CSH Internship Program

Call for Interns 2022

The Complexity Science Hub Vienna is offering five intern positions for a duration of six to eight weeks in Vienna. Conditional on the pandemic situation, the internship is planned to be on-site.

This year's program is starting on June 27, 2022.

Application deadline: April 20, 2022

Successful candidates will be informed by the first week of May.

Who we are

The Complexity Science Hub is a young research institution dedicated to a deeper quantitative and predictive understanding of complex systems for the betterment of society. We provide an exciting, creative, bureaucracy-free environment for open-minded visionaries who want to make a change and are brave enough to step out of mainstream science.

What we offer

Five internship topics proposed by CSH researchers who will supervise the intern working on the project. Applicants can indicate their preferred topic when filling in the application form. Please have a look at a detailed description of the projects below.

We will organize a joint welcome week for all 2022 interns. The aim of this week is to offer you some introduction to Complexity Science through lectures and guided readings. There will be time to get to know your supervisor and other interns through social activities and a reception dinner.

Interns are welcome to participate in all CSH events that are organized during their stay. This refers especially to our Friday seminars series. At the end of your stay, you will have the opportunity to give a final presentation on your results.

The objective of the internship is to give you the opportunity to be part of an excellent research group, experience hands-on academic work and contribute to the group's current agenda. You will learn about complexity science, the structures of an international research institute and have a chance to explore Vienna.

How to apply

Please fill in our internship application form. You can find this form here: CSH Internship Application Form

You will need to upload your CV and a letter of motivation in the form. In this letter, please tell us more about your interest in complexity science, your research vision and goals.

We processes your personal data in accordance with the law (www.csh.ac.at/data-protection/).

Eligibility

Students of all levels are eligible to apply. The program is mainly aimed at students of quantitative disciplines such as science, technology, engineering and mathematics (STEM), economics, finance or related fields. However, we encourage all students with an interest in complexity science to apply.

Funding

Unfortunately, there is no funding available for the internship program. Of course we will support you in obtaining your own funding, for instance through the Erasmus+ program.

Projects

Project 1: Complexity Economics and the Green Transition

Complexity Economics offers new insights by interpreting the economy as a complex system. Recent research suggests that how well economic agents, such as banks, firms or even countries, perform is to a large extent determined by the structure of the networks in which they are embedded. These networks include supply chains that record different types of bilateral business ties between companies or networks of monetary flows between financial institutions. Economic and financial crises can then be understood by means of dynamically cascading non-equilibrium processes on such networks. Based on the students skillset and prior knowledge we will define a research question in relation to our groups current agenda. This year's focus will lie on the role of production networks in the green transition. Potential research questions explore leverage points to reduce carbon emissions or the restructuring of the production network in response to the green transition. We offer a position for students with a background and research interests in finance, network science, physics, mathematics, economics or related fields. Our research is requires strong analytical skills and programming in Python, R or Matlab.

Prerequisites:

- Basic courses in mathematics
- Programming and (big) data analysis is welcome

Advisors: Johannes Stangl, Tobias Reisch, Maria del Rio Chanona, Anton Pichler

Project 2: Using Text Analysis to Understand the Evolution of the Labor Market and the Future of Work

New technologies, pandemic restrictions, and climate policies change the nature of work and the skills employers demand from workers. To design policies that can help workers adapt to the changes in the labor market, we must understand how work has changed so far and predict which new skills and work activities will be highly demanded. In this project, we will investigate how work has evolved and predict future trends using Natural Language Processing techniques.

Our focus of study will be the Wikipedia pages of the occupations in the Standard Occupational Classification system. Wikipedia pages have two important advantages. First, most pages have a lengthy description that includes the history and the work performed in each occupation. Second, Wikipedia records all page edits, the text changed, and the dates. These edit records will allow us to analyze the evolution of each occupation in time. For example, we will track which occupations are increasing in interest (i.e., have more recent edits). We can also study changes in work description and compare among popular occupations. We will use this analysis to forecast occupation growth. We will test our method by using employment growth data and check whether we could have predicted occupational growth using only Wikipedia pages information available at the time.

Advisor: Maria del Rio Chanona

Project 3: Complexity in Open Source Software Ecosystems

Open Source Software (OSS) becomes more and more omnipresent, while staying hidden: almost every application on your phone relies on OSS through package dependencies, as well as most of the webpages you visit, or Linux running on some of the most important servers. However, the development of OSS usually involves many developers contributing to many projects, that depend on each other. The structure of these networks can create hidden vulnerabilities: it has happened in the past that the sudden failure of apparently tiny projects lead to a large part of the internet being down for hours; not even mentioning the impact of security vulnerabilities. These networks can be partly retrieved through data mining from github and gitlab, especially well when focusing on ecosystems of reasonable size (e.g. all packages of a given programming language). Our research focuses on defining the relevant measures to describe the system, and analyzing the impact of specific critical events in the past. An adapted research question will be defined depending on our on-going projects and the specific skillset of the student. We offer a position for students with a background and research interests in software engineering, network science, physics, mathematics, economics or other fields.

Prerequisites:

- analytical skills
- programming in Python
- prior knowledge of SQL and git is a plus

Advisor: William Schueller

Project 4: Dynamics of Innovation and Obsolescence

Innovation and obsolescence describes dynamics of ever-churning and adapting social and biological systems from the development of economic markets and scientific progress to biological evolution. The shared aspect of the picture is that agents destroy and extend the "idea lattice" in which they live, finding new possibilities and rendering old solutions irrelevant. In previous work, we developed a simple model to study the central relationship between the rates at which replicating agents discover new ideas and at which old ideas are rendered obsolete. When these rates are equal, the space of the possible (e.g. ideas, markets, technologies, mutations) remains finite. A positive or negative difference distinguishes flourishing, ever-expanding idea lattices from Schumpeterian dystopias in which obsolescence causes the system to collapse.

We propose to extend on previous work with a more sophisticated agent-based simulation for biological agents and/or firms. This project will involve intensive computation, numerical calculations, and data exploration. The ideal student will be fascinated by this research question, be a knowledgeable programmer in Python and hopefully C++, and be motivated to achieve a tangible research outcome by the end of the internship.

Advisors: Eddie Lee

Project 5: Causality inference

Complex dynamical systems are composed of subsystems (with given properties) interacting between each other and surrounding environment in generally non-linear way. These interactions bring to the whole system new properties, absent in composing parts. One of the fundamental aspects in understanding this phenomenon is determining inner causality relations, i.e. directional information flows between subsystems. Rényi transfer entropy is an information-theoretic functional measuring information transfer between bivariate time series. Due to many appealing properties, as equivalence to generalized dimensions, additivity and ability to emphasize or suppress particular parts of probability distributions, Rényi entropy and its derivative Rényi transfer entropy (RTE) are good candidates to quantitatively characterise complex dynamical systems that are multi-scale and/or non-

Gaussian, typically with heavy-tailed distributions, and thus detect information flows inside or between them.

Based on the students skillset and prior knowledge we will define a research question. Main focus will be on detecting causal information flows in dummy datasets with possible application on real data, e.g. from stock markets. We offer a position for students with a background and research interests in finance, network science, physics, mathematics, economics or fields. Our research requires strong analytical skills and programming in Python, R or Matlab.

Prerequisites:

- Basic courses in mathematics
- Programming and (big) data analysis is welcome

Advisor: Zlata Tabachová