Chapter 27
Peek Over the Fence—How to Introduce Students to Computational Social Sciences

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Abstract The aim of the paper is to present an idea on how to introduce students of social sciences to computational approach. We discuss why there is a need to develop computational education in the social sciences and why it is a challenge. We consider barriers related to students and to academic teachers. Then we present the idea on how to help overcome those barriers. Within the project Action for Computational Thinking in Social Sciences we plan to set up a MOOC program on social computation at an introductory level. The program is addressed to learners of social sciences (mostly bachelor level) who often experience high levels of anxiety when it comes to mathematics, computers and formal modeling and have no working knowledge of advanced algebra, mathematical analysis, programming etc., but it is open for larger audience. We aim at providing them with a series of short introductory courses that will give them an opportunity to peek over this fence built of fears, stereotypes and lack of practice. We want to show the learners that computational approach to social sciences is, first, worthwhile, as it provides a new angle to look at societal phenomena and, second, accessible, if only approached from the story side rather than from the mathematical formulas side. We hope this will encourage the learners to engage in more demanding courses or, at minimum, approach the computational social sciences with a better general understanding.

Keywords Computational social science · Education · Sociology of education · Massive open on-line courses

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Demand for Computational Social Scientists

In the current digital era, with an increasingly complex and turbulent society, demand is rising for social scientists capable of analysing behavioural dynamics[1]. Studying behavioural dynamics is a valuable lens, both in public policy making and community planning, as in scientific projects on how human (economical) behaviour affects ecosystems. Computational Social Science (CSS) offers a framework that connects a complex networked systems perspective with a suite of computational tools and methodologies. CSS covers collecting, processing and visualising large data sets and simulating the dynamics of behaviour, ranging from processes within the individual to society at large. It provides an interdisciplinary approach to the social sciences [3] and allows for a more precise testing of behavioural mechanisms in a dynamic setting [15]. Thus it offers tools to address the current problems in the social sciences regarding lack of replication, artificial and non-representative laboratory settings, and the fundamental limitations of statistical analysis [12]. Furthermore it allows linking to other formal models, such as ecological and economical models. This contributes to bringing social scientific knowledge into projects addressing multidisciplinary challenges, such as adaptation to climate change, opinion dynamics, transitions in energy use and food consumption, and the adaptive capacity of societies dealing with migration (see e.g. [7]). Computer simulations of artificial societies are increasingly being used as a tool to systematically explore the complex behavioural dynamics in social systems [6, 14].

Despite its potential and fast growth, CSS is still hardly found in programs at bachelor and master levels in Europe, be it social psychology, cognitive psychology or sociology. Hence most students are not aware of developments in modelling societal dynamics, automated information extraction (big data) and modelling the complexity of individual behaviour and cognition. It seems that in the current educational landscape there is still a lot to do in order to meet the increasing demand for computational social scientists. Integrating CSS tools into the curricula would help to enhance problem-solving capacities of social scientists, but also offer the necessary approaches in dealing with new kinds of data that are available and relevant for analysing behavioural dynamics (e.g.automatically extracted data that allow us to observe individual behaviour, as well as interactions on a large scale of extended periods of time [17]).

Barriers for CSS Education

Unfortunately, it seems that CSS teaching has not developed the muscle that we had hoped for. In a survey among 4026 teachers of methods and/or statistics in social sciences (31% of which cover big data analytics or data science methods in

[1]The first part of the paper is based on a conference paper: Jager et al."Looking into the educational mirror: why computation is hardly being taught in the social sciences, and what to do about it" [8].

their courses) the level of programming and statistical knowledge that the students possess was indicated as the biggest problem [9]. A key question we face is: why is CSS—despite its relevance—not being widely taught in social scientific educational programs, at least on an introductory level. Two main reasons we identify are: (1) students feeling uncomfortable with more computational approaches, and (2) teaching staff having only limited experience and resources to teach CSS, and limited support from managing boards.

Concerning the student perspective, many students of social sciences do not feel capable enough to study subjects which require competences in mathematics and/or ICT. In a typical social studies curriculum students attend obligatory courses in statistics and quantitative methods. These are usually perceived as difficult and computational social science is often associated with bad experiences with those courses. This problem is described in the literature as “mathematics and statistics anxiety” [1, 11, 18]. Several studies about social sciences students show a high prevalence of statistics anxiety among them (75–80%). This has an impact on students’ subsequent educational and professional paths (e.g. [18]). Considering that CSS relies on programming skills, it is obvious that this anxiety for computing may constitute a first barrier to address.

This problem is related to gender composition of population of social sciences students. Girls are often conditioned from an early childhood to doubt their STEM-related abilities (Science, Technology, Engineering, and Math). As a consequence, perceived self-efficacy in advanced ICT and mathematical skills for girls is significantly lower than for boys [5]. At the same time in all the European countries a student of social sciences is typically a woman. Differences in gender shares of men and women in this group reach even 23 pp. [4]. It is a manifestation of disciplinary segregation, which creates an impression that STEM and Social Sciences, Humanities and Arts (SSHA) are mutually exclusive and contributes to underrepresentation of women in STEM disciplines [2]. At later stages of education this restricts educational options for young women.

