

→"Hot streaks in artistic, cultural, and scientific careers" appeared in Nature 559 (2018)
→"Quantifying reputation and success in art" was published in Science (8 Nov 2018)

Vincent van Gogh had his "hot streak" in Arles 1888/89, where he painted his most famous works within several months. © Shutterstock



A book for complex beginners

Stefan Thurner, Rudolf Hanel, Peter Klimek.

Since the turn of the millennium complexity science has been prospering and progressing, not least due to the exponential rise of data gathering devices and thus, data. This leads to a rise in popularity among students too: Their numbers are rising. Student textbooks so far have not kept pace with the growing interest.

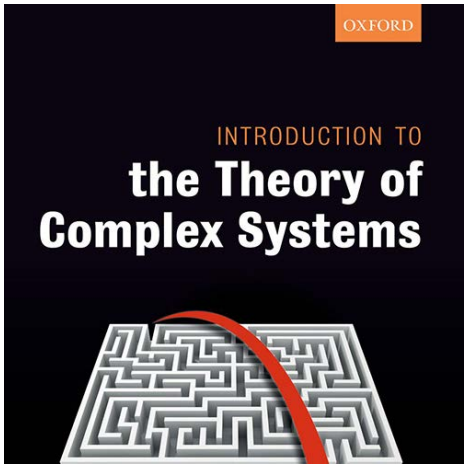
"Although some of them are considered as classics, the existing introductions to complex systems, network theory, agent-based models, and so on, represent 20th century knowledge," CSH president Stefan Thurner found. And he decided to help: In November he published the missing link together with co-authors Rudi Hanel and Peter Klimek. Plainly entitled *Introduction to the Theory of Complex Systems*, their book not only gives an overview of the field. "It also provides the up-to-date mathematical knowledge to deal with data, in particular with complex systems," mentions Peter, pointing out the fact that most young people entering science today will later work as data analysts.

Complex systems work like algorithms

The new *Introduction* is an effort to unify the many loose ends from theories and approaches that were developed (but so far not connected) by a whole generation of complexity scientists. The three CSH researchers propose nothing less than a "coherent framework," as they call it, a simple, comprehensive definition to approach and describe nearly all complex systems: "They work like adaptive, co-evolving algorithms," Rudi explains. With this method, the authors believe, complexity scientists will be able to deal with almost all statistical patterns that have been observed in a multitude of complex systems across domains.

One book for many

The main target group is late undergraduate and graduate students in physics and mathematics. Geoffrey West (CSH External Faculty) recommends it to an even broader audience: "This book will surely become a standard text for anyone who wants to seriously understand complexity, no matter what their background or career stage," the Distinguished Professor at the Santa Fe Institute said after reading it.



Already in reprint: student textbook on complex systems. © Oxford University Press

He might be proven right: The first edition sold out quickly; a reprint is on the way.

→Stefan Thurner, Rudolf Hanel, Peter Klimek: "Introduction to the Theory of Complex Systems", Oxford University Press (2018)

Fingerprinting electoral fraud

Fair and free elections are at the core of democracy. However, a few hundred election observers cannot cover thousands of polling stations. Especially remote areas and smaller towns and villages are rarely monitored and thus prone to all kinds of electoral fraud.

Complexity scientists, headed by CSH's Peter Klimek, introduced a new combination of statistical methods than can help uncover irregularities and relate them to specific forms of malpractice. This includes subtle intimidations, like voting booths without curtains or extensive police presence near polling stations. The "tool kit" further enables an estimate of whether the electoral fraud was strong enough to change the final results of the vote.

"Our method is fast, cheap, and easy to use," explains Peter. "The only input we need is the election results." Usually these lists are provided online within hours after an election. "Our tests show a very specific pattern: the fingerprint of the poll," Peter points out. These fingerprints show places where manipulation can be excluded or hotspots where it occurred with high probability.

Fraudulent polls in Turkey uncovered

In Turkey, for instance, the researchers found several districts with problematic fingerprints right after the constitutional referendum in 2017. Recep Tayyip Erdoğan used the referendum to replace the Turkish parliamentary system with a presidential one. The highly controversial referendum was followed by an equally disputed snap election in June 2018 that installed Erdoğan as president with wide-ranging powers and his AKP as the ruling party in parliament.

Election observation in the digital age

"Unlawful voting throughout the world can be detected, or even prevented, if these methods were systematically utilized for election monitoring," says Peter.

"We offer a simple and cheap method as an ideal extension to the common election observation," co-author Stefan Thurner adds. "Organizations like the OSCE are invited to catch up with the digital age and use the new tools of the 21st century."

→Forensic analysis of Turkish elections in 2017–2018" was published in PLoS ONE *13(10) (2018).*

Hub: Life at work

No doubt, we are all very hard-working people, not only—but especially—our scientists, who are discussing and thinking and calculating and modeling and meeting and thinking and discussing again from morning to night, day in, day out... well, at least most of the time...

An important part of Hub life is those little in-betweens that should make Hub days into (even) nicer days.

In fall, →Huda, an art student from Syria, was hired to prepare the teatime as a daily Meet'n'Relax with snacks, tea, juice and coffee at 4 pm. When a new paper is out (or somebody is up to celebrating a birthday), we might even open a bottle of sparkling wine for the crowd. In summer we did just that to celebrate the habilitation of our Faculty member →Peter Klimek.

