Summer School: Open Science

"The wrong view of science betrays itself in the craving to be right;
for it is not his possession of knowledge, of irrefutable truth
that makes the man of science, but his persistent
and recklessly critical quest for truth."

—Karl Popper (1959)

Course Description:

The ultimate goal of scientific research is to accumulate knowledge. Researchers generate hypotheses and collect data in order to investigate whether or not empirical observations are consistent with these hypotheses. However, even though science aspires toward accuracy in this process, errors are inevitable (e.g., Simmons et al., 2011). A fundamental characteristic that sets empirical science apart from other sources of knowledge is the ability to self-correct; any empirical observation is subject to validation and may be shown to be wrong (Merton, 1973; Ioannidis, 2012). The reproducibility of empirical results constitutes a cornerstone of the scientific method. But as a consequence of accumulative evidence emphasizing low levels of replicability, there is increasing concern that a considerable fraction—or even a majority—of published research claims might be simply false (Ioannidis, 2005). The drivers of this "credibility crisis" are just as manifold as the institutions (researchers, universities, funding agencies, journals, etc.) involved in the academic enterprise: the file drawer effect (Rosenthal, 1979), insufficient statistical power (e.g., Ioannidis et al., 2017), publication bias (e.g., Franko et al. 2014), confirmation bias (Sterling et al., 1995), dodgy incentives in the publication process (e.g., Nosek et al., 2012), p-hacking (e.g., Simmons et al., 2011), etc. This course aims to provide a critical view on the "rules of a game named science" and provides an introduction to remedies to the manifold issues jeopardizing the credibility of scientific results: power calculations, confirmatory research (pre-registration), and open and transparent research practices (see, e.g., Wagenmakers et al., 2012; Miguel et al., 2014; Munafo et al., 2017).

Learning outcomes

Upon successful completion of the summer school, students are expected to: *(i)* understand why and how common (mal)practices in scholarly research translate into low levels of replicability and low reliability; *(ii)* understand the virtue of confirmatory research and transparent research practices regarding the credibility of research findings; *(iii)* establish a thorough understanding of the statistical concepts related to hypothesis testing (error rates, significance, power, etc.); *(iv)* be able to undertake a priori power calculations and sensitivity analysis, and to devise pre-analysis plans for research projects; and *(v)* be able to critically assess scientific projects and results with respect to malpractices, research integrity, and ethical aspects.

Course Structure:

The summer school will span four days (on the fifth day, you are invited to participate in "replication games;" see below for details). Each day of the summer school will feature a three-hour session in the morning and a four-hour session in the afternoon. The sessions will involve lectures, hands-on exercises, and group discussions. The learning outcomes of the lecture part (AG) will be assessed based on course participation (i.e., contribution to discussions) and a final exam administered on Thursday, July 4, 2024. The (optional) seminar part (UE) will involve an individual homework assignment (to be handed in by September 30, 2024). Successful completion of each part will be recognized with 2.5 ECTS points.

Replication Games: A Collaborative Research Initiative

This year's edition of the summer school will feature "replication games" on Friday, July 5, 2024, hosted in cooperation with Abel Brodeur and the Institute for Replication (I4R). Summer school participants (from any field in the social sciences, holding at least a master's degree) are very welcome (or, rather, encouraged) to participate in the games, which can be thought of as a hands-on application of topics covered in the summer school. Participation in the games entitles being granted co-authorship to a meta-scientific article combining a large number of replications. Please refer to www.i4replication.org for a comprehensive description of the "games" and to Brodeur et al.'s comment in *Nature* for a general motivation.

(Tentative) Schedule:

Mon., 2023-07-01	09:00–12:00	welcome, introduction, a crisis of confidence, modes of "reproducibility", roadblocks to credibility
Mon., 2023-07-01	13:00–17:00	scientific (behavioral) norms and practices, a dysfunctional research culture, incentives
Tue., 2023-07-02	09:00–12:00	statistical inference (p-values, power, etc.), error control in null hypothesis significance testing
Tue., 2023-07-02	13:00–17:00	power failure (false negative rate, false discovery rate, exaggeration of effect size estimates, etc.)
Wed., 2023-07-03	09:00–12:00	questionable research practices (publication bias, p-hacking, multiple testing, HARKing, etc.)
Wed., 2023-07-03	13:00–17:00	targeting threats to credibility, preregistration, registered reports, integrating open science
Thu., 2023-07-04	09:00–12:00	research data management, open data, open materials, transparency, reporting guidelines
Thu., 2023-07-04	13:00–17:00	wrap-up, concluding remarks, final exam, course evaluation, closing ceremony (with food and drinks)
Fri., 2023-07-05	09:00–17:00	**replication games (voluntary; see info above)**