A second barrier resides in the fact that within social sciences faculties only few—often junior—scientists are familiar with CSS, and if they are familiar, this does not always translate into CSS education. One reason is pretty simple and it is the division into two almost separate worlds of researchers: using qualitative and quantitative methods, which does not occur in case of STEM disciplines. Therefore, some researchers do not use quantitative methods and are not familiar with CSS methods. More importantly, traditional social science is relying very much on statistics, whereas CSS is focussing more on dynamics of behaviour. Because it is very difficult to translate for example regression equations into agent rules, discussion on a theoretical level is often avoided.

Summarising, to stimulate CSS teaching at social scientific faculties, we need to address computational anxiety in students, and support teaching staff with an easily available high quality material tailored to the needs of students of social sciences.

How to Change That—Action for Computational Thinking in Social Sciences

To help the social scientific community in absorbing the CSS approach, it would be good to offer educational material that supports students in getting an accessible introduction into CSS. This material could be studied independently, but preferably local learning communities emerge around this educational material, especially when exercises address programming issues. Especially here peer support is important, and universities could support such learning communities by allocating support staff.

It is worth noting that much material is already freely available on the web, facilitating the organisation of learning communities. For example, within Netlogo [16] a rich library of exemplary models is available, organised along different scientific disciplines, including the social sciences. Netlogo offers a number of standard models that are inviting to play with, which naturally raise an interest in the computations in the model and its dynamic outcomes. The CoMSES computational library (www.comses.net/codebases) offers a growing collection of executable models that have been used in published research. Many videos can be found on the web explaining computational methods and platforms. To connect with this material, Massive Open Online Course (MOOC) modules can be developed addressing different theoretical concepts, applied cases, methodology and tools. We aim at creating such a modular MOOC within the project "Action for Computational Thinking in Social Sciences" (ACTISS), co-funded by the Erasmus + Programme of the European Union.

For this endeavour to be successful several conditions should be met. As it was already stated it is crucial that the program is tailored to the needs of students of social sciences (mostly bachelor level) who often experience high levels of anxiety when it comes to mathematics, computers and formal modeling and have no working knowledge of advanced algebra, mathematical analysis, programming etc. We aim at providing them with a series of short introductory courses that will give them an opportunity to *peek over this fence* built of fears, stereotypes and lack of practice. The concept of peeking over the fence relies on two principles: the educational materials have to be accessible (to help get 'through the fence') and they have to be relevant (to make it worthwhile).

So, first, in order to help social sciences students beginning their education overcome the barriers all the educational materials should not require prior knowledge of advanced maths and programming. E.g. with NetLogo models learners can investigate interesting social mechanisms illustrated by Agent-Based Models in an almost "game-like" manner which will be engaging and informative both for students with and without prior knowledge of mathematics and programming (students with more advanced skills can engage in more advanced tasks and modify the code while those without them may experiment with a ready ABM). Secondly, educational materials should rely on examples that are relevant for social problems. We should give students the opportunity to get a better understanding of future applicability of computational models in different professional fields. By presenting them real-world cases from public policy, marketing, economy, finances or others, where computational models are being used to analyse or improve problem-solving capacities in general, a MOOC can inspire students to deepen their knowledge in CSS.

In addition, in order to make the learning experience more accessible and easier to combine with other educational activities, we propose that the program is structured in a modular way (one basic introductory course and 4 thematic courses independent of each other, meaning that a student should be able to choose any of them and skip others without any problems with following the material). Within each module the same principles as stated above should hold: we want to show the learners that computational approach to social sciences is, first, worthwhile, as it provides a new angle to look at societal phenomena and, second, accessible, if only approached from the story side rather than from the mathematical formulas side. In order to achieve those goals we want each module to have a similar structure:

- Start with a real-life example that is important to nowadays society and build an intuitive understanding of the dynamics of the phenomena
- Introduce very simple models, starting with those that can be done with pen and paper and slowly enriching them with details
- Show, without going too much into details, some advanced models that can be used to understand the real-life phenomena introduced in the beginning (in order to show how specific models or tools can be applied to study real-life problems and encourage learners to pursue the path of computational social sciences e.g. by taking more advanced courses).

Offering a basic introduction to CSS in a comprehensive MOOC for students could be the first step of a broader strategy leading to an increased use of computational thinking in social sciences. By gaining the first experience in CSS and realising the benefits for own research and studies, as well as by identifying the potential to provide enhanced problem-solving capacities and the connectivity to real-world problems, social science students might develop a greater interest in acquiring CSS skills in the future. In other words, we hope this will encourage the learners to engage in more demanding courses or, at minimum, approach the computational social sciences with a better general understanding.

As far as the format is concerned, MOOC seems promising for a couple of reasons: in a modular MOOC we can bring together videos with basic explanation of a phenomena, papers with the full details, models to exercise with, and a worked out learning paths to build up and test students' knowledge and experience. This opens up the possibility for students to follow more individual learning lines. At the same time, for teaching staff it becomes easier to organise various courses when such educational materials are available. MOOCs in particular fit well in new educational formats such as community learning and flipping the classroom. Working in small groups on exercises, watching and discussing the videos on social phenomena, and studying and reflecting on papers contributes to a vivid learning environment where students help each other in mastering the computational skills. This is also an educational format that is well defined and that can reach large audiences—e.g. on Futurelearn platform, dedicated for such courses, an average MOOC has appr. 5 thousand participants in one edition and it is possible to have multiple reruns of such courses. In future, we may see even more possibilities to make our work accessible for various types of learners. Perhaps we could develop exciting computational challenges for high school projects, or even primary education. And hopefully they may witness CSS reaching a scientific adulthood.

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