From time to time there are Hub newbies to be welcomed. In 2018, six people started working as resident scientists at the Hub:

→Markus Strauss
→Carlos Molinero
→Niklas Reisz
→Simon Schweighofer
→Aniko Hannak
→Rahim Entezari

Some of them already joined our devoted tabletop soccer team: The guys (quite a gender imbalance there! Country-wisethe Italians are at the forefront...) regularly meet in the kitchen to engage in their favorite after-lunch activity. It can get quite noisy...

Always enriching are the times we spend with our visitors. →Laura, our invaluable organizational mastermind, counted them and came up with the incredible number of 165 scientific Hub visits in 2018. Wow!

What we had planned, but definitely missed this year was a big garden barbecue. Probably the heatwave stopped us. But next summer will surely come.

Last but not least, we welcome(d) the Danube University Krems as our 7th member!

It has been a busy and inspiring year indeed. Thanks to everyone.

The new resident scientists at the Hub: Markus, Carlos, Niklas, Simon, Aniko, Rahim.

We wish you

Happy holidays and a good, successful, promising New Year!

HUBLIFE

UPCOMING

We are already busy organizing the many events planned to take place at the Hub in 2019.

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

CSH Workshop
→***"Current challenges in nonlinear regulatory system dynamics & evolution"***
February 21–22, 2019

This workshop, organized by Rudolf Hanel, intends to advance questions about the interplay of structure, dynamics and the evolution of non-linear regulatory systems. Such systems are keys to understanding a wide field of phenomena, from the dynamics of cellular organisms on a molecular level up to entire societies or ecosystems. "We will discuss questions concerning dynamic stability as an evolutionary potential at the systemic level, the dynamical implications of compartmentalization, problems relating to data and inference, characterizing 'attractor landscapes,' or the controllability and reversibility of attractor deformations under controlled parameters," Rudi explains. The aim of the workshop is to formulate a list of tasks and concrete plans on how to prioritize and distribute efforts into tackling top-scoring common interests.

CSH Vienna →Winter School
March 3–8, 2019

The first Complexity Science Hub Vienna Winter School offers an intensive week of morning and afternoon classes, afternoon skiing and evening fireside chats with internationally renowned complexity scientists in Obergurgl in the beautiful Austrian Alps. This year's winter school will host lecturers such as Brian W. Arthur, Roberta Sinatra, Vito Latora, Eörs Szathmáry, Ricard Solé and Stefan Thurner. Courses will include topics concerning Evolution & Ecosystems, Physics of Complex Networks, Science of Success, Network Science and many more. We are looking forward to lively discussions!

CSH Workshop
→***"Information-theoretic Methods for Complexity Science"***
April 29–May 1, 2019

This workshop, organized by Jan Korbel, Stefan Thurner and Petr Jizba aims to discuss the question of how and to what extent methods from information theory and (non-equilibrium) statistical physics can boost the understanding of complex dynamical multilevel systems. The idea is to fathom the limits of usefulness of thermodynamics for complex systems, and discuss if there are fundamental limits to a statistical theory of complex systems.

Art at the Hub

Our next vernissage in the scope of our →*Art at the Hub program* will present paintings and objects by the Vienna-based artist Wendelin Pressl.

Wendelin studied at the Master Class for Painting, Graz, as well as the Academy of Fine Arts in Vienna.

His works read like experimental arrangements. He aims to disassemble reality into individual particles in order to reassemble them in his own individual, intelligently humorous way, to associatively combine them and thereby generate reinterpretations and new meanings. Thinking along with the viewers as the essential "users" is always part of the concept.

"Planetomat" (Detail), 2016. © Wendelin Pressl

→CSH Vernissage, February 21, 2019, 6 pm

PUBLICATIONS

This is a selection of publications affiliated to the Hub.

Check out for more at
→***www.csh.ac.at/publications***

S. Thurner, R. Hanel, P. Klimek
→Introduction to the Theory of Complex Systems. Oxford University Press (2018)

T. Niederkrotenthaler, B. Tilla, D. Garcia
→*Celebrity suicide on Twitter: Activity, content and network analysis related to the death of Swedish DJ Tim Bergling alias Avicii,* Journal of Affective Disorders (2018)

P. Klimek, R. Jimenez, M. Hidalgo, A. Hinteregger, S. Thurner
→*Forensic analysis of Turkish elections in 2017–2018,* PLoS ONE 13(10) (2018) e0204975

S.P. Fraiberger, R. Sinatra, M. Resch, C. Riedl, A.-L. Barabási
→*Quantifying reputation and success in art,* Science 8 Nov (2018) eaau7224

M. Szell, Y. Ma, R. Sinatra
→*A Nobel opportunity for interdisciplinarity,* Nature Physics 14 (2018) 1075–78

M. Perc, V. Capraro
→*Grand Challenges in Social Physics: In Pursuit of Moral Behavior,* Front. Phys. (2018)

J.-P. Aguilar, C. Coste, J. Korbel
→*Series representation of the pricing formula for the European option driven by space-time fractional diffusion,* Fractional Calculus and Applied Analysis, Vol. 21 (2018) 981–1004

S. Poledna, A. Hinteregger, S. Thurner
→*Identifying Systemically Important Companies by Using the Credit Network of an Entire Nation,* Entropy 20 (2018) 792

A. Polleres, M. Kamdar, J. Fernandez, T. Tudorache, M. Musen
→*A more decentralized vision for linked data,* DeSemWeb@ISWC (2018)

O. Saukh
→*Capturing Inhalation Efficiency with Acoustic Sensors in Mobile Phones,* Proceedings of the 7th International Workshop on Real-World Embedded Wireless Systems and Networks (2018) 19–24

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